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RESPONSES OF INDIGENOUS VEGETATION TO CONTRASTING TRENDS IN UTILIZATION BY RED DEER IN TWO SOUTHWESTERN NEW ZEALAND NATIONAL PARKS

Summary: The responses of rain-forest vegetation on Secretary Island (Fiordland National Park) which was subjected to low but sustained browsing by red deer, are compared with those of the full range of mountain vegetation in Mt Aspiring National Park where deer numbers had been reduced substantially from previously high numbers.

On Secretary Island the most palatable species have continued to decline - Woody plants are debarked by chewing or antler rubbing, and herbs are grazed. Accessible parts of palatable trees and shrubs continue to be heavily browsed, while stems of some species continue to be distorted because lateral buds substitute for removed terminal shoots. Some unpalatable species have increased.

In Mt Aspiring National Park, marked sites in five major vegetation types were assessed three times during 1970-1986 when deer numbers were kept low. The order of increasing recovery of communities has been: high-alpine fellfields and snowbanks through forests, subalpine shrublands, valley grasslands and low-alpine snow tussock grasslands. In the last, midribbed snow tussock grassland and many associated species recovered dramatically whereas previously prominent unpalatable or tolerant species have become less conspicuous.

Vegetation has not yet stabilised in either Park. Possible future trends are evaluated in relation to changing management. For Secretary Island these include more effective lures with improved 1080 poison gel formulation; for Mt Aspiring a continuing decline in the commercial return from hunting

Keywords: Indigenous vegetation, vegetation monitoring, permanent photographic points, deer browsing, vegetation recovery, Fiordland National Park, Mt Aspiring National Park.

Introduction

This paper documents observations made over the last 20 years on contrasting trends in vegetation condition and flora associated with differences in density of red deer in two national parks in southwestern New Zealand. Secretary Island (80 km') in Fiordland National Park was initially designated a Special Area to recognise its almost unique virgin (i.e. deer-free) state. However, the condition of the vegetation has declined since 1965 when the first clear signs of deer browsing were noted (Mark and Baylis 1975).

In Mt Aspiring National Park (2872 km'), a reconnaissance vegetation survey in the late 1960's showed early signs of an improving trend (Mark 1977) following drastic reductions of the large deer population by commercial hunters using helicopters. Representative samples of vegetation were monitored with a series of photographs and semi-quantitative descriptions at 88 permanently marked sites. These were established in 1970-1973 and monitored in 1977 and 1986.

Methods

On Secretary Island quantitative descriptions of undisturbed forest vegetation (Baylis and Mark 1963, Mark 1963, Wardle 1963, Wardle *et al.,* 1970) were generally inadequate to allow detailed appraisal of the often subtle impacts of a relatively low density of red deer. Subsequently, more detailed descriptions were obtained of some obviously vulnerable communities and species, by combining quantitative measurements and photographs of permanently marked plots, with general observations (Mark and Baylis 1975, 1982). These included an 80 m^2 permanent quadrat to follow effects of selective browsing on the stem apices of juvenile lancewood *(Pseudopanax crassifolius),* two 500 m^2 permanent quadrats to assess the impact of antler rubbing on celery pine *(Phyllocladus aspleniifolius* var. *alpinus);* a 200 m^2 permanent quadrat to study responses in four herbaceous species, two obviously palatable *(Asplenium bulbiferum* and *Dicksonia squarrosa)* and two apparently non-palatable *(Blechnum discolor* and *Cyathea smithii);* and one permanently marked site to follow the fate of *Asplenium bulbiferum* and *Cyathea smithii* using oblique and vertical photography.

Locations of these areas, the deer control operations of the N.Z Forest Service, and Forest Serivce studies up to 1981 are given in Mark and Baylis (1975, 1982). This paper updates these observations to 1987.

In Mt Aspiring National Park, the large area plus limited research and financial resources dictated a more generalised appraisal. After the 1967-69 vegetation survey (Mark 1977), 68 permanently marked photographic points were installed in February 1970 and 20 more in February 1973. These were distributed among five major vegetation types as follows: forest (13), subalpine scrub (3), valley grassland (7), low-alpine snow tussock grassland (53) and high-alpine fellfield-snowbank (12). Details of the method and summarised results for the first 4-7 years are in Mark (1978). A five-point scale was used to rank species according to cover as follows: 1 = < 1%; 2 = 1-5%; 3 = 6-25%; 4 = 26-50%; 5 = > 50%. Vegetation descriptions and photographs were repeated in January-April 1986 to provide an additional nine-year record. In this exercise, colour photography supplemented the previous black and white. Nine of the 88 sites were abandoned because marker pegs have been lost, usually by snow sliding but occasionally by human interference. Information is therefore presented on 12 sites in forest, three in subalpine scrub, six in valley grassland, 48 in low-alpine snow tussock grassland, and ten in high-alpine fellfield-snowbank communities.

There are distinct limitations to assessing sites using oblique photography and brief semi-quantitative assessments of cover, structure and composition of so wide a range of vegetation (Mark 1978). Nevertheless, three records over a 13-16 year period provide clear comparative information for detecting trends in each vegetation type. Photography was timed to avoid complications from the irregular flowering years of several species, particularly snow tussocks *(Chionochloa* spp.). The unpredictability of weather conditions could not be avoided. Care was taken with camera location and height but there were some differences in relocation of the scaled metre stake, tape and blackboard. Moreover, the relatively coarse scaling of species cover, together with the limited time available at a site, inevitably meant that only the major changes are likely to be revealed.

