

TUSsock GRASSLANDS AND MOUNTAIN LANDS INSTITUTE REVIEW



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December, 1974	Editor—J. Runga

Our cover illustration, drawn by Pat Prendergast, depicts the destruction of surrounding flora with extraction logging. On page 4 Dr G. T. Daly presents a personal view on indigenous forestry use.

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Forehead Lines

FIRE!

Kevin O'Connor

A few years ago burning of tussock country was the hottest topic going. Now it is more likely to be Fire in the hill and high country. What is the difference? A forester once put it: A burn is a fire that won't start and a fire is a burn you can't put out! Vegetation fires have become every one's business.

Residents of hill suburbs in Christchurch are beginning to understand the fears of a tussock country farmer for safety of life and possessions in the face of fire. On Monday 6 January "The Press" of Christchurch carried no news on its front page except eight fire stories, from Auckland, Johnsonville, Lewis Pass, Bexley, Nelson, Weka Pass, Banks Peninsula and the Tararuas. Even a cigarette advertisement did not seem out of place in this incendiary special. The accumulation of ungrazed grass and shrub on the Port Hills in the long hot dry days that followed a wet spring put Christchurch hill-dwellers in mind of the third fierce fire of two summers ago when four or five dwellings were destroyed before firefighters could get water reeled out to them. Now there was threat of a firemen's strike in Christchurch. Notices to clear and remove fire hazards had been issued. Contractors had inspected properties, shaking their heads: "You will have to do it by hand. I can't get my machine on to that slope." "But whose hand?" asked the residents. "To slash I am not accustomed. To pay I am not able!" It has been remarkable to witness the return of the grazing animal to the hills of suburban Christchurch, sheep, goats and cattle, often behind temporary fences, nibbling their way towards the social security of people who had become

accustomed to think of animals only as pets or as a source of overseas exchange for the nation at large. Perhaps it is as well that grazing animals seemed to provide some social security for it has seemed this last summer that neither sheep nor beef cattle would provide much prosperity for their farming owners.

The fire potential of the New Zealand hill country this summer has been immense. We can thank the New Zealand Forest Service, County authorities, Catchment Boards, newspapers, radio stations and farmers and other citizens themselves that loss and damage have been contained so well. The thorough and far reaching discussions of the Combined Fire Committees under the chairmanship of Mr A. L. Poole appointed in 1972 after the Mt White fire led to recommendations to the Minister of Forests for improvements in rural fire prevention and control. Most weight was given to the broad question of fire prevention including the matters of co-operation among fire authorities and improved uniformity of standards and practices of Catchment authorities in fire prevention and burning control activities, fire breaks, publicity and training. The other broad questions covered in the recommendations included fire fighting equipment and communications, fire detection including fire hazard monitoring, fire suppression itself and the rehabilitation of burned vegetation.

Fire prevention itself is acknowledged to be an increasingly complex business. Increased fuel because of reduced grazing pressures by rabbits and domestic livestock, improved access for and higher mobility of recreational visitors, increase in scrubby vegetation all have contributed to a heightened fire potential. The burning permit systems operated through the catchment authorities have among their other functions served to reduce the risk of wildfire from this heightened fire potential. Public education must have contributed significantly to the lowering of actual risk in that perhaps a higher proportion of high country users are no longer habitual or occasional fire lighters. How much this education has in fact succeeded is impossible to measure. From an

appendix to the Combined Fire Committee's main report compiled from reports from catchment authorities and N.Z.F.S. conservancies, it is evident that there have been about forty significant accidental or unauthorised fires in the South Island high country during the last ten or a dozen years. Recreational use has apparently been a significant factor among the causes. So too have been other forms of non-pastoral use. The number and area of permits to burn pastoral land have declined substantially over the last decade or more and the area in fact burned is considerably less than that annually approved. Escaped permit fires are not numerous and are not represented as a currently serious problem.

This appendix report noted that there is some indication of an increase in the occurrence of escaped and unauthorised fires over the last two or three years (to November 1972). It was suggested that "this may be due to an increasing hazard, short term seasonal conditions, increasing tourist traffic in hazard areas or merely an increased awareness and notification of fires in the hill and high country areas".

Unquestionably, there has been an increase in the fire potential because of an increase in unconsumed and undecomposed vegetation in many areas and its conversion to potential fuel. This increase in fuel has not been quantified in the hill and high country in New Zealand. Nor has the increased frequency been measured of potential fire starters. The Combined Fire Committees agreed that catchment authorities and the New Zealand Forest Service be asked to co-operate in setting up an extension of the fire hazard and drought index monitoring systems for inland hill and high country areas. The simple readings with relatively cheap equipment which could be carried out by Post Offices, meteorological observers or other potential co-operators would be a start. We may well have to learn to manage land and vegetation much more effectively to reduce its fuel value or to reduce the likelihood of fire igniting or spreading out of control. Our methods and practices up to now have been based on the simplest of observation and theory. We know little or nothing

of the relationships of water conservation values to fuel values in our tussock grasslands. The tussock grasslands in the main are the product of fire. If we are going to live with them we shall have to learn to live with fire or, perhaps with greater difficulty, learn to live without it. That is a lesson for suburbanite and high country rangers and runholders alike.

LOGGING INDIGENOUS FORESTS — A PERSONAL VIEW

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In this article I wish to refocus attention on the continuing tragedy of native forest destruction by traditional logging methods. The basic problem in rimu rain forest is that felling the best-shaped canopy trees inevitably destroys 50 percent or more of the advance poles, saplings and seedlings. Then the massive logs are hauled through standing trees to the loading bank on steel ropes, using a spar tree and diesel-powered winch. In 50 years the only change in this operation has been the replacement of the old steam haulers with diesel units. On their way, these logs dragging at the trailing end, smash a swath through the bush, destroying many more of the younger trees. Up to 85 percent of the mature wood is left in the broken forest because it is unusable or cannot be sold. Waste wood includes that marked by insects and fungal attack. Or it may be split, twisted and badly formed. But it also includes wood of the wide range of non-commercial species present in these mixed podocarp/hardwood forests. Regeneration of commercial species in clear-felled bush is negligible and the tangled remains undergo slow repair by broadleaved native trees and shrubs.

Rough extraction logging is made even less acceptable by assurances from scientists and managers that the waste is not necessary—efficient forest use is possible. But the ecologically designed selection logging techniques are being applied to only a small area of the remaining merchantable forest estate. The commercial view is that on most sites there is an uneconomically high capital outlay for the ground scarifying, log skidding, or skyline hauling and greatly increased skilled labour needed. These costs cannot be justified by the relatively small economic returns from current wood sales. The policy-makers also consider that the cost is too high, for indigenous wood is variable in quality, it grows very slowly and is exceedingly difficult to regenerate within the forest clearings. Consequently, most of the rimu dominated rain forest continues to be logged for the best timber, clear-felled and fired in preparation for exotic forestry. In most production units this is radiata pine planting for short rotations of 25-30 years per tree crop.

Many before me have contributed heat to these complex issues in resource conservation. A few others have shed more light. Notable examples among these include L. Cockayne (1926) who wrote a lucid monograph on his ecological survey of beech forests and "Westland's Wealth" in which J. H. Johns' striking photographs and C. G. Chavasse's spirited narrative tell a moving story of forest destruction and hopes of resurrection. In 1964, many professional foresters contributed to *New Zealand Forestry*, a competent review of production, protection and recreational forestry practice. Franklin (1968) reviewed the biology of rimu, our chief durable native timber tree. Then in 1970, Peter McKelvey produced a very balanced text on the role of indigenous forests at a time when Forest Service was formulating its conservation policy and practice. More recently the research and progress on terrace rimu selection logging has been described by Franklin (1972) and Gover in the 1972 *Journal of Forestry*.

Now with active public discussion of native beech forest utilization a new awareness exists. A climate of opinion against continued wasteful destruction of native forests is at last having an effect on political decisions. The Forest Service should be applauded warmly for bringing this about. However, there are narrow-minded people who see nothing but bad in Forest Service actions and plans. For example, reviewers of Kirkland and John's informative booklet on beech forest management described it as one-sided, misleading propaganda. Having some familiarity with both the beech forests and current logging practice I considered the publication to be fair, realistic and effectively designed to bring lay people into discussion of the planned developments. It is certainly a clear distillation of the many statements on beech forest management to be found in the New Zealand Journal of Forestry over the last 15 years.

It is my hope in this article to be at least informative in presenting my version of a balanced view of the Forest Service's conservation policy and practice in indigenous production forests.

The Forests

Ten years of exhaustive air and ground surveys from 1945-55 established the broad extent and condition of our native forest estate. A summary of this exacting survey was published by Masters, Holloway and McKelvey in 1957. When the mountain forests, large scenic reserves and freehold blocks are combined they total 5 740 000 hectares. A breakdown of these includes:

	(ha) (1000's)
State Forests - - -	2760
National Parks and Scenic Reserves -	1040
Unalienated Crown land -	700
Maori land - - -	400
Freehold and leasehold - - -	800
	<hr/>
	5740
	<hr/>

Another Forest Service figure is that State Forests total 4 million hectares of which some 1.2 million are provisional.

Forest containing a favourable stocking of merchantable trees and therefore economically worth exploiting is approximately 520 000 ha or 9 percent of the total. In his T.G.M.L.I. Review article on the role of indigenous forests, McKelvey (1970) commented that the greater part of millable timber on Maori, private and leasehold land is already being utilized. It amounts to less than one third of total resources and is declining rapidly. The State is therefore the custodian and manager of most of the large tracts of virgin bush which remain. However, it is encouraging to note that vigorous efforts are being made by lay people and scientists to protect remnant native forests throughout the country. The energy of activists and the goodwill of land owners are an essential combination for saving these tattered remnants.

Protection Forests

The truly large expanses of native bush stretch in almost unbroken order throughout the mountain chains of high rainfall and erosion risk. Such protection forests will be maintained in perpetuity to protect soil and mountain stream water quality. More than 2 million ha of mountain forest then, is as sacrosanct as that within National Parks. Native forests, scrub and grasslands will always be a feature of our wet, dissected hill and high country. Unfortunately, the protection forests which vary from beech to rata, kamahi and kaikawaka, are being disastrously modified by introduced browsing animals, particularly deer and possums. Heavy grazing and trampling pressures coupled with fires and widespread slope and stream-channel instability are drastically modifying extensive areas. Their repair with exotic deciduous and conifer trees will produce a unique mixed forest in the future.

Native Softwoods

What then of the lowland indigenous forests now largely in State ownership? The kauri is regenerating, but has been logged to within a few thousand hectares of extinction. Though many small Reserves remain more or less as plant museums, the slow-growing kauri can no longer supply the cheap, durable timber which framed our Victorian townscapes. However, such is the value of this tree giant and its timber that Forest Service plans to restore 20 000 ha in high kauri forest.



Podocarp/beech forest in north west Nelson, part of the remaining 5.7 million hectares of indigenous forest in New Zealand, including those in National Parks.
(R. Goundrill — transparency)

Seven days to destroy the natural order of several thousand years. A West Coast rimu falls to the bushman's chainsaw.
(R. Goundrill)



Podocarp-hardwood forests of the North Island have been projected to cut out within 20 years. Apart from some future for selection logging in rimu-tawa forests, little hope is held for sustained yield management. Most of the cutover is being converted to exotic tree crops. Some experiments continue on the enhancement of hardwood regeneration, principally tawa, while supplementary plantings of groups of eucalypts, Douglas fir and pines, have shown promise. These experimental areas will be enlarged, consolidated and about 1 200 ha made into permanent scientific areas.

In the South Island, dense, manageable forests of rimu with mixed hardwoods still clothe the glacial terraces and morainic hills from Hokitika to Jackson Bay. Seemingly impenetrable when seen from such vantage points as the Okarito trig, these are the magnificent successional forests of the Post-glacial. In them the Forest Service is already providing hard evidence of its conservation policy in practice. At least 20 000 ha of densely stocked terrace rimu forest are being managed for a continuous yield of timber. The management technique evolved by foresters like Chavasse and Travers (1966) is selection logging with a conversion to normality cycle of 120 years involving four cutting cycles. Franklin (1972) has provided a graphic report of difficulties in achieving productive conservation of these valuable mixed-age tree crops, but expresses optimism following the modest success of 7 years progress. In a similar vein, Gover (1972) foresees the extension of selection logging to 32 000 ha of terraces and eventually to replace clear-felling of rimu on hill country.

Well-stocked rimu remains in Southland's Waitutu State Forest and on the Maori Lands toward the sea. Plans for logging these remote forests have been held in abeyance pending further scientific study. The beautiful rimu stands of Stewart Island are also held in reserve. A more fitting tribute to their wilderness value would be as Forest Sanctuary or National Park.

No amount of protest now can change the reality that our prosperity has been supported by the wholesale clear-felling and logging of podocarp and hardwood forests for farming land and building timber. It is equally clear that belated attempts to regenerate rainforest logged by traditional methods have not been successful. Consequently, up to half a million hectares of logged forest land lie idle. This area should be given the highest priority for conversion to productive, rapid-growth exotic soft and hardwood forests.

The Forest Service statement on its conservation policy and practice makes much of the happy circumstance that exotic forests, now planted over 700 000 ha of land is leading to the preservation of millable indigenous forest. Indeed, the annual cut from all exotic forests, farm woodlots and shelter belts now amounts to 80 percent of total wood sales. Given that in the absence of exotic forests, the same volume of timber would have been extracted by milling of native trees, nearly 320 000 ha of indigenous forest has already been saved. The next and only logical and justifiable step is to restrict all podocarp exploitation to that using sustained-yield tree selection management. Increases in exotic wood yields by improved extraction techniques and more efficient utilization of small round wood would make up any immediate shortfalls. In addition, the Forest Service has played a major role in methods to preserve exotic timbers, making these as durable as the native woods. Indigenous forest no longer need be cut to supply long-lasting working grades of timber.

A winch bank in indigenous forest. Log handling techniques have not progressed in fifty years. Testimony to the old mining philosophy "cut out and get out". (R. Goundrill)





Red/silver beech on the Shenendoah. All forests near public roads are, or should be, scenic and recreational reserves. This is a written policy not effectively observed. (R. Goundrill)

A strong conviction is appearing in the timber industry that rimu and other native softwoods should be used only as the highest quality end products, i.e. as finishing, feature and furnishing timber and veneers. If rimu, kahikatea, totara, matai and miro were used only for decorative products, the sustained-yield forests could then meet the demand. I am certain that it is morally indefensible that we allow further permanent losses of thousand year old rain forest wilderness when the end product is simply working timber for house framing and concrete boxing.



Valley farmland and hill forests. There has been a visual and productive marriage of uses determined by soil fertility and topography in this area of Maruia Valley.
 (R. Goundrill)

Rimu saw logs passing through young pine and fir plantings in the Grey Valley. Such forest veterans recently graced this landscape.
 (G. T. Daly — transparency)



But traditional felling, hauling and milling is still occurring. It continues where only 20 percent of the wood is extracted and the rest cut or smashed to waste followed by a 40 percent wastage of extracted wood at the mill—*this is clearly environmentally untenable*. Industrial wood companies know it, but claim economies do not allow them to improve. The Forest Service knows it but long-term wood sale concessions and statutory requirements to provide wood at acceptable stumpage rates can be cited as reasons for continuance of the destruction and waste. What is abundantly clear to me is that on the West Coast alone 100 000 ha of cut-over podocarp/hardwood waste land is not yet planted in exotic forest trees. Yet the destructive felling and log extraction goes on into the last and least-accessible virgin rimu forests of North West Nelson, the Grey River valley and Western Southland.

Beech/Podocarp Forests

In northern valleys of the West Coast a uniform cover of beeches spills down mountain slopes onto young alluvial terraces. A broad altitudinal sequence has mountain beech at timberline, silver beech on the slopes with red and hard beeches in the valleys. Similar communities but without hard beech occur in Fiordland and western Southland. Podocarps like rimu, kahikatea, miro and Hall's totara are scattered through the dense beech and the hardwoods, kamahi, quintinia and rata may also be present.

Small areas of accessible beech forest have been logged traditionally for mine pit timber and boardwood. Vigorous red, silver and hard beech regeneration has appeared on those logging sites, tracks, abandoned mining towns, fire patches and in wind-thrown forest. This effective restocking and the relatively rapid growth of straight poles in even-aged stands has encouraged the Forest Service to experiment with beech forest management for production of hardwood (Johnston, 1972). Their silvicultural promise is increased by prospects of particle board, wood chip and pulp production.

On sites of good quality, well-managed stands of red and silver beech will produce timber and veneers in 80 to 100 years. Their growth rates are comparable with the best European hardwoods. But the forests are being wastefully logged

for their rimu and occasional prime beech sawlogs. Only by integrated use as particle board and/or paper pulp together with saw logs can all the wood be extracted to allow effective beech regeneration. In addition, beech grows too slowly to sustain a viable permanent forest industry. The fast-growing exotic soft woods and more recently hardwoods like eucalypts must therefore be used on extensive areas. The combination will allow the best beech areas to be managed as indigenous production forest in perpetuity. At present, with no integrated forest use, they are being gradually cut to waste and slowly converted to exotic plantations anyway. These practical matters lie behind the Government's invitation for industrial proposals to utilize the available beech wood more efficiently on a permanent basis.

As Kirkland and Johns (1973) make clear, the beech forests have already been a source of commercial wood for a century. This has been a destructive process, only a few prime sawlogs being extracted, the remainder of the valuable cellulose being cut to waste. There is no market for the many logs bearing defects. In fact, present-day beech logging is as wasteful as that in hill podocarp forests. The old beech forests contain few trees without pin-hole borer and fungal damage, butt rot, splits or sap stain. All that wood is unsaleable. Nevertheless no effective silviculture is possible unless a market is developed for the existing wood. Such a market can be developed in beech hardwood chip, pulp and particle board production. Forest Service proposals are therefore based on:

- (a) the urgency to use efficiently the large volume of wood wasted in logged forest and at conventional mills;
- (b) the intention to replace "robber economy" exploitation of production forests with sustained-yield management;
- (c) the necessity to develop permanent forest industries in regions where traditional employment for bushmen and timber millers is nearing an end. In this there are significant short and long-term social benefits for several small communities on the West Coast and in western Southland.

In evaluating and inviting beech utilization proposals the Forest Service included for renewable wood production, only those areas which were not more important for other uses.

They acknowledged from the outset that value judgements had to be made and wisely opened the forest zoning to public comment and criticism. This has been received in large measure and in its light the plans are being modified and improved.

Broad zoning is firstly for Protection Forests above 830 m altitude in West Coast and 670 m in Southland hill country. The lower boundaries of this major mountain and hill forest land are being refined in the light of plant, soil and geologic information. In the Production Forest, reservation continues of areas which are:

Amenity Reserves in which scenic values and public recreation predominate e.g. roadsides, along rivers, around lakes;

Biological Reserves having scientific value for the preservation of representative plant and animal communities and their associated soil types.

Biological Reserves are being increased as quantitative information is gathered and evaluated. Their extent so far stands at 28 000 ha for Southland and 40 000 ha for the West Coast though a good deal of this is actually Protection Forest.

From the remaining areas of red, hard and silver beech and some podocarp, proposals have been invited from commercially interested parties in New Zealand and overseas. The maximum volumes of wood offered annually are 848 000 cubic metres in the West Coast and 170 000 m³ in Southland. This can be placed in perspective by comparison with present sale commitments on the West Coast of 300 000 m³ of sawlogs per year.

The offers are for terms of 20 years renewable for a similar length of time. A substantial area of at least 110 000 ha will be regenerated in beech with some eucalyptus on West Coast red, hard, and mixed beech areas. A cutting cycle of 80-100 years from clear-felling is planned.

It has been already decided that an effective supply of wood in perpetuity can be sustained only if productive exotic trees are planted over large areas. Pines, eucalypts, spruces, firs, poplars and cedars are being grown within the beech project areas with some success. Planting of radiata pine and eucalypts, in particular, has been greatly expanded in the last five years. The Forest Service is seriously engaged in the

development of permanent forest industries in Nelson, West Coast and Southland-Otago. It has a firm intention of converting up to 100 000 ha of forest cutover land into exotic tree crops to be milled in 25-30 year cycles. Unless the public is willing to allow large capital expenditure for the purchase and planting of existing cut-over waste land the cash required will have to come from commercial utilization of the beech forest.

