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The botany of change in tussock grasslands in the Mackenzie Country, South Canterbury, New Zealand

H.E. Connor

The 1992 McCaskill Memorial Lecture Presented at Lincoln University, Canterbury on 3 July 1992

Summary
Plant communities are always changing and the tussock grasslands of the Mackenzie Country are no exception. Recording the exact nature of the changes and their dates is not always easy, no more than identifying the underlying reasons for the changes.

The fescue-tussock grasslands of the Mackenzie Basin have changed greatly since I first examined them in detail 30 years ago. Equally great changes are seen in red-tussock grasslands, but the snow-tussock communities are less modified. In the fescue-tussock grasslands in particular some plant species are no longer found there; fescue- and blue-tussocks are fewer as are plume grass and blue wheatgrass. Useful weeds like catsear and hawksbeard are reduced in the grazing and the cover values they used to contribute. Much of the space these plants once filled is now occupied by mouse-ear hawkweed *Hieracium pilosella*.

Although there is a tendency to describe the loss of plant species and the loss of the cover they once provided, identifying the kind of survivors and their reasons for survival is important. Annual herbs and grasses have come through the period of change and have increased in numbers, as have the perennial grasses brown-top and sweet vernal.

The following account is about such changes, the rise of hieracium, and the probable future of the grasslands themselves.

---

1 Honorary Lecturer, Lincoln University, Canterbury. Visiting Fellow, Department of Geography, University of Canterbury, Christchurch
Introduction
At the first Memorial Lecture Kenneth B. Cumberland said of Lance William McCaskill that succeeding lecturers would “... long be able to speak about him, if they are so inclined, without treading on each other's toes, and without exhausting the story of their subject's life and work and successes” (Cumberland, 1988). Cumberland left, as geographers are wont, the option - “... if they are so inclined”. My inclination will be clear at the conclusion of this lecture.

It is just over 50 years since the Soil Conservation and Rivers Control Act 1941 was passed into law. L.W. McCaskill held that Act dear; his roles in its political and practical development, and in its local and national execution he told elsewhere (McCaskill 1973). I note with interest that it is one of the few Acts not repealed by the 1991 Resource Management Act. That decision may attest to its wartime wisdom and to its general applicability “in a changing world”. I do not propose to examine the success of that legislation as a tribute to McCaskill, because the changes through half a century would demand the work of a trained lawyer or a professional historian. The topic, though, should surely constitute the theme of a Master's Degree at this University.

In the local administration of the SC & RC Act by the North Canterbury Catchment Board I shared membership with “Wee Mac” at times during my period, 1957-1980. That association generated its own stories.

Castle Hill
Everyone who knew L.W. McCaskill automatically knew about the Castle Hill limestone tors, and the buttercup Ranunculus paucifolius. The effort he expended, the care and the attention he devoted to this species is revealed in McCaskill (1976a, b, 1979, 1982). There is still some uncertainty about the status of the reserve at Castle Hill although this seemed clear to all of us about 20 years ago. Not everyone accepts the status of the Castle Hill buttercup as a species in its own right preferring to treat it as a subspecies of Ranunculus crithmifolius as Fisher (1965) did.

The latest discovery at Castle Hill would have thrilled him. Growing beneath the overhangs of the great Trelissick limestone tors that are Castle Hill, is a small, delicate grass first gathered there in 1990 by Brian P.J. Molloy - a botanist much admired by McCaskill. This grass was unknown to New Zealand botany despite a century of assiduous plant
collecting in limestone habitats, and despite everyone’s work at Castle
Hill from the time of J.D. Enys onward.

This small grass has some interesting features:

i. it is a member of a small genus of perennial wheatgrasses which is
primarily Australian - appropriately called *Australopyrum*

ii. it is the first and only diploid grass endemic to New Zealand; it has
14 chromosomes

iii. it is always associated with detrital limestone here in Canterbury,
and near the Leatham River in Marlborough where it was collected
by A. P. Druce in 1973

iv. it seems probable that it came from Central or Western Asia, as do
most of the perennial triticoids, and probably reached New
Zealand via Australia or New Caledonia

v. it has had no role in the evolution of the seven other native New
Zealand triticoid grasses currently included in the genus *Elymus*

vi. it has been here for a very long time.

This only emphasises that new discoveries can be made in well worked
areas, areas as exhaustively examined as Castle Hill. Brian Molloy and
I have submitted a name for this Castle Hill endemic *Australopyrum*
(Connor, Molloy and Dawson, in press; Molloy in press.)

Changing tussock grasslands
I propose in this Memorial Lecture to examine some aspects of the
phenomenon of change in the tussock grasslands. I want to describe what
happens, over time, to individual species of plants in the grassland
communities, and to express it in terms of the life-form of the plants
themselves. Do species recognised as vulnerable, resilient, or resistant to
the changes of the last 30 years have common characteristics? Does
specifying growth habit more particularly than as grasses, herbs, shrubs
and trees assist our understanding?
Locality
The Mackenzie Country is a suitable region in which to make these comparisons because I described the grasslands as I saw them in 1961 and 1962 (Connor, 1964), and nearly 30 years later Treskonova has redescribed the snow- and red- tussock grasslands as she saw them in 1989 (Treskonova, 1991a). Some unpublished work on the fescue-tussock grasslands will be presented here.

The database consists of the complete enumeration of all the species, with estimates of the cover provided by each, at:

i. 38 fescue-tussock grassland sites in 1962 and 34 in 1989
ii. 8 red-tussock grassland sites in 1962 and 4 in 1989
iii. 36 snow-tussock grassland sites in both years

Although these samples cover a wide representation of the Mackenzie Basin it is impossible to account for every square kilometre of grassland there. Allowance should be made for imbalance caused by the small number of red-tussock grasslands and of the fescue-tussock grassland derived from them. They may not always reflect the overall picture, even though they are the only data available.

My observations and conclusions will be based on these data, and in this area. I shall not attempt their transfer to other South Island localities, tempted though I am.

Life-forms of plants
Life-forms describing and classifying the growth habits of plants is a system devised primarily by Raunkiaer (1934); I shall use the expanded versions of Ellenberg and Mueller-Dombois (1967) and Hartmann (1968). Here life-forms are expressed in non-technical terms, but their standard technical abbreviations are included.

There is no particular account of the life-forms of New Zealand plants although flora descriptions allow life-form classifications to be fitted. Careful field examination is often necessary to complete the life-form descriptions. Some of the species discussed here are arranged by Wardle
(1991) in life-forms, and also often by leaf dimensions; I shall not be using the latter here.

Life-forms of tussock grassland plants
The number of grassland species in each life-form class is in Table 1; their number at two dates, and their distribution among the three major grassland communities are included. The total number of species\(^2\) of each life-form is listed there.

There were 12 species of mat-forming shrubs (Ch vel) in snow-tussock grasslands in 1962 and 1989, and there were more tall shrub species (N) in snow-tussock grasslands than in fescue-tussock communities. There are no real differences over 30 years in the number of shrub species in the grasslands.

The perennial grasses (H csp Gram) and herbaceous plants behaved differently. Fewer species of grasses were present in these grasslands in 1989 than were found in 1962. Particularly affected is red-tussock grassland but not the fescue-tussock grassland recently derived from it. “Grass-like plants” include the woodrush *Luzula rufa*, the wild spaniards, *Aciphylla spp.* and *Celmisia lyallii*; their numbers of species in each community were unchanged.

Rosette-forming species of herbaceous plants (H ros) are reduced in number relative to 1962. Two species with the life-form “rosette-forming and creeping” (H ros rept), are species of *Hieracium*, hawkweeds.

The annuals (Th) reflect differences between plant communities; more annual species are in old fescue-tussock grassland than in snow-tussock stands. There is little or no change in number over the period.

\(^2\) Species occurring in <5% of the possible occurrences are omitted.
Table 1  Life-forms and number of species of each, in tussock grasslands of Mackenzie Country (species occurring <5% of time excluded).

<table>
<thead>
<tr>
<th></th>
<th>Fescue (O)</th>
<th>Red (xR)</th>
<th>No. of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life form</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tall branched shrubs (N)</td>
<td>62</td>
<td>89</td>
<td>6</td>
</tr>
<tr>
<td>Short shrubs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mat forming (Ch vel)</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>cushion forming (Ch pulv)</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>dwarfed (Ch fr)</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Perennials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tussocky grasses (H csp Gram)</td>
<td>10</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>grass-like (H csp)</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>herbaceous rosette-forming (H ros)</td>
<td>13</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>rosette-forming and creeping (H ros rept)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>shoots creeping (H rept)</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>branched above (H)</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Annuals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grasses (Th csp)</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>herbs (Th scap)</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Roots with buds; rosettes above (G rad)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rhizome below</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shrub above (Grh Ch)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>grassy tufts above (Grh csp)</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>rosettes above (Grh ros)</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>branched above (G rh)</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Bulbs (bulb)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Botanical conventions in parentheses
O = older grasslands
xR = recently derived from red-tussock grassland
Geophytes (G) are plants that may overwinter underground, or have generative buds on underground stems or roots. These characteristics could be considered advantageous when pressures of various kinds are exerted above or at ground level. Sorrel, *Rumex acetosella*³, (G rad), has buds on an extensive root system and forms rosettes above; and there is only one mat-forming shrub with underground rhizomes, *Cyathodes fraseri*, patotara (Grh Ch).

There is one significant change in the number of species of the life-form - "rhizome below, grassy tufts above" (Grh csp), and that is in the red-tussock community. Elsewhere there is a marked uniformity between dates.

In Table 1 the number of species of each life-form was indicated. The frequency of presence of the species in the 156 samples of grassland communities will detail the behaviour of individual plant species.

**Grasses**

The grasses here all have the one life-form (H csp Gram); there are 17 species. Three species (L in Table 2) are lost from the grassland by 1989; that plume grass, *Dichelachne crinita*, and windgrass, *Lachnagrostis filiformis*, would be among them was predictable. Two or three others are reduced in presence frequency (R in Table 2); the trend is uneven except for the predictable reduction of the presence of blue wheatgrass, *Elymus rectisetus*. Fescue-tussock is now also of reduced frequency.

Sweet vernal, *Anthoxanthum odoratum* has increased in frequency of presence (I in Table 2), and the very small desert poa of open sites, *Poa maniototo*, has found its fullest expression. It is a native species of particular purpose.

Eleven of 17 species of grasses are listed here. The remainder are unchanged in presence frequency - *Festuca 1 sp., Chionochloa 3 spp., Agrostis 1 sp.*

---

³ (asterisk) preceding the proper name of a plant indicates that the species is naturalised here.
Table 2 Changes in perennial grass species 1962, 1989 (Life-form H csp gram).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dichelachne crinita, plume grass</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>23</td>
</tr>
<tr>
<td>Koeleria kurtzii</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>49</td>
</tr>
<tr>
<td>Lachnagrostis filiformis, windgrass</td>
<td>L</td>
<td>L</td>
<td>(L)</td>
<td>34</td>
</tr>
<tr>
<td>Poa lindsayi</td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>22</td>
</tr>
<tr>
<td>Elymus rectisetus, blue wheatgrass</td>
<td>(L)</td>
<td>R</td>
<td>R</td>
<td>71</td>
</tr>
<tr>
<td>Rytidosperma pumilum</td>
<td>(L)</td>
<td>-</td>
<td>R</td>
<td>82</td>
</tr>
<tr>
<td>*Holcus lanatus, Yorkshire fog</td>
<td>R</td>
<td>-</td>
<td>L</td>
<td>19</td>
</tr>
<tr>
<td>Poa colensoi, blue-tussock</td>
<td>R</td>
<td>-</td>
<td>-</td>
<td>136</td>
</tr>
<tr>
<td>Festuca novae-zelandiae, fescue-tussock</td>
<td>R</td>
<td>-</td>
<td>R</td>
<td>130</td>
</tr>
<tr>
<td>*Anthoxanthum odoratum, sweet vernal</td>
<td>I</td>
<td>I</td>
<td>L</td>
<td>78</td>
</tr>
<tr>
<td>Poa maniototo, desert poa</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>15</td>
</tr>
</tbody>
</table>

L = lost from the grassland  
R = reduced in presence frequency  
I = increase in presence frequency  
( ) = almost so  
- = unchanged in presence frequency
Herbaceous plants
Perennial herbaceous plants forming rosettes above a single tap root (H ros) are vulnerable, as was indicated in Table 1. The losses and reductions and where they occur, are in Table 3. Of 16 species in the group 13 are listed there.

