EFFECT OF COMMERCIAL HUNTERS ON THE NUMBER OF POSSUMS, *TRICHOSURUS VULPECULA*, IN ORONGORONGO VALLEY, WELLINGTON

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SUMMARY: The relative abundance of possum faecal pellets in two neighbouring blocks of lowland rimu-rata forest was measured. On the commercially-trapped and poisoned block, 12.9% of sample plots contained pellets, compared with 26.3% on the other block free of hunters for 14 years. On the commercially exploited block there was a mean 0.215 pellets/m^2 compared with 0.347/m^2 on the untrapped block, which was probably carrying its full capacity of 9.0-12.3 possums/ha. If the relative abundance of faecal pellets directly reflects the relative abundance of possums, the trappers were holding possum numbers to between 49% and 63% of the full carrying capacity, though the confidence limits for these figures cannot be calculated.

INTRODUCTION

It is widely supposed that because possum *(Trichosurus vulpecula)* skins are currently fetching high prices, commercial hunters are exerting considerable pressure on the animals and holding populations to low densities. Only anecdotes support this view, for no figures have been published on the effectiveness of trappers in reducing or holding down possum populations. In Orongorongo Valley, two blocks of land lie side by side. Both blocks contain tall rimu-rata *(Dacrydium-Metrosideros)* forest. One block has been used as an experimental area by DSIR, and all commercial trappers banned from working the block since 1966. The other block has been commercially worked throughout this period. Such proximity provided a good situation to measure the effectiveness of trappers in holding down possum numbers.

STUDY AREA

The study area extends 8 km along the lower Orongorongo Valley (41° 21'S, 174° 58'E), 18 km east of Wellington city. The blocks run between Peak Stream (66 m a.s.l.) and Matthews Stream (152 m a.s.l.) and along a steep rainfall gradient from about 2000 mm/annum at Peak Stream to 3000 mm/annum at Matthews Stream. This length of valley is divided into two, almost equal halves by Browns and Turere Streams Fig. 1). The study area was divided into possum trapping blocks, previously administered by the Wellington Regional Water Board but, since May 1981, by the Forest Service.

1. Block 41 (1200 ha), bound by Browns Stream to the north and Peak Stream to the south, is a DSIR research block, and commercial trapping has been banned since 1966. The possums have been left to find their own population balance with the forest. Returns of c. 1200 tagged animals suggest that there is little movement between the trapped and untrapped blocks. Within Block 41, two small areas have been centres of close studies of possum populations and the composition and condition of the bush: 'Station Grid'-15ha of mature forest 140 m a.s.l. directly north of the DSIR Field Station, and 'Woottons Grid'-8ha on the southern edge of Rimutaka Forest, bounded to the south by Woottons Stream and to the west by the Orongorongo River.

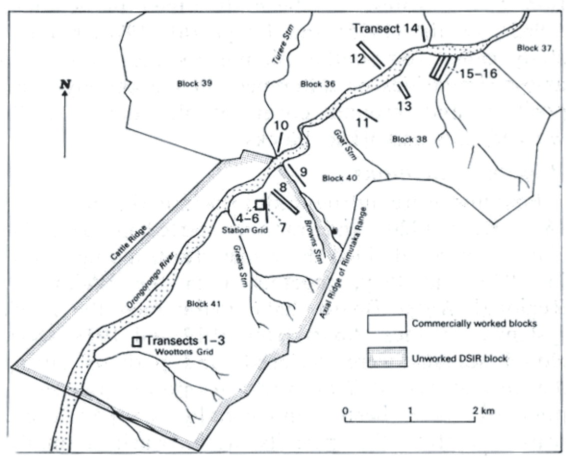

FIGURE 1. *The lower Orongorongo Valley showing boundaries of blocks in which possum trapping was permitted* or *banned and the location of pellet-sampling transects and grids.*

New Zealand Journal of Ecology 5: 21-28. ©*New Zealand Ecological Society*

2. Blocks 36, 38 and 40 provide the contrasting area, between Matthews Stream to the north and Browns and Turere Streams to the south. Since 1930 hunting permits issued for these blocks have allowed one or two trappers to work them, sometimes separately, sometimes collectively, and some blocks have occasionally been left untrapped.