Results

(a) Secretary Island Forest Deterioration

Most accessible stems of *Pseudopanax colensoi* var. *ternatum* and var. *fiordensis* exceeding *c*. 3 cm diam. have now died and collapsed. Hence, there is little indication of their previous importance as a sub-canopy species whose stems could reach 40 cm d.b.h. The occasional mature stems which persist are either densely covered with bryophytes or are inaccessible as epiphytes or on bluffs. Seedlings established from these sources persist up to the size where their bark apparently becomes attractive to deer.

Both the subalpine shrub *Pseudopanax linearis* and juvenile stems of the lowland small tree *P. crassifolius* continue to have a high proportion of their stem apices removed by deer. Most regrow from the nearest axillary bud (Mark and Baylis 1982). *P. crassifolius* stems were monitored in a 20 x 4 m permanent plot which contained 41 living juveniles when records began in November 1981. Twenty-nine of them had stems distorted by previous browsing (Mark and Baylis 1982, Fig. 14) (mean distortions/plant = 2.14 ± 0.23 (SE) in 1981). Of the 12 undamaged stems four were epiphytes beyond reach of deer. The remaining eight were either relatively tall (> 1.95m) and perhaps out of reach, or very short (< 30 cm) and had thus escaped attention (see Wardle *et al.,* 1971). In the ensuing three years (to Nov. 1984) one of the 41 *P. crassifolius* stems died (after to 1 cm of the 215 cm tall stem was broken off – something that often happens during browsing (Mark and Baylis 1975, Fig. 3). All but six of the remaining 40 stems had been obviously browsed in the interim – four of these six were the inaccessible epiphytes mentioned above (mean distortions/plant = 3.91 ± 0.30. n = 34). Mean stem height decreased by 8.4 ± 5.0 cm (range 12 to -101 cm) over the period. This compared with a mean increase in height of 6.5 ± 2.9 cm (range 3 to 20 cm) for the six unbrowsed stems. Thirty months later (May 1987) one more plant had died and only five were still unbrowsed. Continued browsing of the other 34 stems resulted in a mean of only 3.50 ± 0.31 distortions and a further decrease in mean height of 1.2 ± 5.2 cm.

Of the two 500 m2 plots set up to study *Phyllocladus,* that at The Gut was resampled in November 1984 and again in May 1987. In the first period, six of 51 stems over 1 m tall had died, but on only two was the bark obviously damaged by antler rubbing. A further six died in the second period, two of which showed obvious deer damage. The Blanket Bay plot was resampled only in May 1987 when two of 160 stems over 1 m tall were dead. This plot revealed little sign of deer usage and neither of the two dead stems appeared to have been damaged by deer.

The 200 m^2 quadrat set up in November 1981 to follow browsing responses of four species of fern of varying palatability (see Mark and Baylis 1982, Table 1) was resurveyed in May 1987. There had been

Table 1: *The numbers of individuals in four species of ferns grouped according to size classes and the intensity of browsing by deer in a 20 x 10 m permanent plot in lowland mixed beech-podocarp forest on Secretary Island (see Mark and Baylis* 1982 *for size class details and exact location of site). a* = 1981 *values, b* = 1987 *values (italicised).*

Browse rating	Dicksonia squarrosa						Cyathea smithii						Blechnum discolor				Asplenium bulbiferum			
	Juv.		Immature		Mature		Juv.		Immature		Mature		Juv.		Adult		Juv.		Adult	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Nil	21*	_40*_	24	*1*	9	*6*	20	*28*	13	*19*	18	*17*	86	*97*	63	*48*	60*	_38*_	4	*0*
Slight	-	-	14	*3*	4	*1*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	-	-	0	*0*
Moderate	-	-	19	*2*	3	*5*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	-	-	6	*0*
Severe	-	-	12	*14*	0	*15*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	-	-	0	*4*
TOTALS	21	*40*	69	*20*	16	*27*	20	*28*	13	*19*	18	*17*	86	*97*	63	*48*	60	*38*	10	*4*

* Juveniles of these species were not rated for browsing damage.

obvious reduction in both density and condition of *Dicksonia squarrosa* (Fig. la, b) and *Asplenium bulbiferum* but relatively little change in *Cyathea smithii* and *Blechnum discolor* (Table 1). Changes in plant numbers between size classes and browse intensity among the four species (Table 1) require some interpretation. The increase in 'juvenile' plants of *Dicksonia* (for size class definitions see Mark and Baylis 1982) has been at the expense of 'immature' plants in which severe browsing has reduced the size and number of fronds. While mature *Dicksonsia* plants have increased from 16 to 27, only those which exceed 2m tall remain unbrowsed. Most are now classed as severely browsed. By contrast, recruitment of juvenile and immature *Cyathea* plants has continued and none have been browsed. *Blechnum discolor* showed no overall change (though some differences in observer interpretation of size classes are apparent): no plants showed any browse damage. With *Asplenium bulbiferum* both juvenile and adult plants declined and all four of the latter were severely browsed by 1987.

On the photographed site at sea level near Grono Bay the small plants of *Asplenium* present in 1981 (Mark and Baylis 1982, Figs. 4 and 5) continued to decline while the three immature plants of *Cyathea* flourished. In 1981 some 72 small plants of *Asplenium* were visible in the 0.96 m' area covered by a vertical photograph (Mark and Baylis 1982, Fig. 6.). By November 1984 they had been reduced to about 20 plants (mostly smaller) with fronds generally *c*. 8 cm long. The pattern was little changed in 1987.

General observations indicate that most accessible branches of *Griselinia littoralis* and *Coprosma lucida* have been heavily browsed, together with several twigs of the shrubs C. *foetidissima* and C. *colensoi*.