Species of reduced presence are varied, though many are members of the Compositae. Only catsear, *Hypochoeris radicata*, behaved unequivocally throughout; it is grazing attractive. Hawksbeard, *Crepis capillaris* was also severely reduced. Creeping and mat-forming plants like piripiri, *Acaena caesiiglauca*, and cudweed *Gnaphalium audax*, are also reduced in frequency of presence.

Two grasses and three sedges are rhizomatous (Grh csp). Browntop, *Agrostis capillaris*, increased in frequency in the tall-tussock communities but was of unchanged frequency elsewhere. Mountain twitch, *Pyrranthera exigua*, essentially a montane species of the fescue-tussock grassland remained unaltered there. *Carex breviculmis* which forms tight, green, close packed tufts of grassy leaves, was of unchanged frequency in its characteristic fescue-tussock grassland, but increased in presence in snow-tussock communities.

Geophytes
An underground branching system could be expected to be protective of species. Frequencies of geophytes are in Table 4. Rosettes are formed above (Grh ros) in the grassland violet, *Viola cunninghamii*, and in the harebell, *Wahlenbergia albomarginata*; both are reduced in frequency; and the small white daisy, *Lagenifera cuneata*, was not seen 30 years later. Two species of *Leptinella (Cotula)*form open mats; both were varied in response.

Shrubs
The number of species of woody plants was largely unchanged over the years in the grasslands (Table 1). An indication of their persistence is in Table 5. Two features signify: the mat-forming, tap-rooted, dwarf New Zealand broom, *Carmichaelia monroi* is lost to most, if not all, of the grasslands, but the taller shrub matagouri, *Discaria toumatou*, is not. Turf karamu, *Coprosma petriei*, is of reduced frequency. Species of *Raoulia*, scabweeds, are resilient.
Table 3 Changes in presence of perennial rosette-forming and mat-forming herbaceous plants, 1962, 1989.

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rosette-forming (H ros)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Brachyglottis haastii</em></td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td><em>Microseris scapigera</em></td>
<td>(L)</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td><em>Kirkianella novae-zelandiae</em></td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td><em>Craspedia lanata</em></td>
<td>L</td>
<td>L</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Oreomyrrhis rigida</td>
<td>-</td>
<td>L</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td><em>Ranunculus gracilipes,</em></td>
<td>-</td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td><em>Plantago spathulata,</em></td>
<td>R</td>
<td>-</td>
<td>(L)</td>
<td>L</td>
</tr>
<tr>
<td><em>Crepis capillaris,</em></td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td><em>Hypochoeris radicata,</em></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Geranium sessiliflorum</td>
<td>R</td>
<td>R</td>
<td>-</td>
<td>R</td>
</tr>
<tr>
<td>Brachyscome sinclairii</td>
<td>R</td>
<td>R</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td><em>Ranunculus multiscapus</em></td>
<td>R</td>
<td>-</td>
<td>R</td>
<td>-</td>
</tr>
<tr>
<td><em>Brachyglottis bellidioides</em></td>
<td>L</td>
<td>-</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td><strong>Creeping and mat forming (H rept)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acaena caesiiglauca,*</td>
<td>R</td>
<td>-</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Gnaphalium audax,*</td>
<td>R</td>
<td>-</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Hydrocotyle novae-zeelandiae</td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>R</td>
</tr>
</tbody>
</table>

L = lost from grassland
R = reduced in presence frequency
( ) = almost so
- = unchanged in presence frequency
Table 4 Changes in species with underground runners 1962, 1987.

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhizomes below, rosettes above (Grh ros)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Viola cunninghamii</em>, grassland violet</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td><em>Wahlenbergia albomarginata</em>, harebell</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td><em>Lagenifera cuneata</em></td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Rhizomes below, mat-forming above (Grh vel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Batchelors buttons</em>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Leptinella pectinata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>L. pusilla</em></td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td>Rhizomes below, grassy above (Grh csp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Agrostis capillaris</em>, browntop</td>
<td>-</td>
<td>-</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td><em>Pyrranthera exigua</em>, mountain twitch</td>
<td>-</td>
<td>R</td>
<td>(L)</td>
<td>(L)</td>
</tr>
<tr>
<td><em>Carex breviculmis</em></td>
<td>-</td>
<td>-</td>
<td>R</td>
<td>I</td>
</tr>
<tr>
<td><em>C. colensoi</em></td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>-</td>
</tr>
<tr>
<td><em>C. muelleri</em></td>
<td>L</td>
<td>(L)</td>
<td>(L)</td>
<td></td>
</tr>
</tbody>
</table>

L = lost from the grassland  
R = reduced in presence frequency  
I = increase in presence frequency  
( ) = almost so  
- = unchanged in presence frequency
Table 5 Changes in woody plants 1962, 1989.

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall branched shrubs (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Carmichaelia petriei</em>, NZ broom</td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td><em>Discaria toumatou</em>, matagouri</td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>-</td>
</tr>
<tr>
<td>Small shrub (Ch fr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pimelea oreophila</em>, native daphne</td>
<td>R</td>
<td>-</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Mat-forming small shrubs (Ch vel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Carmichaelia monroi</em>, dwarf NZ broom</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td><em>Coprosma petriei</em>, turf karamu</td>
<td>R</td>
<td>-</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td><em>Raoualia subsericea</em>, pink scabweed</td>
<td>R</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>R. hookeri</em>, scabweed</td>
<td>R</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

L = lost from grassland
R = reduced in presence frequency
- = unchanged in presence

Species behaviour and cover
When a grassland is examined phytosociologically every species found in the sample stand is listed and an estimate made of the contribution each makes to the vegetative cover. I want now to show how some individual species behaved at the two dates of observation, and to express the results in terms of the cover they provided in the grassland.

Distinctive in the grasslands is the small and slender native grassland celmsia, *Celmisia gracilenta* (H esp), (Table 6). In 1962 in fescue-tussock grasslands it was found in 50% of the sample areas; there it provided little by way of cover. In snow-tussock grasslands it was a little more frequent and made about the same contribution to ground cover - perhaps a little more. In 1989 its presence frequency was reduced and also its cover value. Overall, there is now less of the small grassland celmsia because it was also lost to red-tussock grasslands.
**Hypochoeris radicata**, catsear, (H ros), was always prominent in fescue-tussock grasslands, and generally found very frequently in red- and snow-tussock communities (Table 7). It even produced significant amounts of ground cover. Catsear has been savaged in fescue-tussock grasslands; in 1989 its presence frequency is down to 40%, and its cover value reduced to 1/3 or less of its former contribution. In the red-tussock grassland it fared no better. On the other hand it has almost maintained its status in frequency and in cover in snow-tussock communities.

### Table 6  
Frequencies (as percentages) in cover classes of grassland celmisia, *Celmisia gracilenta*, 1962, 1989  
(*n* = 64).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>53</td>
<td>82</td>
<td>0</td>
</tr>
<tr>
<td>spasmodic</td>
<td>18</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>sparse</td>
<td>29</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>small (2%)</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

### Table 7  
Frequencies (as percentages) in cover classes of rosette-forming catsear, *Hypochoeris radicata*, 1962, 1989  
(*n* = 98).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>6</td>
<td>61</td>
<td>25</td>
</tr>
<tr>
<td>spasmodic</td>
<td>9</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>sparse</td>
<td>32</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td>small (2%)</td>
<td>18</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>29</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 8 Frequencies (as percentages) in cover classes of woody, rhizomatous patotara *Cyathodes fraseri*, 1962, 1982 (*n* = 114).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>32</td>
<td>33</td>
<td>25</td>
</tr>
<tr>
<td>spasmodic</td>
<td>6</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>sparse</td>
<td>35</td>
<td>34</td>
<td>25</td>
</tr>
<tr>
<td>small (2%)</td>
<td>15</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>9</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 9 Frequencies (as percentages) in cover classes of woody, mat-forming, rooting, turf karamu, *Coprosma petriei*, 1962, 1989 (*n* = 70).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>32</td>
<td>43</td>
<td>38</td>
</tr>
<tr>
<td>spasmodic</td>
<td>24</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>sparse</td>
<td>24</td>
<td>26</td>
<td>12</td>
</tr>
<tr>
<td>small (2%)</td>
<td>6</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>12</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 10 Frequencies (as percentages) in cover classes of rosette-forming from root buds, sorrel *Rumex acetosella*, 1962, 1989 (*n* = 129).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>3</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>spasmodic</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>sparse</td>
<td>41</td>
<td>3</td>
<td>63</td>
</tr>
<tr>
<td>small (2%)</td>
<td>24</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>26</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>
The short, woody, colony forming shrub with sharp-pointed leaves and orange berries, *Patotara*, *Cyathodes fraseri*, (Grh Ch), was listed in Table 1 as the only member of its class. It is rhizomatous. Its presence frequencies and cover values in the grasslands in 1962 and 1989 are in Table 8. Overall, it occurs as often now as it did then, and provides about as much cover now as it did then. Patotara has retained relative stability.

Turf karamu, *Coprosma petriei*, (Ch vel), is a prostrate woody shrub, rooting as it forms large mats; its fruits may be pearly white or translucent blue. It was most frequently found in fescue-tussock communities where it often afforded significant ground cover (Table 9). By 1989 it was less frequent in snow- and red-tussock communities than earlier, and in fescue-tussock stands its cover value scarcely altered although its presence was marginally reduced. *Coprosma petriei* seems able to maintain its 1960s role in fescue-tussock grasslands.

Sorrel, *Rumex acetosella*, (G rad), a naturalised species, produces buds on long underground roots, and has small rosettes on the soil surface above. It often forms communities by itself. It is now (Table 10) less frequent than formerly in fescue- snow- and red-tussock grasslands, and there is an associated shift towards lower cover values in fescue-tussock stands, but less cover change in snow-tussock communities. Sorrel may not be quite holding its own.

Currently there is a *Hieracium* problem in the Mackenzie Country grasslands. Both *H. pilosella*4 and *H. praealtum* form rosettes and are stoloniferous, (H ros rept); they were the only entry of their class in the Life-forms in Table 1. In 1962 the two species had identical patterns of distribution in fescue-tussock grasslands and in the snow-tussock grassland; both were widespread but rarely dense (Connor, 1992). By 1989 (Table 11) *H. pilosella*, mouse-ear, is omnipresent in fescue-tussock communities and about half the time its cover value is high. The shift in snow-tussock grasslands is less spectacular both in terms of presence frequency and in cover. Nevertheless, *H. pilosella* is now a well established species in snow-tussock grasslands and often is at higher cover values than in 1962.

---

4 Its subspecies *micradenium* is that referred to throughout.
King devil *H. praecatum*, was scarcely different from *H. pilosella*, mouse-ear hawkweed, in its distribution in fescue-tussock grasslands in 1962. This no longer obtains and *H. praecatum* now occurs less frequently although the cover values are modestly extended. Clearly king devil has increased in snow-tussock grasslands in presence frequency, but cover values are relatively static.

Blue tussock, *Poa colensoi*, (H csp Gram), is one of the reputed grazing favoured plants, and is usually one determinant of short tussock grassland physiognomy. It was reduced in presence frequency (Table 12) and in cover value in 1989 in fescue-tussock grasslands. Even though blue tussock is still abundant in snow-tussock communities there is a small, perhaps nonsignificant, shift in cover values.

The species which gave its name to the fescue-tussock grasslands, fescue- or hard-tussock, *Festuca novae zelandiae*, (H csp Gram), in 1989 was significantly reduced in presence frequency. It has, too, a considerably extended range of cover values which effectively reduces its cover in fescue-tussock grasslands (Table 13). In snow-tussock grasslands where the combination *Chionochloa rigida - Festuca novae zelandiae* obtains, there is also a change in presence frequency but a lesser change in cover value.
Table 11  
Frequencies (as percentages) in cover classes of hawkweeds, species of *Hieracium* forming rosettes from creeping stolons, 1962, 1989.

