THE HISTORY AND CONTROL OF RED DEER IN THE TAKAHE AREA, MURCHISON MOUNTAINS FIORDLAND NATIONAL PARK

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SUMMARY: Red deer *(Cervus elaphus scoticus)* and wapiti *(C. e. nelsoni)* colonised the Murchison Mountains in Fiordland National Park during the 1930s and 1940s. After the rediscovery of the rare, flightless bird the takahe *(Notornis mantelli)* in the area in 1948, efforts were made to control the numbers and dispersal of deer to protect the birds and their habitat. These early efforts were sufficient to halt the eruption of wapiti but not red deer, which by about 1960 had spread throughout the area. This caused considerable damage to the vegetation, despite a kill of at least 5000 deer before 1962. Hunting on foot was then intensified and since 1975 has been supplemented by shooting from helicopters. At least 17 000 deer have been shot in the area since 1948.

Four surveys to estimate faecal-pellet densities have been carried out since 1969 and showed that deer numbers did not decline between 1969 and 1973; however, an increased shooting effort and the use of helicopters resulted in a 60% reduction by 1975. We estimate that the population size fell over this period from about 2040 deer to the present 815 deer.

Deer have now largely deserted the once highly favoured subalpine scrub, and make far less use of the alpine grasslands and climax forests. However, no significant changes in density have occurred within the seral forests. The relationship between these changes in deer density and distribution and the known range use of the takahe are discussed.

INTRODUCTION

The rediscovery in 1948 of the takahe *(Notornis mantelli),* a large, flightless gallinule endemic to New Zealand (Orbell, 1949), coming some 50 years after its supposed extinction, generated considerable interest and prompted the New Zealand Government to declare the 530 km^2 Murchison Range as a "Special Area" of restricted entry within the Fiordland National Park (Fig. 1). Studies were initiated to determine the status and biology of the birds to help conserve this rare species (Reid, 1967; Mills and Lavers, 1974; Mills, 1976) and efforts were made to trap predators and to limit numbers of other animals likely to threaten the birds or their habitat.

Takahe share their range with a variety of introduced mammals; the stoat *(Mustela erminea)* is known to prey upon the birds (Reid, 1967) and the five herbivores present-red deer *(Cervus elaphus scoticus),* wapiti *(G. e. nelson;),* opossum *(Trichosurus vulpecula),* chamois *(Rupicapra rupicapra),* and hare *(Lepus europaeus)-are* all potential competitors for food. Chamois and hare are in very low densities. Only five chamois have been shot in the area and the presence of hares is indicated only by their faecal pellets (Tustin, 1970 unpubl.; L. Perriam, *pers. comm.)* and from the discovery of a skull (Riney *et al.,* 1959). Opossums may be discounted as threats to takahe because of their relatively low densities and differing habitat requirements; they dwell largely in the forests and are mainly arboreal. The cervids are by far the most serious threat to the well-being of the takahe; this fact was recognised soon after the bird's rediscovery (Harper, 1951; Williams, 1952), and control operations against deer began in 1948.

This paper describes the establishment and spread of deer in the Murchison Mountains, and the subsequent control operations to limit their numbers. It also reports on recent changes in their distribution and density as revealed by four surveys undertaken between 1969 and 1976.

The initial survey was carried out over the summer of 1969-70 by the Protection Forestry Division of the Forest Research Institute (FRI) to investigate the status of introduced ungulates and to review their effect on the condition and trend of the vegetation over the whole of north Fiordland (Wardle *et al.,* 1971; Tustin, 1970 unpubl.). The data from the Murchison Mountains included in that survey are reported here, along with those from are-survey of the same area undertaken during the summer of

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1975-76 (Evans *et al.,* 1976 unpub1.; Parkes, 1976 unpubl.). Two further animal surveys were conducted in the Murchison Mountains by Southland Conservancy Forest Service staff over the summers of 1973-74 and 1976-77.