Coastal forest on the talus slope along the southwestern side of the Island which was described virtually in its unmodified state by Mark and Baylis (1982 - Site A in Fig. 1) was being actively used by deer in November 1984. The dense herb layer of *Asplenium bulbiferum* up to 1.0 m tall was reduced to mostly small fronds about 60 cm tall that still provided a relatively continuous cover. The darker green, tall, old fronds with their distinctive black rachises had been mostly removed. Unmodified areas of *A. bulbiferum* persisted locally on very steep slopes and among large boulders, here and elsewhere. The general cover at this site was little different in 1987 when it was measured again by the quarter method of plotless sampling. The density of herbs had decreased only slightly (from 32,580 plants ha^{-1} in 1981 to 31, 830 in 1987). However, the proportion of *Asplenium* had dropped from 77% to 65% of plants in the herb layer (>30 cm tall) or from 25,100 to 20,700 plants ha^{-1}. By contrast, *Blechnum chambersii* increased from 9 % to 21 % relative density. Other herbs retained their original minor (<7%) status (Mark and Baylis 1982).

(B) Aspiring National Park Vegetation Changes

The results are discussed in turn for different plant communities among each of the five major vegetation types.

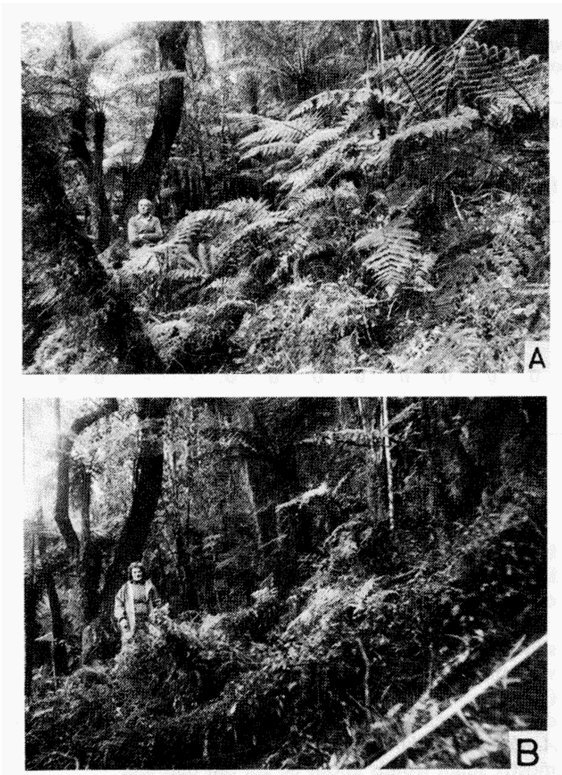

Figure 1: *Forest interior of Permanent Quadrat No.1, Secretary Island, taken from the same point, showing depletion of Dicksonia squarrosa cover between November 1981 (A) and May 1987 (B).*

1. *Forest.*

a. Montane Red-Mountain-Silver Beech Forest

The one site in the West Matukituki Valley (518 m) has shown only slight recovery in regeneration of *Nothofagus fusca* (red beech); in the numbers and sizes of most shrub and small tree species *(Coprosma foetidissima,* C. *propinqua* and *Griselinia littoralis);* and of *Polystichum vestitum* in the herb layer.

b. Montane Silver Beech Forest

All three sites being monitored (Dart, Joe and Wills Valleys - 523 ± 33 m) had noticeable seedling recruitment of *Nothofagus menziesii* (silver beech) and obvious recovery of *Coprosma foetidissima,* C. *propinqua* and *Polystichum vestitum* at two sites and of *Griselinia littoralis, Pseudopanax simplex, Coprosma pseudocuneata* and C. *parviflora* at one.

c. Montane Mountain Beech Forest

At the single site in the Dart Valley (518 m) the most notable change had been establishment of abundant seedlings of *Nothofagus solandri* var. *cliffortioides* (mountain beech) which were 5-10 cm tall in 1970, *c*. 20 cm in 1977 and 30-60 cm in 1986. The herb layer remained sparse but occasional plants of *Polystichum vestitum* reached 40 cm and were ungrazed.

d. Subalpine Silver Beech Forest

Among the four sites (845 ± 81 m) the changes have been relatively slight. Some *Nothofagus menziesii* seedlings have established, and the size and density of *Polystichum vestitum* plants has increased. Locally, *Chionochloa flavescens* and C. *conspicua* plus the woody species *Coprosma propinqua,* C. *pseudocuneata* and *Hoheria glabrata* have increased in both size and density.

e. Subalpine Mountain Beech Forest

The single site in the mid-Rockburn Valley (801 m) has experienced a striking recruitment of mountain beech regeneration. Plants were 5-8 cm tall in 1970, 25-30 cm in 1977 and *c*. 80 cm tall in 1986 (Figs. 2a and 2b). *Polystichum vestitum* has also increased. One adult beech tree has fallen but otherwise the forest interior remains apparently unchanged.

f. Seral Mountain Ribbonwood Forest

Only one site has been monitored; in the Howe Creek tributary of the Burke Valley (610 m). Initially (1973) there was a sparse cover of *Polystichum vestitum* in the herb layer dominated by *Hypolepis millefolium* and *Uncinia affinis* with local *Poa cita* under gaps in the *Hoheria glabrata* canopy. By 1977 *Polystichum* had largely displaced *Hypolepis* to become the dominant herb at a height of *c*. 50 cm. By 1986 *Polystichum* had increased to *c*. 70% cover and 70 cm tall. The original smaller ground layer species - *Cotula squalida, Blechnum penna-marina, Cerastium fontanum, Galium* spp., *Oreomyrrhis ramosa, Acaena* spp., *Viola cunninghamii, Poa cita* and *Uncinia affinis* persisted only locally. Basal shoots of *Hoheria* remain unbrowsed.

