SUCCESSFUL CONTROL OF FALLOW DEER BY RECREATIONAL HUNTERS IN THE BLUE MOUNTAINS, OTAGO

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(Received for publication 12 December 1987; revision 20 June 1988)

ABSTRACT

The annual reported kill of fallow deer (**Dama dama** L.) in the Blue Mountains, Otago, declined from 2038 in the 1962–63 year to 394 in 1984–85. Surveys of faecal pellet density in 1975, 1980, 1983, and 1985 indicated that deer density decreased through the late 1970s and into the 1980s. The decline up to 1980 was mainly the result of commercial hunting. Although commercial hunting ceased after 1980 the efforts of recreational hunters continued the decline in deer density. By 1985, most deer inhabited areas >1.5 km away from access points. In the 1984–85 year 1284 hunters spent 3710 man days hunting, but most had little impact on the deer population. Only 199 hunters (15.5%) killed deer, and just 45 (3.5%) accounted for over half of the reported kills. This core group hunted more frequently than average, but were also the most skilled at finding and killing deer. Most hunters (84%) came from within 90 km of the Recreational Hunting Area. The ability of recreational hunters to control deer populations appears to depend on the size of the hunter population within 100 km and on the extent of road access.

Keywords: recreation; hunting; control; wildlife management; population density; Blue Mountains; **Dama dama**.

INTRODUCTION

Deer were originally introduced into New Zealand primarily to provide opportunities for sport, but there were too few hunters to prevent deer populations from reaching high densities that caused rapid changes in the indigenous vegetation (Cockayne 1926; Holloway 1950; *see* Veblen & Stewart 1982 for a recent review). Government hunters on foot were unable to reduce the animals' impact (Caughley 1983), and widespread control was not achieved until commercial hunting began in the 1960s (*see* Challies 1985 and Batcheler 1986 for reviews). Therefore, the gazettal of 10 Recreational Hunting Areas (RHA) between 1980 and 1985 in order to protect some of the more important hunting opportunities available to recreational hunters (Miers 1985; Cleland 1986) prompted concern that recreational hunting alone might not provide adequate control of deer populations. The animal populations of most RHA have therefore been monitored to ensure control is maintained.

This paper documents a reduction in the fallow deer population of the Blue Mountains, Otago, both before and after their gazettal as New Zealand's first RHA in

June 1980, and examines the factors that have contributed to this reduction. Changes in deer density, deer distribution, and hunting effort are described using information from hunting returns, faecal pellet surveys, and anecdotal evidence from long-time residents and hunters.

THE STUDY AREA AND HUNTING SYSTEM

The Blue Mountains RHA comprises 9800 ha of indigenous (mainly silver beech (*Nothofagus menziesii* (Hook. f.)Oerst.*)) forest, 10 200 ha of exotic plantation (mainly *Pinus* spp.), and 2700 ha of subalpine shrub and tussock grasslands (Fig. 1). The mountains rise from 30 m a.s.l. to approximately 1000 m a.s.l. Below fire-induced timberlines, the indigenous forest contains few clearings (where deer are particularly vulnerable to hunters), but the exotic plantation contains substantial cleared and newly planted areas. Rainfall is frequent, with falls of >1.0 mm occurring on an average of 137 days/annum, but annual rainfall is not high (average 997 mm at Tapanui – New Zealand Meteorological Service 1983). Snowfalls occasionally close roads at higher elevations and may limit hunter access for up to several weeks.

Fallow deer have been present since 1869 (Baker 1972) and have been heavily hunted since about 1910 when they began to damage crops on nearby farmland (McKinnon & Coughlan 1960). Despite continuous hunting and control operations, including poisoning trials (Anonymous 1933; Wodzicki 1950; Shearing 1965), densities in the 1950s were at, or near, carrying capacity as many deer were diseased and malnourished (Daniel 1967; Baker 1972, 1973; Forest rangers H. Maunder & L. Coburn pers. comm.). The establishment of a game-buying depot at Beaumont in 1960 accompanied the beginning of commercial hunting. Deer were taken either by hunters on foot (ground hunters), or by poachers operating from vehicles at night with the aid of spotlights. Unusually, helicopter-based hunting was not a major feature of the commercial era in the Blue Mountains. Commercial hunting was prohibited after 1980, when the area was gazetted as an RHA.

