MODIFICATION OF GRASSLANDS BY GRAZING ANIMALS

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Principles and Patterns

Martin Jones (1933), working on high producing pastures in Great Britain, found that heavy grazing or close cutting resulted in a reduction of the root weights of the major species (ryegrass, cocksfoot, timothy, red and white clovers). By altering the time of early spring grazing, the species composition of pastures could be changed. Grazing, when one of the species was commencing growth and its level of food reserves was at its lowest point, weakened that species as a competitor in the sward. Thus, in the production of clover seed in New Zealand, the planned heavy grazing of ryegrass/white clover pastures in spring, when growth of ryegrass is just beginning, results in dominance of the pasture by white clover, which starts spring growth later.

Weinman (1952) studied a large number of grass species in East and South Africa. He also showed that constant defoliation caused carbohydrate reserves to be depleted, resulting in reduced herbage yields and a reduced root system which, in turn, resulted in a reduced absorption of water and mineral salts and greater susceptibility to frost, heat and drought. The more prostrate growing grasses resisted defoliation best since there was generally a higher proportion of the foliage left. (Fig. 1.)

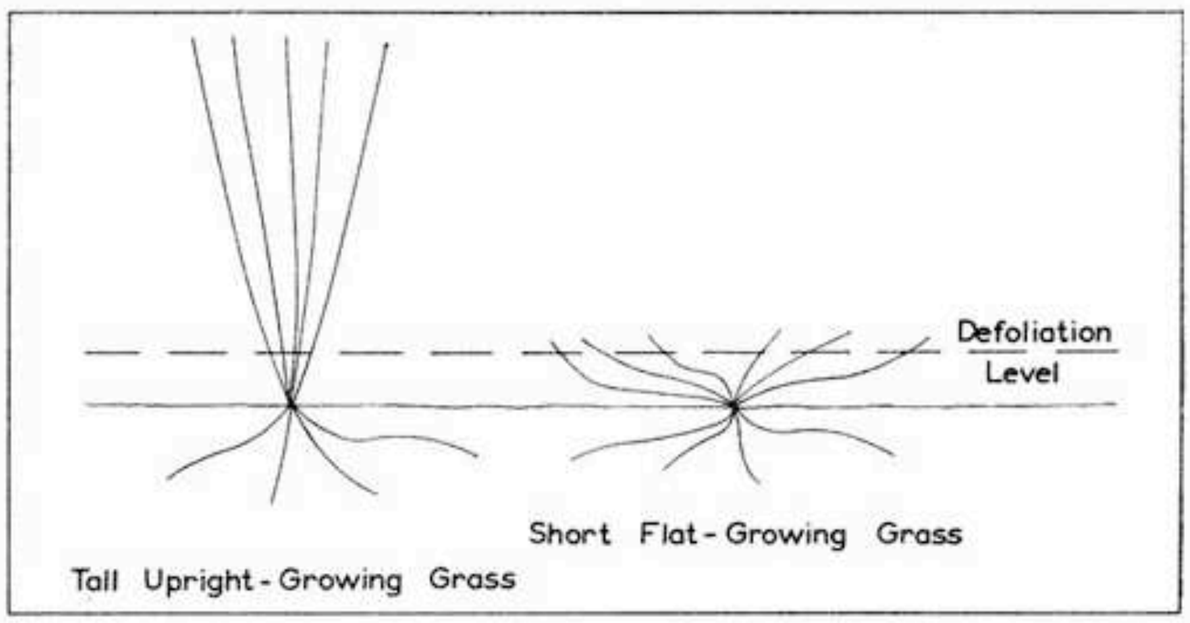

Figure 1. *Showing relative amounts of foliage left to maintain carbohydrate reserves after defoliation.*

Talbot, Biswell and Hormay (1939) have shown that, on the dense annual grasslands of California, the grass to forb ratio could be quickly altered in a similar manner, the upright-growing grasses increasing in abundance with spelling, the flat-growing forbs assuming dominance under heavy grazing.