Figure 2: *Photo. Point No.8, subalpine mountain beech forest, 801 m. Rockburn Valley. The very open interior in 1970 (A) had c 50 % cover of Hymenophyllum multijidum and numerous beech seedlings to 8 cm on the floor; by 1977 the only obvious change was increased height of the seedlings (to c. 30 cm tall); by 1986 (B) further increases in cover and height (to c. 80 cm) had concealed the litter on the forest floor. There was minor establishment of Polystichum vestitum.*

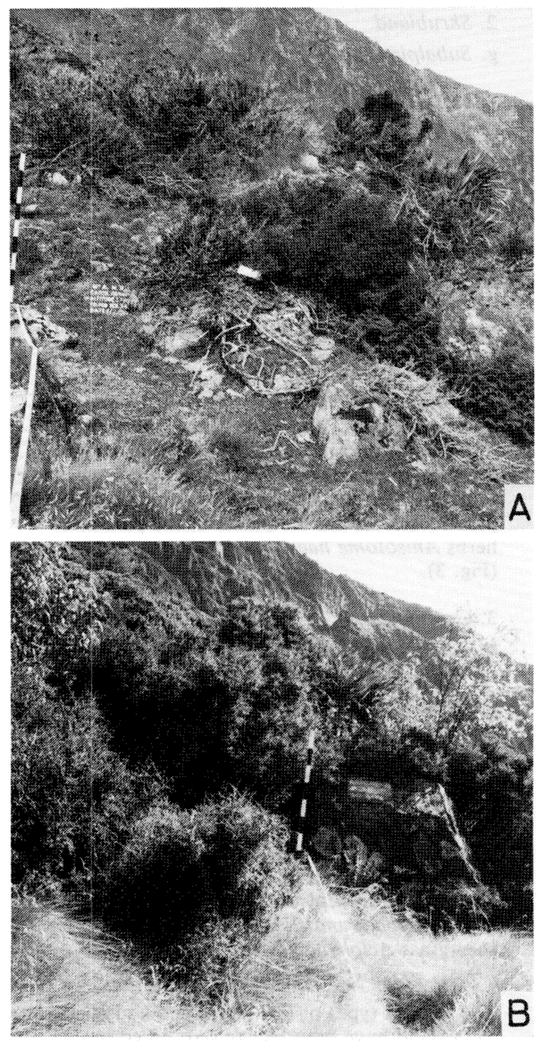

Figure 3: *Photo. Point No. 35, mixed subalpine scrub, 1152 m, upper Arawata Valley. A severely damaged scrub of Podocarpus nivalis (cover ranking = 4), Coprosma propinqua (3) and C. rugosa (1) with an understorey of Hypolepis millefolium (3) and openings occupied by a mixed turf in 1970 (A). By 1986 (B) surviving bushes had recovered while Hoheria glabrata, Hebe subalpina, Carmichaelia grandiflora, Polystichum vestitum and Ranunculus lyallii were established among them and the turf had been supplanted by Chionochloa flavescens.*

2. *Shrubland*

g. *Subalpine Mixed Scrub*

The three sites with this community, in the Beansburn, Arawata and Waiatoto Valleys (1061 ± 59 m), all show obvious improvement. This is particularly evident in the western valleys where damaged shrubs of *Podocarpus nivalis, Coprosma propinqua,* C. *rugosa, Pseudopanax colensoi* and *Hoheria glabrata,* plus *Polystichum vestitum,* in the herb layer, now appear fully recovered. In addition, some palatable species such as *Carmichaelia grandiflora* have appeared. Areas previously dominated by a low turf of mixed herbs *(Poa colensoi, Cotula squalida, Uncinia caespitosa, Rytidosperma setifolium, Pratia angulata, Viola cunninghamii, Hydrocotyle novae-zelandiae, Wahlenbergia albomarginata, Ranunculus lappaceus, Helichrysum bellidioides, Stellaria gracilenta, Blechnum penna-marina)* have been largely displaced by *Chionochloa flavescens* plus occasional mature plants of the palatable herbs *Anisotome haastii* and *Ranunculus lyallii* (Fig. 3).

3. Grassland

h. Valley Grassland

The six sites (696 ± 77 m), distributed on both sides of the main divide, have all shown obvious increases in height of both indigenous *(Poa colensoi,* P. *cita, Uncinia affinis)* and adventive *(Anthoxanthum odoratum, Senecio jacobea)* herbs. At some sites there have been increases in size of snow tussocks (mostly *C. flavescens)* and of shrubs *(Coprosma propinqua, Hebe subalpina* - Fig. 4). Locally there has been obvious recruitment of the palatable shrub *Carmichaelia grandiflora* and of the large speargrass *Aciphylla scott-thomsonii* (Fig. 5).

i. Low-alpine Snow Tussock Grassland

Seven types of low-alpine snow tussock grassland have been recognised, based on various combinations of the dominant snow tussock species (Mark 1977). Increases in height and cover of the tussocks are obvious in most grassland types, but particularly midribbed snow tussock *(C. pallens),* which was preferentially grazed initially.

Broadleaved Snow Tussock Grassland - Scrub.