Between 1963 and 1987 hunting in the area now comprising the RHA (Fig. 1) was managed by the New Zealand Forest Service (NZFS) under an exclusive block system. Groups (parties) of hunters were issued permits granting exclusive hunting rights to one of 34 hunting blocks, usually for 2–5 days. The 22 blocks in the well-roaded exotic forest areas were available for hunting only at weekends, while the remainder were available year round. Hunters were expected to file a hunting return when their permits expired. After 1980 maximum party size was limited to four hunters, a separate permit was issued to each hunter, and more effort was made by RHA staff to collect returns.

METHODS

Pellet Survey

Deer faecal pellet density was surveyed in 1975 and 1980 (Southland Conservancy, NZFS) and in 1983 and 1985 (Forest Research Institute). In each survey, the occurrence of faecal pellets was recorded on 1.14-m-radius plots spaced systematically along semi-

* Botanical nomenclature generally follows Allan (1961).

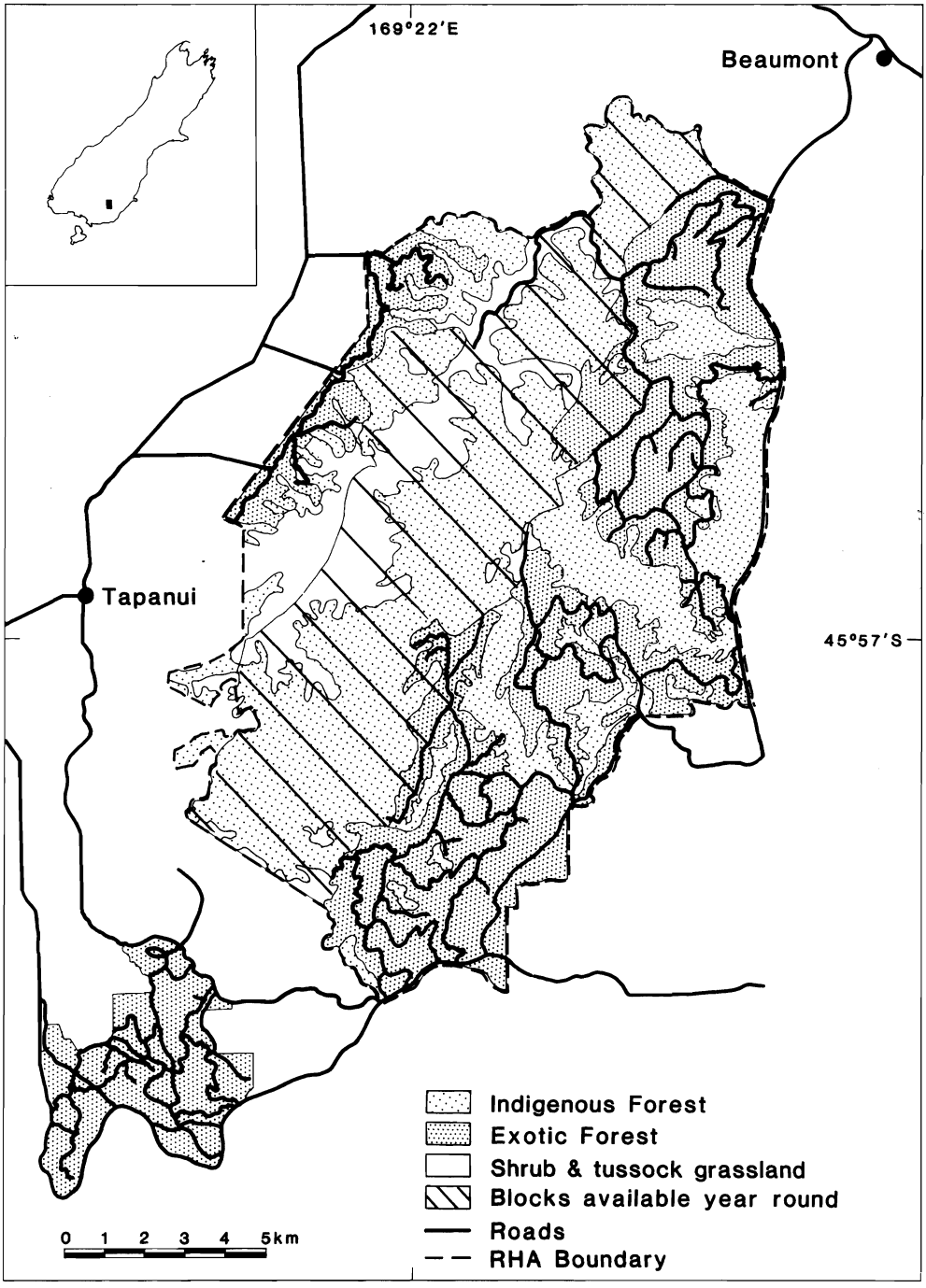

FIG. 1—The Blue Mountains Recreational Hunting Area, showing roads and the main habitat types.