Other species likely to increase in abundance under grazing are those which are unpalatable or which are protected against grazing by thorns, etc. Thus Allred (1952) has described the invasion of American rangelands by unpalatable shrubs after sustained heavy grazing and Bokyo (1952) has described the complete replacement of grassland by shrub desert under similar grazing regimes in Israel.

Weaver and Hansen (1941) and Dyksterhuis (1952) describe three stages in deterioration of mid-western U.S.A. rangelands following over-grazing.

Stage I. The most palatable species (decreasers) in the climax grassland decrease in abundance; where they are tall growing, they may be eliminated. Species of an intermediate habit of growth lose dominance to become minor sward constituents.

Stage II. The low-growing grasses and forbs (increasers), which were minor constituents of the climax sward, increase both in percentage composition of the cover and as a percentage of total herbage production.

Stage III. With baring of the soil, species foreign to the climax appear (invaders). These are largely annuals.

Application to New Zealand Lowland Grasslands

Wraight (1957) has shown that these same principles apply to the natural (uncultivated) lowland grasslands of Lake Ellesmere Spit. On the spit there is a clearly marked zonation in the vegetation, the boundaries between zones paralleling the sea and lake shores. Boundaries between plant associations are quite distinct and are determined by soil type and altitude above sea level. These plant associations vary

from salt meadow and salt marsh near the lake shore, through moist silver-tussock grasslands and several dense annual grasslands over the centre portion of the Spit, to sand-dune and shingle-beach vegetation near the sea coast. (Fig. 2). Transects were established from the sea coast to the lake shore, intersecting all the associations (Fig. 3). Stocking intensities ranged from low and spasmodic on Line 3 (sheep and cattle), to 0.35 ewe equivalents per acre on Line 1 (sheep only), to 0.57 ewe equivalents per acre on Line 2 (sheep plus a few cattle). Variations in sward composition under these different intensities of grazing are shown in Table 1. Only *differences* in species composition between lines are shown, i.e. where species occur in approximately similar amounts on all lines they are not included.

TABLE 1. *Comparison on four sites of differences in stocking with differences in species composition as measured by specific frequency in 6-in. diameter rings at three times in the year.*

SITE	LINE 3	LINE 1	LINE 2
	Light Spasmodic Stocking	Moderate Stocking 0.35 ewe equivs/acre	Heavy Stocking 0.57 ewe equivs/acre
KAIRAKI SAND (Unstable young sand dune)	Kairaki sand not present.	*Desmoschoenus spiralis*	*Desmoschoenus spiralis*
		Lagurus ovatus	*Lagurus ovatus*
		Pteridium aquilinum var *esculentum*	None
		Scirpus nodosus	None
WAIKUKU BROWN LOAMY SAND (Dense annual grassland)	Waikuku soils not present	*Pteridium aquilinum* var *esculentum*	None
		Scirpus nodosus	Trace
		Poa caespitosa	Trace
		Poa anceps	None
		Pyranthera exigua	Trace
		Light sprinkling	Heavy *Stipa variabilis*
		None	*Vulpia bromoides*
		None	*Aira caryophyllea*
		Heavy *Bromus sterilis*	Light
		Light *Trifolium glomeratum*	Heavy *Trifolium glomeratum*
		Trifolium arvense	*Trifolium arvense*
		Heavier *T. dubium*	Lighter *T. dubium*
		T. incarnatum	None
		More *Rumex acetosella*	Less *R. acetosella*
		Much less *Erodium cicutarium*	Much more *E. cicutarium*
		Hypoxis pusilla	None
		More *Racomitrium crispulum*	Less *R. crispulum*
MOTUKARARA SILT LOAM SANDY LOAM SHALLOW SANDY LOAM (Weakly and very weakly saline phases	This site not present.	More *Poa caespitosa*	Less *Poa caespitosa*
		More *P. pratensis*	Less *P. pratensis*
		P. anceps	None
		More *Trifolium repens*	Less *T. repens*
		T. hybridum	None
		T. fragiferum	None
		More *T. dubium*	Less *T. dubium*
		Less *T. glomeratum*	More *T. glomeratum*
		None	*Falcatula ornithopodioides*
		More *Rumex acetosella*	Less *R. acetosella*
		More *Hypochaeris radicata*	Less *H. radicata*
SITES NEAR BUT NOT ON THE LAKE EDGE SUBJECT TO PERIODIC FLOODING (2.8ft to 4.0ft above mean sea level) (Salt meadow)	*Agrostis stolonifera*	*Juncus maritimus*	*J. maritimus*
	None	*A. stolonifera*	*A. stolonifera*
	Heavy *Trifolium fragiferum*	*Hordeum marinum*	*H. marinum*
	None	Moderate *T. fragiferum*	Very little *T. fragiferum*
	None	None	*Plagianthus divaricatus*
	None	None	*Cotula dioica*
	Trace	More *Apium prostratum*	Less *Apium prostratum*
	None	Light *Selliera radicans*	Heavy *Selliera radicans*
	Mimulus repens	High *Atriplex patula*	None
	None	*Mimulus repens*	None
		Very small amount	Much *Plantago coronopus*