<table>
<thead>
<tr>
<th>Cover value</th>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
<td>'89</td>
</tr>
<tr>
<td><em>H. pilosella (n = 108)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>not present</td>
<td>29</td>
<td>3</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>spasmodic</td>
<td>56</td>
<td>3</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>sparse</td>
<td>6</td>
<td>8</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>small (2%)</td>
<td>6</td>
<td>16</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>3</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50 - 75%</td>
<td>0</td>
<td>32</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>H. praecatum (n = 90)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>not present</td>
<td>29</td>
<td>37</td>
<td>75</td>
<td>25</td>
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<tr>
<td>spasmodic</td>
<td>44</td>
<td>13</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>sparse</td>
<td>21</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>small (2%)</td>
<td>6</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 12  

<table>
<thead>
<tr>
<th>Cover value</th>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
<td>'89</td>
</tr>
<tr>
<td>not present</td>
<td>6</td>
<td>32</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>spasmodic</td>
<td>3</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sparse</td>
<td>15</td>
<td>29</td>
<td>12</td>
<td>75</td>
</tr>
<tr>
<td>small (2%)</td>
<td>18</td>
<td>16</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>41</td>
<td>5</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>18</td>
<td>0</td>
<td>25</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 13  Frequencies (as percentages) in cover classes of the native grass fescue-tussock, *Festuca novae-zelandiae*, 1962, 1989 (*n* = 130).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>spasmodic</td>
<td>0</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>sparse</td>
<td>0</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>small (2%)</td>
<td>0</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>20</td>
<td>29</td>
<td>25</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>50</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>50 - 75%</td>
<td>30</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 14  Frequencies (as percentages) in cover classes of perennial grass sweet vernal *Anthoxanthum odoratum*, 1962, 1989 (*n* = 78).

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Fescue</th>
<th>Red</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover value</td>
<td>'62</td>
<td>'89</td>
<td>'62</td>
</tr>
<tr>
<td>not present</td>
<td>68</td>
<td>21</td>
<td>50</td>
</tr>
<tr>
<td>spasmodic</td>
<td>24</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>sparse</td>
<td>9</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>small (2%)</td>
<td>0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>5 - 25%</td>
<td>0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

I discussed above the overall increase in frequency of sweet vernal *Anthoxanthum odoratum*, (H csp Gram), and the particular increase of browntop, *Agrostis capillaris*, (Grh csp), in tall-tussock grasslands. Sweet vernal was infrequent in the Mackenzie Country in 1962 - it was not found in 70% of the sample areas and even where it was found it was of very low cover value (Table 14). In 1989 it was present in nearly all
fescue-tussock grasslands visited and in about half the snow-tussock communities. Overall, sweet vernal has increased. I am well aware that in 1962 it had not quite arrived in, or possibly not quite returned to, the Mackenzie Country. By 1976 it seemed very widespread. By 1989 it is less frequently seen, though relative to 1962 it must be interpreted as much increased. The intervening years are inadequately documented for sweet vernal, and may also be for other species.

A group of 10 species of annuals (Th) occurs in the grasslands, mostly in fescue-tussock communities but occasionally in snow-tussock grasslands. All are naturalised plants except Gypsophila australis. All are plants of open ground. All are vernal plants. There are three grasses (Th csp Gram) among them only *Vulpia bromoides, hair grass, seems vulnerable.

The seven herbaceous members (Th scap) of the vernal flora have increased in presence frequency, but none substantially in cover value. The list is presented here for completeness:

*Airia caryophyllea, silvery hair grass; *Bromus tectorum; *Erophila verna, whitlow grass; Gypsophila australis, clammy gypsophila; *Hypochoeris glabra, smooth catsear; *Myosotis discolor, grassland forget-me-not; *Trifolium arvense, haresfoot trefoil; *T. dubium, suckling clover; *Veronica verna, spring speedwell; *Vulpia bromoides, hairgrass.

The intervening years 1963 -1988
I do not know the exact dates for all the changes that have occurred in the grasslands of the Mackenzie Basin during the time since I first examined the plant communities. I am aware that rabbits did reach, in very recent years, the plague proportions I first saw in February 1947. And I have tried to outline the behaviour of sweet vernal during the 1970s and 1980s. I have recently seen the distribution and extent of species of Hieracium on the outwash plain; I have seen areas formerly dominated by red-tussock, Chionochloa rubra, become short-tussock grassland. But I do not exactly know when major individual changes occurred. Professor K.F. O'Connor of this University several times asked me to revisit the original sites and describe their contemporary state. Some data about 1975 would have been useful. At that time I was preoccupied, with completing the second edition of "The Poisonous Plants in New Zealand" (Connor, 1977) and writing about the inheritance of secondary metabolites in toetoes, Cortaderia spp. (Connor and Purdie, 1976).
Nevertheless, I made a few records on the vegetation of the Basin. On the Richmond Range in February 1968 *H. pilosella and *H. praealtum were present in snow-tussock grassland dominated by *Chionochloa macra at 4770 ft, and also in a grassland on a rocky slope dominated by *C. rigida at 4830 ft. Similarly at “Glenrock” at 4,600 ft on the Rollesby Range, both species of *Hieracium were present in *C. macra grassland and *H. pilosella in *C. rigida grassland on a sunny slope. Neither differs from the 1962 records at nearby sites.

In fescue-tussock grasslands on the outwash plains near Whisky Cutting, and near the Lake Tekapo settlement, Dr Brian P.J. Molloy and I examined some sites in detail in 1976. At Whisky Cutting, *Hieracium pilosella was scored at variable cover values but *Elymus rectisetus and *Dichelachne crinita were both thriving in the open, and *Lachnagrostis filiformis was present in the community.

The floristic composition there indicates that in 1976 the fescue-tussock grasslands on deeper soils were not as degenerate as they are in 1989; those on shallow soils with abundant *Raoulia australis were of the floristic composition and structure of Phase A in Connor (1964) except for the abundance of *H. pilosella, and a lowered cover value for *Poa colensoi.

Floristically more complex fescue-tussock communities there (see cover of Journal of New Zealand Mountain Lands Institute Review 47 1990) correspond to Phase F of Connor (1964) except for *H. pilosella cover values. In 1976 *H. pilosella was not at its peak, no more than fescue-tussock grassland was at its nadir. Deterioration in its most severe phase began after 1976. I regret that I do not have a more precise date to offer; neither Anon. (1976) nor Scott (1984) helps with dating the decline.

Direct diet measurement and change in some species
Grazing pressures and preferences were exerted on species in the communities during the interval. No species is known to contain any secondary plant compounds causing rejection by animals. Only the yellow-flowered St Johnswort, *Hypericum perforatum, is a known poisonous herbaceous plant (Connor, 1977). The origin of the localised swamp fever (Schwarz, 1972; Scott, 1985) is unknown.

Sheep grazing preferences in undeveloped grassland on “Ribbonwood” nearby in inland North Otago (Hughes, 1975), can be related to some of the changes in species presence and cover reported here. The relatively
high overall sheep preferences (order in parenthesis) given to *Hypochoeris radicata, (2), *Crepis capillaris, (6), Elymus rectisetus, (7), Dichelachne crinita, (8), accord with decreases in presence listed here (Tables 2, 3, 7). Lachangrostis filiformis was not high on the preference scale, 18th, but, was eliminated from our samples. Dwarf native broom, Carmichaelia monroi, had an even lower rating, 22nd, but was only rarely recorded in 1989.

*Agrostis capillaris* the first preference inHughes’ list, maintained its cover in fescue-tussock grasslands and increased in tall-tussock communities; this may be one reliable instance of life-form being associated with the ability to withstand changes. The relative difference in acceptability to sheep of species of *Hieracium* is unrelated to their increases in cover resulting from change.

Hughes (1975) noted that cuticles of *Cyathodes fraseri* and *Geranium sessiliflorum* were rarely if ever found in faeces; the former was discussed above and its high continued presence noted; *G. sessiliflorum* was always of reduced frequency by 1989. *Anthoxanthum odoratum* at “Ribbonwood” was not a preferred species of sheep diet; it did not rank among 25 species there (Hughes, 1975) although Harris and O’Connor (1980) found that it was important in the Rakaia River Catchment - about 20% of diet, with browntop by comparison 6-12%. My estimate of its behaviour of sweet vernal is described above; it has a measurable increase in abundance and in cover.

Life-forms and change
Change in the Mackenzie Country is most noticeable in the fescue-tussock grasslands; this is acknowledged by all commentators. They are called severally “semi-arid lands”, “500-600 mm precipitation zone”, “rabbit prone areas”. It is evident that the outwash plains and the morainic areas are becoming homogenised by the losses or reductions in cover contribution by many species, and by abundance and high cover value of *Hieracium pilosella*. Treskonova (1991a) reported that the floristic and structural differences, once a feature in snow-tussock grasslands are now lessened, and that those grasslands are becoming more homogenous.
Is life-form associated in any way with species, or groups of species, which:

i. have declined in presence frequency and in cover value, or even been lost to the communities, or

ii. remain unchanged in frequency and cover value after a further 30 years of use, or

iii. have increased in number and in contribution to cover?

Woody shrubs
The number of species of woody shrubs seem to be of the same now as before. The exception is *Carmichaelia monroi* the mat-forming taprooted, New Zealand broom; taller *C. petriei* remains but is still grazed. Mat-forming and rooting along the stems are two features of *Coprosma petriei*; it seems competent to withstand the pressures generating change. Woody *Cyathodes fraseri* forms mats and is assisted in this by rhizomes; its role seems unchanged over the years.

In the snow-tussock communities there is a group of six shrub species omitted from the special tabulations. They persist; mat-forming species are *Cyathodes colensoi*, *Drapetes dieffenbachii*, *Gaultheria depressa*, *Pentachondra pumila*; small shrubs are *Dracophyllum pronum* and *Pimelea traversii*.

Grasses
The grass habit possess two special qualities:

i. new shoots (innovations or tillers) arise from buds at ground level in the axils of leaves;

ii. leaves grow from basal meristems.
These features are advantageous in terms of reaction to grazing. The grasses were not universal in their behaviour; the persisting species have rolled or acicular, highly sclerized leaf-blades; and those grasses that were eliminated or reduced in presence frequency usually have wider, flat, soft leaf-blades. Forty-five years ago I found blue wheat grass, *Elymus rectisetus*, and plume grass, *Dichelachne crinita*, growing solely within the protection of the leaves of fescue tussocks. In 1976 both were growing in the open and I marvelled at them; currently the former is at risk and the latter not found in our samples.

Those same intrinsic grass features are present in *Anthoxanthum odoratum* which has a flat leaf-blade, but which increased in frequency and abundance. *Agrostis capillaris* which has rhizomes is normally an aggressive species, and it increased in tall-tussock communities. But a tall grass with tough round leaves e.g. red-tussock, *Chionochloa rubra*, or narrow-leaved snow-tussock, *C. rigida* may be easily eliminated from communities, as may the softer leaved slim tussock, *C. macra*. The effort required, however, is much greater than is needed to eliminate plume grass, *Dichelachne crinita*, from a community.

Secondly: the grass habit does not universally guarantee resistance to change, but underground stems assist in persistency. One would expect the same of sedges.

Herbaceous plants
Herbaceous dicotyledonous species are numerous, and new shoots arise wherever there are leaf axils - at ground level, below it, or above it. Rosette-forming species were easily changed in presence frequency and in cover value; *Hypochoeris radicata* was typical; and many small indigenous rosette herbs were thinned out or lost to the communities including *Geranium sessiliflorum*, *Brachyscome sinclairii*, and the grassland buttercup, *Ranunculus multiscapus*. The rosette habit, which always has significance for cover, was not an advantage.

Stoloniferous mat-forming herbaceous species like *Hydrocotyle novae-zeelandiae* or *Gnaphalium audax* or *Acaena caesiiglauca* persisted and were perhaps aided by their growth habit - their life-form.
Two significant species which form very large aggregations of rosettes and have creeping shoots are hawkweeds, *Hieracium pilosella* and *H. praeatedum*; *H. caespitosum* is a recent arrival about which I have no data. The ultimate size of most of the rosettes of *H. pilosella* is greater than the growth potentiality of most indigenous species, and its relative speed of growth must exceed that of *Hydrocotyle novae-zeelandiae* or *Raoulia subsericia* by several orders of magnitude. No experiments are clear on this point.