randomly located transects using the presence/absence method (Baddeley 1985). Transects were of similar length in each survey, but sampling intensity was increased in later surveys by increasing the number of transects, decreasing the distance between plots, and, in 1983 and 1985, surveying two separate non-overlapping plots at each sampling point. The slight differences in survey design are unlikely to have biased results. The number of transects, the plot spacings, and the number of plots for each survey are shown in Table 1. The percentage of plots with pellets present (pellet frequency) was used as an index of deer density. Pellet frequencies are presented with associated 95% binomial confidence limits (using the normal approximation – Snedecor & Cochran 1980). Means whose confidence limits do not overlap are taken to differ significantly ($p<0.05$). Where confidence limits overlap, contingency tables were used to test the null hypothesis that the ratio of plots with and without pellets present was the same.

TABLE 1–Sampling effort and plot spacing in the four presence/absence surveys of faecal pellet density in the Blue Mountains. The 1983 and 1985 transects were in approximately the same locations, but those in 1975 and 1980 differed in location, both from each other and from the two later surveys. Subalpine tussockland plots are excluded from the table.

Year	No. transects	Plot spacing (m)	No. plots per forest type		
			Exotic	Beech	Shrub-hardwood
1975	19	20	923	619	194
1980	24	15	1406	1427	437
1983	37	10 (2 plots)	4900	8492	1440
1985	37	10 (2 plots)	6104	8348	1296

The effect of rainfall on disappearance rates of pellets (and thus on pellet frequency) was inferred from the rainfall preceding each survey. Approximately half the pellet groups deposited in the Blue Mountains disappear within 3 months, and three-quarters have disappeared 6 months after deposition (unpubl. data). The average rainfall recorded at the Beaumont and Tapanui recording stations (Fig. 1) for the 3- and 6-month periods preceding each survey were, respectively, 210 and 577 mm in 1975, 352 and 574 mm in 1980, 358 and 616 mm in 1983, and 268 and 580 mm in 1985.

As sampling intensities in the different habitat types were not consistent between surveys and the disappearance rate of pellet groups differed significantly between types (unpubl. data), results are presented separately for the three main forest types: exotic forest, beech forest, and shrub-hardwood forest dominated by either broadleaf (*Griselinia littoralis* Raoul) or manuka/kanuka forest (*Leptospermum scoparium* J.R. et G. Forst/*Kunzia ericoides* (A. Rich.) J. Thompson). The latter type comprised less than 15% of the indigenous forest. The subalpine shrub or tussock grassland was not fully surveyed in 1980 or subsequently, as it was seldom used by deer.

Hunting Returns

Summaries of the permits issued and the reported kill for the years ending 31 March 1963 to 1982 were obtained from NZFS files. From 1982–83 onward, more complete

summaries were derived directly from returns. In December 1982, a new return form was introduced requesting additional information on the number of hours spent hunting, and the number of animals seen and killed each day.

The return data were used to indicate trends in annual kill and hunting effort. The returns for the 1984–85 year were used to describe the hunting effort in greater detail (the number of days spent hunting, the number of hunters involved, how often individuals used the RHA, and the distance they travelled). The percentage of the human population using the RHA was estimated in 30-km annuli around the RHA from 1986 census data.

Anecdotal Evidence

Between 1982 and 1985, hunters (>100) and local residents were asked for their impressions of deer population trends and reasons for the trends. In particular, the staff administering the RHA provided useful information, including 50 dockets for the game sold to the Beaumont depot between August and December 1978. A postal survey of hunters conducted in 1985 (Nugent & Mawhinney 1987) was used in the interpretation of data from pellet surveys and hunting returns.