Information on the spread of deer through the area and on the control efforts expended has been extracted from the files of the Department of Internal Affairs and of the Forest Service. Some of the earlier records are incomplete or poorly reported and tallies are often contradictory, but accuracy improved in later years.

METHODS

In all four surveys, randomly selected transects were followed up the hill and the presence or absence of at least one intact, undecayed, deer faecal pellet was noted within evenly spaced circular plots. The 1969-70 and 1975-76 surveys were on the same set of 17 transects and every 15 m a 0.0005 ha plot was searched, giving totals of 1409 and 1340 plots, respectively, in each survey. As part of an independently designed survey in the alpine grasslands, 360 and 300 additional plots were searched in each FRI survey. These data are lumped with the grassland

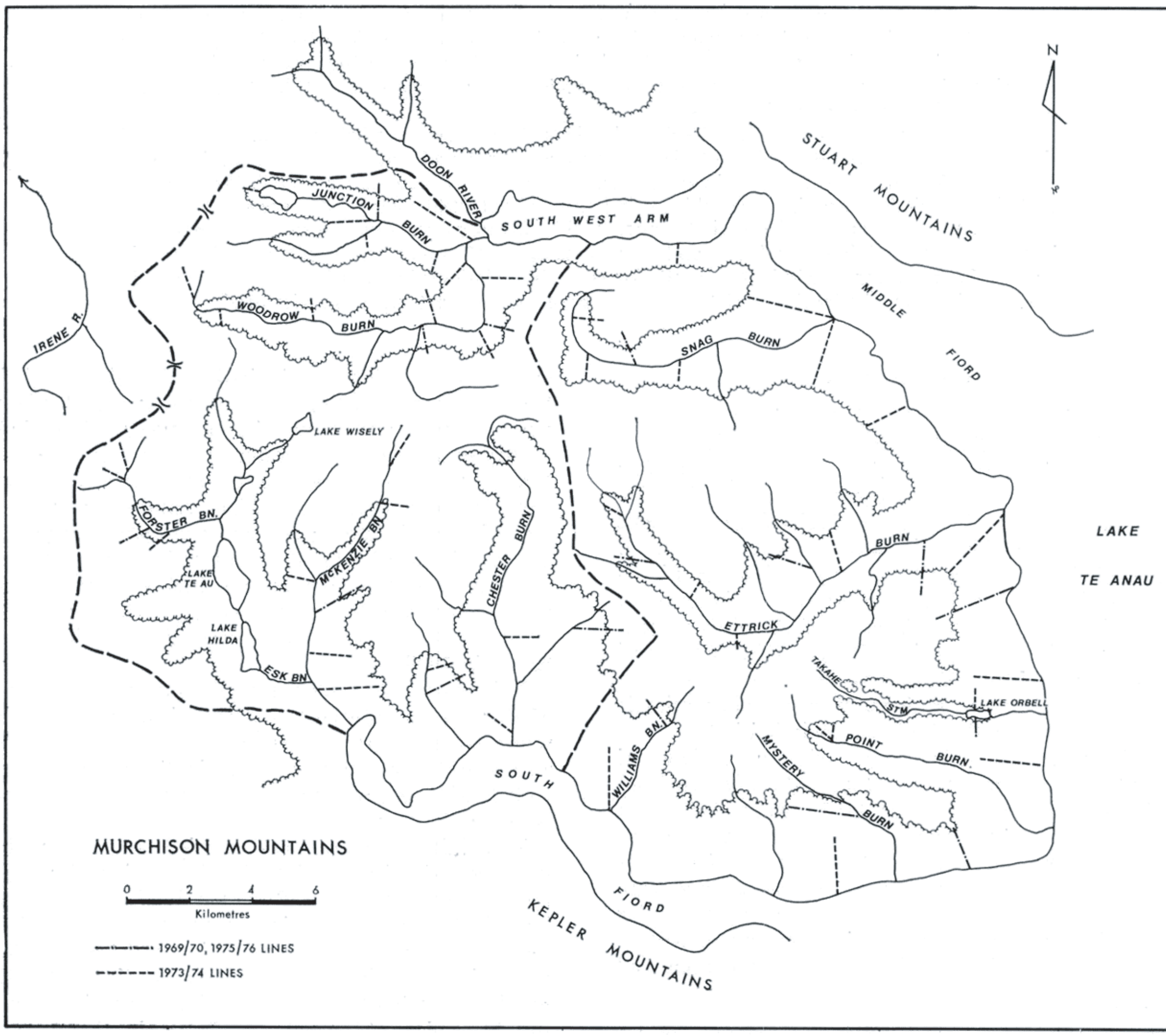

FIGURE 1. *Sketch map of the Murchison Mountains, Fiordland National Park, showing the position of the transects,*

plots from the transects.

The 1973-74 survey established 46 new transects on which 3225 circular 0.0004 ha plots were searched, one every 10 m. Twenty-two of these transects were re-surveyed during 1976-77, when 1486 plots were searched (Fig. 1).

To allow comparisons to be made between the two sets of transects, the frequencies of occurrence of plots with pellets, f, were transformed by the relationship:

$$d = \frac{-\ln(1-f)}{A}$$

where d is a measure of the density of pellets, and A is the plot size (Greig-Smith, 1964).

We have made four assumptions:

1. The transformation is based on the Poisson distribution and therefore the defaecations are assumed to be randomly distributed, an unlikely event. However, as the bias due to contagious distribution has little effect on density estimators at low frequencies (Batcheler, 1973), comparisons between the surveys may be made validly on this point.
2. The decay rate of the pellets did not differ significantly over the periods preceding and during the four surveys. We have some evidence that this assumption is acceptable as we have each estimated decay rates in eastern catchments of north Fiordland in 1969, 1974 and 1976. The actual rates were 0.846, 0.797 and 0.613% decay/day respectively.
3. We have assumed .that each of the two sets of transects is representative of the whole area and would give similar results for similar pellet densities.