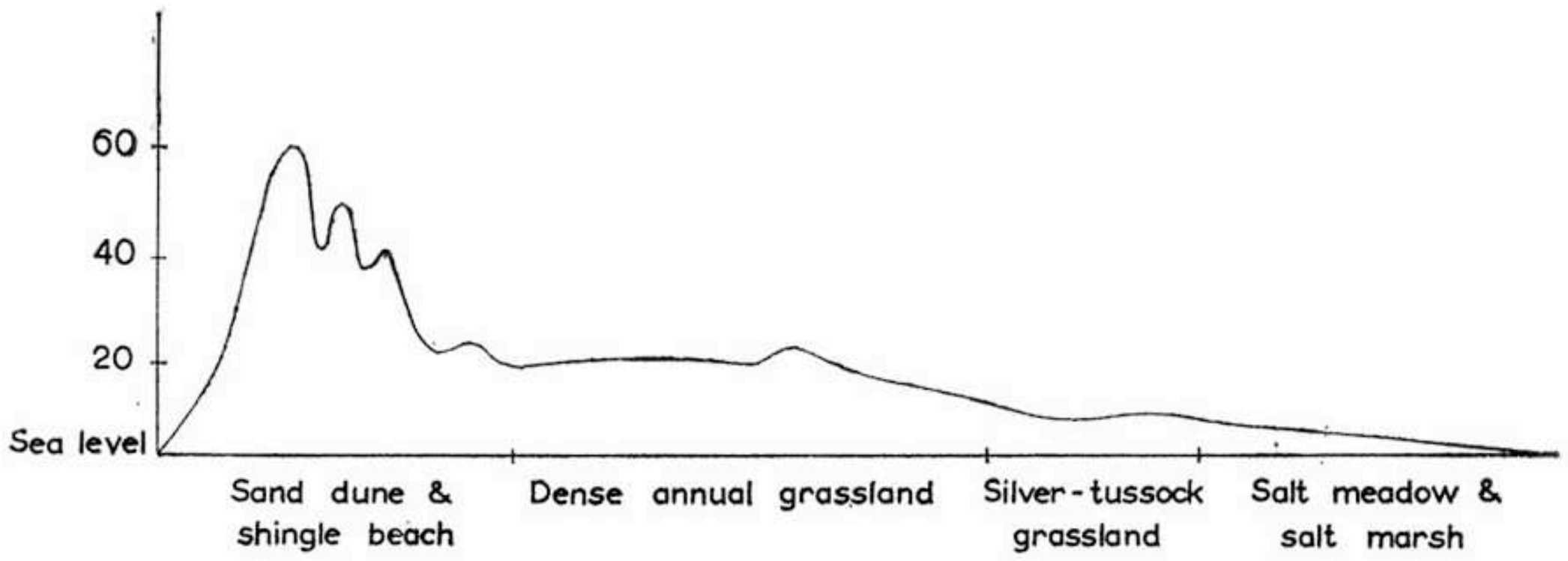

FIGURE 2. *Lake Ellesmere Spit. Typical altitudinal profile from the sea to the lake showing the correlation of vegetation with altitude.*