RESULTS AND DISCUSSION

Changes in Deer Density

1963–75

Between 1963 and 1975 the annual reported kill for the Blue Mountains decreased steadily (Fig. 2). Return rates over this period, although low, were reasonably uniform (30–50%, Forest ranger D. Harrison pers. comm.). The reduction in deer numbers was mainly the result of commercial hunting. Initially, over 1000 deer/year were sold to one Beaumont depot alone, and presumably many more to the several other depots within 100 km (L. Saxon, depot manager, pers. comm.). The decrease in deer numbers was not caused by a decreased carrying capacity as deer body weights improved markedly over this period; carcass weights of yearlings (eviscerated and minus the head and hocks) sold at Beaumont seldom exceeded 15 kg in the early 1960s, but after 1970 averaged approximately 22 kg (L. Saxon, pers. comm.). In 1972 the population had a high reproductive rate and the deer were in good condition (Baker 1973).

1975–80

The deer population continued to decrease during the late 1970s, as shown by the continued fall in the annual reported kill (Fig. 2) and significant decreases in pellet frequency in two of the three major habitats between 1975 and 1980 (beech $\chi^2 = 17.9$, $df = 1$, $p<0.001$; exotic $\chi^2 = 5.4$, $df = 1$, $p<0.05$; Fig. 3). The decreases in pellet frequency are greater than can be explained by a faster disappearance rate of pellets in 1980, particularly as the rainfall for the 6 months preceding both surveys was nearly identical. However, the rainfall for the 3 months before the surveys was 40% lower in 1975 than in 1980, suggesting that slower disappearance rates were partly responsible for the 50–60% higher pellet frequencies in 1975 (i.e., the decline in pellet frequency over-estimates the decline in deer density).

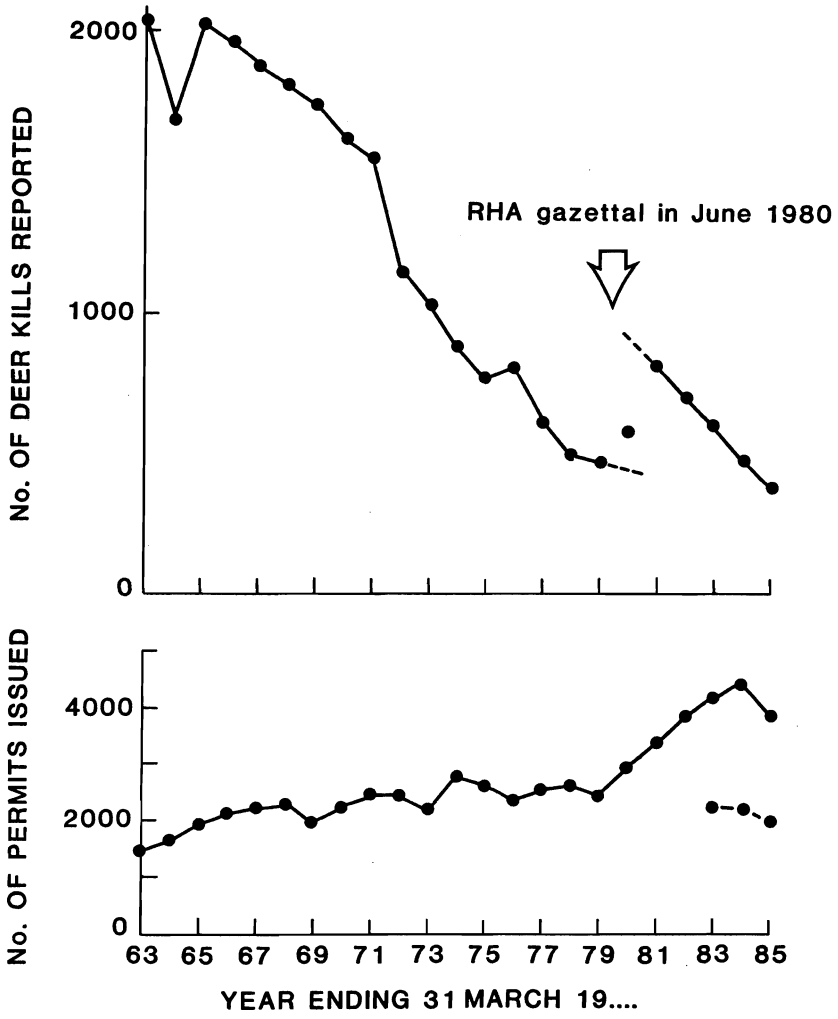

FIG. 2—The number of kills reported and permits issued annually from 1962–63 to 1984–85. Before 1980 one permit was issued per party, but after 1979 there was a gradual change to issuing a permit to each hunter. The number of party permits was not available for 1980–81 and 1981–82, but is shown for later years as a dotted line.