There is a fair measure of environmental restraint already apparent in the beech forest proposals and the official invitation to industry stresses this. Forest felling will proceed on five-year plans and reservations within each area will be assessed. The Forest Service will retain complete control of management during the logging and restocking of all areas. It will specify locations of all forest operations and these will be spread throughout the project areas. Location and extent of any logging operation will be controlled for protection of soil and water values. In addition, techniques used must be able to minimise mass soil movement on slopes, stream sedimentation and effects on stream border vegetation.

Social factors will be weighed and careful attention given to siting, construction and management of processing plants to ensure that social and environmental values are protected. Effective treatment of processing effluents must be installed to protect human water supplies, fish, recreation and other values of natural water.

Forests of the Future

We have grown used to radiata pine as the economic mainstay of production forestry. But few people consider it a beautiful tree and its dense shade suppresses most native vegetation. In the beech and podocarp/hardwood regions, pines are at present the most widely used exotics. These plantations cause sharp reductions in biological diversity. Measurements indicate that native animals, particularly birds, insects and soil surface dwellers, are much scarcer in pine stands than in the native forests. For these reasons alone it is heartening to note that enthusiasm is growing for the use of a range of other exotic trees. For instance, in the wet, mild climates of the West Coast, the visually striking Douglas fir and sitka spruce are being planted in some quantity in forest compartments. Native ground flora will flourish under these stands.



Prime beech logs in freshly clear-felled production forest. This is an experimental beech management forest on intermediate-age terraces of the Inangahua Depression, West Coast project area.

(G. T. Daly — transparency)

Mixed beech/podocarp forest. In the foreground are “run of the forest” logs of beech stacked for transport to a chipping plant. The logs were skidded behind a tractor in the same manner as bullock-hauling.

(G. T. Daly — transparency)





The emerging exotics. Eight-year-old *Eucalyptus delegatensis* over scrub-weeds at Inangahua Junction. There is promise of chip and pulp at 12-20 years or peelers at 30 years from the right eucalypts.

(R. Goundrill — transparency)

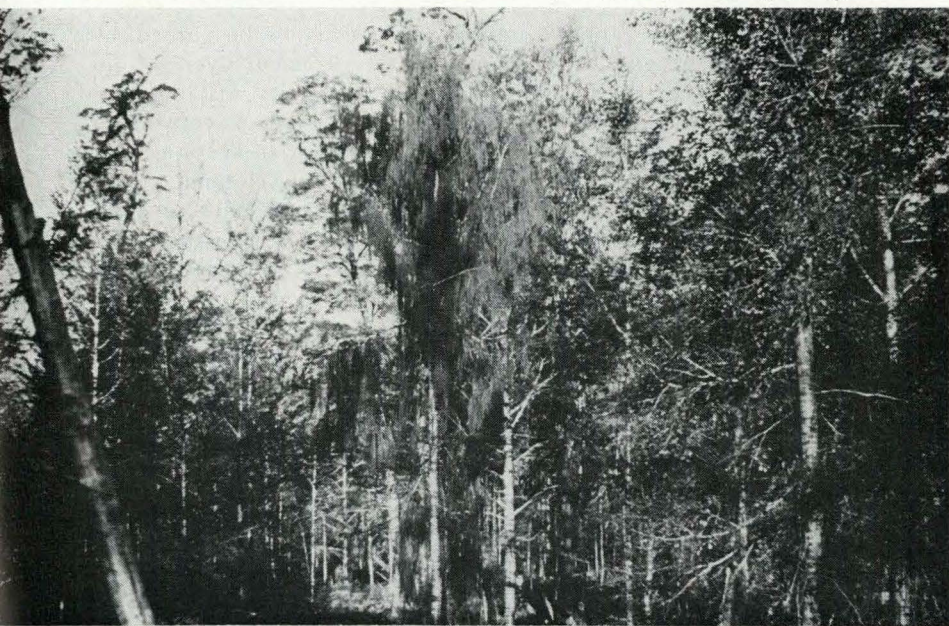
There are also promising species of Australian gums, particularly *Eucalyptus delegatensis* for drier ground and *E. regnans* and *E. nitans* for moister soils (Franklin 1972b). Eucalypts grow as fast as radiata pine but with an open leaf canopy they are proving to have a remarkable ability to live with and assist hard and red beech regeneration in cutover mixed forests.

Supplementary planting of eucalypts is being considered for some 62 000 ha of beech forest planned for clear-felling. These forests may in time become an ecologically and visually interesting synthesis of native and exotic plants and animals.

It is worth recording that suitable eucalypts have many advantages in commercial forest practice. These according to Barr (1973) include high growth rates, ability to coppice after cutting, few branches and easy bark peeling. They can also be dried without defect and produce fine hardwood pulp and particle. A valuable characteristic too, is their ability to grow well on the phosphate deficient soils within the beech forest project areas. Much of the eucalypt, spruce and fir planting being undertaken now is in indigenous cut-over and certainly ahead of marketing developments for the wood to be produced. However, I am an optimist and forecast firm export markets within 20 years for eucalyptus hardwood. My conviction is based partly on the fact that eucalypts are already being used for veneers in Australia and Hawaii, and for pulp in Norway from Brazilian eucalypt plantations.

Beech forest management. Selectively-thinned regeneration 20 years after logging in a mixed red and silver beech/podocarp forest on "Ahaura" soils, West Coast. Planting experiments with eucalypts indicate that they have a high sociability with this regenerating beech.

(G. T. Daly — transparency)



I would like to conclude with some comments on the possible size and distribution of logging and processing within the beech projects. It is certain that the injection of capital, manpower, roading, logging, transport, processing plant and growth in human communities should be gradual rather than sudden and massive. On both ecological and social grounds a widespread, small-unit growth is preferable to the rapid development of a large pulp industry utilizing available wood at the maximum rate. Of course, any graduated increase in rate of beech/podocarp logging from the present 3 600 ha a year would rule out Kraft wood pulp production till the 1990s—the projected time when the Nelson-West Coast exotic forests would be large enough on current planting rate. Widespread, small-scale beech resource development would have to be based on chip-wood or ground wood refiner pulp, particle board manufacture and increases in saw log extraction. A substantial long-term increase in beech utilization for mining timber could well be sustained by a revitalized export and industrial coal industry. Without doubt, the viable alternative to a massive centralized Kraft pulp mill is the development of local chipping mills and particle board factories in the main regional centres of population.

There are two equally important benefits to be gained by an “easy as she goes” beech resource development over a hundred years rather than 30-40 as planned. In the first instance, the drastic biological and environmental impacts of conversion logging can be muted as a patchwork or mosaic in keeping with the dissected landscape. A flexible, graduated development plan would allow the best use to be designed for each unit of landscape. It would also give greater opportunities for adjustments and survival of native plant communities and animal populations, especially forest dwelling birds.

The second consideration is the maintenance of a sizeable indigenous wood resource as a buffer against possible loss of the exotic forest estate through disasters such as disease and fire. The Forest Service conservation policy includes the withholding of native timber from exploitation as a strategic reserve. In practice the volume of beech and podocarp wood offered to industry in the project brochure is little more than half the

total estimated gross amount within production forest resource units. The remainder is allowed for logging waste, stream side margins, green belts, seed trees, provision for further Biological and Amenity Reserves and a large contingency safety factor.

Commercial proposals for utilization of indigenous wood within the beech project areas must reach the Director-General of Forests by 31 March, 1975. Any and all proposals for limited or large-scale use will be considered. These will be subject to intensive environmental as well as economic cost-benefit analysis. Interest so far generated in the forest industry has been keen and at least three commercial investigations are underway. One of these is by a small locally-based company, another is being done by a New Zealand-Japanese consortium. The third is a major consortium of eleven New Zealand organizations with Sir Reginald Smythe of New Zealand Forest Products as Chairman. New Zealand Beech Development Limited has engaged a Finnish firm of pulp and paper consultants to help it investigate the proposals. Studies are being made of marketing prospects, forest resources, pulp, timber, veneer and plywood production, site selection, environmental considerations, logging, roading and transport.

No commitment has yet been made to proceed with a beech wood industry of maximum size. From the published statements of the Minister of Forests, Mr Moyle, it is clear the Government wishes to encourage effective local participation irrespective of commercial size in keeping with its policy of regional development. This is related to the attitude of Mr Tizard as Minister of Finance. He considers that any West Coast beech industry should be spread over as wide an area as possible, in small economic units. The scales appear to be tipping in favour of the graduated development of integrated, permanent indigenous-exotic forest industries in West Coast-Nelson and Southland-Otago. Whatever the outcome, production, management and research divisions of the New Zealand Forest Service deserve commendation for the degree to which they are practising a stated conservation policy. That is, conservation through maximum wise use, for soil and water protection, insurance, scientific purposes, scenery, wilderness and recreational values and protection of genetic resources.

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Compensatory Growth in Weaner Heifers

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Poor growth rates in yearling cattle on pasture during the month following the cessation of winter supplementary feeding have often been observed. This occurs frequently in the tussock country where weaners are wintered on a hay ration and turned out in the spring onto an oversown hill block which apparently has adequate pasture to sustain liveweight gains.

Regular weighings of cattle at the Tara Hills High Country Research Station have shown that yearlings fail to increase weight during the month after the end of hay feeding. A gradual reduction in the hay ration during the first three weeks on spring pasture did not improve the situation.

Because the poor growth rates at this time may be offset by compensatory growth later there could be advantages in discontinuing hay feeding earlier than normal practice and relying on compensatory growth. This system was investigated in a small trial at Tara Hills in 1972.

The Trial

Twenty Angus weaner heifers were fed 6 kg lucerne hay per head a day from 1 June until 10 August. Pasture intake would have been negligible as the heifers were stocked at 5 per hectare on improved pasture which had been heavily grazed during the autumn, and little pasture regrowth occurs during winter in this environment.

On 10 August, when the mean liveweight was 147 kg, 9 heifers were turned out onto an oversown hill block on which little feed was available. In this group the period of poor liveweight gain following the termination of winter feeding coincided with a period when little feed was available on the hill.

The remaining 11 heifers continued to be fed lucerne hay at 6 kg per head a day until 20 September.

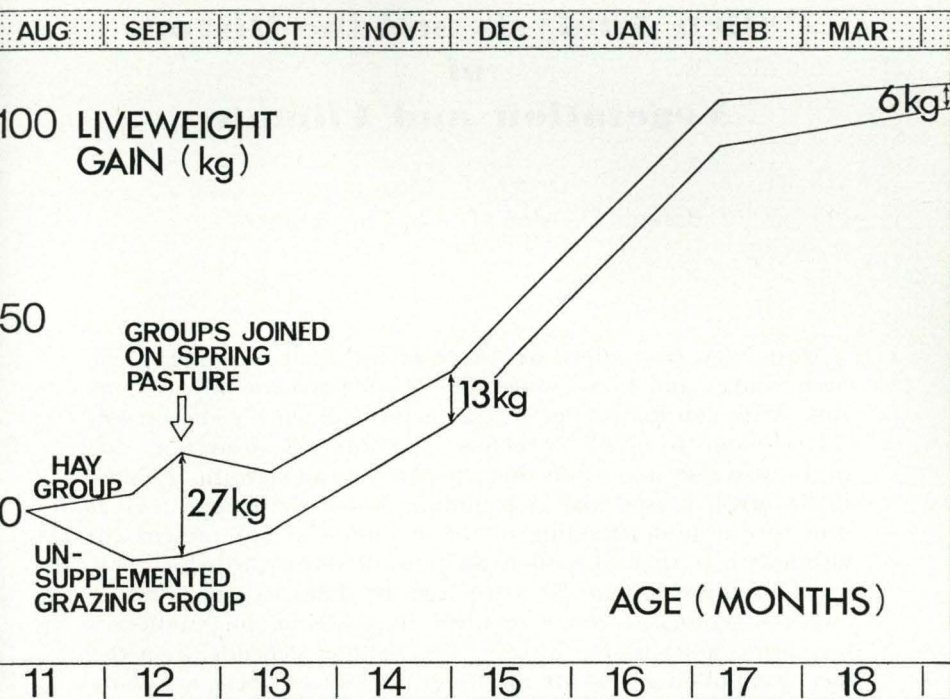
The heifers which were turned out early had been fed hay for 71 days (426 kg/head) and the heifers turned out at the normal time were fed hay for 112 days (672 kg/head) representing a difference of 246 kg/head or approximately nine bales. All animal weighings were preceded by a 24 hour fast to reduce differences in gutfill.

From 20 September, all heifers were run as one group on an oversown hill block on which there appeared to be good spring pasture growth.

Between 10 August and 20 September the group turned out onto the hill with no supplement lost 12 kg liveweight, whereas the group fed hay on the flat gained 15 kg. This difference in weight of 27 kg was progressively reduced between 20 September and 6 April to only 6 kg, representing 75 percent compensatory growth.

The Figure shows that 10 kg of the 21 kg recovered during the post-winter period were recovered during the first 23 days on the hill. During the first 23 days the group which had been fed hay through the entire winter lost 4 kg whereas the group turned out early gained 6 kg which suggests that the latter group were better able to utilise the early spring pasture growth.

Unfortunately it was not possible to continue the trial beyond 6 April but the graph shows that at this time the liveweights of the two groups were continuing to converge.



Liveweight change from 10 August 1972 to 6 April 1973

The results of this trial show that early turnout has only slight detriment to liveweights at 20 months, and suggests that where heifer replacements are not mated until 27 months of age considerable savings in hay during the *first winter* can be made by turning out the heifers six weeks before pasture growth starts in the spring. The pattern of liveweight recovery during the post-winter period indicates that the difference in liveweight may have been further reduced had the trial continued until 27 months, although in the absence of further evidence this remains speculative.

At 15 months of age there was still a 13 kg liveweight difference between the groups and therefore early turnout could not be recommended where heifers are mated at 15 months.

Pollen Analysis and the History of Vegetation and Climate

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Most New Zealanders are aware of the need to protect their environment and know something of the problems involved in this. Although knowledge of the factors influencing the present environment is necessary before planning for protection can begin, it is also important that the planner can view the problem in historical perspective. A technique which contributes a great deal to our understanding of the evolution of our present environment is that of pollen analysis—a technique which was first developed about 60 years ago by Lennart von Post, a Swedish geologist, who recognised its potential for studies in vegetation and climate history. The method depends upon the fact that pollen grains are produced in great numbers, are easily dispersed by air currents, and that the pollen grain wall is extremely resistant to decay and is easily preserved in peats, lake muds and other sediments. The importance of pollen analysis was quickly recognised and it is now regularly employed in many countries as one approach to environmental studies.

Pioneer studies in New Zealand were made in 1936 when von Post and the then botanist at the Auckland Institute and Museum, Lucy M. Cranwell, published an account of pollen analysis of sites in Southland and Otago. Since then we have built on this early work and I hope to show how the application of pollen analysis in New Zealand, and the South Island in particular, can contribute to an understanding of the history of our environment.

To undertake pollen analysis we have first to extract and then concentrate pollen from sediments in which it is preserved. Sediments best suited to study the last 14,000 years, that is, since the last major retreat of glaciers, are peats, the sediment from infilled lakes or that on the bed of existing lakes. From these sites samples are usually collected with hand-operated

corers, which with extension rods may penetrate 10 m or more of soft sediment. Samples are taken at 5 cm or 10 cm intervals as a routine, but it is possible to collect continuous cores for more leisurely and closer sampling in the laboratory.

There are various ways of extracting pollen from the sample. A standard method for organic samples involves the use of 40 per cent hydrofluoric acid to remove any silt or clay fraction and a mixture of concentrated sulphuric acid and acetic anhydride which reduces the amount of plant material in the sample. Sometimes a strong oxidizing agent, such as potassium chlorate, is required to separate pollen from other plant material and this is now becoming standard procedure in our laboratory. After each treatment the residue is washed in distilled water and spun in a centrifuge at 300 rpm. The residue containing pollen, is stained red with Basic Fuchsin and finally a small portion is strewn-mounted in glycerine jelly on a slide for microscopical examination.

The pollen grains on each slide are identified and the different types are counted. Identification is possible because pollen grains derived from different species often possess distinctive characters. The pollen of some groups however, e.g. the grasses, cannot easily be identified below the family level (Gramineae), whereas others, e.g. species of beech except silver beech, cannot be identified below the generic (*Nothofagus*) level. This difficulty limits the precision with which paleoecological interpretations can be made and must always be remembered when discussing the results of pollen analysis.

When an analysis is completed the results are usually presented as a pollen diagram in which the percentage frequency of each pollen type is calculated for each level sampled. The resulting pollen curves then illustrate the changes in vegetation in the study area through a particular period of time. Besides the limitation imposed by the precision of identification, other factors need to be considered which must influence any interpretation of a pollen diagram. Some of these are:

1. Wind pollinated plants usually produce much more pollen than do insect pollinated plants. This means that the frequency of pollen in a pollen diagram is not necessarily related to the frequency with which a particular plant occurs in the vegetation.

Recently we examined moss samples from Porters Pass where turpentine plant (*Dracophyllum uniflorum*), an insect pollinated plant, is the dominant shrub. Very few *Dracophyllum* pollen grains were recorded during the analysis, a result which reflects the mode of pollination, but which does not reflect the importance of the plant in the local vegetation.

The pollen of wind pollinated plants may also be variously represented in pollen diagrams. Silver beech (*Nothofagus menziesii*) is not so well represented as are the pollen grains of other beech species—hence low frequencies of silver beech pollen may carry greater significance, in terms of source vegetation, than similar frequencies of pollen derived from other beech species. In this context it is interesting to note that work by Mrs Mary McKellar, Dunedin, suggests that silver beech pollen is not so widely dispersed as that of the other species.

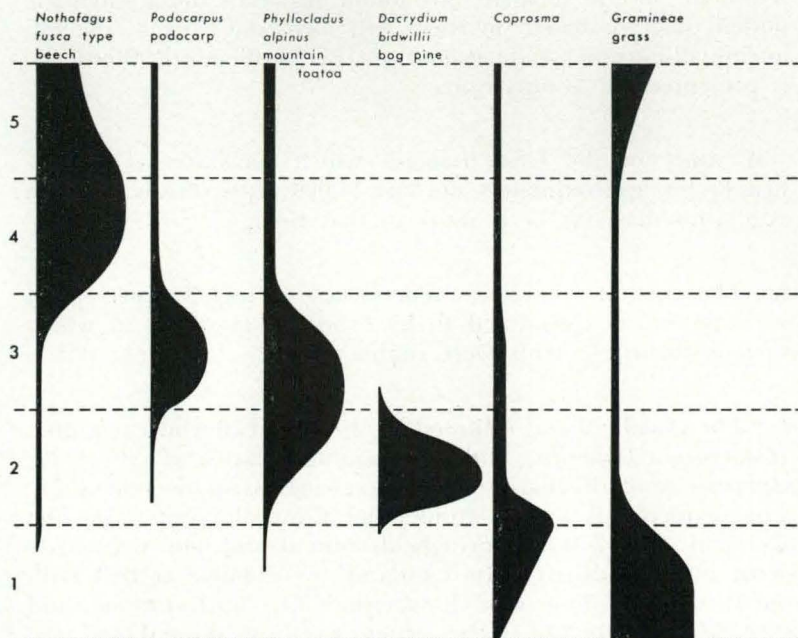
2. Some pollen grains are rarely recorded in an analysis because the pollen grain wall is delicate and easily destroyed. This difficulty is not a common one, but it does affect the pollen of some important forest trees, and from the North Island, tawa (*Beilschmiedia tawa*), provides an example.

3. Some pollen grains are more widely dispersed than are others. An extreme example is that of the carriage of the she oak (*Casuarina*) pollen to New Zealand from Australia. Similarly the pollen of our major forest species, e.g. rimu and beech, is found in peats from the sub-antarctic islands and can only have been carried there from the mainland by prevailing westerly winds.