The six sites are on both sides of the main divide at relatively low elevation (1084 ± 42 m). All have shown obvious increases in cover and height of the broadleaved snow tussock (c. *flavescens).* This tussock has displaced *Poa colensoi* (blue tussock) plus a range of turf-forming herbs and sub-shrubs: *Rytidosperma*

Figure 4: *Photo. Point No.7, valley grassland. 801 m, Rockburn Valley. The original shrubs of Coprosma propinqua in 1970 (A) had obviously enlarged, a single tussock of Chionochloa flavescens (left rear) had grown considerably but the grass cover of Poa colensoi and Festuca matthewsii (foreground) had thickened only slightly* by *1986 (B). The browse line on the margin of the mountain beech forest (rear) has largely disappeared.*

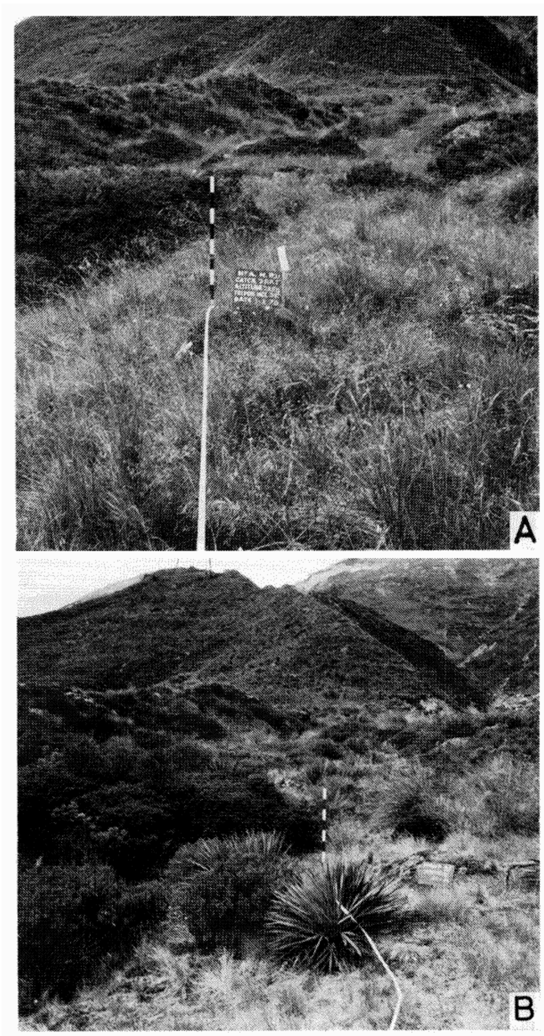

Figure 5: *Photo. Point No. 21, valley grassland, 869 m, upper Dart Valley. The original sward of grasses Agropyron scabrum (= Elymus rectisetus) (cover ranking = 5), Poa cita (3), Poa colensoi (3) and mixed turf of small herbs with scattered tussocks of Chionochloa flavescens in 1970 (A) had been invaded by several plants of speargrass (Aciphylla scott-thomsonii) by 1977, some of which flowered in 1984-85. By* 1986 *(B) shrubs of Hebe subalpina had also established in the turf in which the three grasses still persist, but with some reduction in cover of Agropyron and further increase in Aciphylla.*

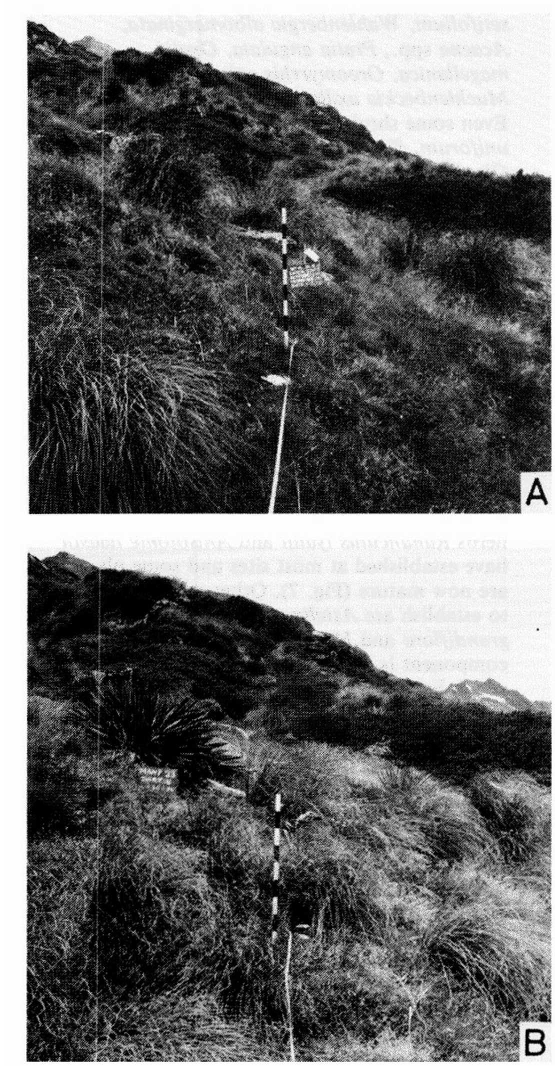

Figure 6: *Photo. Point No. 23, low-alpine broadleaved snow tussock - scrub, 1188 m, upper Dart Valley. The mixed turf with scattered snow tussocks in 1970 (A) was invaded by additional tussocks plus speargrass (Aciphylla scott-thomsonii) by 1977. These continued to increase in number and size by 1986 (B); some have flowered. The shrub cover of Dracophyllum unif1orum does not appear to have changed.*

setifolium, Wahlenbergia albomarginata, Acaena spp., *Pratia angulata, Oxalis magellanica, Oreomyrrhis colensoi, Muehlenbeckia axillaris, Pentachondra pumila.* Even some shrub species (e.g. *Dracophyllum uniforum,* D. *longifolium, Podocarpus nivalis, Olearia lacunosa)* have been displaced though they have enlarged at some sites. The large speargrass *Aciphylla scott-thomsonii* has established and grown rapidly at some sites (Fig. 6), while large *Celmisia* spp. *(C. petriei, C. armstrongii)* have become less conspicuous at two sites.