Many, perhaps most, of the deer shot between 1975 and 1980 were sold; e.g., 88 fallow deer were sold to the Beaumont game depot over 4 months in spring 1978. Many hunters contacted also recalled selling deer elsewhere.

Even though deer densities in 1975 were lowest in the well-roaded exotic forest (Fig. 3; H. Maunder pers. comm.), hunting apparently had a greater relative impact there than in the less accessible silver beech forest (declines of 40% and 30% in pellet frequency respectively). As most legitimate (i.e., permitted) hunters concentrated

their effort in the native forest blocks (Baker 1973), it is likely that this greater impact in the exotic blocks was the result of illicit hunting at night along the road networks.

1980–85

The apparent increase in the annual kill between 1979 and 1981 (Fig. 2) reflects the increase in hunter returns after the RHA was gazetted. Once return rates had stabilised at 90–95% of issues, the reported kill resumed its downward trend. Pellet frequency decreased significantly in both indigenous forest types between 1980 and 1985 (Fig. 3). Higher rainfall in 1980 suggests that the decline in pellet frequency under-estimates the decline in deer density. Pellet frequencies in 1983 were intermediate between the 1980 and 1985 values, suggesting a steady decline over the 5-year interval. The apparently stable frequencies in the exotic forest over the same period indicate that hunting

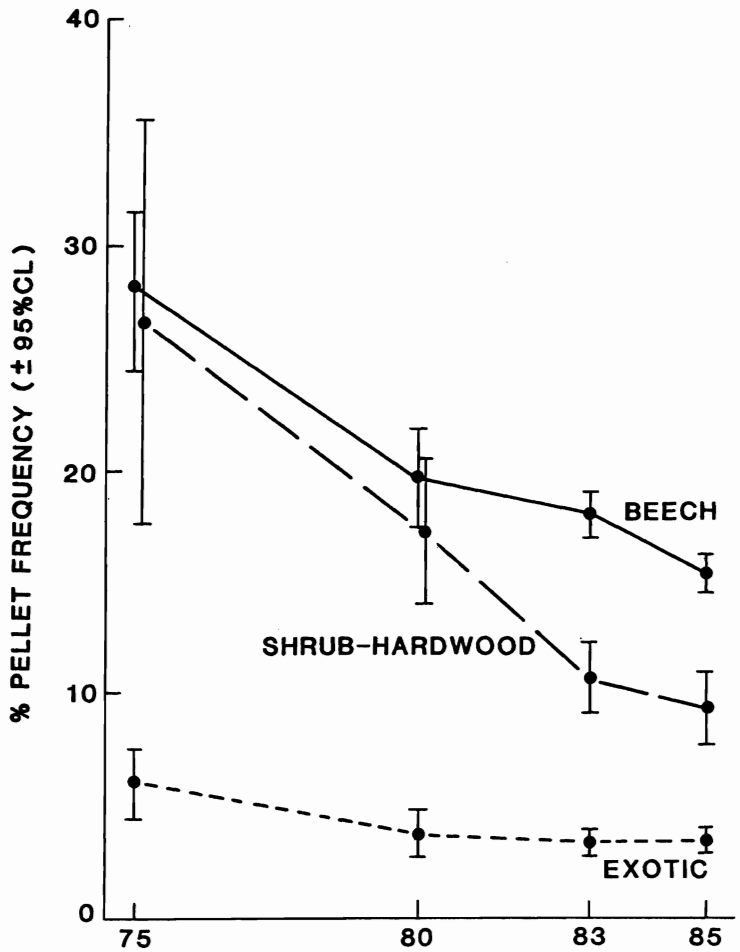

FIG. 3—Changes in pellet frequency between 1975 and 1985 for the three main habitat types (beech ——; shrub-hardwood — — ; exotic - - - -).

impact was now greater in the indigenous forest types. This is consistent with a reduction in the level of spotlighting from the previous period (J. Whyte pers. comm.).