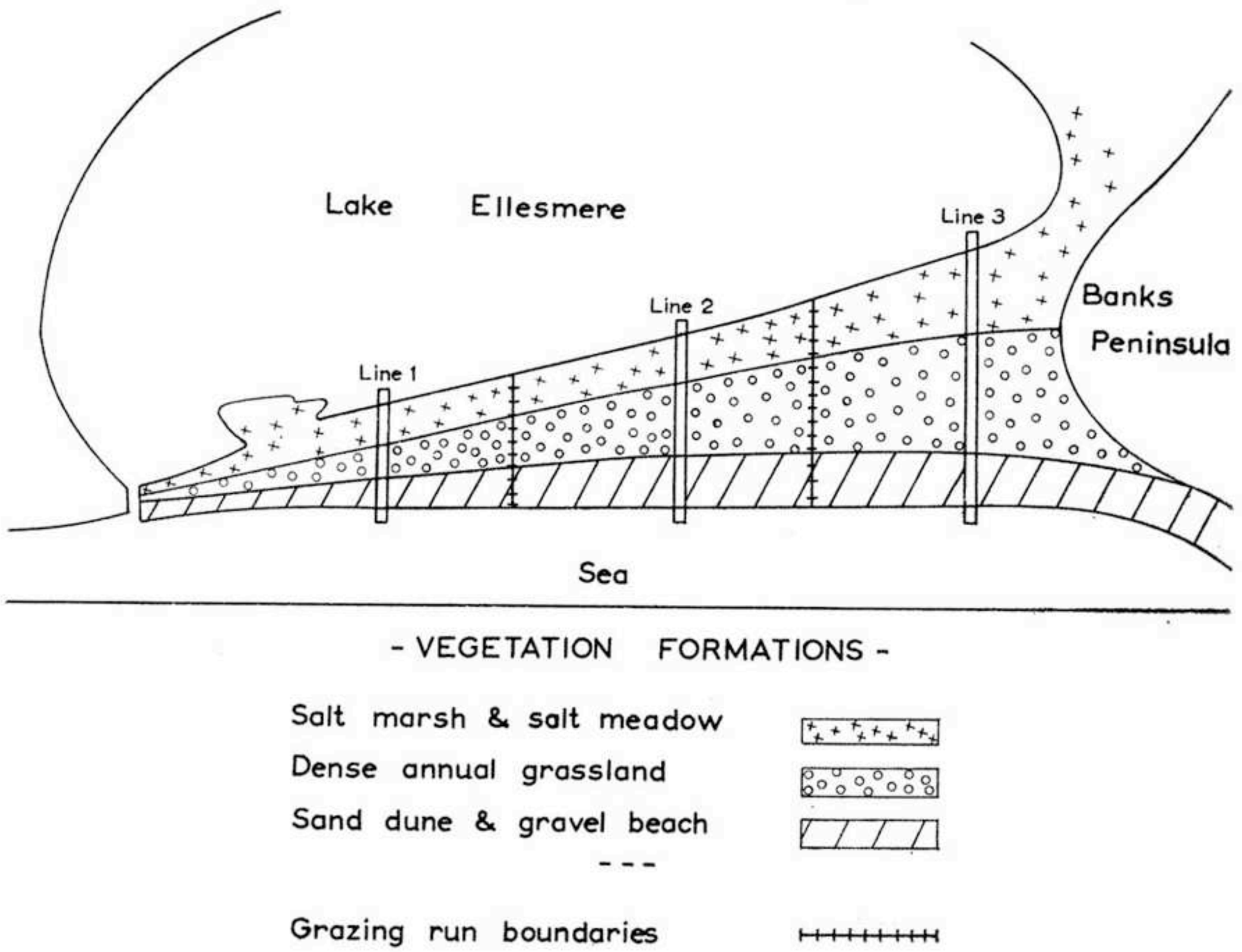

FIGURE 3. *Lake Ellesmere Spit showing the layout of transects with respect to vegetation formations and the differently stocked grazing runs.*