Forest types

Orongorongo Valley is clothed in a fine-grained mosaic of at least 25 forest types, but along Orongorongo River is of two main types (D. J. Campbell pers. comm.). The lower outwash fans, river terraces and gullies are clothed with tall rimu-rata forest, in pockets running back 100-200 m from the riverbed. Beech forest *(Nothofagus truncata, N. solandri* and *N. menziesii)* or beech-podocarp-broadleaf forest cover the ridges. This pattern extends upstream and into the commercially trapped areas. The composition of the forest has been described by Robbins (1962), Daniel (1975) and Fitzgerald (1976) but this study called for another simple botanical survey to assess similarities or differences in the canopy composition and ground cover of the commercially worked and unworked blocks.

Possum populations

Possums were introduced to Rimutaka Range in 1893 (Kirk, 1920), and trapping started in 1912. The Forest Service divided the range into trapping blocks in 1929 and they, together with the Wellington Regional Water Board, have maintained the block system ever since. Apart from 1932 and 1938, when closed seasons were declared, and perhaps during the Second World War when manpower was short, possums have been commercially trapped every season. Until 1976, permits were issued annually, but are now issued quarterly. Hunters usually work their blocks during winter.

METHODS

Possum population density in the commercially worked and unworked blocks

Mark-recapture studies have been conducted since 1966 on the Station Grid by a succession of workers from Ecology Division, DSIR. Sixty-four live-traps were set monthly in an area of 210 x 210 m, and a larger area extending out to 15 ha was trapped quarterly (Efford and Hearfield, 1981). Another grid of 78 live-traps was used to estimate the possum population density on Woottons Grid monthly since 1978 (Cowan, pers. comm.).

Within both trapped and untrapped areas, relative population densities were estimated by counting faecal pellets. Pellets were sampled on Station and Woottons Grids, and on transects following compass bearings on the north side of Station Ridge and east of Waerenga hut. At l0-pace intervals along these grids or lines, circular sampling plots of 2 m2 were searched for sound possum pellets. Damaged, eroded or broken pellets were not counted. In this way, 568 plots in the unworked DSIR block were searched between 15 December 1980 and 9 January 1981, and a further 200 plots on 11-12 May 1981. Five transects were searched in the commercially worked blocks between J5 December 1980 and 9 January 1981, totalling 344 plots, and three further transects, comprising 146 plots, counted on 11-12 May 1981. In all, 768 plots were searched in the unworked DSIR block and 490 in the commercially worked blocks.

Sampling lines and grids ran only through rimu-rata forest, and plots falling outside this forest type were not counted. The counts were made by two parties working simultaneously or alternately between the trapped and untrapped blocks to minimise the effects of different production and decay rates.

Vegetation survey

The forest canopy was noted at 545 points and the ground cover at 596 points in the unworked DSIR block; 488 canopy points and 419 observations on the ground cover were made in the commercially worked blocks. Each observation on the plant species in the canopy and the type of ground cover was made directly over or in the pellet-sampling plots.

RESULTS

Canopy composition of the two blocks

Although the commercially worked and unworked DSIR blocks contained similar tree species, their proportional representation in the canopy of the two blocks revealed several differences. Pigeon wood *(Hedycarya arborea),* mahoe *(Melicytus ramiflorus),* rimu *(Dacrydium cupressinum),* rewarewa *(Knightia excelsa)* and pukatea *(Laurelia novaezelandiae)* were present in both blocks in roughly equal proportion. The unworked DSIR block contained 11.4% more light gaps and 6.4% more kawakawa *(Macropiper excelsa).* This difference arose largely from old farming practice on Woottons Grid, which was burned over in years past, and where kawakawa is now growing strongly to fill the light gaps. The unworked DSIR block contained 6.2 % less northern rata *(Metrosideros robusta)* and 7.4% less kamahi *(Weinmannia racemosa),* fewer tree ferns *(Cyathea* sp. and *Dicksonia sp.)* and matai *(Podocarpus spicatus),* but more hinau *(Elaeocarpus dentatus)* (Table 1, Fig. 2). Some of these differences were probably imposed on the forest by the selective browsing of the