Mixed Broadleaved - Midribbed Snow Tussock Grassland - Scrub. The seven sites on both sides of the main divide are at similar elevations to the previous type (1081 ± 34 m) but differ in having midribbed snow tussock, *C. pallens.* This species everywhere has shown conspicuous improvement in both cover and height, usually at the expense of *Poa colensoi.* The palatable herbs *Ranunculus lyallii* and *Anisotome haastii* have established at most sites and some plants are now mature (Fig. 7). Other palatable species to establish are *Astelia petriei, Carmichaelia grandiflora* and *Hebe macrantha.* The shrub component is mostly *Dracophyllum uniflorum* which has shown negligible change over the period of monitoring (Fig. 7).

Mixed Broadleaved - Curled Snow Tussock Grassland. The five sites are with one exception west of the main divide (1151 :t 39 m). They have shown the least change of any of the low-alpine snow tussock grassland types. At three sites there were very occasional immature plants of palatable species, *Anisotome haastii* (2 sites) and *Ranunculus lyallii* (1 site). In the Burke and Wills Valleys, on sites near silver beech tree lines, previously heavily browsed beech seedlings had increased in height from 40 cm to 1 m.

Mixed Broadleaved Ö*Midribbed* Ö*Curled Snow Tussock Grassland.* All six sites are west of the main divide (1269 ± 54 m) and show obvious recovery of only *C. pallens* among the snow tussock species. *Ranunculus lyallii* and *Anisotome haastii* have each established at one site with a few plants of each species now mature. Changes, however, appear to have been relatively minor.

Mixed Midribbed - Curled Snow Tussock Grassland. The largest number of monitored

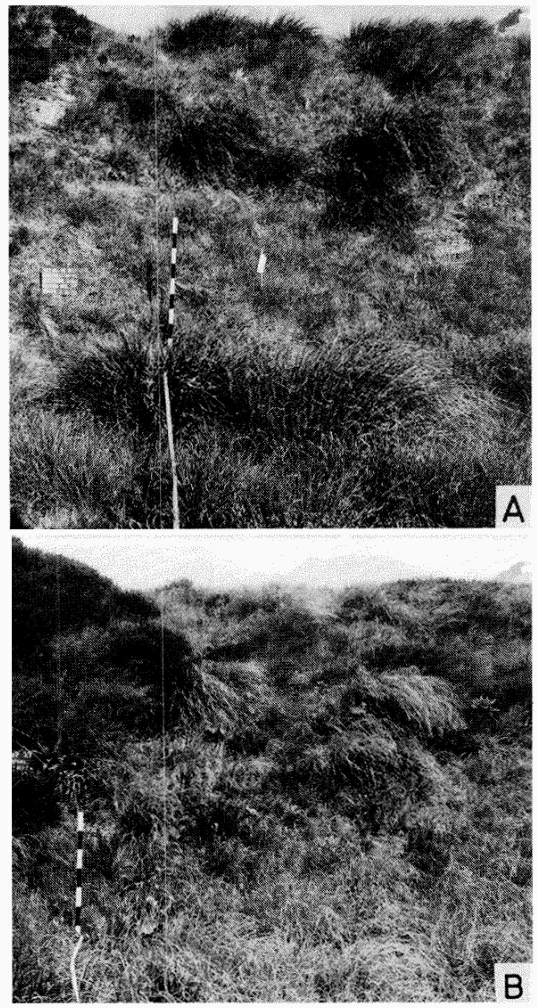

Figure 7: *Photo. Point No. 29, low-alpine mixed broadleaved-midribbed snow tussock - scrub, 1174 m, West Matukituki Valley. The original short sparse cover of midribbed snow tussock (Chionochloa pallens) among the scattered large broadleaved snow tussocks (C. flavescens) in 1970 (A) increased in both height and cover, and also has been invaded* by *numerous, as yet immature plants of Ranunculus lyallii (cover ranking = 2), Anisotome haastii (2; some mature), Astelia petriei (1), and Hebe macrantha (1; some mature). A shrub of Carmichaelia grandiflora had emerged above the somewhat increased cover of Dracophyllym uniflorum scrub (left)* by *1986 (B).*