On the sand dunes, the unpalatable species *Desmoschoenus spiralis* and *Lagurus ovatus* occur at both stocking rates but *Pteridium aquilinum* var. *esculentum* and the upright rush-like *Scirpus nodosus* occur only where stocking is moderate.

In the dense annual grassland, species such as *Pteridium aquilinum* var. *esculentum*, *Scirpus nodosus*, the upright-growing species *Poa caespitosa* and *Bromus sterilis*, the upright and very palatable *Poa anceps*, the palatable *Rumex acetosella* and the bulb-like *Hypoxis pusilla* are present in much greater amounts under moderate than under heavy grazing. Under heavy grazing the unpalatable grasses *Stipa variabilis*, *Vulpia bromoides* and *Aira caryophyllea* are of much greater importance, and there is a much greater amount of *Erodium cicutarium* in heavily stocked swards. The latter species was the main forb found by Talbot, Biswell and Hormay (*loc. cit*) to assume dominance in heavily grazed annual grassland in California. The more upright growing clover, *Trifolium dubium* is favoured by light grazing; the more prostrate species *T. glomeratum*, is more successful under heavier grazing. In the silver-tussock grassland this pattern of sward modification under varying intensities of grazing is repeated with the apparent anomaly that *Hypochaeris radicata* occurs more frequently under light grazing. The explanation for this is that, in the denser silver-tussock grassland, *Hypochaeris radicata* is not a flat-weed but an etiolated, upright-growing, very palatable herb. Clovers of upright habit (*Trifolium repens*, *T. hybridum*, *T. fragiferum*, *T. dubium)* are replaced under heavy grazing by the low-growing species *T. glomeratum* and *Falcatula ornithopodioides*.

On the salt meadows, under very light and spasmodic grazing, an *Agrostis stolonifera-Trifolium fragiferum* sward has developed, the only other species of significance being the upright, palatable herb, *Mimulus repens*. Under moderate grazing the unpalatable species *Juncus maritimus* and *Hordeum marinum* invade, together with some low-growing *Selliera radicans*, and very small amounts of the prostrate *Plantago coronopus*. The tall and very palatable species *Apium prostratum* and *Atriplex patula* occur in considerable amounts amongst the rushes, but with heavier grazing, although there is a marked increase in abundance of *Juncus maritimus* (with some invasion of the sward by the shrub *Plangianthus divaricatus*), *Atriplex patula* and *Mimulus repens* are eliminated and *Apium prostratum* is markedly reduced in frequency, as also is *Trifolium fragiferum*. There are much larger amounts of *Selliera radicans*, *Plantago coronopus*, and the also very low-growing *Cotula dioica*.

APPLICATION TO NEW ZEALAND ALPINE GRASSLANDS

It has been shown that patterns of sward modification are broadly comparable, whether we are concerned with high-producing pastures in Great Britain, with the grasslands of East or South Africa, with the rangelands of mid-western U.S.A., with the dense annual grasslands of California, or with the sand-dunes, silver-tussock, annual-grassland or salt-meadow associations of Lake Ellesmere Spit. Comparable patterns are also evident in the alpine grasslands of New Zealand.

The examples given (Table 2) are from the Wairau river catchment, Marlborough (Wraight 1963). It must be admitted that here we do not know the precise history of grazing, and fire has certainly helped to modify the vegetation. Nevertheless in the light of the principles and patterns outlined above, the writer considers that the stages in sward modification illustrated do reflect degrees of grazing intensity. Site factors, in all cases, are broadly similar (altitude 4,900-5,800 ft., slope 28-33 degrees, soils formed from greywacke talus), and the writer considers that the primitive cover (dense snowgrass) had been the same throughout.