4. Lastly, we have assumed that the defaecation rate of the deer has remained unchanged.

In the two FRI surveys sociological descriptions of the vegetation were made (Wardle *et al.,* 1971; L. Burrows, *pers. comm.)* and this allowed the measurement of pellet densities within each of six major vegetation associations:

a) Alpine grasslands.
b) Subalpine scrub.
c) Complex forests dominated by silver beech *(Nothofagus menziesii).*
d) Complex forests with a large component of mountain beech *(N. solandri* var. *cliffortioides).*
e) Mixed scrub-hardwood seral forests.
f) Simple mountain beech and/or silver beech forests.

The relative use by deer of each vegetation type was ranked for each survey by an index of use, **I**, where,

$$\mathbf{I} = \frac{\text{pellet density in the vegetation type}}{\text{pellet density over the whole area}}$$

The area was divided into two sub-areas: (i) the western catchments dominated by complex forests and the first to be colonised by deer, and (ii) the eastern catchments dominated by simple beech forests and more lately colonised by deer. .

RESULTS

Introduction and establishment of deer

Red deer in the Murchison Mountains originated from liberations made between 1901 and 1910 near Manapouri, 30 km to the south (Logan and Harris 1967). They spread into the area via the Kepler Range and around the head of the South Fiord of Lake Te Anau, arriving in some western catchments about 1930.

Wapiti began colonising the north-western Murchison Mountains after about 1940. They resulted from a liberation made at George Sound in 1905 (Banwell, 1966). They were commonly encountered in the Murchison Mountains in the early years but have failed to maintain a significant presence in the area, although wapiti and wapiti-red deer hybrids (Caughley, 1970a; Batcheler and Mc-Lennan, 1977) are still occasionally shot in the area.

At the time of the rediscovery of the takahe, red deer were well established in the north-western Murchison Mountains and were beginning to colonise the eastern and southern catchments. In 1953 the Field Officer in charge of the control operation reported that in the eastern catchments "infestation (was) light. . .” but in the north-west "infestation (was) quite heavy with the average of thirty-odd deer shot per day, per man. . ." in parts of the Snag Burn (purdon, 1953 unpub1.).