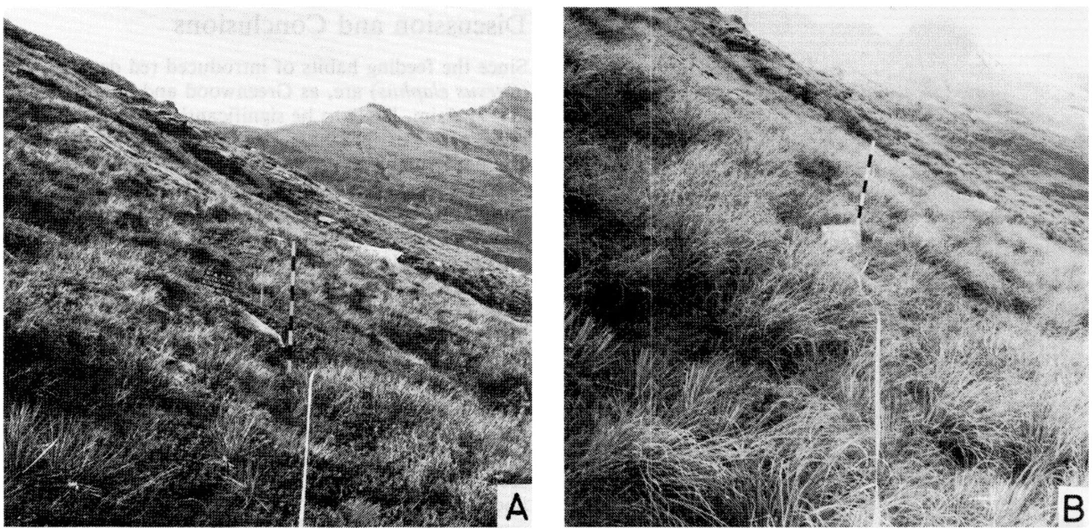

Figure 8: *Photo. Point No.3, low-alpine mixed midribbed - curled snow tussock grassland,* 1341 *m, East Matukituki Valley. Here the snow tussock cover in 1970 (A) was sparse (c. 15%), mostly of curled snow tussock (Chionochloa crassiuscula), with minor midribbed snow tussock (C. pallens). Most of the ground cover was provided by Celmisia walkeri (cover ranking* = 5), *Poa colensoi* (4), *Celmisia lyallii* (3), *Anisotome flexuosa* (3), *Hebe hectori* (3), *Marsippospermum gracile* (3), *Drapetes lyallii* (3) *and Coprosma perpusilla* (3). *There was some increase in the cover of snow tussock by* 1977 *but little other change, whereas by* 1986 *(B) tussocks of* C. *pallens have obviously increased both in cover* (4) *and height (to 50 cm), somewhat overtopping those of* c. *crassiuscula and concealing the subcanopy species.*

sites (13) are in this community (1346 ± 38 m). Midribbed snow tussock *(C. pallens)* has obviously increased in both height and cover at almost all sites while there has been less obvious change in curled snow tussock, C. *crassiuscula* (Fig. 8). *Ranunculus lyallii* has established and even reached maturity at four of the sites and *Anisotome haastii* at one. *Poa colensoi, Astelia nervosa, Celmisia petriei,* C. *Lyalli* and C. *walkeri* have become less conspicuous at up to five of the sites (Fig. 8).

Midribbed Snow Tussock Grassland. All nine sites (1413 ± 62 m) show the most obvious signs of improvement of any of the grassland types. Not only has C. *pallens* increased in both height and cover, but in all cases the less palatable species that were conspicuous previously *(Astelia nervosa, Celmisia petriei,* C. *armstrongii,* C. *walkeri* and *Poa colensoi* in particular) have now become subdued (Figs. 9 and 10). In addition, palatable species *(Anisotome haastii, Ourisia macrophylla* and especially *Ranunculus lyallii)* have increased markedly and in most cases have now reached maturity.

4. *High-Alpine Vegetation*

j. Snow Bank

None of the eight snow banks (1567 ± 67 m) have changed noticeably over the period. The dominant species, *Chionochloa oreophila,* shows no obvious change at any site, but at two, previously bare areas are being colonised by a range of species: *Luzula pumila, Coprosma perpusilla, Phyllachne colensoi, Agrostis magellanica, Lycopodium !astigiatum, Celmisia sessiliflora, Raoulia grandiflora, R. subulata, Microlaena colensoi, Carex pyrenaica* and *Colobanthus buchananii.*

k. Fellfield

Neither of the two fellfield sites (1542 ± 49 m) has shown any obvious changes in plant cover.

Figure 9: *Photo. Point No. 32, low-alpine midribbed snow tussock grassland, 1275 m, West Matukituki Valley. In 1970 (A) most of the cover was provided by Poa colensoi (cover ranking = 5) and numerous emergent clumps of Astelia nervosa (4), plus a mixed turf of Helichrysum bellidioides (4), Viola cunninghamii (4), Pratia macrodon (3), Uncinia caespitosa (3), Muehlenbeckia axillaris (3), and at least 10 other species of lesser importance. There was only a thin scattered cover of midribbed snow tussock (c. pallens) composed of numerous small, heavily grazed and obviously weakened plants. These had recovered by 1977 to provide c. 50% cover, largely at the expense of Poa colensoi (3). The snow tussocks have continued to increase in both height and cover to become co-dominant with the Astelia by 1986 (B), while the turf-forming species have continued to decline. The single tussock of c. flavescens that was conspicuous on the skyline in 1970 is now barely distinguishable from those of C. pallens surrounding it.*

Discussion and Conclusions

Since the feeding habits of introduced red deer *(Cervus elaphus)* are, as Greenwood and Atkinson (1977) claim, likely to be significantly different from those of the extinct indigenous moas *(Dinornithidae),* this paper may seem to have little relevance to the central theme of the symposium. Nevertheless, it is important for both the management and ecological values of national parks to monitor adequately the effects of introduced mammalian herbivores on the indigenous plant communities. This paper deals with such effects *of* red deer in the two largest parks and at different altitudes.

Despite continuing success with killing deer. on Secretary Island, the most palatable species are still declining at rates depending on site accessibility to deer, but with a tendency for the relatively small population to concentrate in certain areas. Thus, there seems no reason to modify the conclusion *of* Mark and Baylis (1982) that "the present level and type of operation on Secretary Island, combining 1080 poison as gel on live foliage baits (of *Griselinia littoralis)* with ground and air shooting, aided by three huts and a partial tracking system, will not achieve eradication nor even a level *of* control compatible with the 'Special Area' status recognised for the Island in the management plan of Fiordland National Park." Although the validity *of* retaining this status has been questioned by both Forest Service staff and the Southland National Parks and Reserves Board it has not as yet been revoked. It could be defended on the basis that the Island is rat-free which probably explains its unusual diversity of insects (Peter Johns, Canterbury University, pers. comm.). Moreover, the modification caused so far by deer is obviously less than in most other parts of Fiordland. Palatable species persist on most sites they previously occupied though often in substantially reduced numbers and/or sizes. Moreover, there remains the possibility that, with further research into eradication methods, deer could yet be eliminated from the Island.