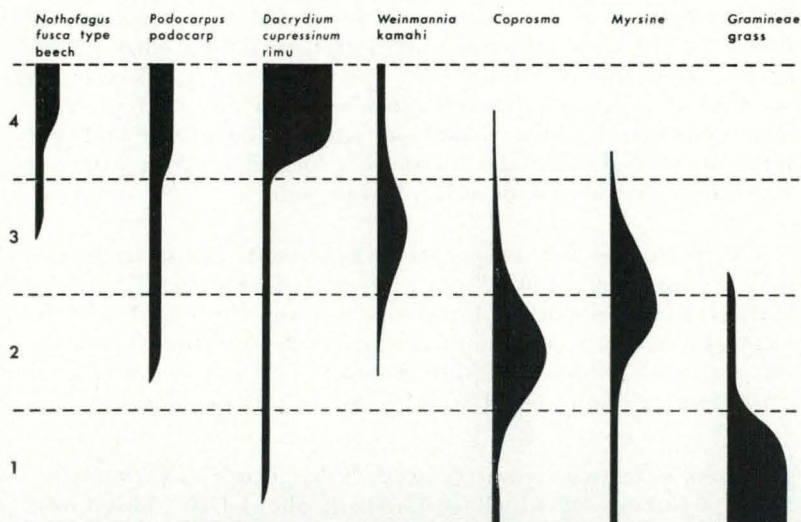
In order to understand the problems of dispersal and representation in pollen diagrams it is standard practice to study the pollen "rain" derived from existing vegetation in any area under investigation. A thorough background knowledge of this sort is invaluable when attempting to interpret pollen diagrams.

We must now consider the history of the vegetation as revealed by pollen analysis. When South Island glaciers began their major retreat about 14,000 years ago at the end of the last glaciation, sediment, including pollen, began to accumulate in lakes, and in water-filled hollows (kettleholes) formed in moraine. In many kettleholes sediment accumulated until the basin was filled and peat began to accumulate on the water-laid

A. CASS BASIN



B. BELL HILL



Schematic pollen diagrams based on pollen analysis of sites at A, Cass Basin, inland central Canterbury, and B, Bell Hill, north Westland.

sediment. Several such sites are found near Cass and a schematic pollen diagram based on them will form the basis of the following discussion. A diagram from Bell Hill, north Westland, is presented for comparison.

A study of the Cass diagram which illustrates vegetation history for approximately the last 14,000 years reveals that the vegetation has not been static in that time.

1. The earliest vegetation, represented by high frequencies of grass pollen, is considered to have been a grassland in which various shrub elements were represented.
2. The grassland was followed by shrubland in which bog pine (*Dacrydium bidwillii*) and then mountain toatoa (*Phyllocladus alpinus*) were the most important elements in the vegetation. This sequence is known from other Canterbury sites, e.g. the Rubicon River, near Springfield, but it did not necessarily occur in other districts. In Westland, for example at Bell Hill, the shrubland phase was characterised first by *Coprosma*, and then by *Myrsine*. As investigations continue throughout New Zealand other patterns are likely to be revealed to emphasise the diversity already demonstrated.
3. In most areas shrubland was succeeded by some form of forest. In the Cass area podocarp forest, including miro (*Podocarpus ferrugineus*) matai (*P. spicatus*) and kahikatea (*P. dacrydioides*) spread through shrubland, but did not replace it. The evidence we have, based on pollen grains, seed and leaf remains, suggests that the forest trees formed enclaves within a vegetation dominated by celery-leaved pine.

This pattern is not unique to the Cass Basin, but nevertheless, it is not universal. Thus, from a site at Lake Henrietta near the Harper River, podocarp forest replaces the shrubland, and in Central Westland, shrubland is replaced by kamahi (*Weinmannia racemosa*) which is rapidly followed by rimu forests (*Dacrydium cupressium*) which remain to the present day.

4. Podocarp forest was succeeded by beech (*Nothofagus*) forest, remnants of which still remain about Cass. This forest was widespread and in the Cass area completely replaced the podocarp forest. This pattern is only one of many. At Timaru

podocarp forest was dominant throughout the forest phase until its destruction by fire during the Polynesian era; in central Westland rimu forests were dominant through to the present; in north Westland, at Bell Hill, beech began to spread into the rimu forest, but did not replace it; at Springs Junction beech succeeded podocarp forest and remains the major forest element to this day; at Tophouse, Nelson, further north and at greater elevation, the only forests to occupy the area were beech forests. 5. The final phase illustrated in the Cass pollen diagram is the development of grassland following the wholesale burning of forest in pre-European times which was discussed in an earlier issue by Dr Molloy. This effect is demonstrated from various eastern South Island sites by the increase in grass and other herb pollen. Sometimes the influence of European settlement is also clearly indicated by the presence of birch, pine, willow and other pollen derived from plants brought to New Zealand by European settlers.

To provide a sound basis for discussing the reasons for the vegetation changes discussed, it is important to know when these various changes occurred. This is done by means of radio-carbon dating. Although we do not have as many dates as we would like, we have enough to provide a framework for a chronology of post-glacial events.

It is generally accepted that a major retreat of glaciers occurred about 14,000 years ago. Grassland was dominant at Rubicon Creek, Springfield and at Omoeroa Bluff, Fox Glacier, about 13,000 years ago, and from another site near Fox Glacier, we know that shrubland was dominant about 11,000 years ago. Forest began to spread in most South Island sites about 10,000 years ago, about 4,000 years later than in northern North Island.

The timing of the spread of rimu and beech demonstrates that changes in vegetation were not necessarily synchronous. At Bell Hill, North Westland, rimu began to spread about 9,500 years ago, three thousand years earlier than it did at Swampy Hill, Dunedin. In the Hauraki Plains, North Island, rimu was dominant more than 12,000 years ago, and at Trentham, it was not an important element in the vegetation until about 10,000 years ago.

The story for beech is similar and is best known from the central South Island. Beech forests were dominant in the Tophouse area at least 8,000 years ago, spread through podocarp forest in the Springs Junction region about 6,000 years ago, and

began to establish about Lake Brunner 2,500 years ago. Available dates for central Canterbury suggest that beech forest occupied mountain sites about 7,000 years ago, somewhat earlier than it did in downland sites as at Pyramid Valley in North Canterbury. Beech forest was not extensive in lowland and coastal areas of Central and South Canterbury.

It is clear that there were differences in forest development during the last 10,000 years and we need to explain these. The obvious explanation is that of adjustment to climate change, but unlike the major differences between glacial and interglacial climate, the changes would have been subtle and not always registered in pollen diagrams.

The records of miro and matai at Cass suggest that effective precipitation was somewhat greater than it was when beech forest was established 6,000 - 7,000 years ago. It is difficult to see this trend towards dryness as universal when it is realised that rimu forest, implying as it does abundant precipitation, began to spread at Swampy Hill, Dunedin, at about 6,000 years ago. South Island forests began to spread about 10,000 years ago, some four thousand years later than in central and northern North Island, and these events cannot easily be connected with the same climatic event. The same difficulty applies to the beech forests which were established at different times in different places.

These apparent contradictions can be reconciled if it is accepted that because of differences in latitude, and because of regional, and even local variations in topography, response to a changing climate occurred at different times in different places. Soil differences too would influence the rate of change, and the importance of this factor in maintaining kanuka (*Leptospermum ericoides*) scrub on soils formed on old gravels in Canterbury has been emphasised by Dr Molloy.

The pollen evidence is not yet clear-cut, but trends are beginning to emerge which help us understand the complexities of our present environment. As our studies are extended, and variations in vegetation patterns are traced through time, the role of a changing climate, and its influence upon the environment should become clearer. Further, a knowledge of change during the past should, as more information becomes available, allow predictions, albeit tentative, about climatic change in the future.

Landscape Conservation in Great Britain

Story and photographs by
1973 Nuffield Foundation Travelling Scholar,
Bernard Pinney,
Dunrobin Station, Mossburn.

The aim in this brief study was to examine the way the British use their limited land resources, and to observe what efforts are being made to retain the character of the countryside. I set out to study the authorities which are responsible for the conservation of the landscape in order to find out how the constructive use of land for farming, water, forestry and recreation is being achieved.

With about 20,000 hectares being withdrawn from agriculture each year in Great Britain, it is an easy calculation to see that this means a loss of a million acres in twenty years. For a country of just over 24 million hectares, this is a figure to cause grave concern. The worry is not so much on the effect it will have on agricultural production in the foreseeable short term, because trends in increasing production and yields will balance the land lost, but rather that once land is lost to agriculture the move is irreversible. The land being lost tends to be the best land close to the towns and cities which were originally sited in fertile areas.

The crux of the problem is that Britain is becoming rather like a heavily stocked farm whose fences and reserves are being really strained. One wire snaps or a gate gets left open and the stock are everywhere unthinkingly helping themselves to anything that catches their fancy.

A farmer can sell off stock to solve his problem but a heavily stocked population that wishes to keep a semblance of control must erect tight controls on land use. Britain's stocking rate is 980 inhabitants per square kilometre compared with New Zealand's 48. Like much of New Zealand, many of the 7.6 million hectares in Scotland and the 1.2 million hectares in Northern Ireland are uninhabitable. In case some may think that the difference in density makes comparison irrelevant they only have to look at what has happened to Auckland, and what is happening around Christchurch.

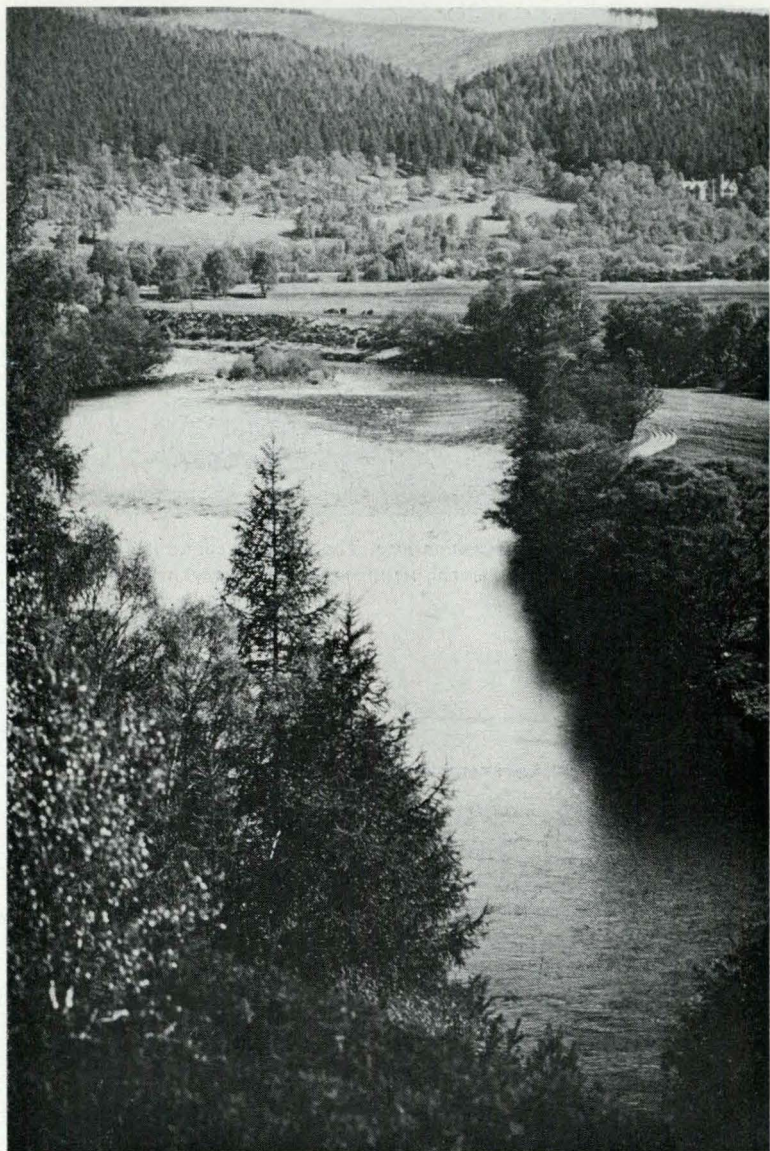
It is felt that before the land use is changed forever, there is a need for an overall plan and the bureaucracy to make it work. Mention the word *planner* in Britain and one often sees hackles rise immediately. They form a profession apart who have enjoyed a lot of power and prestige in reshaping the appearance of Britain since the World War II. This has upset numbers of property owners and many short-sighted people who cannot see that the planners have controlled the spread of towns from covering the whole of the South-East. Generally the planners, as shown by the restrictions they impose, have had a negative job as far as country planning is concerned. On the other hand their urban work has been more positive, as they attempted to improve the drabness of the heavily populated towns. They claim to review any proposition for development on its merit. There are clearly defined channels to follow and appeal procedures.

The tenacious and more prosperous tend to get their way, which gives the cynic cause to believe that money tends to provide the best argument and that good law is not necessarily compatible with good planning. His suspicions have been confirmed in recent months.

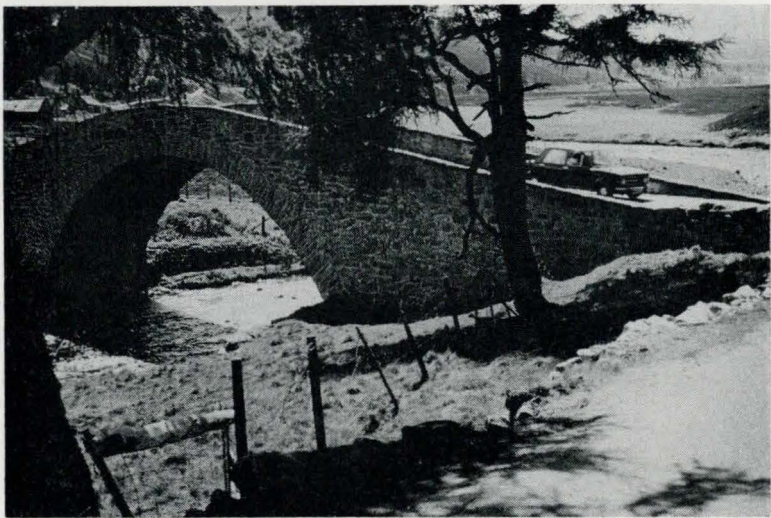
Most planners are urban born, trained, and biased as is reasonable to expect with the countrydweller comprising such a small part of the population.

There are some indications that they are taking more interest in the neglected rural planning. This is overdue. Up to date the farmers have had a pretty free rein and the same can be said for the foresters. This is likely to change soon and farmers will have to consider seriously the visual design effect and the materials they use much more carefully and seriously.

The National Farmers Union and the Ministry of Agriculture, Fisheries and Food could both be criticised for their apathy to encourage the aesthetics of good design for farm buildings. There are innumerable examples of thoughtless siting and tasteless design of farm buildings all over Britain, which is all the more surprising as it is so much in contrast to the rigid housing design controls.



Classic multiple land use—salmon and trout in the river, well farmed flats, mixed hardwood plantings on riversides and roadsides, mixed conifers for commercial forestry on lower hills, grouse and deer on the moors above, and whiskey distilleries galore. Tulchan waters on the Spey near Grantown.



Bridge over River Don, Aberdeenshire. The Scottish countryside would be much the poorer without such picturesque yet sturdy bridges.

Cotswold houses. An example of local materials put to use.



To be fair there are many areas which do achieve harmony as is done in the Lakes District where it has almost become an obsession.

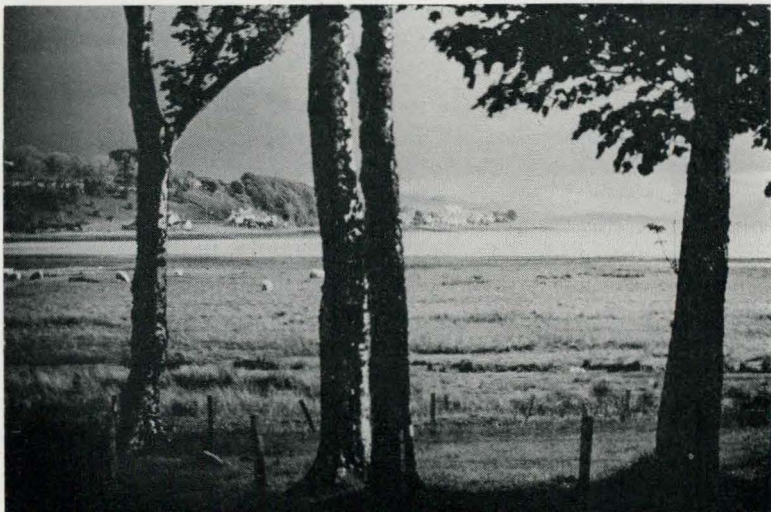
Answers to questions of improved design can usually be found with a little more thought, time, and consultation, if necessary. I feel that it is a subject which should be given more emphasis at the various levels of agricultural training, and in fact these institutions should start the ball rolling by setting a much better example themselves. The Rowett Institute must be commended for its effort in building a very large barn which nestles into its background so skilfully. This has been achieved by breaking the roofline, the clever use of wood, and a feeling for colour. If these comments are valid in Britain how much more so are they in New Zealand. Apart from the already mentioned planners, other bodies are concerned with the appearance and alternative uses for the countryside.

Urban Rustics is my description of a new type of being. They are the people who would be quite happy if the main purpose of the open countryside was to provide them and their town neighbours with somewhere to go when their week is over, to give a life which can be a safety valve from the tension of the packed communities where they are obliged to earn their livings.

It matters not at all to them that a sheep is for producing lambs to eat (they can be got from New Zealand far cheaper anyway), or that a cow is for producing milk which is easier bought at the corner dairy. A tree is something to admire and a hedgerow somewhere to go bird's-nesting or collecting wild-flowers which are becoming harder to find now that the car has immobilised legs and the County Council is cutting or spraying the road sides.

These are the people who become upset because waterskiers' noisy boats on remote Scottish Lochs prevent them from hearing a bee at fifty yards. They deplore that the farmer's animals graze the unusual plants, so intrigue to stop them. A few years later the plants they saved are smothered anyway, and the new undergrowth discourages them from visiting the place again.

The Urban Rustic is now prosperous and on his country drives, seeing a stone cottage for sale, buys it, installs central heating and plumbing ready for his irregular visits. He cannot



Amenity planting and sophisticated management of a highland deer forest. Applecross, a crofting community in Wester Ross.

understand why he is not really accepted in the country community, so sets things right by becoming involved. If he is articulate he is elected to committees which give him something worth doing in the district.

Suddenly the *farmer* wakes up and realises he has no spare cottage left for his newly married son, and his neighbours have also sold theirs. Because they have not been taking an active enough interest in their community affairs the farmers are being pressed to provide and pay for district amenities which they had never dreamt of. One man decides that farming has changed so much with the coming of the Urban Rustics that he sells his stock instead of having it let out to roam all over the district by hordes who will not shut gates. In place of the stock he grows crops, but occasionally finds them flattened just before harvest by disgruntled ramblers who are looking for a public footpath on the farm. It was accidentally ploughed because no one walked there.

This is not much exaggeration of what is happening to the Lakes District and other areas where tourism is rapidly being integrated with farming. Many a farmer is accepting the hard truth that there can be benefits in letting out caravan sites, letting rooms for the night, and cashing in on tourists' disenchantment with expensive, impersonal, and noisy hotels. Frequently it is his wife who initiates the idea.



Fine use of hardwood species in the Kirkudbright landscape.

There are many opportunities to do the same in New Zealand particularly in the back country and the coastal regions. It would be reasonable to expect improved relationships between the farmer and visitors. This will become more necessary each year as townspeople become further separated from their rural ties.

ORGANISATIONS

The **Nature Conservancy** is divided into nine regions. It is Government funded and staffed with a highly respected team of dedicated men. They have set up some 130 areas of national significance legalised by purchase agreements or lease. These are places containing sites of special scientific interest which may be endangered if continuing under present tenure.

They prefer them to be large areas of several hundred hectare if possible. They are deeply concerned in Scotland with the pressure that has been brought to bear on the hill country since the industrial revolution, when much of it was cleared of trees. Its reconstitution is difficult after such a time and there is a need to re-establish a protection forest. They are concerned at the effects of monoculture in this forest. They are encouraging a swing from extensive to intensive projects. For example a 20,000 hectares estate may be advised by them to set aside 800 hectares of glens for farming if available, and the rest would be assigned for forestry, sport, and wildlife. They would advise on the sound transition.

Unlike in New Zealand there are no government restrictions on how much or how often land is burned, nor upon stock density except in the cases of nature reserves. Though restrictions would be hard to enforce, I feel that the Scots here lag behind New Zealand, and could learn something from our Catchment Boards' approach to hill management. As increased tree planting is done a growing number of foxes and rabbits is becoming especially noticeable and is posing a real problem.

The National Trust. The National Trust Act of 1907 empowered the declaring of land as *inalienable*. Once declaration is made the property is protected against compulsory purchase by local authority or Government. It can only be taken from the National Trust by special will of Parliament. In 1967 the area owned by the Trust was nearly 160,000 hectares of which 14,800 were in Scotland. It has grown since then. The Trust is advised by the Nature Conservancy on ecological matters.