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<td>herbaceous perennials, rosette-forming or open-mat forming from stolons, indigenous or naturalised, possess no intrinsic life-form characters offering resistance to the kind of pressures current in the Mackenzie Basin. The exceptions are the rosette-forming, stoloniferous, naturalised species of <em>Hieracium</em>.</td>
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**Geophytes**

Have species with buds on underground stems or roots shown any advantage during this period of change? *Cyathodes fraseri* has held its former rank in presence and cover value; it is a woody species with prickle-tipped leaves. Herbaceous *Viola cunninghamii* and *Wahlenbergia albomarginata* did not possess the ability to resist change, and the gentle daisy, *Lagenifera cuneata*, fell mortally wounded. *Rumex acetosella*, with buds on the roots, appears to be reduced to some extent in its cover value and presence frequency.

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<td>geophytes, on average, have withstood change</td>
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**Annuals**

There is not a large number of annual species and they usually constitute a spring flora, a vernal flora, in depleted and open areas, purging flax, *Linum catharticum*, excepted. Annuals have reacted favourably to change, but their cover contribution is slight. Nevertheless, a vegetation comprising essentially a multitude of annual herbs and grasses could be
produced. It has occurred before and elsewhere. As Allan (1937) observed of the annuals they “... are largely an indicator of the amount of disturbance that man has caused.”

Fifthly: annual herbs have responded successfully.

Why hieracium and why now?
Is *Hieracium pilosella the new sorrel? Would *Rumex acetosella have been the major component if species of Hieracium were not in New Zealand? Characteristically in the past, deterioration in tussock grasslands was associated with the ingress of sorrel. It seemed to be an early dioecious immigrant, spread easily, seeded freely (Harris 1970, 1971, 1972) and as deterioration of the grassland progressed, sorrel became more extensive. Its red flowering stems often dominated landscapes. Apomictically reproducing *Hieracium pilosella is today frequently and considerably more abundant, greying the landscape except at flowering time. It forms tighter and larger rosettes than does sorrel. The essential life-form difference has been referred to exhaustively above, but not to the point recognising that the underground biomass of *H. pilosella will be less than that of *R. acetosella. Both are shade intolerant.

Today *H. pilosella has taken up much of sorrel’s role and place in fescue-tussock grasslands; it is the latest opportunist. As Treskonova (1991b) noted the capability for speed of growth, rosette size, patch formation are inherent in *H. pilosella. There are no studies of the relative growth rates of mouse-ear hawkweed to any other species. There are annual estimate of aerial biomass of 100 kg ha\(^{-1}\) yr\(^{-1}\) on Acheron soils in the Tekapo - Pukaki interfluve, and about 500 kg ha\(^{-1}\) yr\(^{-1}\) at the Wolds, where *H. praealtum was estimated to yield 1350 kg ha\(^{-1}\) yr\(^{-1}\) (Makepeace 1985). On the Sawdon site (nearby that which Molloy and I investigated in 1976), the yield was estimated at 10 kg ha\(^{-1}\) yr\(^{-1}\). There are no estimates of the aerial biomass of sorrel. In the absence of *H. pilosella *Rumex acetosella, would have continued its accustomed role, but its cover values would have been lower, and its speed of cover formation slower than *H. pilosella.

Nevertheless, sorrel continues in one role. On the extensive dry flats above Lake Benmore the sorrel dominated communities are little altered since the 1960s; where a few remnant fescue-tussocks persist on small hillocks of deeper soil some rosettes of *H. pilosella now accompany
them. My analogy is not as a universal, but I limited it to fescue-tussock grasslands.

Why the advance of *H. pilosella in the fescue-tussock grasslands of the Mackenzie Basin was delayed until the mid 1980s is unclear to me; it had happened earlier elsewhere. Extensive *H. pilosella mats were known in the Orari Catchment by 1950 (Kerr, 1950). I described similar conditions in 1963 in Rangitata Catchment snow- and fescue-tussock grasslands (Connor, 1992; Connor and MacRae, 1969). A comparable state might have been expected by the early 1950s in the Mackenzie Country, but I did not see it except in one stand of fescue-tussock grassland near Burkes Pass in January 1963 (Connor, 1964, 1992). In 1989, Treskonova (1991a) found cover values of *H. pilosella in montane snow-tussock communities comparable with those in the Rangitata Catchment in 1963 but this was 25 years later. What transpired was a long period of respite, a long lag phase, which went unrecognised until the ecological threshold had been crossed in fescue-tussock grassland in particular. Once that major advance was initiated there, resistance failed and the indigenous species were out flanked together with many naturalised species.

Conclusions

I have described the responses of species of particular life-forms, to the cause of change to the Mackenzie Country grasslands. I have, too, added some details to those in Treskonova (1991) for tall-tussock grasslands. The Mackenzie Basin emerges with the best documented records of high country grasslands in South Island New Zealand.

No new species of significance have arrived except *Hieracium caespitosum, and the clear identification of *H. pilosella ssp. pilosella, as another part of the community; no new life-forms can be added to the list.

The changes in the appearance of fescue-tussock grasslands are dramatic. By 1976 at least, fescue-tussock communities though containing *H. pilosella at modest cover values, were distinguishably fescue-tussock grasslands. Today the physiognomy is often drastically changed, and the grassland devastated; the grassland is often now a herbland because of the extent of *H. pilosella. Attrition rather than devastation signifies in the snow-tussock communities where change is occurring on a lesser, though important, scale. The weedy stands of sorrel are imperceptibly changed,
and may not alter to any greater extent. There is a gradient of change among the plant communities.

One of the attributes of science is its predictive nature, and some predictions could be expected here.

In the continued presence of pressures causing change, the snow-tussock grasslands are expected to follow the predictions of Treskonova (1991a):

i. decrease in the abundance of *Chionochloa rigida*, narrow-leaved snow-tussock, at lower altitudes

ii. reduction in the number and cover of indigenous species comprising the inter-tussock vegetation

iii. continued homogenisation of the communities

iv. increase in *Hieracium pilosella* in the montane zone

v. balance of *H. praealtum* at appropriate sites.

Release of those pressures there may not yield a very different response because the changes have already been initiated; but the speed of change will be slower.

The fate of the residual red-tussock communities is already determined (see Connor, 1964; Treskonova, 1991a), as also of the sorrel communities.

Should the pressures responsible for the changes in the “fescue-tussock grasslands” of Mackenzie Country be alleviated, we can expect, apart from a general increase in height and growth:

i. some small woody plants will be overtopped by growth of residual resident plants - *Cyathodes fraseri* by *Rumex acetosella* for example

ii. annuals will increase in number for some time - *Aira caryophyllea, Erophila verna, Veronica verna*

iii. surviving geophytes will increase in cover - *Rumex acetosella* and *Agrostis capillaris*, to a greater extent than *Viola cunninghamii* and *Wahlenbergia albomarginata*

iv. the naturalised perennial grass *Anthoxanthum odoratum* will increase
v. the hawkweed *H. pilosella*, will persist, and *H. praealtum* will increase in cover

vi. the replacement of the fescue-tussock grasslands by a new community dependent on survivors from the old, and on immigrants from seeds.

Should the pressures responsible for the changes in the “fescue-tussock grasslands” of the Mackenzie remain, or increase, we can expect apart from a reduction in height of some species and a general reduction in biomass:

i. a continued loss of species of perennial habit regardless of life-form

ii. maintenance of some geophytes

iii. increase in annuals

iv. progressive increase in *Hieracium* cover

v. a decrease in the durability of the woody species

vi. the formation of plant communities we have never experienced.

Cumberland (1988) in setting the tone for L.W. McCaskill Memorial lecturers allowed us a choice. My inclination was to speak on a topic which would have suited McCaskill’s disputatious habits; he would not have been party to a widely held error that one major result of change in the Mackenzie Country is its cause.

Acknowledgements
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The high country in transition - some implications for occupiers and administrators*

I.G.C. Kerr

Historical perspective
Over the last hundred and twenty five years over thirty scientific papers and official reports have commented on the actual or impending degradation of the tussock grasslands of the high country.

Buchanan, as early as 1865, described the deterioration of the tussock grasslands of Otago caused by repeated burning. His well known comment 'Nothing can show greater ignorance of grass conservation, than repeated burning, which is so frequently practised' is an extract from the first report in the scientific literature concerning the deterioration of the tussock grasslands.

Petrie in 1912 also commented on the 'permanent deterioration' of the tussock grassland of Central Otago as a result of being 'eaten out' and that continued grazing (by rabbits and sheep) of the depleted grasslands prevented regeneration. Petrie was the first person to refer to the most depleted areas as a 'desert'.

In 1910 A.H. Cockayne noted that "the problem of regeneration of these (low rainfall) waste areas is already one that is keenly felt, and as time goes on the difficulties of its solution will be greatly enhanced."

A 1910 Commission on Canterbury Pastoral Runs Classification commented on the "weary feeling of sadness and regret at the large area of country (the Mackenzie Plains) which is almost depleted of all vegetation, save sorrel and 'scab-weed'".

Leonard Cockayne in 1919 commented that 'Generally speaking, .... burning has been indiscriminate, with the consequence that acres and acres of tussock grassland have been turned into stony debris, indigenous

weeds have replaced wide areas of more or less palatable grassland ..... forest and scrubland - both valuable for shelter purposes - have disappeared, and finally, the depredations of the rabbit have become intensified'.

In 1920 a Commission to Report on Southern Pastoral Runs found that deterioration and depletion of the tussock grasslands had taken place as a result of burning, overstocking, rabbits and general mismanagement. The Commission commented that ‘..... although lowland farming in New Zealand has made great strides forward, that of the mountain sheep-stations has not merely shown no advance, but has gone backward. This is a state of affairs not at all creditable to the Dominion.’

Thomson in 1922 when writing about the infestation of New Zealand by rabbits noted that their effect ‘is to be found in the grass denuded districts of Central Otago parts of which had been reduced to the condition of a desert.’

Zotov in 1938 in a survey of the tussock grasslands of the South Island discussed at length the deterioration of the tussock grasslands and concluded that ‘fire with heavy grazing was responsible for the elimination of various species, one by one, and finally for the more or less complete destruction of vegetation’. Zotov also observed that ‘heavy infestation by rabbits added to the effects of overgrazing’ and commented that ‘this infestation was possible largely through the depletion already in progress.’

It is revealing to note that in 1940 a Sheep-farming Industry Commission reported that:

At present Crown leases and licenses contain little or no provision for ensuring that the lands are properly maintained, and defaulters in this connection cannot be penalised.

Gibbs and Raeside in 1945 reported widespread soil erosion in the high country and called for remedial action through elimination of burning, control of grazing, and revegetation of eroded areas.

A number of reports, notably those of Cumberland (1945), another Royal Commission to Inquire and Report on the Sheep-Farming Industry in New Zealand (1945), Kerr (1950), and the Tussock Grassland Research Committee (1954) made similar comments about the condition of the tussock grasslands and made suggestions for improved management.
Molloy in 1962 described the modification of the forest/shrub/grassland vegetation to tall tussock grasslands by fire during the Polynesian era and their further modification by early European pastoralists to short tussock grasslands better suited to pastoral use.

Connor and McRae in 1969 described the process of deterioration of tall tussock grasslands and attributed their transformation to fescue tussock grasslands to "heavy grazing following large scale burning" and "at many sites there is evidence that the grassland has deteriorated even further ....".

In 1956 Moore commented that 'As long as tussock grassland is to be retained it must be remembered that, because its dominants are perennials with very long lives, it has many of the characteristics of a forest and few of those of a short rotation pasture. Like a forest, it is the product of a long slow development, and like a forest it is much easier to destroy than to rebuild.'

The introduction of the European rabbit (*Oryctolagus cuniculus* (L)) into New Zealand was an environmental and economic disaster. In particular, rabbits invaded depleted vegetation of the inter-montane basins of the South Island and further depleted vegetation (Petrie 1883), precipitated soil erosion (Petrie 1912; Mather 1984), reduced pastoral production (Thomson, 1922; Munro and Wright, 1933; Wodzicki, 1950; Warner, 1956; O'Connor, 1982, 1987) and financially burdened land occupiers and tax payers (Kerr *et al.*., 1983; Saunders, 1991).

O'Connor in 1981 attributed the decline in pastoral production from unimproved tussock to the effects of 'exploitative pastoralism' and claimed that 'increasing scientific understanding of the tussock grasslands and mountain lands has progressively demonstrated the dangers of repeated burning and grazing on such communities as tussock grasslands, the widespread limitations of soil fertility to plant production and animal health and performance, and the vulnerability of vegetation to grazing in zones of low or erratic rainfall'.