By the late 19508 the deer population in the eastern catchments had shown "a marked increase", with "scattered mobs comprising up to 10 animals. . . observed in most basins" in the Takahe Valley /Point Burn area (Kershaw, 1957 unpub1.). Kershaw also reported "Exceptionally heavy browsing by deer on the northern face of the Takahe Valley has now practically destroyed all palatable species originally present. . .". The following year, K. Miers *(pers. comm.)* expressed the view that ". . . deer are more numerous in the east end of the Murchison Range in the vicinity of the Point and Mystery Burns than in the west at the heads of the Snag, Ettrick or Chester Burns".

In summary then, the Murchison herd appears to have followed the eruptive oscillation sequence described by Riney (1964), with a period of about 20 years between the establishment of a breeding population and peak population densities. The wave of peak densities moved across the range from west to east so that, while deer numbers in the western catchments were declining and stabilising, those in the east were still increasing.

Control of deer

The history of deer control in the Murchison Mountains has been one of increasing effort and technology. The Department of Internal Affairs began its first deer destruction campaign in the area in 1948 when 35 deer were shot in the Snag/Junction Burns, and in 1949 a few deer were destroyed in the Esk/ McKenzie Burns.

In 1953, a three-man party shot 356 deer, mostly in the north-west catchments, and 517 deer were shot during the following year, again mostly in the western catchments. Poor weather and a smaller operation resulted in fewer deer killed (193) in the summer of 1955. Between 1955 and 1962, the department conducted small annual campaigns against deer within the eastern catchments, accounting for a total of 4363 red deer and 88 wapiti, while sportsmen probably accounted for at least 1500 more over this same period. Annual kills and effort expended are not available for this period. The effect of these operations was considered by Kershaw (1963 unpubl.) to be minimal as deer numbers remained high.

After 1962 the responsibility for the control of deer in the area passed to the Forest Service, which has subsequently maintained a team of hunters in the Murchison Mountains. To date, these Forest Service operations have accounted for over 13 000 deer (Table 1). The high kill rate of 6.8 deer/man/day attained over the first season was not sustained and, together with the reported high kill rates during the 1950s, is an indication that the increased effort in 1962-63 caused a large reduction in the size of the deer herd.

In 1975 and 1976, hunting on foot has been supplemented by shooting from helicopters. This has been restricted to the winter months as a precaution against disturbing the takahe during their breeding season. In both years this method has accounted for almost half of the deer shot (Table 1).

Changes in the density and distribution of deer since 1969

The pellet densities recorded in the first two surveys were not significantly different from each other, either between the two surveys or between the eastern and western sub-areas, and therefore, by assumption, no significant change in the population size was achieved by hunting from 1969-70 up until 1973-74. However, sometime between this latter survey and the 1975-76 survey, pellet densities were reduced by about 60% and have since remained around this lower level (Fig. 2). Reductions in pellet density were consistent for all of the transects. Thus it seems probable that a decline in the number of deer occurred during the 1974-75 season. Kill rates also declined over this period from nearly two to about 0.5 deer/man/day hunted (Table 1).

TABLE 1. *Deer killed and effort expended in N.Z.F.S. control operations in the Murchison Mountains.*

Year ending	Deer killed	Man-days hunted	Kills / man-day
31.3.63	1767	260	6.80
64	1020	575	1.77
65	1322	405	3.26
66	1195	549	2.18
67	1242	597	2.08
68	800	430	1.86
69	872	446	1.96
70	314	266	1.18
71	368	281	1.31
72	495	350	1.41
73	511	252	2.03
74	757 + 86*	356	2.13
75	718	407	1.76
76	330 + 230 †	603	0.55
77	282 + 302 †	603	0.47
78	162 + 105 †	459	0.35

* Kills by private hunters for which no man-days hunted data are available.

† Helicopter kills.