If a landowner wants protection for his land he can enter into an agreement with the National Trust, but he must agree to the terms laid down by the Trust. These agreements are used for all sorts of purposes. For example 280 hectares were committed in order to retain its unspoilt skyline on the Pentland Hills which provide the background to Edinburgh.

In England and Wales the Trust has been running the Neptune Appeal to provide funds to buy up large tracts of coastline which they plan to keep as near to its unspoilt state as possible. Farmers may lease the land back in places for grazing purposes on terms dictated by the National Trust. In conjunction with the Countryside Commission and the local authorities the National Trust of Scotland has set up a Countryside Park at Culzean Castle together with five miles of coast and 220 hectares. Visitors to the area have doubled to about 200,000 a year in the last five years. They have been encouraged with picnic spots, nature trails, rangers and so on. Projects like this appear to work in Scotland where the degree of communication between the bodies concerned appears to be close.

The National Trust does a lot of work representing conservation causes, good planning interests, and other issues which it conducts quietly behind the scenes. It is very selective before it becomes involved in public issues.

The **Countryside Commission**, set up in 1968, replaced the National Parks Commission. Its job is to provide parks or camping sites, long distance footpaths, to protect beauty spots, and to supervise the National Parks. It produces many research reports, participates in joint studies such as the South Hampshire Structure Plan, is closely involved with the designation of National Parks, Areas of Outstanding Natural Beauty (A.O.N.B.); major development intrusions such as the A66 road through the Lakes District, and public enquiries. They have four research teams working on grant aiding, picnic sites, County and National Parks.

One of its problems is that land is not owned by the nation but by a multitude of landowners, and that the few existing areas of wilderness are in private hands. It feels that all roads, large developments, skyline developments, should be referred to them for comment before work begins. They have a team of competent men, devoted to their work. However many outsiders I asked felt that the Commission lacked punch. This could be an effect of the relatively small budget they are asked to work on.

The growth of a body like this is really a by-product of socialist effects on land ownership. In the past there would have been no need for such an organisation as there was such an active feeling for the appearance of the countryside by the large landowners. As their estates are being broken up one wonders whether the new owners will have anything like the same feeling for this land and whether they will have the same long term view? If not one presumes that this interest will have to be taken over by the general public and their representatives. It is very questionable in my mind that they will make such a good job.

The **Country Landowners Association** is deeply concerned with the appearance of the countryside in distinct contrast to the National Farmers Union who tend to concentrate more on the economics and politics of farming.

SPORT

It is easy to underestimate the way in which sport has influenced the appearance of the British countryside. Hedges are nurtured as hatching grounds for all form of game. The height they are trimmed is often calculated to suit the shooter.



Drynachan grouse moor, Nairn. Keepers manage the heather carefully for shooting which costs £500 a week per gun, a much more profitable use of land than grazing sheep.

Grouse chicks are unable to be hand reared, but thrive on regrowth heather. Sutherland.



The tree species planted are calculated to provide feed. The forage crops are carefully sited to provide winter shelter and feed for the pheasants. On the heather moors of the north of England and Scotland burning is carefully organised in strips to provide feed for the grouse. Such considerations are taken for granted by many farmers in the UK to improve the visual and sporting amenities of the countryside.

Besides these reasons they have good economic grounds in preserving the sport. Here are a few figures which illustrate the value they place on it:

Trout fishing on a reservoir in Leicestershire £120 per rod for one day a week during the season.

Salmon fishing, £2 a half day in Wester Ross. £600 a week for four rods to fish a beat on the Spey.

Grouse shooting at £500 to £1,000 a week.

Deer stalking £150 for a 14 pointer stag or a penalty of £5 for missing it.

Pheasant shooting up to £1,200 for a week's shooting in Hampshire.

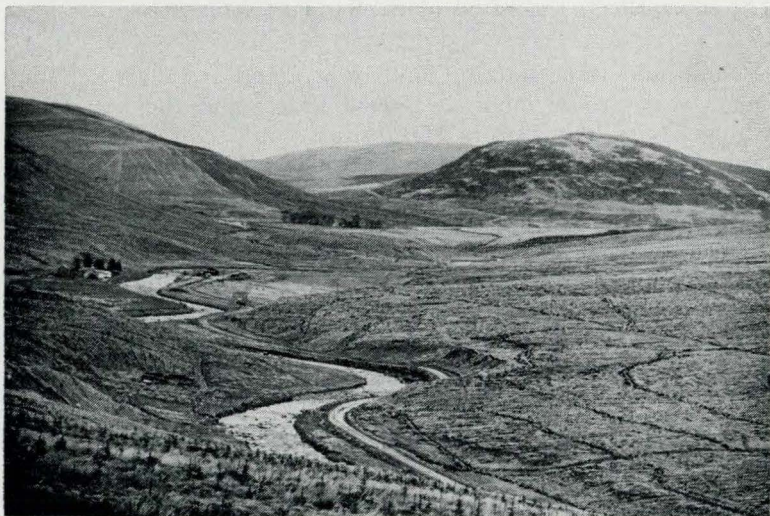
These are mostly high figures and by no means typical as there is great variation in the quality of the sport available. The sport affects the value of the land in some areas.

One would value stalking land in Scotland at £5,000 per stag shot a year, grouse moor at £800 a brace; and the best trout fishing, say on the Test in Hampshire, could cost about £30 a yard. A mile was sold last year for £30,000. These figures point out the real demand for sport in the UK and how it is not available in adequate quantity. It is also implied that to meet the demand a lot of skilled management is required. There is a long tradition in providing this. The point as far as New Zealand is concerned is that if we started managing our sporting resources with similar skill, there could be considerable benefits. I am not suggesting altering the shooting or fishing laws, but trying to point out the value that some farmers who wished to provide the facilities of accommodation, transport and guiding could place on such services. They could provide fishing, stalking and duck shooting as good as any in Britain for both local and overseas visitors.



Hill peat (pH 3.5-5.5) is ploughed straight up and down and conifers planted on the upturned turf. Sitka spruce is the main species, with an increment of 25 mm and growth of .45 m a year.

Syndicated forestry, Carsphairn, Kirkudbright. Forestry is rapidly replacing sheep in much of Scotland's hill country where land like this sells for around £40 per hectare.



FORESTRY

Some of the most dramatic changes to the British countryside have been made by trees, especially in Scotland where there is great pressure on landowners to plant their hill country. The scene is complicated by tax concessions to foresters and it is the political aim during regional development to stop a drift to the town.

There has also been a controversial Government White Paper criticising the lack of profitability of forestry.

The Urban Rustics have been outspoken about the changed appearance of the bleak landscapes they were brought up to as normal. They ignore that trees were present over much of the same country before the industrial revolution. They become abusive about the planting of softwoods in places as attractive as Loch Lomond, believing that the present deciduous trees have always been part of the local scene. But in fact many are a remainder from the coppicing days of previous centuries when trees were planted purely for economic rather than aesthetic reasons.

There has been a healthy development by foresters in the UK of a new concern for the good appearance of their forests. No longer is the Forestry Commission encouraged to plant its monocultures of sitka spruce to the exclusion of all else. Public pressure has encouraged them to intersperse these plantings with patches of Douglas fir, Norway spruce, Scots pine, larch and hardwoods. These patches are not geometrical shapes but are now carefully blended in to suit the contours of the landscape. The edges of the plantings are being planted with hardwoods. There is a feeling that foresters' mistakes last longer than most and they are not keen to repeat mass plantings of single species. Has this lesson been learnt in New Zealand?

One interesting development is the extent to which landowners are prepared to use private enterprise instead of the Forestry Commission (which is very akin to our powerful Forest Service). There are a number of organisations available to him to choose from. S.W.O.A. (the Scottish Woodland Owners Association) has two branches which look after the private forestry interests at a political level and arrange the practical



Scots pine planted 1905 near Golspie, Sutherland, worth £1600 per hectare standing. Scots pine is favoured by the Nature Conservancy for its ability to support wildlife. This particular plantation is used for wintering cattle.

field operations on behalf of the landowner. There are several businesses which organise the whole forestry programme from planting to marketing. The economic Forestry Group (EFG), Fountain Forestry, and Tillhill have various approaches to syndicating forestry. They may do the work for the landowner, or he may wish to sell them the land which they syndicate between city investors, as is done by beef syndicates in New Zealand.



These 17-year-old thinnings are worth £7 per tonne. Tayworth Castle Estate, Perthshire.

The E.F.G. is by far the biggest of these firms. They have planted 88,000 hectares in the last 20 years. They feel that however enthusiastic farmers may be for a forestry programme, they are nearly always up against a cash shortage.

By involving outsiders who are keen to use the tax advantages of forestry they can benefit both the farmer and businessman. The farmer benefits from the roads and fences which are a direct result of the forestry, and also from the sum of money obtained if he sells his land.

The E.F.G. provides all the planting and tending and manages the whole of the finance. They have been considering the integration of forestry and grazing, and have also moved into Australia.

It works in basic units of 4,000 hectares wherever possible. These it feels can be handled by one leader and three assistants.

They seriously considered setting up a branch in New Zealand but were forced out by the large timber companies. If the same approach is adopted in New Zealand, careful consideration will have to be given to whether to involve these companies or not, and all their local skill and marketing experience. With the increasing world timber prices, and growing world shortages of newsprint, the future for timber production looks excellent.

Much of the South Island tussock country could be planted to good effect. It has the advantage of easy planting and little need for releasing. The cash provided from forestry syndication could provide a useful injection of capital for developing the easier country. As one Scotsman commented, it is then possible to spend all the time looking at the stock instead of for them.

There is a development in planting which is causing the Forestry Commission to review some of its ideas. A seed can be germinated in a small cylinder in a glasshouse, then hardened off out of doors before being planted with a special spike which makes a hole in the ground into which the tube and seedling are dropped. There is no wrenching, raising is simple, planting can apparently be done at any time of the year, and at much faster rates than currently achieved. This method should be investigated, especially for the planting of tussock country where the competition is slight.

In Britain much attention is given to the preservation of historical buildings and places. This extends as far as protecting certain trees in order to prevent their destruction. These "Tree Preservation Orders" have been an effective means of maintaining the character of the countryside in many districts.

ROADING

I was impressed with the attention given in major roadworks to the replanting of scarred areas and the reconstruction of stone walls matching the local style. Whilst expensive to effect, the visual appearances were much enhanced as a result. The irony is that the landscaped motorway verges, prohibited as they are for pedestrians and stopping, may provide the best sites for the unique or rare plant associations of the future.

CONCLUSIONS

The farming community in the UK is rapidly being made aware by the community at large, that whatever the tenure of the land, the public has a right to be concerned at the use to which it is put.

In countries like New Zealand and the UK, it is vital that strong controls be kept on the appearance of the countryside, and *particularly in those places where land use is being changed forever.*

The design and siting of farm buildings is one subject which needs attention. Strict functionalism and minimum cost should not be the only criteria for such buildings. There is a need especially in Britain, to bring farm buildings under planning control. The agricultural colleges and institutions should be encouraged to set an example of improving farm building appearances.

Landscaping should become a crucial part of all large development and roading projects, and trees should be used wherever possible to heal the scars made.

The value of sporting amenity to both the appearance and economy of the countryside has been long appreciated in Britain and deserves greater consideration in New Zealand. There are good economic reasons why some New Zealand farmers should market recreation as well as farm produce.

Forestry appearances are becoming a feature of new plantings in Britain where there has been a marked swing away from monocultures. The dominant species are now being mixed wherever possible with other species to break the monotony. Hardwoods are being planted on the edges of the forests.

Guidelines For Construction of Roads, Access Tracks and Firebreaks

(Waitaki Catchment Commission Circular)

Approval of Commissioner of Crown Lands be obtained before construction is begun on areas of land where the Department of Lands and Survey is lessor.

The track be sited and constructed so as to cause minimal disruption of landscape.

Before construction begins the route of the track be competently surveyed and adequately marked.

No construction be attempted on potentially unstable areas.

The minimum width of the trafficable surface be 3 metres.

In general the maximum grade of the track should not exceed 1 in 8 (7°), except where circumstances or ground conditions demand (such as hard rock, avoidance of bluffs, short access lengths of roads to gain a ridge or turns in a zig-zag section of track), then the maximum grade may be increased to 1 in 5 (11°).

On hill construction the track be sloped at 3-4 centimetres per metre (2°) in towards bank, and a water table constructed to provide free drainage of water to safe disposal points via culverts or cutoffs.

On flat areas the running surface be built up and cambered at 3-4 centimetres per metre from centre line to each water-table to allow surface drainage.

On hill formation frequent culverts or cutoffs be constructed where necessary and with adequate protection at both inlet and outlet to prevent erosion of water tables, fill batters and waterways.

The crossings of all streams be constructed to a hard bottom, rockfilled or culverted.

After the first winter following construction the track be inspected and graded where necessary, so as to allow ready passage of vehicles.

Where possible the uphill batters be sloped back or struck off to a stable gradient to minimise slumping and to allow grassing down.

Where vegetation will not prevent erosion and where practicable the affected running surface be covered with suitably compacted gravel to a depth $1\frac{1}{2}$ times the largest stones.

In the spring following construction all disturbed ground and the surface of the track be sown with at least 3 kg pelleted white clover, 1 kg yorkshire fog, 2.2 kg perennial ryegrass, 0.5 kg browntop and 250 kg molybdate, 200 sulphur superphosphate per hectare.

All precautions be taken to prevent the establishment of noxious weeds and if need be action taken to eradicate any that do establish.

The track be readily negotiable so that it is available for access and as a firebreak in times of accidental fire.

Should there be a necessity to do so, an environmental impact report must be prepared by the agency promoting the construction.

Periodic track maintenance involving repairs to culverts, water tables and running surface be regularly carried out.

In the event of instability occurring following track construction or abnormal weather appropriate remedial measures such as poplar and willow planting, additional cut outs etc. be undertaken.

The advice of the Waitaki Catchment Commission be sought should there be any doubt as to the standards of construction necessary or the remedial works required.

The following article is extracted from the report of the Government Caucus Committee on Noxious Animal Control and Related Matters, August 1974; terms of reference and recommendations.

Government Caucus Committee On Noxious Animal Control And Related Matters

Noxious animal control has been a contentious issue for a very long time and policy had become clouded by the great increase in commercial hunting, particularly helicopter hunting, over the past few years.

It was for this reason that I recommended to Government that Mr J. H. Williams MP, Mr A. E. W. Begg MP and Mr T. K. Burke MP be appointed a Caucus Committee to investigate and report on policy issues which I detailed in the terms of reference. Mr J. H. Williams led the team as Chairman and Mr P. H. Gresham, of the Commissioner for the Environment's office was appointed secretary.

The Committee sought written submissions, travelled widely and discussed particular problems with individuals and organisations able to assist in clarification of the issues. The enquiries were thorough and far-reaching and the Committee is to be complimented on the standard of the report. In view of the need to translate some of the recommendations into action I arranged for the report to be considered by my colleagues at Caucus; their reaction was favourable.

Accordingly, the report is presented to the House of Representatives as a basis for future policy.

*C. J. MOYLE,
Minister of Forests.*

TERMS OF REFERENCE

That a Government Caucus Committee be appointed for the purpose of considering:

- (a) the effect of commercial hunting, both helicopter and ground, on:
 - (i) recreational hunting;
 - (ii) safari tourist hunting;
 - (iii) the need for continued Government operations;
- (b) the adequacy of present legislation to control the game industry and whether the industry should come under the control of a Board or Authority;

- (c) the administration of the Noxious Animals Act as a means of maintaining the integrity of national parks, and of complying with the requirements of the National Parks Act 1952 for the extermination as far as possible of introduced animals, with particular reference to Fiordland National Park;
- (d) the activities of commercial tourist hunting entrepreneurs in encouraging safari type hunting on land susceptible to erosion;
- (e) whether control of noxious animals is being hindered by access problems or present tenures;
- (f) deer farming;
- (g) whether or not the situation has been reached (or is approaching) in which controlled and localized game management for recreational purposes could be considered;
- (h) whether there is any circumstances where any land owner or occupier should be permitted to assign exclusive hunting rights for any noxious animal;
- (i) the current relevancy of the provisions of the Noxious Animals Act 1956 to the control of deer and other noxious animals and the appropriateness of the Act to reflect Government policies.

RECOMMENDATIONS

- A 1. That Government control operations be continued in areas which have priority for the conservation of soil and water and in other special areas where official operations are necessary or desirable.
- B 2. That an independent licensing authority be established for the licensing of all commercial game meat hunters.
 3. That companies involved in the processing and export of game meat be invited to form an industry association.
 4. That the New Zealand Forest Service and other land administering authorities be directed to co-operate in indentifying areas of unoccupied Crown land for which the Forest Service could issue hunting permits.
- C 5. That the New Zealand Forest Service be responsible for all noxious animal control operations in National Parks through control plans drawn up by the Forest Service and approved by the Boards concerned, any disagreement being referred to the National Parks Authority. (This is the current National Parks Authority policy.)

6. That the authority to issue permits for commercial and private hunting operations in National Parks rest with the National Park Boards.
 7. That National Park Boards be empowered to delegate the issuing of permits for commercial and/or private hunting to the New Zealand Forest Service by arrangement.
 8. That a technical investigation be undertaken to provide the information necessary to establish whether it would be in the best interests of Fiordland National Park to issue additional licences for venison recovery or aerial hunting.
 9. That as appropriate these findings be incorporated into a revised noxious animal control plan for the Park.
 10. That no action be taken to remove deer in the Wapiti Block from the schedule of noxious animals in the Wildlife Act 1953, to declare the Wapiti Block a special area under section 12 of the National Parks Act 1952 or to amend section 3(2)(b) of that Act as recommended by the New Zealand Deerstalkers' Association.
 11. That the revised noxious animal control plan for Fiordland National Park contain policies for the control of animals within the Wapiti Block with the primary objective of controlling numbers to levels which will not interfere with other Park values. The 1970 Forest and Range Experiment Station Report should be used as a guide in establishing these levels.
 12. That subject to the primary objective, control policies should specifically provide for selective control concentrating on red deer and hybrid wapiti.
 13. That the Fiordland National Park Board give consideration to retaining a sub-committee which could advise on ways and means of promoting recreational hunting in the Wapiti Block both as a method of animal control and as a sport in itself.
- D 14. That safari hunting be permitted under licence on unoccupied lands of the Crown but that no operators should be given sole shooting rights. Operators to be licensed by the New Zealand Forest Service.
15. That safari hunting be permitted on Crown leasehold land but only under special leases or licences drawn up by the Land Settlement Board and containing conditions relating to the control of noxious animals approved by the New Zealand Forest Service. The terms of such leases or licences are to take into account the condition of soil, the vegetation, the

effects of issuing leases or licences or access to recreational lands of the Crown and the spread of noxious animals onto neighbouring properties.

16. That special leases or licences permitting safari hunting on occupied lands of the Crown be subject to the environmental impact assessment and reporting procedures and consideration be given to the publication of environmental impact reports prior to final approval being given by the Land Settlement Board to the lease or licence.

17. That safari hunting be permitted on land of tenures other than occupied or unoccupied Crown lands but only under licences issued by the New Zealand Forest Service. These licences are to take into account the condition of the soil, the vegetation and the effects of issuing licences on access to recreation lands of the Crown and on the spread of noxious animals onto neighbouring properties.

18. That Class VIII and Class VII land susceptible to erosion should be excluded from any lease or licence which permits tourist safari hunting on occupied lands of all tenures.

19. That the New Zealand Forest Service retain and exercise its right under the Noxious Animals Act to enter onto any land for the purpose of control of noxious animals.

20. That in accordance with the existing policy of the National Parks Authority no special rights be granted for safari tourist hunting in National Parks or Reserves.

E 21. That the registration of fire arm users with provision for the loss of use of fire arms be further investigated through discussions with outdoor sportsmen, landholders, land controlling departments and other affected groups.

22. That the investigation include a review of the Arms Act 1958, the Dog Registration Act 1955 and the Trespass Act 1968 with the objective of providing adequate security to land owners or land occupiers from trespass with gun or dog.