O'Connor (1982) questioned the sustainability of extensive pastoralism and listed 'four valid, potentially viable and sustainable land uses to succeed exploitative pastoralism ..... intensive pastoral farming, resource based recreation, protection-production forestry, and nature conservation'.

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Disturbance factors had a destructive role in all the pathways outlined in a reconstruction by McKendry and O’Connor (1990) of the historical vegetation changes in tussock grassland vegetation in the eastern South Island.

Recently, Treskonova (1991) showed that ‘the process of infestation (of tussock grasslands) by species of Hieracium, which was believed to be chaotic and unpredictable, .... is a pattern of stages related to the degradation of tussock grasslands’. This new perspective has revealed, in stark reality, the consequences of man-induced successions in tussock grassland communities.

Large areas of the now former ‘unimproved’ tussock grasslands are in such a state that there is an accelerating decline in pastoral production as a result of continuing depletion of the land resource. Some of the land is currently without value (Johnston, pers comm).

Until recently, little heed was taken of the overwhelming evidence and only limited action taken by land occupiers and the public agencies involved to realistically address the issue.

What has happened is a large-scale ‘systems failure’ in the management of one of New Zealand’s largest land resources - the mountains. The cause has been the failure by all the unconnected resource management decisions to be considered in the light of ecological reality.

Hawkweeds in tussock grasslands
About half a million hectares are currently dominated by hawkweeds and on over a further million hectares they are conspicuous (Hunter 1991).

The prevailing authoritative opinion of scientists confirms the view that the invasion and dominance of tussock grasslands by hawkweeds is predisposed by their disturbance and subsequent degradation (New Zealand Mountain Lands Institute 1990; Treskonova 1991; New Zealand Ecological Society 1991).

Conversely, to avoid their dominance by hawkweeds, all tussock grasslands need to be maintained in a vigorously growing and dense condition to resist their further invasion by hawkweeds.
For the large areas of unimproved short tussock grasslands which are currently in a degraded state it is unlikely that further invasion by hawkweeds can be resisted until a natural or assisted process of rehabilitation is complete. This implies that the grazing influences of all feral and domestic animals must be eliminated for at least an extended period.

All tall tussock grasslands in an undisturbed state are naturally resistant to hawkweed invasion. However their disturbance by fire and continued grazing, unless accompanied by sustained pasture ‘improvement’, is certain to result in their invasion by hawkweeds.

It now has to be accepted that the pastoral future of all ‘unimproved’ tussock grasslands is at best severely limited. Whatever grazing capacity there is will be dictated by available forage and the need to retain sufficient herbage in situ. For most, now depleted, ‘unimproved’ short tussock grasslands (often yielding less than one tonne dm/ha/yr) even an extensive pastoral system will not be able to be sustained indefinitely.

Perceptions of the problem
The modification of the indigenous grasslands/shrublands of the eastern South Island to a form suited to extensive pastoralism has had its ecological consequences. One perception of this change is that it was ‘development’ or ‘improvement’ and so it was for the purposes intended - grazing. Unfortunately the consequences were not foreseen.

What is now often described as ‘degradation’ has provoked intense resentment from land occupiers who feel assailed with blame. This is not a new phenomena, especially in Australia (Pickard, 1991) and the United States (Fergusson and Fergusson, 1983).

If blame is to be assigned then Government, which established and administered a system of land tenure designed to protect the land and then failed to act on the overwhelming evidence of deterioration of the tussock grasslands, must surely carry the predominant proportion of the blame.

However, assigning blame to land occupiers and administrators seems to be of little relevance when compared with the urgent need for them to understand the realities of land degradation and to implement the necessary corrective measures.
Even today there are scientists, administrators and farmers who seem unaware of or are unwilling to grasp the reality of what has happened to the tussock grasslands over the period of their pastoral use or understand the significance of their degradation.

As a very recent example, the aim of the South Island Land Protection Coordinating Committee (as expressed in a ‘Land Conservation Statement’ dated 18 October 1991) is ‘To preserve the at risk lands of the South Island, primarily the land affected by rabbits and *Hieracium* (hawkweed), to ensure sustainable land use as defined by the Resource Management Act 1991’. The Committee goes on to state that *Hieracium* is out of control in many areas of the high country’ implying that hawkweeds are a cause of degradation of the tussock grasslands rather than being a symptom of it.

**Recent responses to the problem**

From time to time, as efforts were put in place to control rabbits, limit stock numbers, eliminate burning, rehabilitate land, and develop ‘improved’ pasture, recovery seemed to be occurring. However, what was not appreciated was that in spite of periods of apparent recovery (of the unimproved tussock grassland) the long term trend has been an initially imperceptible but inexorable and latterly increasing rapid change in composition and loss of species diversity (McKendry and O’Connor, 1990, Treskonova, 1991) and decline in production resulting from the loss of soil, nutrients (O’Connor and Harris, 1991), organic matter (Hewitt, 1991), and soil microfauna (Basher *et al.*, 1990).

In 1948, a reform of the law relating to Crown Land (Land Act, 1948), saw the final evolution of the contemporary pastoral leasehold tenure. It is a matter of considerable regret to observe that the Crown as landlord has failed (or was unwilling) (through enforcement of the covenants requiring good husbandry and the control of pests) to prevent the misuse of land leading to its degradation.

Rabbit Boards (later Pest Destruction Boards) were formed over the whole country in the 1950’s to destroy the rabbit pest. Concern about the recent lack of success in the semi-arid areas of the South Island (Review Committee 1983, Rabbit and Land Management Task Force 1988) has resulted in a thirty million dollar Government assisted and directed five year ‘Rabbit and Land Management Programme’ being implemented by

Another initiative aimed at the conservation of the land resource were soil and water conservation plans promoted in the 1960's by the former Soil Conservation and Rivers Control Council and catchment authorities (Kerr and Douglas, 1984). This generally successful programme has, it seems, been abandoned only half complete because of a lack of administrative will and funding.

As part of the Nation’s drive for exports in the 1980’s, land development incentives (the land development encouragement loan scheme and the livestock incentive scheme) were offered to farmers to assist them to increase pastoral production. It has been alleged that much of the farm development in the high country that took place under this programme was unsustainable (Parliamentary Commissioner for the Environment 1991; McRae 1991).

What is alarming, is the obvious collective failure by the public agencies responsible for the protection of the land resource, and the land occupiers and their advisors, to recognise the nature and scale of the problem and act on it.

This failure has been a result of serious inadequacies in public policy, and an ignorance of consequences of their actions by the many elected representatives, administrators, advisors, conservators, and occupiers who have had divided and often unconnected responsibility for the management of the land.

While this phenomenon is not new internationally (World Commission on Environment and Development 1987) and most evident in desertification of the Sahel region of Africa (UN, General Assembly 1986) it is nevertheless a truly ignoble example in New Zealand’s management of natural resources. It is certain to be included in the international literature as a classic example.

What has to be done
There is an urgent need for the removal of all rabbits, sheep and cattle from the most seriously degraded land and from all that land that is likely to become further degraded (and hawkweed dominant) with continued grazing disturbance.
This is necessary to enable whatever natural regeneration that is possible to take place and, where it is feasible, to facilitate land rehabilitation through the introduction of new plants and new uses of the land.

This urgently required adjustment will involve the successful elimination of the current rabbit plague and the removal (at least for an extended period) of approximately half a million livestock units.

Whether there is a prospect for any pastoral use of this land once rehabilitation is complete is a matter yet to be determined. It is a matter of some urgency that prescriptions for sustainable grazing (if any) of the many categories of unimproved tussock grasslands be developed through scientific research. *Prima facie*, because of the need to balance any pastoral use with the need to retain sufficient residual protective herbage, this may not be possible.

Harris (1991) estimated that approximately forty percent of the almost three million livestock units on high country farms are currently carried on ‘unimproved’ tussock grasslands. Some properties are highly dependent on continued grazing use of this land. Others which are, conversely, highly developed are less dependent. It is clear that the pastoral future of many runs relying on a high amount of grazing of ‘unimproved’ tussock grasslands is bleak indeed.

Already, the Rabbit and Land Management Programme is near the end of the second of its five years. The easy part, the control of rabbits, has been done. What remains is the hard part - the prevention of reoccurrence of rabbit plagues and the establishment of a sustainable land use.

Late in 1990, the New Zealand Mountain Lands Institute recommended to Government a programme of investigation and strategy for the management of land affected by hawkweeds. No measurable response from within Government has been observed.

The cost of control of rabbits on the high and extreme rabbit prone land exceeds the value of production on that land by a considerable margin. A perceived lower cost, and more environmentally acceptable, option of biological control of rabbits is being sought by high country land occupiers through an application to Government for the introduction of the myxoma virus and the European rabbit flea vector.
The public agencies responsible for the administration of the high country need to foster an enlightened and self-motivated 'landcare' attitude among all land users and adopt for themselves assertive land rehabilitation policies. To be able to act effectively and to understand the implied environmental, social, and economic issues, they must employ staff with a high level of technical and interpersonal skills. These ingredients are clearly lacking.

Land occupiers must act responsibly in their management of the land, be fully accountable to the Crown and to Regional Councils for their actions, and learn new land management skills, or face the prospect of forfeiture of their lease or the imposition of statutory land management requirements.

In response to prevailing land management problems, many high country farming communities are moving to embrace the concept of 'landcare' as a means of collectively addressing land management issues described above. This involves small communities of land occupiers developing a self managed approach to land rehabilitation and management.

The combined outcome of these initiatives is intended to facilitate land rehabilitation. It remains uncertain whether they will work to the degree anticipated and whether the required adjustments in land management for most of the high country are achievable. The economic limits within which land occupiers must operate and the historical performance of the public agencies involved inevitably suggests that there will not be a wholly successful outcome.

The costs of change will be high.

The overall costs of the Rabbit and Land Management Programme are expected to be in the order of thirty million dollars largely directed towards the control of rabbits.

Removal of domestic stock from the affected land may involve costs amounting to a further fifty million dollars.

If the application for the introduction of the myxoma virus (and the vector the European rabbit flea) is approved by Government the question of who is to pay for the associated costs will need to be settled equitably.
Any substantial changes in land use, for example to forestry, or any substantial land rehabilitation measures will inevitably involve large costs. Whether these costs will be met by existing land occupiers, or by new investors in the land, or by government, or at all, is very unclear.

Apart from the small proportion of funds available for ‘land management’ in the rabbit and land management programme there are no funds available from government for land rehabilitation at this time.

Bearing in mind reduced net farm income (as a result of reduced productivity) and the expected low rate of return from, for example, forestry on the semi-arid environment, there seems little realistic prospect of reinvestment or new investment funds being applied to land rehabilitation.

There is little to attract new investment in new land uses other than the salvage value (and low purchase price) of the degraded land resource.

One of the more attractive options that might be available to land occupiers is for them to persuade the Crown to resume the land and take responsibility for its rehabilitation.

The effect of the inevitable adjustment on individual runs and the families which operate them will be variable. Some will be able to meet the costs and re-establish their enterprises on a sound basis. A number may not survive.

In the interests of ensuring the necessary changes are effected without delay and further depletion of the land resource some form of enticement may be necessary.

Strategies for land occupiers
How does an individual land occupier respond to the prospects of the loss of available grazing?

An average high country property carrying 9000 su is likely to have a gross income in the 1991/92 year of about $271,800 and a total farm expenditure of $219,000.

For a high country property of average size with all of the unimproved tussock grassland hawkweed-dominant or conspicuous the required
destocking will reduce the number of livestock able to be carried by as much as forty percent (to 5400 su).

This loss in productivity will (because the fixed costs have to be met from the income from less livestock) reduce the net farm income ($52,800) to a level where the property will, in all probability, show a loss.

The immediate economic effect is, therefore, a substantial loss of income and a substantial reduction in the value of the property.

Add this loss in productivity to the recent large increases in pest destruction rates and the loss in income and capital is even more severe.

In the face of the reality of there being no (or at least very limited) pastoral future for much of the ‘unimproved’ tussock grassland on their run the only options available to land occupiers are to:

- eliminate rabbits
- reduce the number of domestic animals
- rapidly develop improved pastures on suitable land to restore (and possibly enhance) the productivity of the run as a whole
- acquire additional land to make up for the production lost from the unimproved tussock grasslands
- find off-farm employment
- adopt an alternative land use
- accept a lower annual income and loss of capital
- sell the property

Already, each of these strategies have been adopted by several farmers. The initiative, skill and resources of many farmers in devising strategies for business growth and survival is probably the greatest hope for a rational and sustainable adjustment process. It is important that the public agencies recognise this and create, rather than inhibit, conditions that foster the initiative of the existing occupiers of the land or new investors in its future.