It is unlikely that commercial hunting contributed to the decline in deer density during this period. Legitimate commercial hunting was prohibited, and the game buying depot at Beaumont was closed in 1979. Low success rates *(see* below) and a low economic return for fallow deer make a significant commercial take unlikely. The decline is therefore attributable mainly to recreational hunting.

1985 Deer Distribution

In 1985, deer density increased with increasing distance from roads (Fig. 4), continuing the pattern apparent since the 1960s (L. Coburn pers. comm.; Baker 1973). This reflects the vulnerability to hunters of deer near roads. The low pellet frequencies in the most remote beech forest (>3 km from a road) reflect the proximity of the tussock grassland, where deer were also extremely vulnerable to hunters.

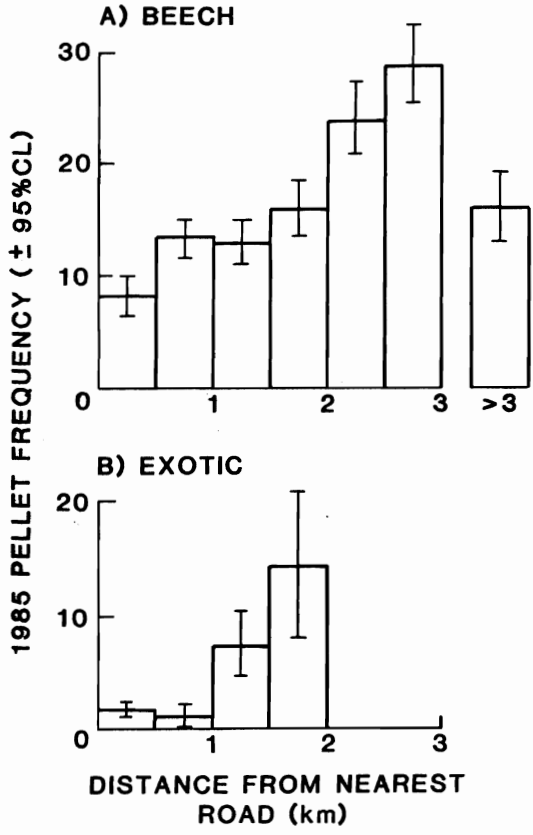

FIG. 4—The relationship between pellet frequency and distance from a road for the two main habitat types (a) beech, (b) exotic. All exotic forest was within 2 km of a road.

Fallow deer home ranges seldom exceed 1.5 km in diameter (unpubl. data), which suggests that spotlight hunting along roads was likely to affect deer densities only within 1.5 km. The significant increase in pellet frequency on beech forest plots between 1.5 and 3.0 km from a road (Fig. 4) therefore indicates that hunters on foot also had their greatest impact near access points.

Changes in Hunting Effort

The number of permits issued increased between 1962–63 and 1973–74, in spite of the decreasing reported kill (Fig. 2). After the peak coinciding with the high prices paid for venison in mid-1973–74 (Bennett 1979), the number of permits decreased slightly to 1979. The gradual change to issuing of a permit to each hunter (rather than to each party) accounts for the apparent increase in hunting effort after 1980. The number of parties using the RHA in 1982–83 was the lowest for the preceding decade, and subsequently decreased further (Fig. 2). The total number of permits also dropped after 1983–84.

Most of the hunters who sold deer at Beaumont in spring 1978 hunted in the RHA after 1980, although some hunted less frequently (D. Scott pers. comm.). The postal survey also indicated that 78% of hunters using the Blue Mountains in 1984–85 had been hunting before 1980 (Nugent & Mawhinney 1987). This continuity makes it unlikely that quality of the over-all hunting effort (i.e., the average hunter skill) changed substantially after commercial hunting stopped.

The demand for hunting was positively related to deer density on particular blocks (Fig. 5; $r = 0.73$, $df = 27$, $p<0.01$). This relationship, and the absence of an abrupt decrease in the demand for hunting after commercial hunting stopped, suggests that declining deer densities were responsible for the small decline in hunting effort between 1980 and 1985.

1984–85 Hunting Effort

In this year 3692 permits were issued, allowing up to 7873 man-days hunting, and 3327 (90%) returns were received. Of these returns, 816 (24%) had not been used, and the remainder reported some hunting on 3710 man-days. On average, 5.3 hours were hunted on each of these days, during which 0.74 deer were seen and 0.11 were killed. Although 394 deer were killed, success rates were low with one deer kill per 9 days or 48 hours hunted.