23. That the Government pursue an active policy of providing public access to recreational lands of the Crown by:

- (a) making finance available through the Public Works Roads Vote of the Ministry of Works and Development to county councils to assist in the construction of access roads;

- (b) having the New Zealand Forest Service identify and mark existing legal access routes through private land to State forest;
- (c) having the New Zealand Forest Service negotiate for legal access through private land to State Forest;
- (d) providing through the New Zealand Forest Service subsidies or grants to county councils for the opening up and maintenance of legal access to State forests;
- (e) having departments administering unoccupied Crown land ensure that any person or body authorised to erect a gate across a public road leading to that land fulfills his obligation under Section 145 of the Public Works Act to clearly mark the gate with the words "Public Road";
- (f) having the Department of Lands and Survey responsible for identifying and marking legal access roads and for negotiating legal access through Crown leasehold properties to recreational lands of the Crown—priority being given to cases where alternative routes are required because of existing legal routes being impracticable;
- (g) having the Department of Lands and Survey exercise its powers under Section 117 of the Land Act if agreement for public access through leasehold property cannot be reached within a reasonable period of time;
- (h) undertaking a programme of public education to
 - (i) inform the public of their rights and responsibilities when seeking access through private or leasehold land to recreational lands of the Crown;
 - (ii) inform the public of the availability of legal access routes;
 - (iii) having the New Zealand Forest Service and the Department of Lands and Survey designate proposed access roads in district planning schemes which would allow public participation through a democratic process including rights of objection and appeal.

24. That national organisations whose members have a legitimate interest in obtaining access to recreational lands of the Crown be provided legislative powers to petition local authorities for the removal of fences or obstructions across public roads.

- F 25. That the Noxious Animals in Captivity Regulations 1969 be amended:
- (a) to require that when a permit is issued to breed deer to supply carcasses for processing and sale, the holder must apply for a deer farming licence within a specified term—his permit to lapse if no licence is issued;
 - (b) to permit the farming of deer outside their feral range.
26. That the Deer Farming Regulations 1969 be amended to ensure that permits issued for deer farmers do not restrict existing legal access to public lands.
27. That New Zealand Forest Service scientists be associated with the Ministry of Agriculture and Fisheries research programme into deer farming.
28. That research into deer farming be extended to cover deer farming under free range conditions on land of low productivity.
- G 29. That Government adopt and implement a policy that all unoccupied Crown land be positively managed according to management objectives which, where appropriate, should include specific objectives relating to the control of noxious animals.
30. That for the areas mentioned below, and for others which the New Zealand Forest Service may from time to time specify control of noxious animals be through recreational hunting alone:
- (a) sambar deer in the Manawatu and Rotorua,
 - (b) white tail deer at the head of Lake Wakatipu,
 - (c) fallow deer in the Kaipara, Wanganui and Blue Mountain regions,
 - (d) rusa deer in the Galatea region,
 - (e) red deer in north west Nelson,
 - (f) red deer in the Kaimanawa Ranges.
31. That recreational hunting in these areas be a specific objective of land management.
32. That no action be taken to remove any species from the schedule of noxious animals in the Wildlife Act 1953.
33. That the Government reserve the right to re-impose commercial or official hunting should it be demonstrated that recreational hunting is inadequate in maintaining the necessary degree of control of animals.
34. That additional research and management staff and resources be provided so that the vegetation and animal popula-

tions are monitored to ensure that the effects of the latter remain within safe acceptable limits.

- H 35. That provision be inserted in the Noxious Animals Act to prohibit the sale or letting of noxious animal shooting rights or charging for access through occupied property to hunt on unoccupied lands of the Crown.
36. That there be no relaxation of Section 9 of the Noxious Animals Act concerning the Crown ownership of animals not lawfully taken.
37. That exclusive shooting rights should never be granted for any unoccupied lands of the Crown.
38. That exclusive shooting rights should never be granted over any retired Class VIII or Class VII run country whether or not the unstocked land remains part of the run. Such retired country should be taken out of the run and become unoccupied Crown land. Where appropriate the land should be incorporated into nearby or adjacent National Park or State forest.
- I 39. That the Noxious Animals Act be amended to make provision for the licensing and control of commercial hunters, for safari hunting and such other provisions as may be necessary to give the Forest Service clear responsibility for noxious animals control on land of all tenures.
40. That the Noxious Animals Act and the status of "noxious" animals be reviewed by government in three years.

—oOo—

ATTITUDES TO TOURISM

Professor Arthur T. Wilcox, Head of the Department of Recreation Resources, Colorado State University in a discussion with J. Runga. The topic of the first discussion was Attitudes to Outdoor Recreation, Review 29.

Professor, there is in New Zealand a body of opinion which favours low-key tourism, controlled at a slow rate of growth.

I think it should be controlled but I'm not sure you can guarantee a low-key approach. An important factor is that tourism has a very good economic future here. It is good money, with relatively low investments, which is useful in the national sense.*

* Approaching \$100m a year

The possibility of environmental spoilage arises.

Properly done, though, the country can benefit from tourism. I think it is poorly done at the moment but New Zealanders with their strong social approach to government are able to ensure it makes a proper job of it. The environment has been spoiled at Mt Cook and this could be so for Waikaremoana. Planned a little differently you could still accomplish the tourism without destroying the environment. Te Anau for instance is outstanding, a Tourist Hotel Corporation development beyond the park yet it takes advantage of the park facility.

This is the kind of development the Corporation should follow. Waikaremoana is not like this but it is not too late to do something about it. With Mt Cook it is too late.

The environment aside there are two more associated costs. The first is in changing the character of the people being toured upon.

There is this danger. Tourism tends to case-harden the sensibilities of the people in communities where there is this contact. This is an aspect of tourism which is very difficult to prevent.

The other is that there is created competition for resources where the indigenous population have to compete against itinerants.

The importance of this depends on what is being competed for and whether the carrying capacity of the resource will permit it. For example, the Te Anau-Milford area could be developed to take care of tremendous numbers of New Zealand tourists as well as international tourists without destroying the environment.* You could do the same thing in the Urewera but Waikaremoana is not the place to do it, whereas it is being done successfully at Taupo without destroying it for the local people.

With only three million people the carrying capacity problem is not great as far as most of the populace is concerned and in the case of most of the resources.

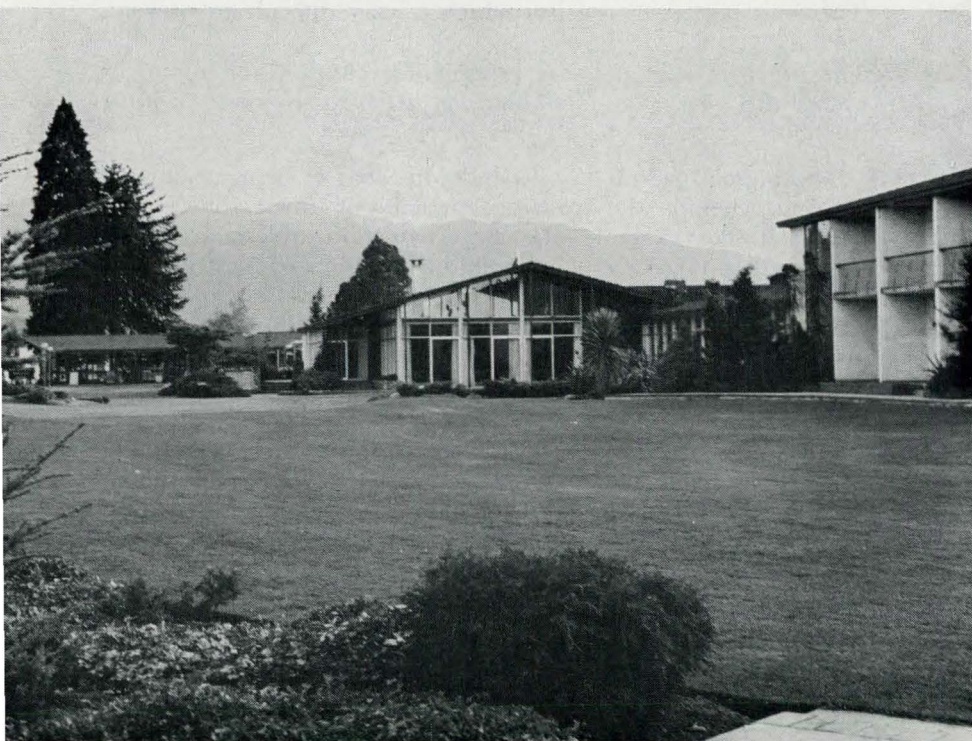
Would our resources cater for a visiting population of the same order?

* Important considerations are whether the Te Anau-Milford area would continue to hold attraction for New Zealanders while it is frequented by large numbers of people—whether New Zealanders become alienated from their own resource, and from each other by socio-economic factors created by tourism—whether such areas become “Once in a Lifetime” places to visit for the population mainstream.

Three million would not be detrimental to local resources if they were planned on a national scale. There is a weakness here. The tourist promotion organisation does not think in terms of spreading use within the total resource of the country. There is virtually no communications between promotion people and parks people. With better communications and more national planning you could do a tremendous job. Right now you are wearing out the Waitomo Caves because everybody who comes to New Zealand has to see them and they're just being eaten to death. I was shocked at the heavy use that goes through the caves.

The THC hotel complex, Te Anau. "Development beyond the Park yet it takes advantage of the park facility."

(Photo: G. A. Dunbar)



As the population grows so might the carrying capacity grow. Is there a finite correlation here?

Yes, although three million is just a guess. There is also a correlation between ground transport organisation and air services. Tourism has to relate to air travel versus ground travel especially in terms of capital allocations. Air travel is by far the more flexible service. If, for instance, you provided 100,000 buses you would need a long season to afford the level of capital investment. So it is a bigger problem than just wearing out Waitomo or something specific.

We ought to be concerned about wearing out national character, this at least should survive tourism, yet I notice that Sir Albert Henry, premier of the Cook Islands, fears tourism for this very reason.

You should be very much afraid of this. You are losing national character in Auckland and Wellington now.

Is this the main limiting factor to an overgrowth in tourism?

It might be. You might call this psychological carrying capacity and the effect is to destroy the people resource.

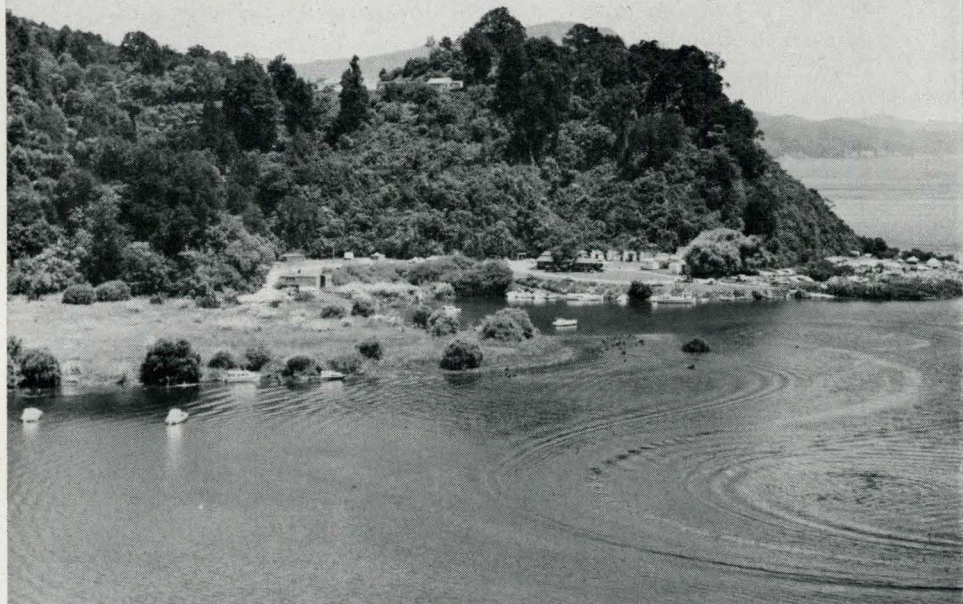
There appears to be a case for determining what is wanted as a national character and then measuring the influence of tourism on it.

I agree. For instance, parts of Indonesia have reached this critical point where the national character has been altered, disembowelled by tourism. The irony of it is that these places lose their attraction. Their romance is lost.

How is such a problem to be researched?

This is a natural resource problem and a social resource problem. It is an area of research beyond the capabilities of the natural resource organisations in New Zealand without regrouping and getting in a lot of sociology and psychology skill.

Our department has been for several years studying the effects of tourism on the Navaho. We haven't done any real research because of the sensitivity of the Navaho to it, so that the research there has been simply discussing the matter with knowledgeable people. The idea was to determine what represents an acceptable level of contact with tourists before the values that people hold are changed too much. The other question is what value is being lost to the tourist. We've come up with few good answers.



Suburbia creep, albeit a motor camp. Lake Waikaremoana, Nov. 1968.
In danger of becoming a sea of ruffled waters. (Photo: R. Anderson,
courtesy National Publicity Studio)

"The essence of this sacredness is an environment which is unassailable."
(Wilcox, Review 29, p 42.) Panekiri Bluff, Lake Waikaremoana, Feb. 1972.
(Photo: G. Hutchinson, courtesy National Publicity Studio)



How important is it to research the sociological problems?

Very important. But it is difficult in that change itself is desirable culturally, and part of that change is towards an international common base which tends to be an European-American base. What constitutes national culture is itself changeable. The fact that the cultural pressures, particularly in Auckland and to lesser extent in Wellington are beginning to be felt and are being accepted as desirable is part of this. The change in Auckland is so marked that it makes that area less attractive for the tourist so that he chooses instead to go to the Urewera or Gisborne or Rotorua. What represents change in Maori culture as opposed to New Zealand culture generally? What is being kept are the superficial things very much as with Indian culture, the song and dance routine, while some of the more fundamental aspects are being lost.

One of these is reverence toward nature especially in the sense of attachment to wilderness. This sacredness is one of the culture values in danger of being lost under the weight of tourism and hyper-active recreation.

The Urewera is the case in point, but I have the feeling that because of the geography of Waikaremoana it is lost in the sense of trying to protect this value to any high degree. But you could do a marvellous job in the Ruatahuna community which is virtually in the park. It is a wilderness situation except that the road goes through it. The Whakatane side might be included in such a scheme. Here is where the Maori feel can be promoted as an absolute requirement of the use of the park. Geographically you can do it because you have control. I look upon the Urewera as the Maori National Park. Tongariro has lost it except in the historical sense, but how do you honour the Maori feel toward Lake Waikaremoana if you have blokes with motorboats and want to use them there? I can see all kinds of specific things you *can* do such as certain islands are sacred because they are grave sites, but as I ride through New Zealand and see the desecration of old cemeteries, anyone's cemetery, a strong sense of tapu is pretty distant. But Hawaii accepts the concept of tapu and I think this should be incorporated in New Zealand culture as a matter of course.

THE SNOW OF AUGUST 1973

Compiled by J. G. Hughes,
Tussock Grasslands and Mountain Lands Institute.

From 5th - 7th August, 1973, heavy snow up to 130 cm (51 in.) deep fell on the upper plains and foothills of Canterbury and North Otago as far south as Middlemarch in a band about 32 km (20 miles) wide. Drifts were reported up to 6 m deep. The snow was accompanied by very heavy rain and high winds in some places. The storm caused the death of at least 133,193 sheep and 4137 cattle—more than twice as many as the November 1967 snow. In addition, there was widespread disruption of power and telephone services as great lengths of line were brought down. To repair them and to clear roads for access was a mammoth task for men and machines. For the first time helicopters played an extensive role.

The Institute has gathered reports of relief operations from almost every organisation involved, and is publishing these separately with recommendations for improvements in dealing with future disasters. This article is a summary of the event.

THE STORM

Sequence of Events

Starting in the early morning hours of Sunday, 5th August, 1973, rainfall from a deep convective cloud mass moved over North Otago and Canterbury from the south and west. By 6 p.m. it had spread over all Canterbury except the area near and on Banks Peninsula. The rain gradually turned to snow at varying times in varying places. Snow began to fall about mid-Sunday afternoon in Canterbury.

The strong and cold south-easterly wind flowing over the coast of Canterbury and North Otago (measured at 50 m.p.h. at Timaru airport) was partly blocked from crossing the Southern Alps by the alps themselves and by upper level winds. Thus the low-level south-east winds were diverted, one arm flowing south over Lindis Pass as a northerly wind and the other north-east as a south-westerly wind.

We expect publication late May 1975 of the full report compiled by J. G. Hughes "THE SNOW OF AUGUST 1973". More than 280 pages of illustrated record, analysis of effects and lessons to be learned. Copies may be ordered in advance at the price of \$4.00 posted. TGMLI Spec. Publ. No. 10.

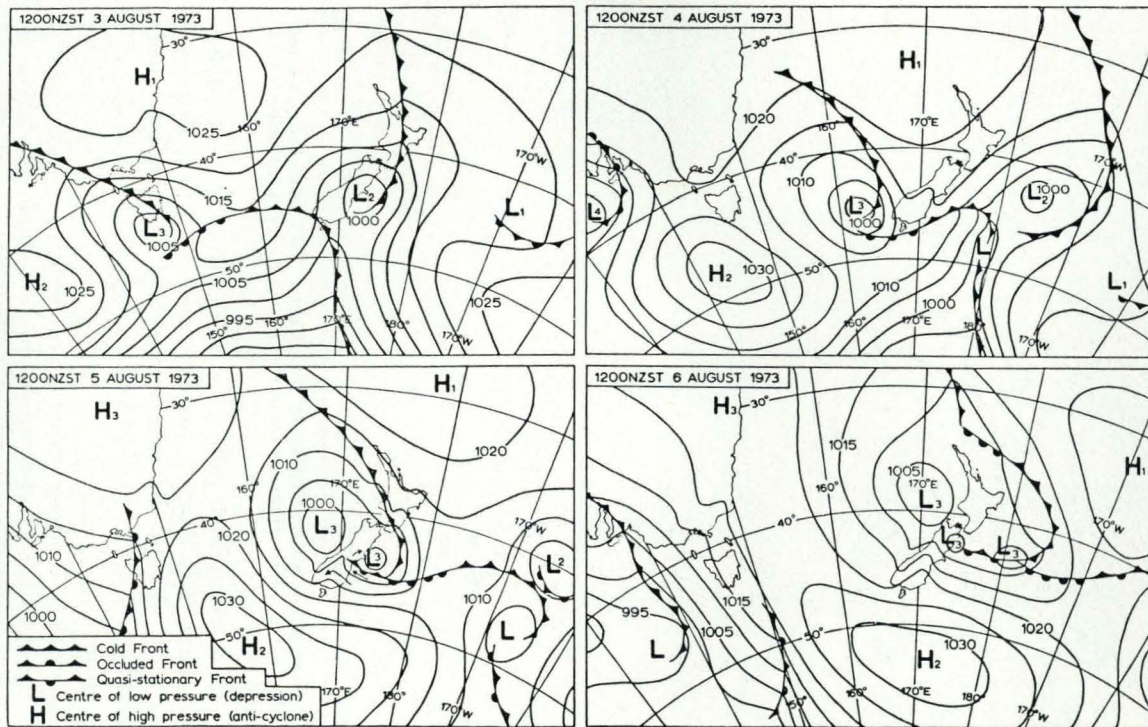


Figure 1: The Weather Pattern 3 to 6 August 1973. (Isobaric values in millibars. Subscripts have been put on the H and L centres so that they can be traced through the four days.)