Whatever options are pursued by land occupiers they will be costly.
As taxpayer and ratepayer input is reduced the burden of the high cost of rabbit control increasingly will fall on land occupiers. As the productivity of highly rabbit prone land is generally insufficient to meet the costs of control land occupiers will increasingly seek a lower cost biological control option.

Reducing the impact of grazing domestic stock will involve a reduction in numbers (possibly as much as forty percent) and/or the alteration of herd/flock composition (e.g. reduction or elimination of wethers) and changes in management (e.g. delayed lambing, agistment of stock in winter/spring).

The costs of pasture development or the purchase of additional land for the livestock displaced will be similar. Both options will incur additional operating, maintenance, and capital servicing costs which, to maintain the existing level of income, will be needed to be covered by production from further development, additional land, or improved livestock performance.

The options available to land occupiers for alternative land uses within the high country are comparatively few.

Forestry, while technically feasible and eventually capable of producing a many-fold increase in revenue from the land, is clearly a long term proposition. On a large scale, it is likely to be beyond the economic capacity of most farmers to wait on their investment until timber is able to be harvested and sold. There are, however, options for sale of cutting rights of even whole forests before maturity. Many high country farmers are currently considering the possibilities.

The provision of services to the tourism industry is only available to a few geographically well positioned. Commercial recreation may be an option for some.

For those with limited resources the only option may be to accept a markedly reduced income and a loss of capital and continue their farming operations on a reduced scale and limited to land where they are able to sustain a self-contained intensive pastoral system possibly supported by off-farm work.
The only other alternative available to some farmers is for them to endeavour to find a buyer for their property and exit the industry enabling others to endeavour to find a sustainable solution to a vexed land use problem.

Because of the high land holding costs (relative to the low productivity of the land) some pastoral lessees are contemplating the prospect of relinquishing the highly rabbit prone and unproductive portion of their leases to the Crown. The Crown (in the form of the Office of Crown Lands) has not made public its view on this issue.

Sooner or later, because of the seemingly relentless decline in pastoral productivity of all tussock grasslands, all land occupiers in the high country will have to assess the options available and respond individually and collectively.

Strategies for land administrators
Clearly, the high cost of rehabilitation of degraded tussock grassland will be minimised through an early action by 'government' to facilitate necessary adjustments in the management of the land. This is necessary because land occupiers will only make the necessary management adjustments (such as reduction in stock), when there are clear signs that the fall in productivity of the property (or parts of it) is irreversible.

Unless action is taken urgently society will be responsible for allowing a bad example of land degradation to continue and thereby ridicule New Zealand's much touted environmental policy of sustainable use of resources.

One of the first requirements of 'government' will be to understand the 'problem'. As evidenced by extant policies and historical action the issues are not well understood.

Clearly, for this to happen, an immense programme of education in the fields of ecology, resource management, and sociology for land managers (be they administrators or land users) will be necessary for the wide range of people involved in the future of the high country.

It is clearly necessary for 'government' to adopt 'sustainable land management' policies rather than continue to contribute to the problem with policies and administrative practices which do not, as a first priority,
effectively reverse the process of land degradation which is now so manifestly apparent.

Now that government is introducing resource management policies aimed at the sustainable use of resources and is devolving responsibility for resource management to regional councils it follows that regional councils should play a major role in bringing about the changes required.

Presumably, to do this, regional councils will seek to develop management plans for a concerted land rehabilitation programme implemented through operational plans involving single or possibly several high country properties. It is self-evident that such a programme will need the input and initiative of land occupiers to carry it through to a successful conclusion. Hence the fostering of 'landcare' is crucial.

The input, initiative and co-operation of other public agencies with responsibilities for land tenure, conservation, agriculture, forestry, and district planning will also be crucial.

Government financial resources in support of special land rehabilitation and adjustment programmes will indubitably be required.

New legislative initiatives may ultimately be necessary.

The complications of high country property rights and administration of land use will require the reconciliation of the conflicting objectives of the many interests involved. Arranging for a rational process and means of funding for the necessary adjustments in land management will not be an easy task.

No longer can the people implicated in the management of the high country explain away their failure to act to ensure sustainable land use. Carefully considered action rather than words is now all that there is between accountability and delinquency.

Finally
It appears that for much of the high country, high country farming as we have known it has come (or is soon to come) to the end of the era of low cost extensive pastoralism.
It is ironic that what was first regarded as an intrusive weed threatening pastoral productivity was in fact the symptom of a pastoral system collapsing. Bearing in mind the more than a century of warnings the reasons for the collapse should have been obvious to us all.

It is to be hoped that the nation has learnt from the experience and will move carefully, effectively, and compassionately to ensure the land and people of the high country endure.

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Guidelines on burning tussock grasslands

Acknowledging that burning is a management tool in tussock grasslands, the Institute saw the need for a set of principles which might guide burning management. Such principles include ecological, managerial and practical considerations.

Two reviews published in 1990 provided a scientific basis for a workshop involving land occupiers and other interested parties held at Lincoln University in October 1990. That workshop was preceded by a scientific review discussion in September 1990.

Institute members discussed a summary report of the scientific evidence the outcomes of the workshop and policy. The 'conclusions' in this report are the Institutes.

The Institute stresses the point that the recommendations are indicative guidelines for interpretation and application to specific local conditions.

They are nevertheless the outcome of a consultative process (one of which was the October 1990 workshop) and careful consideration by the Institute.

Objective

The principal objective of the workshop was to share information and foster discussion among participants on the principles by which the management of burning of tussock grasslands might be guided; these principles to include ecological, managerial or administrative, and practical considerations.

The main outcome of the workshop was expected to be a consensus on these principles and at least a framework for guidelines to assist land occupiers, public agencies and interest groups in their respective roles concerning the management of burning of tussock grasslands.

Outcome of meeting of reviewers and clients

As a preliminary to the workshop an informal discussion took place at Lincoln University on the 20th of September between the reviewers of the effects of burning (DSIR) and the ecology of tussock grasslands (Lincoln
University) and their ‘clients’ which initiated the reviews (Regional Councils, Department of Conservation), to consider the outcomes of the reviews before they were presented to the wider workshop of interested parties.

The reviewers presented only short summaries of their findings at the larger burning workshop.

The discussion on 20 September led to some consensus and a number of items were identified as likely to be part of that consensus:

- Management of burning of tussock grasslands needs to take into account all other influences on the system as a whole and needs to recognise the objectives of the overall management of the system.

- Under present pastoral use of unimproved tussock grasslands, the natural resource system is being run down - but it is unclear by how much or how fast.

- Two fundamental questions emerge:
  - under what conditions is pastoral use sustainable?
  - under what conditions of pastoral use is burning necessary and acceptable?

To answer these questions with confidence further investigation into the processes involved in, and the effects of, burning of tussock grasslands is warranted.

- Burning management needs to be related to pasture improvement and afforestation as well as nature conservation and not simply to grazing use of unimproved tussock grasslands.

- That there is urgent need for more exchange of information and understandings on the effects of burning between the occupiers and public agencies responsible for the management of tussock grasslands.

- That even where burning is seen as pastorally necessary, the public interest may not necessarily be in accord with such burning.

- The effects of transfer of nutrients by animals appears to have been a major influence on the tussock grasslands and may be compounded by the effects of burning in running down the natural resource system.
It will be necessary to develop a systems approach to the management of tussock grasslands for nature conservation as well as for pastoral uses. It was agreed that burning was unnecessary for conservation except where 'managed reserves' were desirable to prevent reversion to scrubland.

That a unified 'burning permit system' is desirable on common basis and with a whole system approach to the management of burning by public agencies.

From these earlier discussions it became evident that some consensus on these issues is required before guidelines can be finalised.

It would also be helpful for a set of research objectives to be prepared to focus future action.

Finally it was concluded that existing burning policies, applied with current understanding of the effects of burning of tussock grasslands, should be retained until more comprehensive guidelines are developed.

Reviews of the impact of fire on tussock grasslands

Two reviews (Basher et al. 1990 and McKendry and O'Connor 1990) which provided workshop participants with information, examined the evidence on the effect of fire on vegetation and soils.

Both of these studies concluded that, in the absence of information about the long term impact of fire a 'conservative' approach to the management of fire in tussock grasslands and scrubland of mountain environments is appropriate.

Basher et al. advocated a set of objectives which fire management policies should promote:

'the maintenance of the quality, quantity, and desired composition of the vegetative cover, whether for production or conservation purposes (including soil and water conservation),

the maintenance of the soil resource since this is the medium for supplying water and nutrients for plant growth and determines the physical sustainability of the agroecosystems,
the maintenance or enhancement of the physical and chemical characteristics of the soil, that is: soil depth, texture, organic matter and structural stability, control the ability of the soil to supply nutrients for plant growth, and to resist the erosive forces of wind and water,

the maintenance of soil fertility is particularly important and is dependent on adequate organic matter levels, a diverse population of soil microorganisms and efficient nutrient cycling,

the understanding that burning without replacement of nutrients by fertiliser, or inputs from the atmosphere and weathering will ultimately result in soil degradation that will limit plant growth and make land use unsustainable'.

The authors conclude that 'evidence from the overseas literature, the limited amount of information on the impacts of burning, and our knowledge of ecosystem processes, support the view expressed throughout this review that the use of burning, without replacement nutrients by fertiliser, will inevitably degrade the soils although the time scale may be long. Grazing will exacerbate this degradation'.

McKendry and O'Connor in their review of the ecology of tussock grasslands for production and protection noted that:

'post burn recovery of snow tussocks was fastest and most sustainable if the fire was not followed by grazing

repeated burning and grazing deplete snow tussock nutrient reserves and that recovery of snow tussocks may take up to fourteen years to equal unburnt plants

repeated burning or some other form of disturbance of short tussock grasslands is likely to result in degradation of the system, unless the trend to nutrient depletion is reversed by 'agricultural rejuvenation'

that fire management in New Zealand does not have a long history to call on .... models of past, current and proposed fire regimes may assist decision making.'
Outcomes from workshop discussion groups

(a) PRINCIPLES

Group One

At present burning of tussock grasslands is aimed at maintaining inter-tussock plants or temporary clearance of woody plants for access by stock to forage.

Burning *per se* is not regarded as a significant problem but that the combination of burning and grazing effects are causing serious depletion.

It is important to identify what (conservative) burning practices are appropriate given the various land types and vegetation that are being burnt e.g. frequency, post fire management, stocking, follow-up.

There is a concern over the lack of knowledge on nutrient loss and present lack of information e.g. what is the loss due to transfer by animals and by fire. It is important to identify these losses through research.

Group Two

Fire is an important management tool on productive land which is infested with scrub weeds and on certain classes of tussock lands if that land is to be used for pastoralism.

The present fire management policies are considered conservative within the current permitting system so long as these conditions are rigidly enforced.

Until scientific evidence is established that proves the hypothesis presented today then the status quo has to be accepted.

The reasons for not burning include fuel reduction, maintenance of conservation values, political reasons, and the issue of sustainability which have to be accounted for in addressing these issues.
Group Three

There is surprising lack of scientific findings about burning. There is a wide range of perceptions, observations, management practices, and scientific information about burning of tussock grasslands. Tussock grasslands are a collection of special cases.

There is a long time scale involved. The long term effect of burning is dependent on the history of management rather than a single event.

Tussock grassland systems are generally all running down. Rate of rundown depends on the size of the nutrient pool. Burning accelerates rundown (North Canterbury 40 yrs, Mid-Canterbury 100 yrs, South Canterbury 200 yrs ....).

Central issue is one of sustainability. Tussock grasslands are cultural features being the product of animal grazing, fire, and management.

There is a need to clarify goals for the management of tussock grasslands. Clearly there are different land management objectives for nature conservation, landscape management and for pastoralism. These objectives are not usually compatible.

There is a need for any burning system to take account of the understanding of the processes of ecosystem evolution and the means of maintaining existing flora.

For nature conservation burning is seldom required. Where there are high values for pastoralism on areas recommended for protection there is an obvious conflict and burning/grazing management decisions are often made without an understanding of the effects of burning on areas selected for their representativeness.