Some changes in the distribution of deer have occurred as a result of the changes in hunting intensity and methods and as a result of lower numbers. During the initial survey, pellet densities indicated that deer most used the subalpine scrub and seral forests, and used the alpine grasslands least. However, by 1976-76 the subalpine scrub was little used while the seral forests were by far the most preferred type of vegetation. The relative use by deer of each of the six vegetation types in 1969-70 and 1975-76 was ranked using an index of use (see Methods) and is compared in Table 2.

These rankings are reflected in the measured pellet densities within the six vegetation types (Table 3).

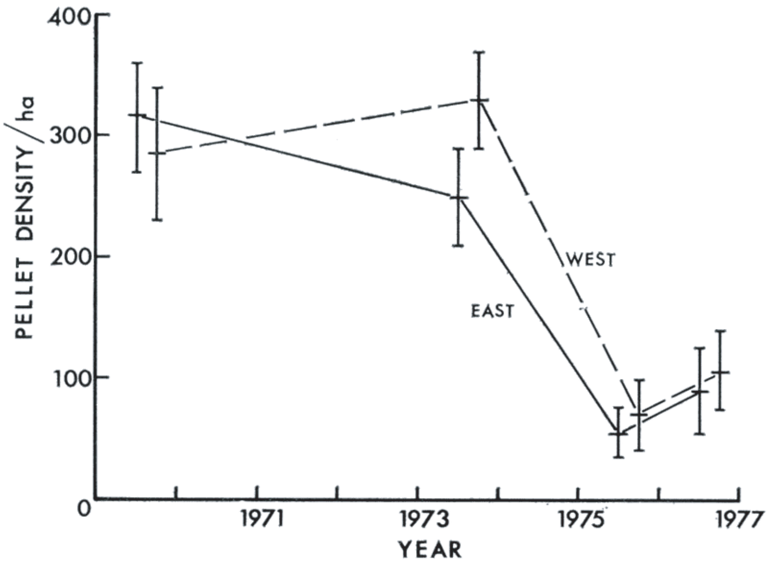

FIGURE 2. *Deer pellet densities* / ha ± 95% *C.L. for four surveys in the Murchison Mountains.*

Between 1969-70 and 1975-76 significant, and even spectacular, reductions in pellet densities occurred in all vegetation types apart from the seral forests. The mean pellet density in the seral forests did drop by 30%, but the relatively small number of plots falling in this forest type (14%) results in a large potential sampling error.

TABLE 2. *Deer preferences for six major vegetation types in two surveys in the Murchison Mountains.*

Vegetation type	1969-70 Index of use	1975-76 Index of use
Complex silver beech	0.85	1.60
Complex mountain beech	0.81	0.69
Seral	1.37	4.97
Simple beech	1.10	1.01
Subalpine scrub	1.73	0.45
Alpine grasslands	0.50	0.28

Population size

We can make an estimate of the population size based on the annual kill figures. Unchanging pellet densities suggest that no significant changes in the number of deer occurred between 1969-70 and 1973-74. Thus the annual average net recruitment over this period must have been approximated by the annual average kill of 510 animals.

TABLE 3. *Deer pellet densities / ha ±1:95% C.I. for six vegetation types in 1969-70 and* 1975-76, *Murchison Mountains.*

	Pellet density / ha ± 1.96 s √ n 1969-70	1975-76
Complex silver beech	254 ± 69	87 ± 44
Complex mountain beech	241 ± 93	37 ± 32
Seral	424 ± 91	283 ± 142
Simple beech	333 ± 58	55 ± 29
Subalpine scrub	551 ± 146	24 ± 23
Alpine grasslands	143 ± 53	15 ± 17

Therefore, assuming that the rate of recruitment has not altered since 1969-70, the minimum population at that time must be that number which can yield a harvest of 510 per year, and the maximum must be that which will be reduced by 60% as a consequence of the harvests of 1974-77. The estimate for 1969/70-1974 was found iteratively by applying a series *of* recruitment rates ranging in 5 % steps from 5% to 40%; an annual recruitment of 25% best fitted the data. Therefore, the initial population size was estimated as 2040 deer (cf. 2490 deer estimated by Tustin, 1970 unpubl.).