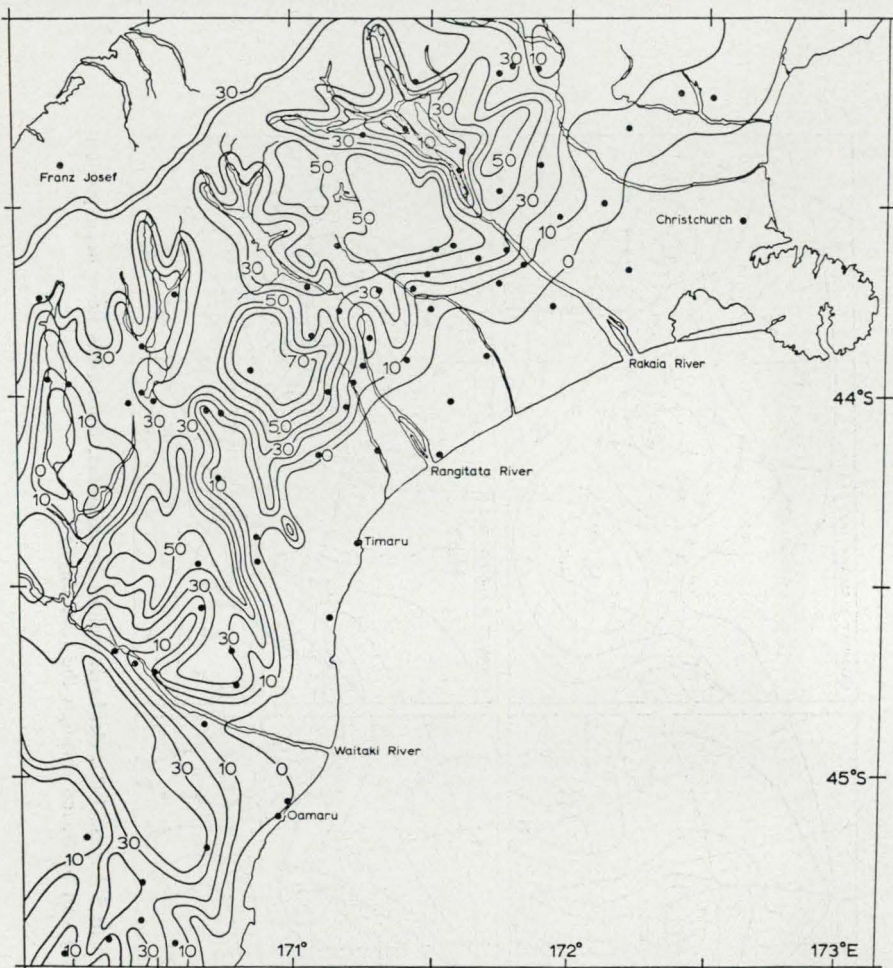


Figure 2: Maximum Snow Depths in the August 1973 Snowfall. (Values are at 25 cm (10 inch) intervals and the observations were adjusted to time of fall.)

The snow continued falling at low altitudes until about Monday night, 6th August, but persisted at higher altitudes, finally giving way to showers of rain and sleet which lasted until the morning of 8th August.

Snow Depth

The amount of drifting varied from region to region depending on the strength of the wind and the topography. Where the winds diverged they were weak and there was little drifting of snow, as for instance at Fairlie. Elsewhere snow drifted up to 6 m (20 ft) deep as at Lilybank Station.

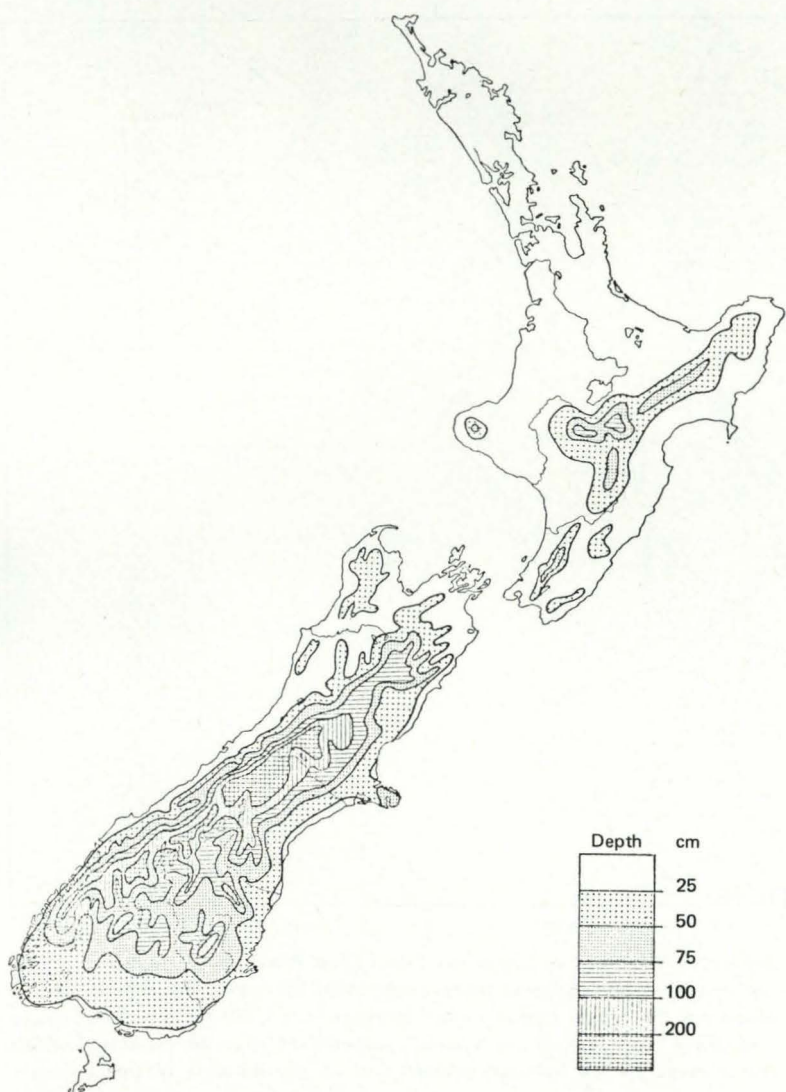


Figure 3: Maximum Snow Depths to be Expected Once in Fifty Years. (Based on data 1862 to 1973 inclusive.)

The depth of snow is shown in Figure 2. The greatest depth fell on the eastern slopes of the foothills of the Southern Alps. Much less fell on the western slopes and indeed the western Mackenzie Basin was sheltered from the storm and relatively snow free.

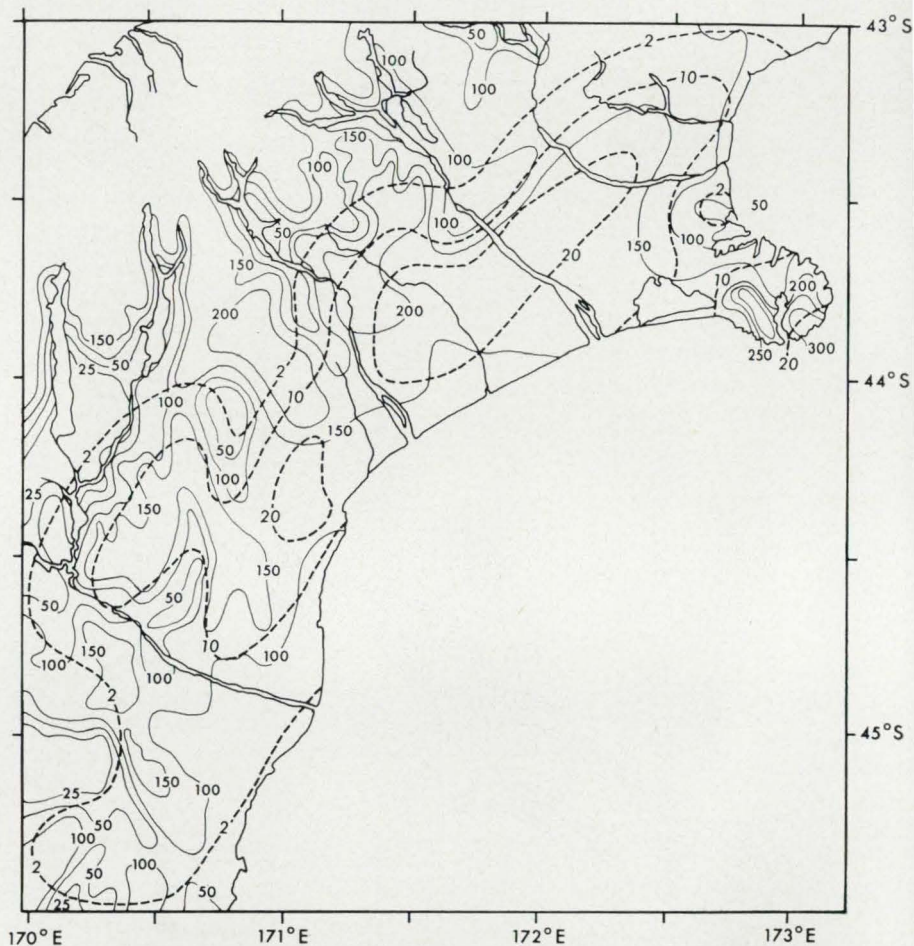
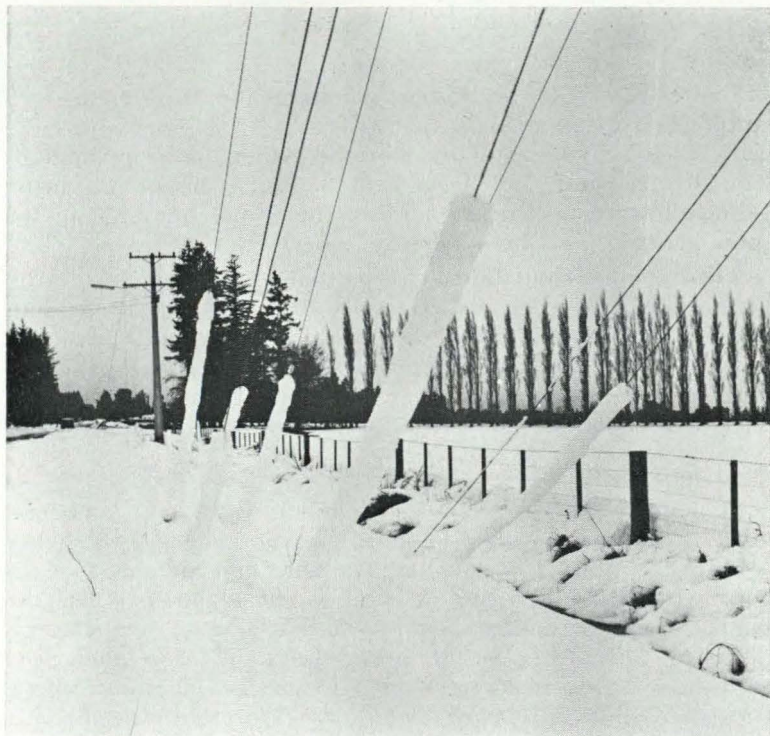


Figure 4. The total precipitation (mm) from 9 a.m. on 5 August to 9 a.m. on 8 August. (Solid lines, values from 25 to 300 mm.) Also shown (dashed lines) are the return period values in years (2, 10, 20) for this precipitation and these lines, based on values computed at over 40 stations, indicate the average period between occurrences of precipitation of this intensity.

Features of the Snow

Total precipitation from both rain and snow was very high in this storm. In some places it is estimated to have been a once-in-50 years amount. For instance at Winchmore 170 mm (c. 7 in.) fell in 48 hours. At Hororata, the return period was more than 20 years.



Wet snow and freezing temperatures caused heavy snow accumulation on power lines.
(Photo: N.Z. Post Office, Timaru)

It has been stated that if the temperature and dewpoint of the air had been just 2-3°C higher, precipitation would have fallen as heavy rain instead of snow. The snow was denser at low altitudes (3-4 grams per cubic centimetre) than at high (0.8-1.0 g/cm³). Put simply, a foot of low-altitude snow would have been equivalent to about 4 inches of water and a foot of high-altitude snow equivalent to about 1 inch of water.

The heavy snow accumulation on power lines at low altitude was due to its wetness, to the air temperature being just below freezing allowing the snow to stick, and to the high wind.

Forecasting

Predicting that this event would be an extreme one was difficult because of the lack of data about high level atmospheric conditions and because the weather came from an area of few reports. Also, quite small changes in windflow pattern and air temperature can have large effects on snow depth.

EFFECT ON LIVESTOCK

Deaths

Figures received from district officers of the Ministry of Agriculture and Fisheries show that at least 133,193 sheep and 4,137 cattle died as a result of the storm, whether due from snow or from strong winds and heavy rain. Several farms in Ashburton County lost 20 percent or more of their stock but most in the snow zone lost about 5 percent.

Two factors contributed to the large numbers of deaths. First, there had been an unusually dry summer and autumn in much of Canterbury, and ewes generally went into the winter in light condition. Second, pre-lamb shearing was taking place on plains properties, many with inadequate post-shearing feed because of the lack of autumn growth.

Pre-Lamb Shearing

Pre-lamb shearing of ewes will undoubtedly help lamb survival in adverse weather because ewes normally go to shelter—but they must have shelter available and enough food to cope with their increased demand for heat and to suckle the lamb. Newly-shorn sheep on full feed can stand temperatures down to -5°C (23°F , or 9°F below freezing) before they need to draw on body reserves in order to survive, but the temperature need only fall below 20°C (68°F) for shorn sheep on a *maintenance* ration to have to draw on their reserves. (see *Review 14*, p.5).

Pre-lamb shorn ewes must have feed and shelter, off shears.

(Photo: Bremford's Studios)



In extreme weather such as this snow, shorn ewes, especially machine-shorn ewes, are at a disadvantage because they cannot keep as warm as fully-woolled ewes. Two of the few factors in their favour are their greater mobility and lower weight of cold wet wool to carry. In other words, in bad weather pre-lamb shearing favours the lamb but not the ewe, while leaving ewes woolly favours the ewe but not the lamb. In very bad weather, lamb survival depends on ewe survival and the woolly sheep is more likely to be the survivor. As so many farmers found out, pre-lamb shearing is a gamble which pays off in lamb survival in most winters if sheep have enough food and shelter; but the combination of food shortage, exposure, and heavy rain or driving snow is lethal.

Stock Health

In Malvern County, the Ministry of Agriculture and Fisheries Animal Health Division sent four teams of staff to visit 72 farms on 14th August and three teams on 15th to inspect stock and advise on animal health and treatment. Elsewhere Ministry veterinarians and instructors gave similar service. Federated Farmers persuaded the Government to fly from the North Island by R.N.Z.A.F. Hercules some 3,000 gallons of glucose-sparing substances such as Ketol and Glysatone.

Farmers made interesting comments about stock health in their replies to a survey by the Darfield office of the Ministry of Agriculture and Fisheries. They emphasised:

- (1) Only sheep rescued in the first week survived—and then only some of them. Early access to stock was very important.
- (2) Greenfeed cereals or saved short-rotation ryegrass were the best medicine to aid recovery but early use was important. Ample turnips and nuts or good quality hay helped although the latter seemed more successful with cattle than with sheep.
- (3) Both sheep and cattle needed food within two days to be fairly sure of survival.
- (4) Shearing sheep after the snow and putting them on to greenfeed appeared to aid recovery.



Digging sheep out of the snow and providing hay. The Acheron.

- (5) Glucose-sparing substances (that is substances which help the ewe to avoid using its own reserves of glucose) such as Ketol and Glysatone which contain propylene glycol were important aids to the recovery of affected animals. Treatment with chemicals was unsuccessful unless saved grains or greenfeed were also available.
- (6) "Sleepy sickness" could be cured only if treatment began before animals lost mobility.
- (7) Dehydration of animals was a risk, especially on a diet of hay or nuts.
- (8) There was a high abortion rate amongst affected sheep (in one case 400-500 lambs from 1300 ewes mated) and to a lesser extent amongst cattle. Abortions still occurred several weeks after the storm.
- (9) Many sheep and some cattle died of chills and pneumonia from exposure, smothering, drowning, and avalanches as well as from metabolic diseases.
- (10) Reduced milk supply from both cows and ewes hampered calf and lamb survival.
- (11) Sheep continued to die weeks after the event.
- (12) Border Leicester ewes were more active than Romney ewes in the snow and survived better where it was deep.



The helicopter—proved its versatility in snow disaster relief.
(Photo: Bremford's Studios)

Future Precautions

J. L. Baker, a veterinarian, writing in *Journal of Agriculture*, July 1974, says that ewes died not only from pregnancy toxaemia (or sleepy sickness) and chills and pneumonia, but also from milk fever. He recommended that any sheep which appears listless should be drenched at once with a substance such as Ketol or Glystatone and injected with calcium borogluconate and penicillin. Ample supplies of these chemicals should always be held by farmers in snow-prone regions.

STOCK RESCUE

Responsibilities

The task of organising stock rescue fell primarily to the Ministry of Agriculture and Fisheries. The following is a list of their rescue headquarters:

1. North of Waimakariri River: Rangiora M.A.F.
2. Malvern County: Darfield M.A.F. and temporary sub-branch at Hororata.
3. Ashburton County: M.A.F., temporary sub-branch of Ashburton office set up in Pyne Gould Guinness Ltd offices at Mayfield and Methven.
4. Geraldine County: M.A.F., temporary sub-branch of Timaru office set up in Geraldine County Council office.

5. Mackenzie County: Fairlie M.A.F. east of Burkes Pass; Waitaki Catchment Commission's Tekapo regional office west of Burkes Pass.
6. Waimate County except Hakataramea Valley: Waihaorunga temporary sub-branch of Waimate office.
7. Waitaki County and Hakataramea Valley: Oamaru M.A.F.; Waitaki Catchment Commission at Kurow, and Lands and Survey Department's Highland Farm Settlement manager at Cattle Creek.

Initial decisions about organising help were usually made by the local Farm Advisory Officer of the Ministry. The Ministry soon convened meetings of Disaster Relief Committees centred at Darfield, Ashburton, Timaru, Kurow, and Oamaru. The first meetings defined disaster areas, and usually confirmed the early actions of the Farm Advisory Officer and appointed him rescue co-ordinator, but in one instance—at Methven—a Federated Farmers member assumed this role. At Kurow, in the early absence of Ministry officers, Disaster Relief Committee members from Hakataramea Valley organised the hiring of bulldozers for snow clearing on farms.

A fleet of Army 4-wheel drive 3-ton R.L. Bedfords of high capability in mud and slush, were effective on stock feed cartage and general relief.

(Photo: N.Z. Army)



Action

The first action by the district co-ordinator was to assess the severity of the disaster. Where possible this was done by vehicle (in Darfield district by following a grader) but access by this means was usually limited, and fixed-wing aircraft or helicopters were hired. When the magnitude of the problem was seen, Ministry staff on behalf of the Disaster Committees began hiring bulldozers, asking for R.N.Z.A.F. helicopters and the right to hire private machines, asking for Army heavy trucks and personnel, directing manpower to properties for stock rescue and arranging stock transport and placement. Local farmer leaders, Catchment Board staff, and private farm advisers usually helped with this organising.

To give some idea of the scale of relief services needed, in Ashburton County alone there were some 300 farmers, 20 run-holders, and 1,000,000 sheep above the snowline. Initially many farmers seemed stunned by the disaster. This exhibited itself either as apparent lack of concern at the situation, or indecision as to what to do. It was noticeable in the Geraldine district for instance that only a few farmers took immediate action and that it was not until Wednesday that requests for help really poured in to the emergency office.

Bulldozers

Bulldozers were the key to getting access to stock and feed and for clearing areas of greenfeed and pasture on flat and easy hill country. Apart from farmers' own machines, 32 contractors' bulldozers were hired in the Fairlie district and another 8 in the Tekapo area. Twenty-four bulldozers were hired in the Hakataramea Valley and 16 in Ashburton County.

Aircraft

Although a few early flights were made in fixed-wing planes for spotting, it was the helicopter which proved its versatility in snow disaster relief activities. Some private hirings of helicopters were made by farmers themselves. Similar payment of Government subsidy on their cost was later made for these as for those hired officially. However, most hiring and organising of the activities of private helicopters, and local liaison with R.N.Z.A.F. helicopters was made through the Disaster Relief

Committees. Requests for R.N.Z.A.F. services were made through the Ministry of Agriculture and Fisheries regional office in Christchurch. The following list gives the maximum number of machines operating in any district at any one time:

Malvern County — 3 R.N.Z.A.F., 3 private
Ashburton County — 1 R.N.Z.A.F., 4 private
Geraldine County — 1 R.N.Z.A.F., 3 private
Mackenzie County — 2 R.N.Z.A.F., 5 private
Lower Waimate County — 2 R.N.Z.A.F., 2 private
Waitaki County and Haka' Valley — 2 private

A total of four R.N.Z.A.F. helicopters and two Devon aircraft from Auckland and Wigram was used with support personnel. The helicopters flew 149 hours on 424 tasks from 8-13 August. The Air Force men worked on average $15\frac{1}{2}$ hour days. Private helicopters continued disaster relief until 23 August. The priority for helicopter use established in the North Otago/Haka' Valley area was:

first: reconnaissance spotting
second: lifting hay to trapped cows and calves
third: ferrying of men for snow-raking

At most emergency bases Ministry of Agriculture and Fisheries staff acted as task setters for helicopters, but communication with the machines was not always satisfactory. In Mackenzie County too, there were reported to be problems keeping private helicopters to a timetable. One machine ordered for reconnaissance at 2 p.m. on Tuesday did not arrive until about 5 p.m. on Wednesday!