There are different objectives for burning of tussock grasslands. Land occupiers objectives are to improve and maintain pasturage and to control woody scrub species. Many land occupiers believe burning improves pasturage and will spread stock grazing, especially where fencing is inappropriate. Burning is used for (a) land clearing purposes prior to cultivation/oversowing and topdressing/tree planting (b) rejuvenation of native pastures and (c) removal of unwanted species (trees, scrub, bracken, and species which contaminate wool, etc.).

In the case of tall tussock grassland burning removes competition for inter-tussock species and allows establishment of ground cover and the
introduction of alternative species.

Prescribed burning may be necessary to reduce the risk of fire (started by recreational users) during summer.

There is a clear interaction between burning and other disturbances such as grazing which opens up tussock grassland for the ingress of *Hieracium* spp and other plants.

**Group Four**

Burning is still a relevant issue in the management of tussock grasslands. There are regional differences. Generally burning is not practised for creation of a ‘green bite’. Most burning is concentrated on the control of shrub weeds. Other burning practices involve the conditioning of previously improved grasslands. Burning of tall tussock grasslands is still relevant in Otago.

The management of tussock grasslands involves more than burning. Objectives for the management, including burning, need to be defined for different land systems.

There is no case for burning of inland fescue tussock grasslands because there is no need to further modify them either for grazing or for plant introduction. Any burning of tall tussock grasslands should be very limited and, if burnt at all, only at long intervals (10 - 15+ years) between burns and with at least one year before any grazing is resumed. The only valid reason for burning of eastern zone silver/fescue tussock grasslands is the removal or reduction of matagouri, bracken, or other plants which restrict grazing. Burning, for the purpose of maintaining a tussock grassland landscape, is possibly an appropriate objective, but in reality such a practice may not be feasible when requirements for nutrient replacement are considered.

The replacement of nutrients lost during (or after burning as a result of nutrient transfer by animals) is essential to maintain grassland. The direct costs of not applying fertiliser (and seed) after burning needs to be balanced against the indirect long term costs of depletion.

Post fire management is considered to be crucial. There is a considerable risk of serious depletion of the ecosystem by grazing animals and by adverse climatic conditions. By way of example both rabbits and sheep tend to congregate on recently burnt areas. There needs to be strongly
reinforced rules governing post burn spelling and the subsequent stocking rate. The overall objective is to reduce the need for, or at least the frequency of, burning.

The alternatives to burning are seen as (a) control of grazing by both domestic and feral animals, (b) application of fertiliser and seed, (c) mechanical thinning or removal of unwanted vegetation such as shrubs, (d) no burning, (e) conversion to forestry, and (f) use of herbicides.

(b) RULES

**Group One**

From the point of view of pastoral farmers the practical requirements are for a burning policy that enables them to burn strongly growing snowgrass and to control woody weeds so as to maintain, and even enhance, the productivity of the run. This objective may not be consistent with a sustainable use of tussock grasslands.

There is a need for rationalisation of the burning permit system. The present system is unnecessarily complicated and costly to administer. Permitting authorities for a fire might include regional councils, rural fire authorities, the Crown (with Land Corporation Limited as agent), and the Department of Conservation.

There is a need for a single permit issuing and fire control authority. Permits should be issued only after being approved by all the agencies with an interest in the land.

There should be one set of rules governing the management of fire throughout the country. The Forest and Rural Fires Act is comprehensive and could provide the legislative basis for the rules.

Criteria for issuing permits to burn snow tussock should be (a) altitude limit 1000 m, (b) frequency (dependent on recovery of tussocks) 10 year minimum for humid areas and 20 years for drier areas, (c) spring burning only, (d) minimum of one full year's spelling, (e) high altitude must be protected by snow cover, (f) experienced people must be employed to control fire, (g) conditions of approval must be well defined and clearly set out in permit.
Burning of tussock grasslands is an important issue which needs to be planned on a regional basis and for defined land systems (e.g. snow-tussock, scrub etc). Because Regional Councils are responsible for environmental management, councils should be involved in the management of burning and responsibility should not be left with land occupiers.

Group Two

At present a common basis for the management of burning exists only in principle. There is a need to better integrate the issuing of permits to burn tussock grasslands by the agencies responsible for land management with the rural fire authorities responsible for suppression of out of control fires.

There is a lot of knowledge available about the effects of burning of tussock grasslands. More information would be valuable especially about: the impact of post burn grazing by domestic and feral animals, the impact of fire on the composition of tussock grassland, impact of fire on soils including soil organic matter and soil micro-fauna, and the amount and significance of transfer and loss of nutrients.

It is important to rationalise the objectives of both the land occupier and the regulating authorities in relation to burning. Similarly it is important that there is public confidence in the practice of, and the process which manages burning of tussock grasslands. An education process is required to make information available to all those people involved.

Group Three

Initially the conservation of water and soil resources were the reasons for imposing rules for the management of burning of tussock grasslands. Other values, particularly the conservation of nature, are now considered as important. The criteria for the issuing of burning permits now overlap those of other agencies.

There are now more 'players' than necessary. Rural fire authorities (usually district councils), being responsible for the control of fire, should have the final say before a permit is issued. It was suggested that a system where only one permit, with four signatures (Land Corporation Limited/Commissioner of Crown Lands, Department of Conservation, Regional Councils, and rural fire authorities) should be adopted.
The Department of Conservation, regional councils, land administering agencies, non-government organisations, and scientists have sometimes been dissatisfied with the effects of burning of tussock grassland. Concern has been expressed by these organisations about the contribution of burning to the degradation of soil and water conservation 'values', to the disturbance of tussock grasslands leading to their dominance by hawkweeds, the lack of post burn treatment (spelling, and oversowing and topdressing).

More scientific evidence on the effect of burning of tussock grasslands is urgently required.

**Group Four**

There is a need for a fire control authority for the tussock grassland zone and there is a need for rationalisation of the number of agencies responsible for the issue of burning permits.

The reasons for burning are considered to be: retention of productivity of pastoral agriculture on tall tussock grasslands; reduction of woody weeds, preparation of land for forestry; maintenance of seral vegetation in the interests of conservation of nature and for landscape preservation; and reduction of fuel to minimise danger from fire.

All of these purposes for burning are conditional on the use of fire being a sustainable option. There is no consensus on the geographical areas where burning may, with conditions, be allowable. Areas need to be considered case by case.

It is necessary to define the objectives of burning. Is burning the appropriate option? Where burning is appropriate the following conditions need to apply before burning: will the area carry a uniform fire? is there sufficient soil moisture to limit the effect of the fire?, what season? (generally limited to spring), and what is the state of the vegetation? (relative to climax).

The post burning management is conditional on climate but generally complete spelling from animal grazing is essential (for at least one year) and replacement vegetation introduced (by oversowing and topdressing). It is necessary to define the condition the vegetation has to reach before grazing is resumed.
The legislative basis of controlling burning is different between the Land Act (burning is prohibited except with the consent of the Commissioner of Crown Lands) and the Soil Conservation and Rivers Control Act (burning permit may be granted only if burning does not aggravate soil erosion).

Because of the multi-agency involvement clarification of the legislative reasons for consenting/permitting burning of tussock grasslands is required. When considering burning policy, agencies need to consider the reasons for restrictions (including why have them) such as concern about soil erosion and other forms of land degradation.

The imposition of conditions (such as post burn management) requires education of interested parties on the effects of burning, agreement between the interested parties, and effective enforcement of the conditions.

Monitoring of burnt areas is necessary to accurately observe changes in the vegetation and the soil.

Any policy decision needs to address the issue of whether the rules should be removed, and what the rules achieve.

One objective may be to ascertain what landscape it is proposed to maintain. Classification of land at risk from fire should assist burning management.

An education programme is necessary to get land occupiers and public agencies to understand that burning is a part of a web of influences on tussock grasslands.

More information is required on: intervals between burning, whether burning is biologically acceptable to the plants, and what happens after the fire.

An objective should be safe, controlled burning with no adverse environmental effects. There needs to be penalties for non-compliance.

There is concern that the effects of fire on tall tussock grasslands above land infested with rabbits opens up the vegetation and creates an extension of the rabbit problem. The increased cost of rabbit control is greater than the income from increased production.
CONCLUSIONS

The overall conclusion from the reviews of research and the deliberations of the workshop was that, on the available evidence, burning of tussock grasslands is inherently unsustainable. It follows that the policies of the public agencies which influence the management of burning of tussock grasslands should be 'conservative' and limited to circumstances where the depletion of soil and vegetation is avoided.

There was general agreement that burning of tussock grasslands depletes both the soil and the vegetation resource. It follows that, ideally, any area of tussock grassland that is burned should be fertilised and seeded.

Both the reviewers of the literature on burning and the participants in the workshop emphasised the need for further information on the effect of fire on tussock grasslands. In particular information on the loss of nutrients, organic matter and soil microorganisms by fire is considered essential to a fuller understanding of the consequences of fire in this environment.

That the attention of the Ministry of Research Science and Technology and research staff generally be drawn to the need for research into the effect of fire on tussock grasslands. In particular it is recommended that the effects of fire on any areas that are regularly burnt should be closely monitored.

There was general agreement that burning of fescue tussock grassland is unnecessary and that any burning of snow tussock grassland to enhance pastoral use be severely restricted.

It is considered advisable that no consent should be given to burn any area of fescue tussock. An exception to this may be in the instances where burning is the only practical means of controlling unwanted woody shrubs.

It is recommended that any burning of snow or red tussock grassland should be restricted (a) to not less than twenty year intervals, (b) to land below 1000 metres (and higher altitude land protected by snow cover), (c) to spring burning only, and (d) to a minimum of one full years post burn spelling from grazing.

In addition, it is considered advisable that a condition applying to any consent to burn snow or red tussock grassland be that the whole of the area burned be oversown and topdressed to ensure there is no
loss of nutrients or ground cover. No such condition should apply to conservation land.

It was generally agreed that when permit issuing authorities are considering applications to burn tussock grasslands they should consider all the environmental effects of and management requirements for the proposed burn before deciding to grant the consent applied for. It was considered that the onus should be on the applicant to state what the proposed burning will achieve.

It was generally agreed that the procedures of the separate permitting authorities by which land occupiers seek consent to burn tussock grassland are administratively complicated. One reason for this is the differences in the objectives of the legislative authority for the control of burning provided in the Forest and Rural Fires Act 1977, the Soil Conservation and Rivers Control Act 1941, and the Land Act 1948.

It is recommended that amendments be made to the relevant legislation to facilitate procedures for single fire permits to be jointly issued by the agencies which consider applications to burn tussock grasslands. It is also recommended that this procedure be used to integrate the policy requirements of the respective land management and fire control authorities.

References


Preamble

The human modification of mountain landscapes is a topic about which there are many opinions. The merits and problems of cultural changes to these perceived natural landscapes are much debated. The impact of human activity on the landscapes of the New Zealand high country has increasingly become an issue affecting the many occupiers, agencies and groups that have an interest in and concern for its future.

Conscious management of landscapes involves an evaluation of the impact of a particular action by someone or some organisation. A prerequisite to any such evaluation is an awareness of the actual or potential effect of a proposed action, a recognition of the design options available, and a willingness to consider these options including not proceeding with a proposed action.

The management of the high country is the responsibility of a mix of regulatory agencies and land occupiers. A consensus in land management has traditionally been difficult to achieve. The issues now being faced and which cross ownership boundaries have provided a common focus and an unprecedented necessity for cooperation.

Occupiers of the high country are particularly sensitive to the introduction of new conditions that seek to 'control' the impact of land use on the landscape. Land occupiers and advocates for managed landscapes generally accept that the issue is not one of controls but one of the need for consensus on the management of inevitable change.

In 1983 the former Land Settlement Board adopted a rural landscape policy as a general policy for all Crown land administered by the Department of Lands and Survey. Since the abolition of the Board in 1987 this policy has remained relevant only to Crown pastoral leasehold land which encompasses much of the South Island high country.

The rural landscape policy of the Land Settlement Board has the general objective of ‘maintenance and enhancement of New Zealand’s landscape ...’

It is intended that the policy be implemented through the (co-operative) development and use of national landscape guidelines, advice and
education, environmental protection procedures, and through the consent procedures requiring land administrators and property managers to 'recognise the unique and sensitive nature of the high country and give special attention to all matters affecting high country landscapes'.