In the slightly modified sward, there is an almost complete canopy of snowgrass and the associated species are mainly of upright habit and/or are highly palatable, e.g. *Poa mackayi* at 37% frequency, etiolated *Oreomyrrhis* and *Epilobium* spp., and even a little of the extremely palatable *Ranunculus lyallii*. Low-growing or unpalatable species are of little importance. The strongly modified sward still has a moderate canopy of snowgrass but the associated species are low growing or unpalatable, e.g. *Poa colensoi* in place of *Poa mackayi* as the major associated grass, and *Celmisia spectabilis* and *Hypochaeris radicata* (rosette form) as the principal herbs. Invasion of the sward by the unpalatable short tussock grass *Notodanthonia setifolia* has commenced. The very strongly modified sward has a very

TABLE 2. *Specific frequency (6 in. diameter ring) and point cover of four snowgrass swards in the Wairau River catchment, Marlborough.*

SPECIFIC FREQUENCY	Slightly Modified	Strongly Modified	Very Strongly Modified	Severely Modified
Chionochloa flavescens	–	–	26	–
C. rigida	90	57	2	6
Notodanthonia setifolia	1	16	60	–
N. unarede	9	–	–	–
Trisetum antarcticum	9	5	–	–
Poa colensoi	2	50	29	8
P. mackayi	37	–	–	–
P. sclerophylla	–	–	–	1
Festuca matthewsii	–	4	3	13
Deyeuxia avenoides	–	1	2	–
Agropyron scabrum (Upper Wairau harsh dark green form)	–	–	8	–
Unidentified grass seedlings	10	–	–	–
Carex species	38	1	–	–
Luzula campestris	5	–	–	–
Ranunculus lappaceus	16	–	–	–
R. lyallii	2	–	–	–
Viola cunninghamii	3	–	–	–
Cerastium caespitosum	3	–	–	–
Rumex acetosella	–	–	–	5
Geranium microphyllum	13	–	–	–
Epilobium spp.	24	1	–	–
Pimelea prostrata	–	1	–	–
Aristotelia fruticosa	–	1	–	–
Geum uniflorum	16	–	–	–
Oreomyrrhis ramosa	14	–	–	–
O. rigida	14	1	–	–
Anisotome aromatica	2	–	–	–
Cyathodes fraseri	–	–	3	2
Dracophyllum pronum	–	–	1	–
D. uniflorum	4	–	–	–
Coprosma pseudocuneata	2	–	–	–
Celmisia spectabilis	–	36	–	6
Cotula squalida	–	5	–	–
Raoulia subsericea	1	–	–	–
Leucogenes grandiceps	–	–	–	2
Hypochaeris radicata	–	13	1	1
Crepis capillaris	23	2	–	–
Wahlenbergia albomarginata	–	5	1	–
Blechnum penna-marina	4	–	1	–
Moss spp.	17	–	–	–
POINT COVER	%	%	%	%
Vegetation cover	69	58	27	19
Litter	28	20	22	4
Exposed rock	3	18	21	2
Exposed shingle	–	–	6	–
Bare soil	–	–	4	–
Erosion pavement	–	4	20	75
	100	100	100	100

broken canopy and contains a very strong *Notodanthonia setifolia* element. The few associated species all have strong resistance to grazing, particularly *Poa colensoi* and *Cyathodes fraseri*. In the final stages of depletion very little is left at all (75 per cent erosion pavement). The scattered plants remaining are very low growing, stunted, or unpalatable. The point cover data included in the table suggest what such changes mean in terms of watershed protection.

Less spectacular but still comparable patterns and stages in modification of alpine grassland in a region of much higher rainfall where there has been, practically speaking, no

burning and no domestic stock (Hokitika river catchment) have been described elsewhere (Wraight, 1960).