Army

New Zealand Army gave invaluable help both with tracked vehicles in the Malvern County for motorist rescue and access to stock, and here and elsewhere with signallers, drivers and other help. It used four M113-type and one M548 tracked vehicles and 73 Landrovers and 3-ton trucks. These were used as follows in support of:

Ministry of Agriculture and Fisheries	5950 hours
Ashburton Electric Power Board	235
Search and Rescue Air Crash	34
Central Canterbury Electric Power Board	160
New Zealand Post Office	20
New Zealand Police	10
	<hr/>
	6409
	<hr/>

The Landrovers and trucks ran a total of over 31,000 miles on disaster relief. In Ashburton County alone, the Army provided 27 trucks and 50 men. The high 4-wheel drive R.L. Bedfords were very successful at traversing deep snow and were used principally for carting feed to livestock and for carrying volunteers to otherwise inaccessible properties for snowraking. The Army signallers, with their Airforce counterparts, provided communication from emergency bases to bulldozers and helicopters. For instance, the Army sent seven mobile units to Fairlie. Even where telephone services were intact or had been repaired, radio contact with machines was a more effective method of communication since there was often no-one at home-steads to take telephone calls and the machines were usually working well away from them anyway.

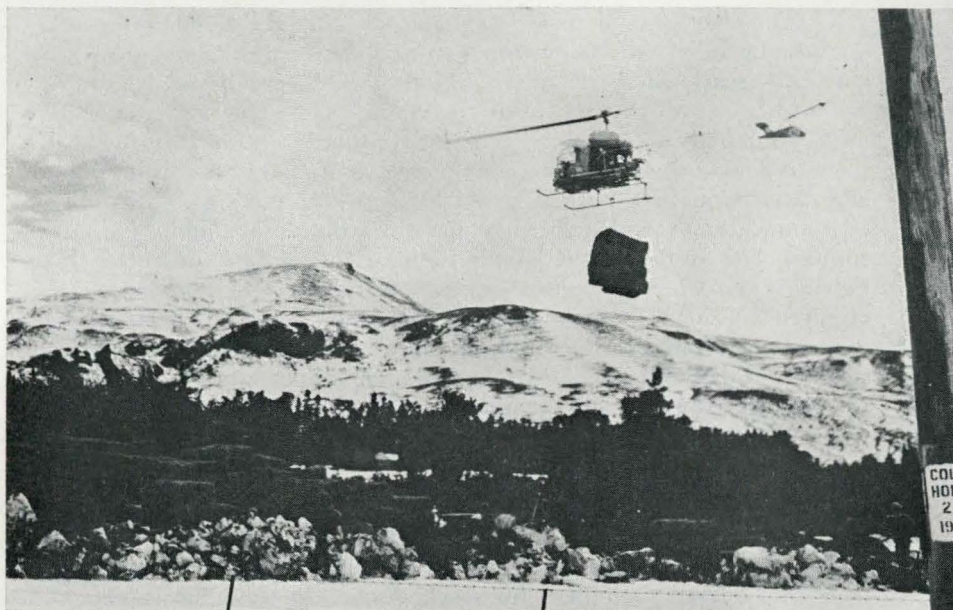
Labour

One of the features of the disaster was the number of volunteers who offered their help for stock rescue. At least 200 came forward in Malvern County, 200 in Ashburton, 100 in Geraldine, and 200 in Mackenzie County. Although many were down-country farmers, many more were from ski clubs, mountaineering clubs, deerstalker groups, Ministry of Works at Twizel, a motor-cycle club and rugby clubs.

Not only were their efforts at rescuing stock helpful and appreciated, but the goodwill engendered between town and country was an unexpected side benefit. Mobile Red Cross disaster relief teams helped provide hot food and drinks for relief workers in many areas.

Stock Feeding

Big quantities of hay were distributed to where supplies were short. But it soon became obvious that with deep snow persisting, surviving stock would have to be taken down country to get food and be dried out if many more were not to die. Accordingly, from about 11-12th August onwards, as soon as roads were cleared, sheep and some cattle were brought out on rough tracks to stock trucks and ferried away. With little pasture down-country after the summer drought, only the fortunate few were able to get good grazing. Most were put on rough grazing blocks or on pads and fed hay bought or donated.



The rope sling proved the quickest method of lifting hay.

Large quantities of hay were given. Darfield office of the Ministry of Agriculture and Fisheries alone received offers of 7,000 bales free within the first six days after the storm. The size of the stock-transport operation can be seen when 50,000 sheep were moved from the Fairlie district in the week beginning 13th August. In Ashburton County a total of 200,000 sheep and 500 cattle were trucked down from the snow.

Communications Problems

One of the greatest problems faced by Ministry of Agriculture and Fisheries staff was lack of communication, both vehicular and by radio. Four-wheel drive vehicles had to be authorised and hired, or borrowed from farmers or Catchment Boards. The Christchurch 4-wheel Drive Club also helped with their machines. No Ministry offices had radio telephones and here again the help of Catchment Boards, and where available, County sets was sought. Army and Airforce signallers were also brought in as has been described. The Canterbury Citizens Band Radio Club provided sets and relay services. There seems to have been few prior arrangements made to have radiotelephones available in such an emergency and there was initial uncertainty and delay in getting them.

Winding Down

In most districts the pressure on emergency base staff began to ease by about 14-16th and outlying sub-branches were closed. However, rescue activity continued until about 23rd - 24th August.

Disaster Relief Committees

While members of these committees were heavily involved in deploying rescue services, the committees themselves in their early meetings spent most of their time seeking financial assistance from the Government for disaster relief.

The Government agreed to pay:

1. Half the on-farm cost of helicopters and personnel.
2. Half the cost of helicopter ferrytime from base to emergency headquarters.
3. Helicopter ferry costs between properties within the disaster area and cost of reconnaissance.
4. Subsidy on hay cartage up to \$10 per ton.
5. Stock cartage one way up to 100 miles by commercial operators.
6. Half the cost of Army vehicles and personnel.
7. Half the cost of Army travel from base to emergency headquarters.
8. Full cost of ferrying bulldozers between properties.
9. Half the on-farm cost of bulldozing for contractors only.
10. Half the cost of having County plant and local contractors bury carcasses.

It was not willing to pay:

1. All helicopter ferry costs to the disaster headquarters.
2. Half bulldozer costs of farmers working on other farmers' properties.
3. Ferrying time for bulldozers.
4. Two-way cost of carting stock.
5. Cartage of root crops or other fodder to maximum of \$10 per ton.
6. Full cost of Army operations.

The Government also would not agree to guarantee bank overdrafts. It considered that the State Advances Corporation loans and later the suspensory loan available to farmers in severe financial hardship as a result of adverse climatic events were enough.

The South Canterbury Disaster Relief Committee also resolved to encourage County Councils, Pest Destruction Boards and Department of Lands and Survey to consider rate and rent relief but this proved unnecessary in that area.

Later meetings of the Committees were mainly concerned with approving claims for Government financial aid.

The Farm Advisory officer at Ashburton must have expressed the wish of many when, after noting the tremendous amount of voluntary help in machinery, labour, feed and fuel given by the community itself to those less fortunate within it, he said that this kind of self help rated every assistance possible. He considered that farmers' requests for assistance were reasonable and in a disaster of this magnitude, it would be justifiable to expect the full cost of emergency operations to be met by the Government.

DAMAGE TO TREES

There was widespread damage to trees in State Forests. The wet adhesive snow stayed in the crowns of mountain beech trees and caused extensive canopy damage in some areas along the foothills. Forest Service estimated that about 30 percent of the beech trees in Coopers Creek and Blowhard Track areas were damaged and of these some 6 percent had suffered permanent damage. However, in Craigieburn Forest, fewer trees were damaged than in the November 1967 snow when 6 percent suffered.

In exotic plantations, there were three bands of damage:

- (1) Toppling of trees up to 6 feet tall, corrected by tying them back with twine.
- (2) Partial snow damage when areas of older trees had been bent over or broken off but sufficient stayed straight to make a crop.
- (3) Total snow damage when there was almost complete throw or breakage.

The three classes more or less correspond to light, moderate and heavy severity of damage.

Canterbury Forests Damaged

	Light (ha)	Moderate (ha)	Heavy (ha)
Omihi	8.4	28.1	32.5
Ashley	55.2	86.1	27.8
Mt Thomas	125.2	0	0
View Hill	20.9	0	0
Kakahu (Geraldine)	72.8	15.7	29.1
	<hr/> 282.5 ha	<hr/> 129.9 ha	<hr/> 89.4 ha
	(698 ac)	(321 ac)	(221 ac)

Damage seemed to be worst on northern or lee slopes where deep snow built up on the canopy.

At Kakahu Forest 180 ac of trees needed propping and tying. A further 66 ac were beyond salvage.

Forest Service found at Ashley that the heaviest damage occurred in the closest (4 x 4 - 8 x 8) planting. There was only light damage in 12 x 12 and 16 x 16 planting. It has been observed that pruning and thinning help survival in snow not only by opening up the forest canopy but also by altering the growth form of trees.

The experience at Kakahu Forest was that *Pinus radiata* was the most damaged species. Douglas fir, poplars, Corsican pine, and *Thuya plicata* suffered only minor damage, although small areas of Douglas fir suffered severe damage in North Canterbury plantings. At View Hill Forest, two to three times more unpruned trees were damaged than pruned trees. In an unpruned compartment, 20 percent were damaged by toppling and a further 4 percent had broken tops or branch damage. More toppling occurred in swampy areas than elsewhere. Toppling in Ashley and Omihi Forests appeared to occur more in younger trees. Older trees suffered largely broken-out crowns.

DAMAGE TO BUILDINGS

Claims

The Earthquake and War Damage Commission received claims involving 600 farm buildings on 327 properties. The cost of claims on the buildings and their contents was \$200,000 of which 46 percent were for sums over \$500. A few claims were over \$5,000. Many claims were declined because of sub-standard



Snow to 1.5 metres lay on Dry Creek Station yet there was virtually no damage to the woolshed. Note roof pitch which allows snow to slide to some extent. (Photo: T. H. Donaldson)

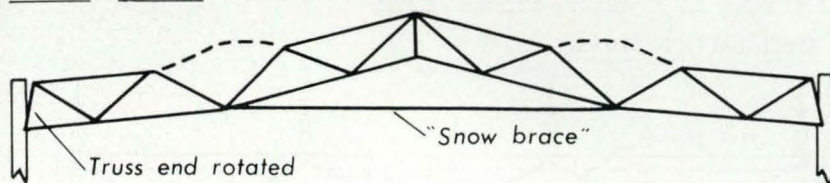
construction, lack of repair and maintenance, or unwise site selection. The Commission was critical of the standard of construction accepted by some local authorities when issuing building permits. It noted, too, the problem of steel-framed structures designed to meet minimum requirements at low cost. These buildings often failed on exposed sites.

Structural Investigation

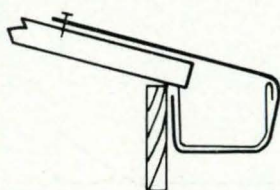
G. C. Pinnell, an engineer with the Ministry of Agriculture and Fisheries, investigated the construction of buildings damaged during the snow. He found that the most common causes of structural failure were:

1. web member compression failure in steel lattice trusses (size too small);
2. top chord compression failure in steel lattice trusses (size too small);
3. timber beams failing in bending (often due to low grade or undersize timber);
4. inferior joint fastening in timber frames (e.g. too few nails);
5. rotten or borer-infested wood;
6. changes in roof pitch (snow from steep roof slid on to lean-to roof) and roof height (changes in height caused eddyding);
7. superficial damage such as loss of spouting (it was found best to place spouting slightly below the line of the roof).

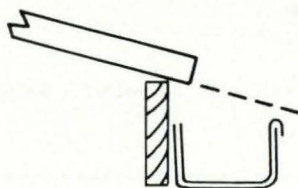
Failure in a Gable Roof-truss with Snow Brace



Spouting details



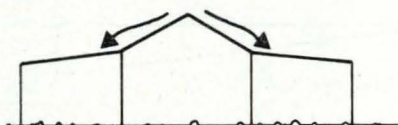
Spouting with snow brace



Spouting below roof line

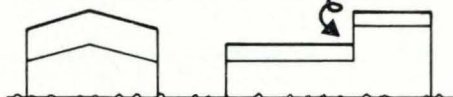
Effect of Roof Shape

Snow slid off gable



Change in slope of roof

Wind eddy

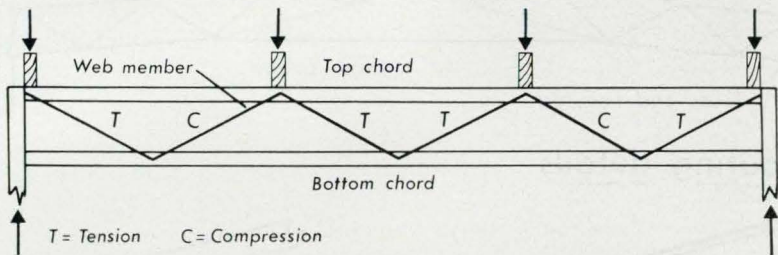


Change in height of roof

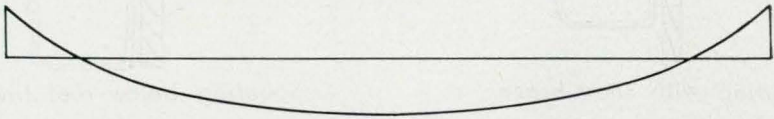
He studied existing building codes, and New Zealand and overseas papers on snow effects on buildings. He discovered that the density of snow used in calculating weights of snow on structures was only about half that of the common density in New Zealand. Also he found that the New Zealand codes had no information on design snow loadings to be used for a particular shape of building in a particular region. As a result he recommended that buildings in high snow-risk areas be more strongly constructed. He calculated that a farm implement shed could be designed to withstand a 2.5 times increase in presently-permitted snow load for only an extra \$100 or 4 percent of erected cost.

Failures in a Steel Lattice Truss

STEEL LATTICE TRUSS

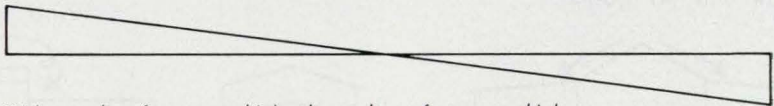


BENDING MOMENT (Beam analogy)



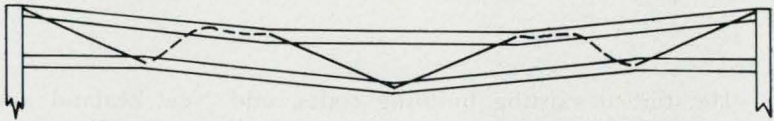
Chord forces are high where bending moments are high

SHEAR FORCE (Beam analogy)

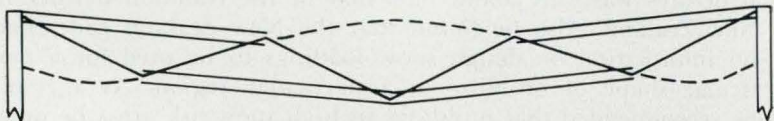


Web member forces are high where shear forces are high

WEB BUCKLING



CHORD BUCKLING



Bottom chord buckled or truss end rotated



Homesteads snowbound.

(Photo: N.Z. Post Office, Timaru)

Sheds damaged. (High Peak Station which experienced the greatest fall.)

(Photo: R. L. Bennetts, transparency)



DAMAGE TO FENCES

Many miles of fence were damaged during the storm—mostly by snow but some by bulldozers. Avalanching of snow off steep slopes caused massive destruction to some fences, but in addition to this, wires were slackened and broken, and posts and standards displaced on fences throughout the affected region.

Comments made by staff of Catchment Authorities were:

1. Frequent breaks in barbed wire raise doubts about its suitability for snow areas. When merely stretched, untying, re-straining and re-tying is slow. Since it is attached to all standards and posts, excess strain in the barbed wire can affect a large number of uprights.
2. Driven posts were superior to hand-rammed posts.
3. Wires should be attached on the down-slope side of posts.
4. Posts liable to be lifted should be well tied down.
5. 12½g high tensile wire stood up to exceptional stress at least as well as No. 8 gauge wire; especially if not strained too tight.
6. "Waratah" type standards stood downslope pressure better than flat standards.
7. Wires should be able to move freely through holes in standards and posts.
8. The quality of tie-back and stay construction is critical to fence strength.
9. On hill slopes, intermediate strainer posts should be stayed or tied against both the direction of wire strain and gravity.
10. Footplates are advisable on standards and T-irons crossing soft ground to stop them sinking and improve fence stability.
11. Siting of fences is very important.
12. Fabric netting fences stood up to snow surprisingly well.
13. Failure occurred often at so-called "permanent" cogdrum individual wire strainers.
14. "Soil-conservation type" fences stood up to snow in general better than conventional type fences. They were also comparatively easy to repair.

ACCESS

Organisation of Clearing Roads

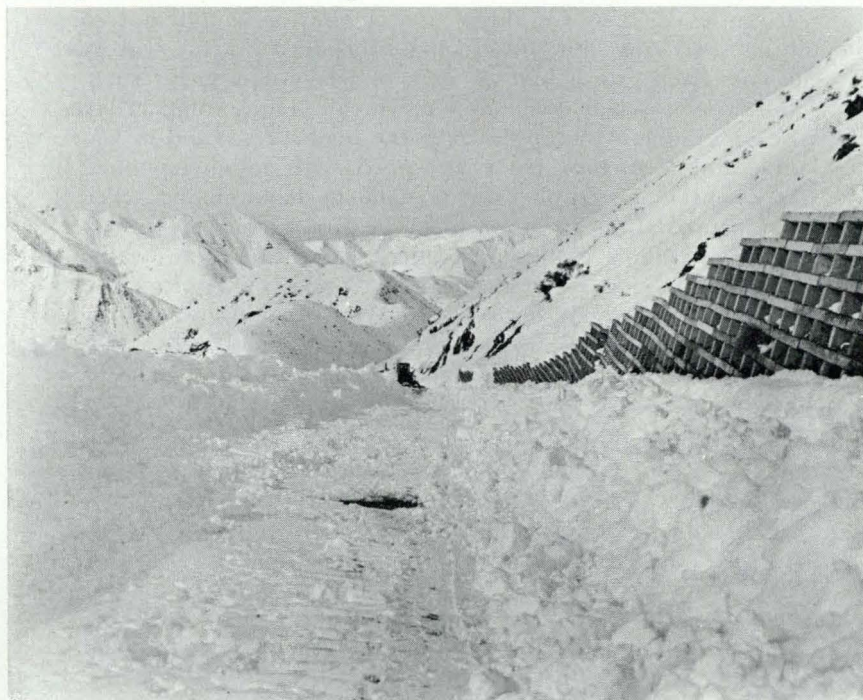
From early on the Monday morning, County and Ministry of Works staff realised that they had a major snow clearing job ahead of them. Aerial inspection, where possible, confirmed it. In Ashburton County alone, 480 miles of road became blocked. Most Counties set up control centres. These could have, as in Geraldine, radiotelephone and telephone communications and a masterplan of the County for plotting the location



Relief work held up by one-way tracks in the snow. Passing bays become priority in stock rescue.
(Photo: N.Z. Post Office, Timaru)

Clearing Porters Pass on 8th August.

(Photo: Ministry of Works)



of staff and plant with coloured pins, and colour banding to show roads cleared. Radiotelephone link with gangs proved to be invaluable not only to locate plant and monitor progress but to keep up staff morale. It has been suggested that dual-frequency equipment would reduce the risk of failure of single-frequency equipment if power failed at a repeater station.

Geraldine County emphasised the importance of starting to clear snow with snowploughs or graders as soon as it began to fall before it had a chance to consolidate and freeze. However, such was the rate of buildup that even Ministry of Works plant was unable to keep highways open when the snow was at its heaviest. On the Pigroot many motorists were stranded for up to 9 hours. On Porters Pass clearing became a race against time to rescue 22 motorists trapped since Sunday in cars. Eventually Army tracked vehicles succeeded in reaching them on the Tuesday. A U.S. Army Antarctic-equipped D8 bulldozer also gave valuable service in this area.