In 1973-74, 840 deer were killed, and as this would exceed the above recruitment (510) by 330, the population would decline to about 1700. Similarly, kills of 720 in 1974-75, 560 in 1975-76, and 580 in 1976-77 reduce a population with an estimated 25 % recruitment per annum to a present estimate of about 815 deer (cf. 560 deer estimated by Parkes, 1976 unpubl.). This amounts, as shown by the pellet density data, to a 60% reduction from the original 2040 deer.

Discussion

Riney (1964) postulated that "introduced populations of large herbivores, if undisturbed, normally follow a pattern of adjustment to the new environment which consists of a single eruptive oscillation". Briefly, the oscillation is characterised by populations exhibiting an eruptive phase after colonisation, a period of levelling off, a decline, and finally a phase of relative stability. In New Zealand this model adequately describes eruptive oscillations of thar *(Hemitragus jemlahicus)* (Caughley, 1970b) and red deer (Holloway, 1950; McKelvey, 1959). Holloway (1950) argued that during the eruptive phase browsing is highly selective-a fact noted by Mark and Baylis (1975) on the recently colonised Secretary Island-and eventually the preferred species are eaten out. As the population approaches the carrying capacity the less palatable species are ,browsed until the carrying capacity of the area is exceeded. The condition of the animals and the density of the population then fall rapidly, until finally a degree of stability is achieved at a level adjusted to the renewal rate of the preferred species and the extent to which the animals can utilise the less palatable species.

The eruptive phase of this oscillation appears to have taken about 20 years in the Murchison Mountains. However, as hunting interrupted the oscillation during the peak density phase in the west, and during the initial eruption in the east, it is not possible to distinguish between the expected natural decline and stabilisation and the effects of hunting on the population.

The fact that pellet densities were relatively evenly uistributed throughout the forests in 1969-70 is some indication that population densities were such that deer were still forced to browse the less palatable species to some extent. This is most easily seen by comparing the situation in the simple beech forests with that in the complex and seral forests (Table 3). The only palatable species occurring in the browse tier in the simple beech forests are the regeneration of silver and mountain beech, and *Coprosma pseudocuneata* (Wardle *et al.,* 1971). None of these species is preferred by deer, being ranked towards the bottom of, or absent from, the lists of preferred food species given by Wardle *et al*. (1971) and Mark and Baylis (1975). Yet, despite the absence of preferred food, deer were utilising these simple forests as much as the complex forests, and must therefore have been browsing the poorer quality food available. After the 60% reduction in population size, the survivors were few enough to be able to exist largely on the regeneration of the more preferred species, which tend to be those plants common in the seral forests. In other words, there has been a reversal to the distribution characteristic of an erupting population.

This reversal has not occurred in the alpine grasslands and subalpine scrub. Even under the higher densities in 1969-70, the alpine grasslands were comparatively little used in the Murchison Mountains as compared to their very high use over the then undisturbed areas in the rest of northern Fiordland (Tustin, 1970 unpubl.). This difference was probably due to the accessibility of deer on the open tops to the hunters, causing the animals to avoid such dangerous places. In 1969-70, deer were still using subalpine scrub as a highly preferred habitat, either for food, shelter, or both, but the advent of helicopter shooting removed them from, or forced them to largely abandon, such areas in favour of the more inaccessible forests.