In Mt Aspiring National Park, effects of deer browsing were less than in parts of Fiordland and South Westland (Wardle *et al.,* 1971, 1973). The vegetation is consistently improving though the extent varies considerably between vegetation types. The low-alpine snow tussock grassland has improved most,

*Deer killed each year by N.Z. Forest Service staff since control began are: 2 in 1970, then 0, 0, 25, 30, 33, 17, 11, 13, 24, 18, 34, 28,48, 60, 48 and (in 1986) 64.

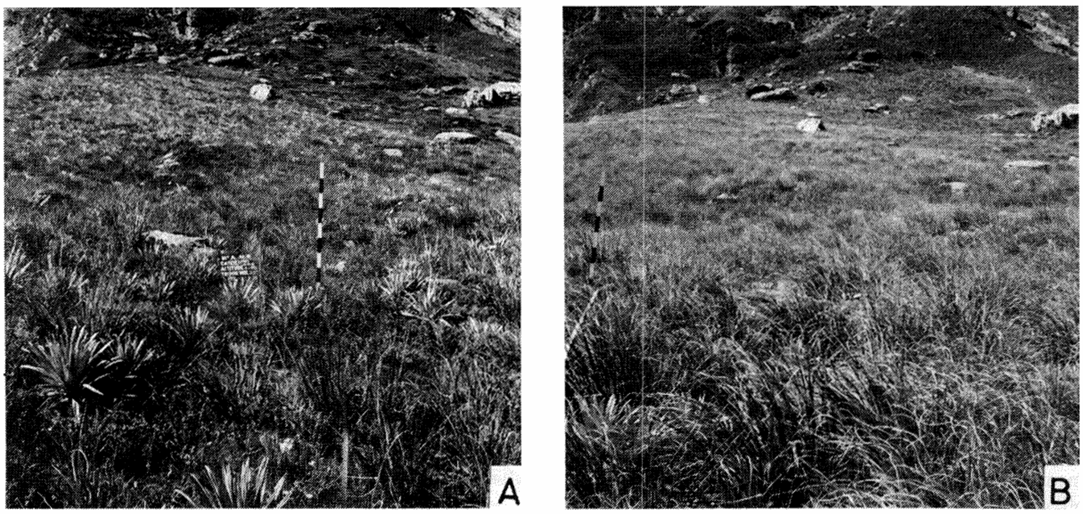

Figure 10: Photo. Point No. 16, *low-alpine midribbed snow tussock grassland, 1250 m, Beansburn Valley. In 1970 (A) the sparse weak and heavily grazed cover of midribbed snow tussock (Chionochloa pallens) (cover ranking = 3) and minor curled snow tussock, C. crassiuscula (1) was exceeded by both the tufted rosettes of Celmisia armstrongii and the trailing subshrub C. walkeri. By 1977 both celmisias had been overshadowed by midribbed snow tussock that had increased conspicuously in both cover (5) and height (to 50 cm). Occasional semi-mature plants of Anisotome haastii, Ranunculus lyallii and Aciphylla crenulata were also present at this time. The* 1986 *view (B) shows that recovery of the snow tussock cover has continued - at 70 cm it now overtops Celmisia armstrongii and most other species.* C. *walkeri still dominates locally in inter-tussock areas.*

Figure 11: *Recovery of Ranunculus Lyallii in low-alpine midribbed snow tussock grassland, Snowy Creek, Dart Valley,* c. *1200 m, January 1980. Only a few seedling plants were present here at the time of the vegetation survey in 1969.*

though some of the more striking examples are not on the permanently monitored sites (Fig. 11). Communities dominated by midrib bed snow tussock, C. *pallens,* are generally the most improved in terms of height, cover, suppression of non-palatable species, and increases in the most palatable forbs *(Ranunculus lyallii, Anisotome haastii* and *Ourisia macrophylla* in particular). Recruitment of these palatable species continues, implying that stability has not yet been reached. By contrast, low-alpine snow tussock grassland communities dominated by curled snow tussock, C. *crassiuscula,* have improved only slightly. Areas of valley grassland and mixed subalpine scrub have also improved noticeably over the 13-16 years in terms of both plant size and increased floristic richness. Palatable shrubs such as *Carmichaelia grandiflora* are newly established in several areas.

In forest communities the size and number of the more palatable species (e.g. *Polystichum vestitum, Griselinia littoralis, Hoheria glabrata)* has generally increased and now they only rarely show even light use by deer. Beech regeneration is widespread and abundant at most sites though often concentrated under canopy gaps.

Only in the high-alpine zone has recovery been negligible or at best slight, over the 13-16 years. There may still be occasional grazing by deer and/or chamois though numbers of both are now extremely low. Hares are thinly spread but would have some effect. The main inhibiting factor to recovery is, no doubt, the climate at these high altitudes.

These results are generally consistent with those from the Forest Service's vegetation and faecal pellet surveys through much of the Park and adjacent to it (Wardle *et al.,* 1973, Challies 1977, Cuddihy and Ross 1979). Pellet counts generally indicate much lower (but variable) densities of deer than in the recent past. Cuddihy and Ross correctly ascribe this reduction to commercial hunting, particularly from helicopters but they also point out that problems will return if this pressure declines. Unfortunately this may soon be the case now that the Government has introduced a "standard value system" for taxing farmed deer which means that the value of animals taken in the wild, either dead or alive, will no longer cover costs. Whether this situation will be allowed to persist is uncertain. Its implications, however, are highly relevent to future deer numbers and hence, vegetation condition throughout the Park, because recreational hunting is unlikely to provide adequate control. Either way, the existing record of vegetation condition, trend, and composition from the 71 sites currently being monitored, combined with Forest Service records, should be adequate to follow future trends.

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