The 3692 permits were allocated to 1284 different hunters, over half of whom hunted only once in the RHA in 1984–85. The infrequent users of the RHA were less successful, on average, than the most frequent users (Table 2).

Only 199 (15%) hunters reported killing one or more deer in the RHA in 1984–85. The other hunters, however, did see a large number of deer (Table 3). Of the successful hunters, most (78%) got only one or two deer. Over half the deer were killed by just 45 hunters (3.5% of the total), who reported killing between three and 14 deer each. These 45 hunters were among the most frequent users of the RHA and most had been highly successful in preceding years. They owed their success not only to their greater

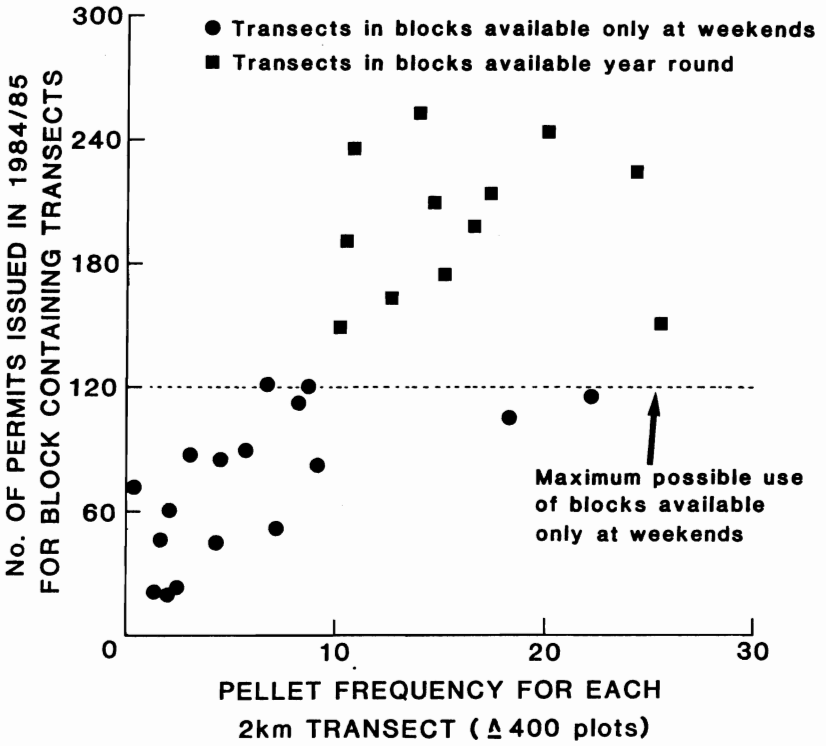

FIG. 5—The relationship between pellet frequency and the number of permits issued in 1984–85 for specific blocks. Where a pellet transect encompassed two blocks the number of permits was averaged for those blocks.

TABLE 2–Hunting effort, frequency, and success rate of hunters in 1984–85.

No. permits	No. hunters	No. days hunted	Mean hours hunted/day	Mean deer seen/day	Mean deer killed/day
1	676	644	5.6	0.60	0.06
2	222	423	5.4	0.63	0.07
3–5	226	811	5.5	0.76	0.11
6–10	91	732	5.7	0.76	0.11
11–15	42	540	5.3	0.79	0.12
16–20	17	300	4.3	0.76	0.18
21–30	10	259	4.7	0.95	0.18

hunting effort, but also to being more efficient at finding and killing deer (Tables 2 and 3). The most successful hunter in 1984–85 spent 30 days hunting in the RHA.

The percentage of the human population using the RHA decreased exponentially with increasing distance from the RHA (percentage of population using RHA =

TABLE 3–Numbers of deer killed per hunter in the 1984–85 year.

No. deer killed	No. hunters	Hours hunted	Deer seen (/h)	Deer killed	Kills/ sighting (%)
0	1085	11 393	1037 (0.09)	0	0
1	115	3 402	577 (0.17)	115	20
2	39	1 781	331 (0.19)	78	23
3	18	1 126	206 (0.18)	54	26
≥4*	27	2 116	576 (0.27)	147	26

* The two most successful hunters killed nine and 14 deer, respectively.