Landscape guidelines were prepared and distributed to all Crown lessees prior to the abolition of the Land Settlement Board.

Landscape policy in mountain environments can be implemented through the planning and regulatory consent procedures.

Regional and district planning schemes, while enabling 'the preservation and conservation .... of landscape ....', have been, and are likely to be, little used for the purpose of specifying requirements for the management of landscapes because of:

a) the absence of an agreed format,
b) sensitivity to potential infringement of the existing use rights of land occupiers, and
c) a lack of practical examples of successful policy implementation.

On 27 March 1991 the Institute convened a workshop of interested parties to consider the policy options for the management of mountain landscapes generally.

It was intended that the outcome of the workshop be a set of policy guidelines which would be of assistance to public agencies when they consider activities which could have a significant impact on the landscape.

It was expected that the outcomes of the workshop would also be of value to occupiers and others with an interest in high country landscapes.

Papers

At the workshop discussion papers were presented by Di Lucas, Claire Findlay, and Alan Rackham. Key issues identified in the papers and the subsequent workshop discussion included:

- That there is some consensus that a healthy tussock grassland landscape is desired.
- That following polynesian fires some areas may have been replanted with tussocks.

- That landscape is both a visual resource and embraces other resource values.

- That the Queen Elizabeth the Second National Trust Act 1977, the Reserves Act 1977, and the Conservation Act 1986 provide for the advocacy of conservation (including the management of landscapes) on private land and provisions for the management or covenaniting private land for conservation purposes with the agreement of the owner.

- That the Land Act 1948 provides for regulation of cultivation, cropping, grassing, afforestation, tracking, felling or removal of bush, burning of vegetation on Crown land.

- That the Town and Country Planning Act 1977 provided for the 'conservation, protection and enhancement of the physical, cultural and social environment' (including landscape).

- That, generally, there is a lack of explicit reference to landscape in the legislation.

- That the absence of professional landscape advice to the regulatory agencies mitigates against the adoption of a coherent landscape management programme for mountain environments.

- That an outcome of the 1984 High Country Landscape Seminar was the drafting of procedures for the consideration of landscape 'values' when consideration is being given to:

  - applications for discretionary consents on pastoral land
  - proposals for Recommended Areas for Protection
  - preparation of regional and district schemes
  - the management of wilding trees, and

- That the concept of Protected Landscapes, being advanced by the National Conservation Authority, may be applied to the high country.
That there is a need for a comprehensive approach to what have been treated as ‘singular’ issues so that an landscape considerations can be appropriately included.

Discussion

Landscape can be defined as the integration in space and time of the physical, biological, and cultural elements of land.

As within all dynamic systems, changes in landscapes are inevitable. We cannot (on any significant scale) reverse the impact of people on the landscape but we can direct it. These changes are the result of the effects of people, plants and animals. There is no longer a ‘natural’ landscape.

Continuing economic use must be environmentally sustainable. However, definitions or thresholds of sustainability are not agreed. It is possible that land occupiers may seek payment for any retreat from existing ‘sustainable’ use.

In the 1991 workshop following issues were raised:

- Should there be a ‘policy’ for managing landscapes? If so should it be enabling or enforcing?
- Should there be national directions and some control over the rate of change?
- What should be the legislative base for any control?
- What agency(ies) should be involved?
- What enforcement mechanisms, if any, are appropriate?
- Who should pay for the costs of implementation, monitoring, and the effects of any controls?

There was some consensus that mountain landscapes should be managed and that some guidelines for this are appropriate.

The workshop noted that the national interest in mountain landscapes could be addressed through a national policy statements as provided for in the Resource Management Act 1991.
Rules governing the management of landscapes should be included in regional and district resource management plans. This process would enable the 'wishes of many' to be included in regional and district decision making within a framework of national and regional guidelines.

A principal issue which will need to be addressed within the framework of regional policy statements is the degree to which any rules for the management of landscapes will infringe on private property rights and the means by which inevitable changes are managed while retaining an overall 'balance' between continued production and the maintenance (or restoration) of valued landscape attributes.

An overall conclusion is that there needs to be a well defined and adequate process whereby all resource management issues are seen to exist within the landscape as a whole and need to be dealt within this broader context.

It is noted that the Resource Management Act 1991 provides for a new approach to the management of landscapes through the integrative process of regional and district resource management plans.

Findings

The following conclusions are recorded with the intention that in the management of mountain land resources there is a process and framework by which landscapes are considered rather than prescribing a set of rules about landscape design which would have general application to all mountain environments.

- That those agencies with statutory responsibilities for landscape protection (i.e. the Queen Elizabeth the Second National Trust, the Department of Conservation, and regional and district councils) should identify their respective roles and determine the practicability of preparing a coordinated policy statement on mountain landscape protection.

- That, because the management of mountain lands is a matter of national significance consideration should be given to the inclusion of policy objectives for the management of mountain landscapes in a national mountain lands policy statement issued under the provisions of the Resource Management Act 1991.

- That, all regional policy statements and regional and district
resource management plans should, where applicable, define objectives for the management of landscapes in mountain environments.

- That, to ensure consistency, the consent procedures (relating to the management of landscapes in mountain environments) of all public agencies with responsibilities for the management of mountain land resources should be coordinated.

- That, in addition to other issues, the following should be specifically addressed in statutory resource management plans relating to the management of mountain land resources:
  
  - provision for the protection of outstanding landscapes,
  
  - performance standards to avoid adverse effect of any proposed modifications to the visual environment.

- That, in the preparation and administration of resource management plans, all district and regional councils should:
  
  - have regard to the needs and views of affected communities, land users and other interested parties, and
  
  - seek the advice of suitably qualified professional landscape architects.

This report was endorsed by the Mountain Lands Institute at its final meeting on July 3, 1992.
In the 1991 Budget Government gave notice of its intention to withdraw its funding support for the Institute, effective from 1 July 1992.

This announcement came as a shock for only a few weeks earlier Government Ministers indicated approval of the Institute's work. With the support of several government agencies the University and Committee made every effort to have the Government decision overturned, but to no avail. Alternative means of funding were explored but came to nothing.

Whilst appreciating the need to cut Government expenditure, Lincoln University Council questioned the wisdom of the decision to cease an activity that was fulfilling important social, institutional, economic, ecological and national needs. Council said it was regrettable that financial considerations had overridden government's concerns for the sustainable management of mountain land environments.

There continues to be a need for discussion debate and the identification of issues by the main stakeholders and interest groups and for consensus seeking comprehensive and consistent advice to governments, both regional and national. An independent group, meeting on neutral ground, is still needed to provide a forum for the resolution of issues related to the management of mountain land resources and for such a group to provide a mechanism for the review and integration of research related to the management of these resources.

Since its establishment over 30 years ago the Tussock Grasslands and Mountain Lands Institute, and more recently its successor, the New Zealand Mountain Lands Institute has, I believe, performed an extremely valuable role in facilitating the co-ordination of research, in the identification of problems and in the dissemination of information through its own journal Review, special publications, seminars, workshops and conferences. Its staff has always been of the highest calibre and the results of their research has made a significant contribution to the understanding and management of hill and high country environments.

It is significant that as I write this final Account of Activities, a request is received from a regional council seeking our views about high country
management with a view to hosting a workshop to define concerns in the high country and to determine who has responsibility for doing what to address those concerns.

Hawkweeds

Following the presentation of the Report on Hawkweeds to Government, the Institute continued to take an active interest in this important matter. The report was published in *Review 48* (December 1991) and papers on the distribution of hawkweeds and an ecological perspective on hawkweeds were published in the same issue. This latter paper by Dr Treskonova is commended to everyone concerned about accelerated land degradation in the high country. Government has had the Report on Hawkweeds for 18 months. We can only repeat what was written in the final paragraph of the report and hope that Government will take some action:

*Summarising the situation and the options that lie open, we can estimate that the fine wool industry in the mountains and the conservation estate are both at grave risk if we do nothing. Pastoral futures and nature conservation futures as they have been conceived are both so threatened by this grassland degradation that within 10 years we may expect to have only a skeleton fine wool industry in the mountains and few representative tussock grasslands in the conservation estate.*

Tussock grassland management

In all its deliberations the Institute has first and foremost placed emphasis on the protection and sustainable use of the land itself. Any land management practices must be based on sound ecological principles to ensure a sustainable future.

Papers outlining some of the most important aspects of tussock grassland management will be published in *Review 49*.

Tourism

In last year's Account of Activities attention was drawn to the impact tourism will have on New Zealand's natural estate, particularly in
mountain lands, especially if the number of international visitors trebles to three million, as some predict, by the year 2000.

The Institute applauded the Department of Conservation’s initiative in producing a draft strategy for managing tourism. In its response to this draft the Institute suggested that DOC should take a positive, proactive stance rather than passively responding to tourism’s needs. Joint management plans (between Tourism and DOC) would allow for public input and enable policy strategies to be implemented according to local needs. In addition, the Institute noted that tourism incurs costs, many of which are borne by the Conservation Estate. A source of funds is needed for estate maintenance and should come from tourist income, perhaps on a per capita basis.

Landscape

Following the publication of ‘High Country Landscapes’ which was followed by a workshop to formulate policy guidelines, the Institute published ‘Mountain Land Landscape Policy Guidelines’, a synthesis of the deliberations of a widely representative workshop of users.

The principal conclusions were:

- That those agencies with statutory responsibilities for landscape protection (i.e. the Queen Elizabeth the Second National Trust, the Department of Conservation, and regional and district councils) should identify their respective roles and determine the practicability of preparing a co-ordinated policy statement on mountain landscape protection.

- That, because the management of mountain lands is a matter of national significance, consideration should be given to the inclusions of policy objectives for the management of mountain landscapes in a national mountain lands policy statement issued under the provisions of the Resource Management Act 1991.

- That all regional policy statements and regional and district resource management plans should, where applicable, define objectives for the management of landscapes in mountain environments.

- That, to ensure consistency, the consent procedures (relating to the management of landscapes in mountain environments) of all public agencies with responsibilities for the management of mountain land
resources should be co-ordinated.

- That, in addition to other issues, the following should be specifically addressed in statutory resource management plans relating to the management of mountain lands resources:
  - provision for the protection of outstanding landscapes
  - performance standards to avoid adverse effect of any proposed modifications to the visual environment

- That, in the preparation and administration of resource management plans, all district and regional councils should:
  - have regard to the needs and views of affected communities, land users and other interested parties, and
  - seek the advice of suitably qualified professional landscape architects.

Thanks
The ratification of this report will be one of the last duties of the Committee.

I wish to thank committee members and staff for the professional and impartial manner in which they have discharged their responsibilities.

The original institute was formed after many years of hard endeavour by people with vision who had the foresight to see the important role such an institute could play. Nothing has changed. The problems that are obvious now, as well as those that will inevitably emerge, justify the existence and continuation of a co-operative, independent body that the Institute has proven itself to be.

G. McMillan, Chairman
9 July 1992
Institute to close

Government funding cuts have forced the closure of the Mountain Lands Institute. In the 1991 budget, Government gave notice of its intention to withdraw funding support for the Institute effective from July 1. Funding had been provided through Vote: Environment.

Established in 1960, the Tussock Grasslands and Mountain Lands Institute became a constituent part of Lincoln College and sought to provide technological information and skills for the conservation and utilisation of natural resources in hill and mountain lands.

From the outset the Institute had a committee of management comprising people from the main user and administrative groups associated with the tussock grasslands and mountain lands. Commenting on the closure the current chairman George McMillan, said that “since its establishment over 30 years ago the Tussock Grasslands and Mountain Lands Institute and more recently its successor, the New Zealand Mountain Lands Institute has performed an extremely valuable role in facilitating the coordination of research, in the identification of problems and in the dissemination of information through its own journal Review, special publications, seminars, and workshops and conferences.”

“Its staff has always been of the highest calibre and the results of their research have made a significant contribution to the understanding and management of hill and high country environments.

“There continues to be a need for discussion, debate and the identification of issues by the main stakeholders and interest groups and for consensus-seeking comprehensive and consistent advice to governments, both regional and national,” Mr McMillan said.

On Friday, July 3, former members of the Institute’s committee met for a luncheon. Among them was former chairman, high country farmer and author David McLeod, now aged 90. Lincoln University is exploring ways of maintaining its interest in, and work for, the sustainable use of mountain land resources.