In other instances, trampling of the sward is of greater consequence than grazing. On Lake Ellesmere Spit, there was far more moss cover, within the sward, in lightly and moderately grazed than in heavily grazed annual grassland. (Table 1). The reduction in moss cover is attributable to trampling; it is evident also in the Wairau alpine grasslands. (Table 2). Damage to or modification of alpine grassland swards by trampling is particularly significant where *Chionochloa rubra* or *C. australis* is the dominant species. Both are unpalatable and few of their associate species are palatable or susceptible to grazing. Where such grasslands are extensive they are little damaged by animals, but where they occur over small areas within a mass of more palatable grassland, and particularly where they lie across frequented animal travel routes, they may suffer severe trampling damage. The sward is rapidly cut up by hoof action and the underlying soils (typically peat or deep, "fluffy", dark organic soils), are rapidly lost through erosion.

REFERENCES

ALLRED, R. W., 1952. Influence of shrub invasion on U.S. rangelands. *Proc. 6th Int. Grassland Congr.* 578.

BOYKO, H., 1952. Shrub invasion and grass competition. *Proc. 6th Int. Grassland Congr.* 624.

BROWN, DOROTHY, 1954. Methods of surveying and measuring vegetation. *Commonwealth Bureau Pasture and Field Crops, Hurley, Berks. Bull.* 42: 223.

DYKSTERHUIS, E. J., 1952. Determining the condition and trend of ranges (natural pastures). *Proc. 6th Int. Grassland Congr.* 1322–27.

JONES, M. G., 1933. Grassland management and its influence on the sward. Pt. I. Factors influencing the growth of pasture plants. *Emp. J. Exp. Agric.* 1: 43–57.

TALBOT, M. W., BISWELL, H. H., and HORMAY, A. L., 1939. Fluctuations in the annual vegetation of California. *Ecology* 20: 394–402.

WEAVER, H. E., and HANSEN, W. W., 1941. Native midwestern pastures—their origin, composition and degeneration. *Univ. Nebraska, Conserv. Surv. Div. Conserv. Bull.* 22.

WEINMAN, HANS, 1952. Carbohydrate reserves in grasses. *Proc. 6th Int. Grassland Congr.* 655–60.

WRAIGHT, M. J., 1957. The Ecology of Lake Ellesmere Spit. *M.Agr.Sc. thesis (Cant. Agric. Coll).*

WRAIGHT, M. J., 1960. The alpine grasslands of the Hokitika River catchment, Westland. *N.Z. J. Sci.* 3: 306–32.

WRAIGHT, M. J., 1963. The alpine and upper montane grasslands of the Wairau River catchment, Marlborough. *N.Z.J. Bot.* 1: 351–76.

A NOTE ON THE CHAMOIS IN NEW ZEALAND

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CLASSIFICATION

The 11 sub-species of chamois *(Rupicapra rupicapra* L. 1758, a member of the F. Bovidae, S. F. Caprinae) are the only members of the genus *Rupicapra* Blainville, 1816 (Simpson 1945). The New Zealand chamois are from the sub-species *Rupicapra rupicapra rupicapra*, native to the Central European Alps.

PHYSICAL CHARACTERS

Chamois look similar to the domestic goat, but differ by having relatively longer legs, a more erect neck, more pointed ears and in the shape and curve of the horns. Riney (1955) gives a general description of the chamois, with an illustration.

Average measurements for four classes of chamois are given in Table 1.

TABLE 1. *Average measurements (in mm.) for four classes of chamois.*

	No. of specimens	Weight (kg.)	Length (incl. tail)	Height at shoulder	Length of horns
Adult male	15*	37	1260	890	250
Adult female	20	23	1130	800	190
Sub-Adult (6 mth.-2 yrs.)	8	14	910	670	110
Young (less than 6 months)	3	5	670	480	Nil

* The weights Riney (1955) gives for adult males appear to be slightly low.