It is worth discussing the seral forests in more detail. Wardle *et al.,* (1971) recognised three seral scrub-hardwood forest types in northern Fiordland, only one of which is important in the Murchison Mountains. It comprises a silver *beech-Hoheria Polystichum* forest forming a seral vegetation on debris slopes and terraces largely in the head basins of valleys. Silver beech is the dominant canopy species and the main subcanopy species, *Hoheria glabrata,* is often associated with other highly palatable plants such as broadleaf *(Griselinia littoralis), Pseudopanax simplex, P. colensoi, Fuchsia excorticata,* and *Schefflera digitata*. The scrub tier is dominated by the palatable species *Coprosma astonii, C. ciliata, C. foetidissima,* and *Myrsine divaricata* along with the unpalatable *Pseudowintera colorata*. The palatable fern, *Polystichum vestitum,* forms a dense ground cover with minor amounts of *Uncinia* sp., *Viola filicaulis, Hypolepis millefolium, Astelia nervosa,* and a variety of other herbs. These latter four species are known food species for takahe and it is of note that *V. filicaulis* and the fern *H. millefolium* are largely restricted to these seral forests. Both *Hoheria glabrata* and *F. excorticata* are deciduous, but what effect this has on the attractiveness of the association to deer during the winter is unknown.

There is good circumstantial evidence that takahe and deer compete for food in the alpine grasslands. Both animals eat the same snowgrass species and, as

Mills and Mark (1977) have reported, both select the same individual plants of *Chionochloa flavescens* and *C. pallens* with the highest phosphorus content. Furthermore, when the alpine grasslands are snow-covered both deer and takahe feed on the small, snow-free patches along the bush line and the stream beds. Thus, the greatly reduced use of the alpine grasslands by deer, coupled with the subsequent increase in vigour and cover of the snowgrass sward (Evans *et al.,* 1976 unpubl.), should be of benefit to the birds. There is no evidence that this competition extends into the forests to any degree, at least as the forest is now constituted. *Hypolepis millefolium,* an important winter food for the takahe (Mills and Mark, 1977), is not eaten by any introduced mammal. However, the fact that deer and, presumably, takahe are now concentrating in the seral forests in winter because of the presence of their forest food species, must give cause for caution until more is known about the feeding habits of both species.

If our estimates of the present deer population size are accurate-informed guesses generally place the size a little higher-the increased effort since 1975-76 has been accounting for about one-half of the population each year. We predict that if this effort is maintained, the total kills will decrease over the next few years until a sustained harvest is taken from a population of a few hundred deer. The low densities recently attained will cause the plane of nutrition of the survivors to improve and the reproductive rate to increase as a greater proportion of yearling and two-year-old hinds produce fawns. So on this count our assumption of a stable recruitment rate may be unwarranted. However, recruitment due to immigration has probably decreased since 1969-70 as deer numbers have declined in the adjacent catchments of the Doon, Irene, and Large Burn (Parkes, 1976 unpubl.).

It is doubtful whether the present techniques could much further reduce such a population, as the diminishing returns from hunting on foot make it difficult to train new hunters, and helicopter-based hunting is effectively limited by its restriction to the winter months, suitable weather, and the need to spell the area to allow the deer to move back onto open areas. If a further reduction of deer numbers is sought, one answer lies in natural bait poisoning. The experience gained in the control of the very low density deer herd on Secretary Island (Bathgate, 1977 unpubl.) could be used to good effect in the Murchison Mountains. Before this technique could be applied in the area, two questions must be answered. Firstly, do present deer numbers constitute any threat to the takahe? Secondly, how can the poison be applied without endangering the birds? The answers to both questions depend on a more detailed knowledge of the takahe's food requirements and seasonal use of the forests.

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REFERENCES

BANWELL, D. B. 1966. *Wapiti* in *New Zealand*. A. H. & A. W. Reed, 183 pp.

BATCHELER, C. L. 1973. Estimating density and dispersion from truncated or unrestricted joint point-distances nearest-neighbour distances. *Proceedings of the New Zealand Ecological Society* 20: 131-147.

BATCHELER, C. L; McLENNAN, M. J. 1977. Craniometric study of allometry, adaptation and hybridism of red deer *(Cervus elaphus scoticus L)* and wapiti *(C. e. nelsoni,* Bailey) in Fiordland, New Zealand. *Proceedings of the New Zealand Ecological Society* 24: 57-75.

BATHGATE, J. L 1977 (Unpublished). Secretary Island, the state of its preservation from deer. *Report to Southland Conservancy. New Zealand Forest Service*. 23 pp.