5.20 – 1.03 ($\log_e$ Distance to RHA), $r = -0.99$, $df = 7$, $p<0.001$; Table 4). Nearly 85% of hunters lived within 90 km of the RHA, and these accounted for 89% of the hunting effort and 90% of the kill. There were few other large public hunting areas available to Otago hunters. This indicates that few Otago hunters were prepared to travel more than 100 km for the type of hunting provided by the RHA.

TABLE 4–Hunter use of the RHA related to travel distance and the population base (1986 census data).

Distance between RHA and home* (km)	Population (× 1000)	No. of hunters (% popn.)†	Reported hunt days (cumul. %)	Reported deer kill (cumul. %)
0–30	4.9	131 (2.65)	472 (12)	59 (16)
31–60	33.8	341 (1.01)	1326 (49)	143 (51)
61–90	133.8	489 (0.37)	1467 (89)	154 (90)
91–120	81.2	96 (0.12)	169 (94)	16 (94)
121–150	14.9	8 (0.05)	13 (94)	0 (94)
151–180	19.9	9 (0.04)	21 (95)	2 (95)
181–210	8.2	16 (0.19)	69 (96)	10 (97)
211–240	40.1	22 (0.05)	59 (98)	5 (98)
241–270	9.1	0 (0.00)	0 (98)	0 (98)
≥271	2961.0	35 (0.001)	73 (100)	7 (100)
Total	3307.1	1284 (0.038)		

* Straight line distance from the centre of the RHA to the address locations given on permits.

† Only the 1147 hunters who gave an adequate address are included in the body of the Table, but all are included in the total.

CONCLUSIONS

Gazettal of the Blue Mountains as an RHA did not result in a loss of control over the deer population, and the results of this study indicate that recreational hunting alone was able to reduce deer densities. Mid-1980s estimates of deer densities prevailing under commecial airborne hunting regimes in South Island beech forests range from 0.4 to 6.3 deer/km^2 forest, with most estimates being between 2 and 3 deer/km^2 (Hickling 1985, 1986; Forest Research Institute 1986; Nugent *et al.* 1987). In

comparison, the reported 1984–85 kill of 394 deer in the Blue Mountains suggests a post-breeding population in early 1984 of around 1500 deer (unpubl. data), i.e., 7.5 deer/km^2 forest. It is likely commercial airborne hunting would be less effective in the Blue Mountains than in some of these other areas as the Blue Mountains are not easy to hunt with helicopters (K. Tustin pers. comm.), and fallow deer are worth far less than red deer. Therefore, although the deer density in the Blue Mountains was higher than the others reported, the actual difference in control effectiveness is minor, particularly when compared to the high densities in the 1960s.

In terms of the number of hours spent hunting per deer kill, the over-all recreational hunting effort was inefficient. In the Murchison Mountains of Fiordland, for example, Government (ground) hunters were able to kill one deer per 2.9 days' hunting in 1977–78, when deer densities were less than one deer/km^2 forest (Parkes *et al.* 1978), compared with one deer every 9 days for recreational hunters in the RHA in 1984–85. This inefficiency was balanced by a greater hunting effort (3710 man-days) than would be sustainable by the potential commercial returns from 394 deer, or by State funding of a control campaign.

This study confirms two of the main criteria used in establishing RHAs, namely that most of the area needs to be easily accessible and that it needs to be reasonably close to a large population. Few hunters seem prepared to travel more than 100 km for the type of hunting provided by the Blue Mountains.

Control effectiveness decreased rapidly when the distance from the nearest access point exceeded 1.5 km. This "control radius" may be larger for other deer species, which have higher dispersal rates than fallow (Caughley 1963). These results can be used to predict where recreational hunting alone would suffice for deer population control.

The ability to control deer is a prerequisite of game management (Caughley 1983; Batcheler 1986). The over-all level of control achieved and maintained by recreational hunters in the Blue Mountains has given managers scope to consider ways of enhancing hunting (Nugent & Mawhinney 1987) without jeopardising important natural values.

ACKNOWLEDGMENTS

My thanks to the staff involved in the pellet surveys and in the collection and collation of returns, and to the many hunters and others for the information and insight they provided. I also thank W. Fraser, B. J. Frederic, J. D. Coleman, and J. Orwin for their comments on early drafts. This project was partially funded by the Department of Conservation.

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