Plant

Counties such as Geraldine and Ashburton found that combining their own and hired plant into "task forces" was most efficient. Each group had an item of heavy equipment such as a bulldozer to clear deep snow down to a 6-inch compact layer, a heavy grader to sweep down to the road surface and to widen lanes, and a pickup truck equipped with radiotelephone. It was essential for rubber-tyred plant to have chains. (Petrol tankers proved to be a problem because chains are not permitted on them.) Front-end loaders where they were available could handle moderately deep snow, especially if equipped with snowploughs, but were best suited to widening junctions of roads, depots, ends of bridges, and passing bays. Graders proved most efficient operating at speed in snow up to a foot deep. Their blades were able to fling snow to the fenceline clear of the road edge.

Priorities and Practices

The priority for road clearing established by Ashburton County and followed more or less by others was:

1. access for rescue or evacuation where human life or health was endangered.
2. access for power and communication restoration.
3. access to areas of greatest population density.
4. access to inhabited properties.
5. access on private roads to dwellings.
6. stock rescue.

While early efforts were made to clear to two-lane width along arterial and State highways, it became obvious that one-lane access on other roads was unsatisfactory unless frequent passing bays were cut out.

Two shifts were worked if necessary on some Counties but Ashburton found it wise to stop work during the night and withdraw machines to safety below the snowline. Working solely during the day not only allowed the most experienced operators to be rested sufficiently to continue working their machines, but minimised damage to road surfaces in darkness. It was found necessary to issue men with snow glasses.

Sightseers

The Counties and Ministry of Works not only had to contend with snow but with inquisitive sightseers. Roadblocks were set up on main roads in Malvern County and from Wednesday 8th to Sunday 12th only drivers with permits for essential travel were allowed through. This caused a good deal of ill feeling among a section of motorists and found expression in an unfortunate front page article in "The Press" on 13th August. To relax the controls (which road authorities in all affected areas imposed in some form) would have been to invite chaos.

Other County Problems

Counties also had some trouble maintaining water supply to residents and to livestock. Power supply to pumping plants failed in some instances—notably to the pumps supplying Darfield—and urgent repairs to lines were necessary. Elsewhere, as in Ashburton County, tankers delivered water to houses without supply. Snow of course blocked stock water races and clearing them was a long job.

Clearing roads continued throughout the week after the storm and the last homesteads on high-country stations were not reached until Saturday 11th August.

ELECTRICITY SUPPLY

Extent of Damage

Although the snowfall was not the heaviest in Canterbury's history it caused more damage to the electric power supply system than any other — much more even than the disastrous November 1967 storm. For instance the South Canterbury Board had 510 poles damaged in the 1973 storm as against 405 in 1967. The Board's engineer reported that restoration of supply could take 3-4 weeks as against 14 days in 1967. And whereas in 1967 rapid thaw after the snowstorm allowed access to lines, in 1973 even 10 days after the snow, access was still difficult in some places.

Over the five electric power boards from North Canterbury to Waitaki, 1338 poles had to be replaced. In the Central Canterbury district 200 miles of line were worked on, in the Ashburton Board's district 100 miles were substantially damaged and 50 miles in the South Canterbury district. The total cost of repair and restoration works to the Boards was estimated at \$385,500.

Cause of Damage

Much of the damage was due to the heavy buildup of snow and ice on conductors. Four to five inches was common and up to 7 inches seen. New Zealand Electricity Department reported 5-6 inch thickness of snow and ice on some of their transmission lines. The Central Canterbury Board reported that because the winds were generally from a westerly quarter, lines oriented north/south had the greatest buildup whereas lines lying east/west were barely damaged. On the other hand the South Canterbury Board reported that east/west lines were more severely damaged than north/south ones and that in their region winds were mainly from the south.

Transmission Lines

The Islington/Kikiwa (220 kV), Islington/Twizel (220 kV) and Tekapo/Timaru (110 kV) transmission lines of the New Zealand Electricity Department all tripped at some time on the Monday but were returned to service on that day. However their Coleridge/Hororata (66 kV) line was extensively damaged and was out for 155 hours.

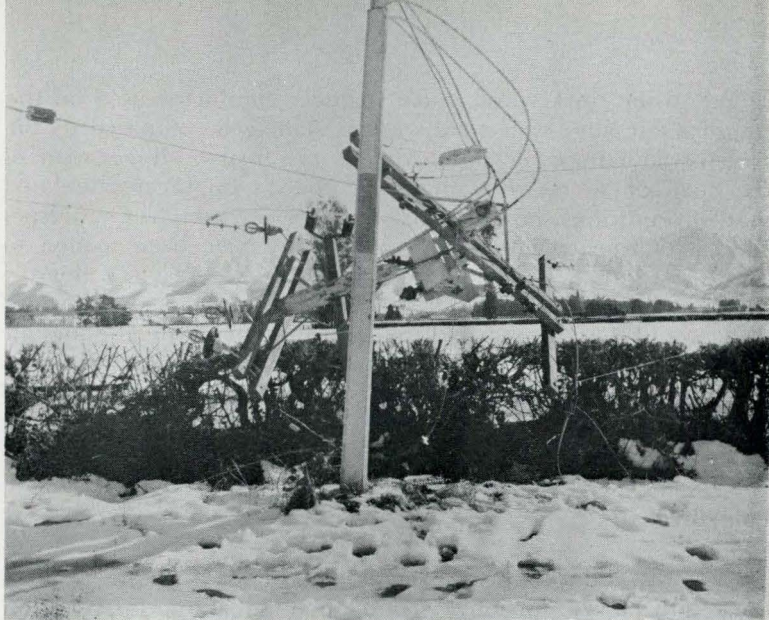
Due to the thicker and much stronger conductor used on the transmission lines, they were scarcely damaged compared to the widespread failure of conductors in the distribution system of the Boards. The South Canterbury Board's Engineer calculated that in conditions similar to those which occurred at Geraldine, Electricity Department conductors would have been loaded to 2.85 their normal maximum designed load, whereas the Board's conductors would have had a 12 times excess load. The former load would be covered by the extra capacity of the design safety factor and the line would survive. The latter load would be outside the safety factor limits and the line would fail—as it often did.

Pole Breaks

Not only did conductors themselves break, but the tremendous unbalanced torsional strain their breaking imposed on crossarms and pole heads caused wholesale breakage of poles, especially those built of reinforced concrete. The Ashburton Engineer calculated that in lines stressed to the ultimate there could be stresses of 24,000 lb/sq.in. set up in the crossarm! Where one pole failed, a chain reaction cascade collapse frequently occurred. In South Canterbury, sequences of more than 20 successive pole failures were seen where weighted conductors had dragged over one pole which in turn caused the next pole to break at the base and so on. Ice unloading from conductors and their consequent whipping, although less severe than the shock of a conductor breaking, also caused similar pole-head failures. This explains why in Ashburton County some lines which stayed intact while snow fell on Monday failed on Tuesday after it had ceased.

Hardwood vs Concrete Poles

Fewer hardwood poles failed proportionately than reinforced concrete poles. In the worst affected regions of South Canterbury 43 percent of concrete poles failed and only 10 percent of hardwood. Hardwood poles were much better able to resist pole head torsion than reinforced concrete. However, a 32 ft long hardwood cost \$40 in 1973 compared to \$27.50 for reinforced concrete poles of the same length manufactured by the South Canterbury Power Board. The 32 ft spun concrete poles cost \$60.



Concrete pole failure resulted in extensive power failure and very costly repairs.

(Photo: N.Z. Post Office, Timaru)

Future Design

All engineers recommended the inclusion of more hardwood poles in new lines, for some Boards had lost concrete poles installed as recently as after the 1967 snow. The Ashburton Board engineer considered that it was uneconomic to attempt to build aerial lines able to resist the occasional very severe snowstorm. Rather, he suggested the less expensive expedient of designing systems in which conductors would fail first, then crossarms, then last of all poles—in exceptional conditions. The South Canterbury engineer calculated that it was almost more economic (and aesthetically much more pleasing) to install 11 kV line underground than to design lines with a conductor size and pole spacing capable of surviving undamaged a 1973 snow. Unfortunately, for high voltage systems, underground power lines cost about five times the cost of overhead lines.

Two Boards also decided to install fully-guyed 2-pole H structures at frequent intervals (e.g. each half mile) to reduce the tendency for whole sections of line to collapse.

Plant and Equipment

All reports praised the usefulness of radiotelephone systems and some stressed the importance not only of having them in all mainline vehicles but also of having repeater stations with auxiliary power supply. New Zealand Electricity Department was best served by vehicles capable of moving on snow. It found Snowtracs very useful although rather prone to throw tracks.

Such an incident led to the stranding of two linemen in their Snowtrac for over 24 hours until rescued by a helicopter. An ex-Antarctic "Nodwell" tractor was able to shift large loads over snow. Army tracked vehicles performed the same task in the Central Canterbury Board's area. Snowmobiles proved to be relatively useless in the soft deep snow which lay at first.

Most Boards used helicopters, especially to replace poles on difficult sites. New Zealand Electricity Department also used them to string conductors, the Waitaki Board to replace batteries at a repeater station, and the North Canterbury Board to drop a radiotelephone set into isolated Lees Valley settlers.

Staff

Line gangs came from as far afield as Marlborough and Invercargill to help repair damage. The way in which linemen worked long hours often in brutally cold conditions was praised by all engineers in their reports.

A Long Job

As noted before, it took four weeks in some areas before supply to the last remote consumers was reconnected. But the Central Canterbury engineer estimated it would be three months before all damage in his district was repaired and the system fully restored to safe condition.

TELEPHONE COMMUNICATION

Extent of Damage

The snow had a devastating effect on the Post Office's telephone system. Fallen lines caused some 2000 subscribers throughout Canterbury to be without service. Several toll lines were damaged, some severely. For instance on the main toll line from Christchurch to the West Coast, some 30 miles of line and 100 poles were down between Darfield and Avoca, leaving only 15 circuits to Greymouth via Reefton and Blenheim instead of the usual 45.

Other causes for official concern were whether batteries at the automatic exchanges at Glentunnel and Springfield and at the manual exchange at Methven would last until relief was possible. Also, standby engine alternators which had cut in at the VHF plant at Mt Alford and at the microwave repeaters at Lowmount and Waitohi would need fuel and servicing. There was no emergency power supply at the Mt Studholme VHF station to substitute for the failure of the aerial line.

Restoration

In spite of the cold and deep snow, servicemen began restoring service, and reconnected the first subscribers on Monday 6th. However, although all subscribers in South Canterbury had service restored by 13th, it was not until 24th August that the last subscriber, in the Windwhistle area, was reconnected.

Temporary service was most commonly restored by laying twin twisted 0.45 drop wire on top of the snow or stringing it along fence posts or on poles still standing. Supplies of this wire were drawn from as far afield as Auckland and by road from Nelson.

Standby engine alternators were got to Glentunnel and Methven exchange just before batteries failed but at Springfield the emergency plant arrived too late. The standby engine plants at Lowmount and Mt Alford were checked and some fuel supplied by helicopter. A helicopter was also used to bring an emergency power supply to Mt Studholme. On 9th August the repeater at Waitohi was reached and refuelled. It was a week before mains power was resupplied to Mayfield, Springfield and Methven exchanges and 18 days before it was restored at Lowmount. Twelve Midland route toll circuits from Christchurch to Greymouth were restored within a fortnight by quickly building a new 24-channel VHF repeater station at Springfield and arranging with New Zealand Electricity Department to use their Lake Lyndon/Cass communication line as a carrier bearer.

Underground Cable

Although some 50 subscribers in Fairlie and Hilton lost service by cable faults due to power contacts, the lack of damage to systems with underground cabling was the feature of the storm. For instance, nearly all subscribers at Glentunnel suffered no loss of local service because most of the outside plant, including service leads to houses, was underground. The Glentunnel telephone service was relatively unaffected by the snow storm—although tolls were not possible beyond Hororata because of aerial line damage. Glentunnel subscribers were said to have been notably impressed that while roads were impassable and power had failed, telephone service remained open.

On the other hand the Springfield exchange which had been converted to automatic some 10 years earlier and had extensive overhead wiring suffered severe damage. Here, temporary service was given with twin twisted drop wire, but in some parts the former overhead system was abandoned, and as soon as the snow had receded sufficiently (1-2 weeks) moleploughing in of underground cable began. Cable was also laid underground in Oxford and in the Sheffield and Hororata/Glenroy areas where new automatic exchanges had already been authorised.

The toll lines from Springfield through Sheffield to Darfield, and from Methven to Ashburton, were underground and unaffected by the storm. Although underground systems survived best, aerial lines with 192lb copper-clad steel conductors on recently-erected poles were immune from direct damage by snow and wind. But where the same conductor had been strung on old poles, although the wire did not break, the poles often did. Other conductors failed badly.

New Exchanges Brought In

Fortuitously, underground cable network for new exchanges at Springburn and Mt Somers had already been laid and jointed before the storm. Underground leads to subscribers had also been installed and automatic telephones fitted. The decision was made to proceed with the changeover rather than restore subscribers to the original manual exchanges at Mayfield and Springburn. Ninety percent of the field work for connecting new underground subscriber leads to the cable network was completed and service restored by 10th August instead of the month it would have taken for aerial restoration. The whole job was finished by 17th August.

Staff and Services

Staff came from as far away as Invercargill for the arduous and uncomfortable work of reconstruction. The Airforce supplied a helicopter to the Post Office for damage survey on 9th and 10th and the Army lent 4-wheel drive trucks for access to lines and later for materials recovery.

Conclusion

The big lesson of the storm for telephone services was undoubtedly the wisdom of laying cable underground.

SUGGESTIONS FOR THE FUTURE

Below are listed recommendations for improving the effectiveness of rescue and relief in future heavy snowfalls.

A. STOCK HEALTH

1. Farmers in snow-prone areas should ensure that they have ample stocks of Ketol or Glysatone, penicillin, and calcium borogluconate before winter starts. They should also lay in supplies of sheep nuts.
2. Farmers should have some snow clearing equipment of their own and should start using it as soon as snow settles to any depth and keep using it, even at intervals during the night, to keep open access to their stock and supplies of feedstuffs.

B. STOCK RESCUE

1. Early reconnaissance is essential. Fixed-wing aeroplanes are usually more quickly obtainable for this than are helicopters.
2. Ministry of Agriculture and Fisheries staff and some key farmers and rural service men need regular familiarization with helicopters and aircraft procedures and tuition in elementary navigation. They also need familiarization with Army procedures and equipment.
3. District lists of contractors and farmers with heavy equipment should be compiled and kept up to date by Ministry of Agriculture and Fisheries offices (now authorised).
4. Ministry of Agriculture and Fisheries district offices in snow-prone areas need radiotelephone equipment, or quick and certain access to it. They need training in using it.
5. A four-wheel drive vehicle should be located at each Ministry of Agriculture and Fisheries district office.
6. Good record keeping is essential. Aids are datestamped paper in pads, large sheets of graph paper on wallboard for scheduling, noting time of each message passed.
7. One man, preferably a staff member of the Ministry of Agriculture and Fisheries should be allocated to act as liaison officer with each helicopter working in a district, to travel with it, keep its records and compile its task schedule.
8. It is probably desirable for the local M.A.F. Farm Advisory Officer to automatically assume the position of livestock rescue co-ordinator for Disaster Relief Committees.

9. Early warning systems should be set up with key farmers expected to telephone in to M.A.F. office when snow builds up to a pre-determined level.
10. Only experienced men should be sent snowraking in steep hill country and in easier country a locally experienced man must lead each team.
11. District offices of M.A.F. need detailed operations plans for use in an emergency (now authorised).

C. ACCESS

1. Early and firm measures to control sightseers must be taken.
2. Self-contained clearing teams work well.
3. Good radiotelephone communication between base and teams is essential. It should preferably be of dual channel type in case a repeater station fails. Reports should be made at fixed intervals.
4. Local resources lists should be compiled and kept up to date.
5. Single-lane access ways need frequent passing bays, and entrances to side roads should be widened out where possible.
6. Much better use should be made of broadcast radio to relay messages at regular times to people without access or telephones, or to stranded motorists. The Police should be the single agency through which messages are relayed.
7. Road clearing by graders and snowploughs should begin as soon as snow starts to lie and be kept going during daylight hours. Non-essential clearing should cease at nightfall and plant be withdrawn from the snow zone.
8. County Councils should consider giving prior permission to some farmers to open snowbound roads in future.
9. All rubber-tyred machines and vehicles in snow need chains.

D. GENERAL

1. Organisations equipped with radiotelephone systems should consider arranging for the establishment of a joint emergency channel.
2. Radiotelephone sets for use in emergencies should be held at a base and dropped in by planes if necessary rather than left at remote sites. Regular servicing and use is essential for reliability.

3. In each region discussion to organize relief services in emergencies should be held between

New Zealand Police

Civil Defence Organisation

County Councils

Power Boards

Ministry of Agriculture and Fisheries

Catchment Authorities

Ministry of Works

New Zealand Electricity Department

Federated Farmers

New Zealand Post Office

4. A central emergency headquarters should be established, perhaps under the control of the Police and in their Operations Room. This station would be in constant touch with the control bases of participating organisations and co-ordinate their activities. The central headquarters would make decisions where human welfare was involved.

5. In an emergency an early meeting of emergency controllers from each organisation is essential. It is probably better that this should happen rather than that a predetermined emergency plan should automatically be set in motion.

6. Army signal units are self-contained, and are expert at running communications systems in emergencies. They should be called in early.

7. Civil Defence have mobile kitchens able to provide food.

CONCLUSION

After the 1967 snow, the Institute published an article about it in *Review*. It concluded with a list of "Suggestions for the Future", based on the opinions of those who took part in relief work. The suggestions were repeated in the full report sent to all contributing organisations. Unfortunately, few of the suggestions appear to have been put into practice before and during this latest disaster—especially those relating to joint organisation of relief services. Most bodies had some sort of disaster plan and set it up for the occasion. But few of these plans were based on prior arrangements with other bodies. Some organisations were even unaware of or failed to advise others in the

same district working on related facets of relief. For instance, until Wednesday 8th—three days after snow relief began—Ashburton County emergency headquarters was unaware that the Ministry of Agriculture and Fisheries was organising reconnaissance and stock rescue from bases at Mayfield and Methven.

All the organisations involved in this 1973 snowstorm seem to have discussed within themselves ways of improving their internal efficiency in future disasters. Some joint meetings have even been held—for example in Ashburton where the Police convened a meeting attended by representatives of Civil Defence, Federated Farmers, Ministry of Agriculture and Fisheries, Ashburton County Council, Ministry of Works, Ministry of Transport, New Zealand Post Office and the Radio Emergency Corps. As a result the Police in Ashburton district are willing to take the initiative in organising relief in future disasters in the County. There are some other loose agreements and irregular dialogue between bodies.

Local arrangements have usually depended on local initiators but no one organisation or even Minister seems to have powers to co-ordinate others except where there is a civil emergency. In truth, some apparent reluctance between bodies to share in continuing formal liaison and regional disaster plans seems to indicate that while many are willing to assume authority, few are willing to dilute what they have.

The organisation of relief services (aided by more and better equipment) was much better in August 1973 than in November 1967. However, by their lack of preparation, too many seem still to hope that “she’ll be (nearly) right” again next time.

CONTRIBUTIONS

This report was compiled from statements contributed by officers of the following organisations for whose help the Institute is grateful.

Ministry of Agriculture and Fisheries—Rangiora
—Christchurch
—Lincoln College
—Darfield
—Ashburton
—Fairlie
—Timaru
—Waimate
—Oamaru
—Palmerston

Earthquake and War Damage Commission

Ministry of Defence—New Zealand Army
—Royal New Zealand Air Force

New Zealand Forest Service—Canterbury Conservancy, Christchurch
—Forest and Range Experiment Station,
Rangiora

Department of Lands and Survey—Christchurch
—Timaru

New Zealand Meteorological Service, Wellington

New Zealand Post Office—Regional Engineers Office, Christchurch
—District Engineer, Timaru

Ministry of Works—Christchurch Residency—Highways
—Water and Soil Division

—Timaru Residency

New Zealand Electricity Department

North Canterbury Electric Power Board

Central Canterbury Electric Power Board

Ashburton Electric Power Board

South Canterbury Electric Power Board

Waitaki Electric Power Board

Malvern County Council

Ashburton County Council

Geraldine County Council

Mackenzie County Council

Waimate County Council

Waitaki County Council

Waihemo County Council

North Canterbury Catchment Board

South Canterbury Catchment Board

Waitaki Catchment Commission

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