CAUGHLEY, G. 1970a. An investigation of hybridisation between free-ranging wapiti and red deer in New Zealand. *New Zealand Journal of Science* 14: 993-1008.

CAUGHLE.Y, G. 1970b. Eruption of ungulate populations, with emphasis on Himalayan thar in New Zealand. *Ecology* 51: 53-72.

EVANS, G. R.; PAYTON, I. J.; BURROWS, L. E.; PARKES, J. P.; BATCHELER, C. L. 1976 (Unpublished). Summary report on a vegetation resurvey of part of Fiordland National Park. *New Zealand Forest Service, Forest Research Institute. Protection Forestry Division Report* No. 141: 43 pp.

GREIG-SMTIH, P. 1964. *Quantitative Plant Ecology*. Butterworths, London.

HARPER, A. G. 1951. Letter to the Secretary of the Ornithological Society of New Zealand. Reprinted in *Notornis* 4: 118.

HOLWWAY, J. T. 1950. Deer and the forests of western Southland. *New Zealand Journal of Forestry* 6: 123-137.

KERSHAW, M. 1957 (Unpublished). Deer control: survey takahe reserve. Letter to the Conservator of Forests, Invercargill.

KERSHAW, M. 1963 (Unpublished). Preliminary report for control of noxious animals in Fiordland National Park. *New Zealand Forest Service Report*. 50 pp.

LOGAN, P. C.; HARRIS, L. H. 1967. Introduction and establishment of red deer in New Zealand. *New Zealand Forest Service Information Series* No. 55, 36 pp.

McKELVEY, P. J. 1959. Animal damage in North Island protection forests. *New Zealand Science Review* 17: 28-34.

MARK, A. F.; BAYUS, G. T. S. 1975. Impact of deer on Secretary Island, Fiordland, New Zealand. *Proceedings of the New Zealand Ecological Society* 22: 19-24.

MILLS, J. A. 1976. Takahe and red deer. *Wildlife-a review* 7: 24-30.

MILLS, J. A.; LAYERS, R. G. 1974. Preliminary results of research into the present status of takahe *Notornis mantelli* in the Murchison Mountains. *Notornis* 2 1 : 312-317.

MILLS, J. A.; MARK, A. F. 1977. The summer diet of takahe with particular reference to food selection in relation to nutrient content and possible competition from red deer. *Proceedings of the New Zealand Ecological Society* 24: 128.

ORB ELL, G. B. 1949. Notornis Valley. *The Illustrated London News,* 26 *Feb:* 275-277.

PARKES. J. P. 1976 (Unpublished). Changes in the distribution and density of introduced ungulates in northern Fiordland. *New Zealand Forest Service. Forest Research Institute. Protection Forestry Division Report* No. 145: 14 pp.

PURDON, R. 1953 (Unpublished). Murchison Range Report. Summer 1953. MS. 4 pp.

REID, B. 1967. Some features of recent research on the takahe *(Notornis mantelli). Proceedings of the New Zealand Ecological Society* 14: 79-87.

RINEY, T. 1964. The impact of introductions of large herbivores on the tropical environment. *IUCN Publication new series* No.4: 261-273.

RINEY, T.; WATSON, J. *S.;* BASSEIT, C.; TuRBOIT, E. G.; HOWARD, W. E. 1959. Lake Monk expedition. An ecological study in southern Fiordland. *New Zealand Department of Scientific and Industrial Research Bulletin* 135. 75 pp.

TUSTIN. K. G. 1970 (Unpublished). Distribution, density and recommendations for management of intruduced animals of the wapiti area, Fiordland National Park. *New Zealand Forest Service. Forest Research Institute. Protection Forestry Division Report* No. 88. 43 pp.

WARDLE, J.; HAYWARD. J.; HERBERT. J. 1971. Forests and scrublands of northern Fiordland. *New Zealand Journal of Forestry Science* 1: 80-115.

WILLIAMS, G. R. 1952. Notornis in March 1951. A report of the sixth expedition. *Notornis* 4: 202-208.