TABLE 1. *Floristic composition of the tree canopy over possum pellet-sampling plots in Orongorongo Valley, based on canopy point intercepts. (Asterisks denote levels statistically significant deviations from equality between blocks.* * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$).

	Unworked DSIR block		Commercially worked block	
Tree species	Number of plots	% frequency of occurrence	Number of plots	%frequency of occurrence
Hinau	113*	20.7	84	17.2
Northern rata	50*	9.2	75	15.4
Kamahi	2C**	3.7	54	11.1
Tree fern	31*	5.7	49	10.0
Pigeon wood	58	10.6	44	9.0
Mahoe	46	8.4	37	7.6
Rimu	17	3.1	21	4.3
Rewarewa	25	4.6	20	4.1
Pukatea	14	2.6	17	3.5
Matai	3*	0.6	17	3.5
Light gaps	78***	14.3	14	2.9
Kawakawa	38***	7.0	3	0.6
Other species	52	9.5	53	10.9
Total	54 5		488	

possums, which favour northern rata and kamahi but not other species on the list (Meads, 1976; Fitzgerald, 1976).

Ground cover

Pellets are more easily seen on litter, bare ground or rocks than among ferns, fallen branches, kiekie *(Freycinetia baueri)* seedlings, and so on. To reduce this potential sampling bias, the ground cover at each plot was noted and results summarised in Table 2. The proportions of various ground cover were almost identical in the two blocks. Differences in pellet counts on the commercially worked and unworked DSIR blocks cannot, therefore, be attributed to different ground cover.

Commercial trapping tallies

The only information on trapping success is from the trappers themselves, who reported taking 3000 possums off Blocks 35-40 in 1977; one trapper took about 500 skins off these blocks in the winter of 1979, and joined forces with a second trapper to take about 1000 skins off blocks 35, 36, 38 and 39 in the summer of 1980. Blocks 38 and 40 received little attention in 1980. In 1981, 1427 skins were taken off all the blocks and about 800 off block 38 in the summer of 1981-82. Most contemporary possums from Orongorongo Valley are small (2000-2500 g) and their skins of notoriously poor quality, classed as having "weak thin fur" at auction. At times, the Regional Water Board has had few takers for these possum blocks, but usually one or two trappers spread their efforts over 4800 ha of the six blocks. It is difficult to calculate the number of possums taken annually per hectare because the trappers work different blocks in successive years, some blocks and some favoured spots are trapped heavily while other areas are neglected, and trapping or poisoning experience and effort varies greatly from year to year. But if we presume that, on average, 2500 animals are taken annually off the 4800 ha block, this represents a mean yield of 0.52 possums/ha, slightly less than the average 0.67 possums/ha taken off the 14 217 ha of Rimutaka State Forest Park in 1980-81 (N.Z. Forest Service, 1982).

Possum population density in the DSIR block

On Station Grid, the possum population is calculated to have fluctuated between 7 and 15 animals/ha since 1966. In February 1981, this grid supported an estimated 12.3 possums/ha (M. G. Efford, pers. comm.). In December 1980, the minimum number of possums alive on Woottons Grid was 8.8/ha, but the actual number was probably a little higher (P. E. Cowan, pers. comm.).

Relative abundance based on the presence or absence of pellets

Of 768 plots in the unworked DSIR block, 202 (26.3 %) contained pellets (Table 3). Over the eight transects, the percentage of plots with pellets ranged

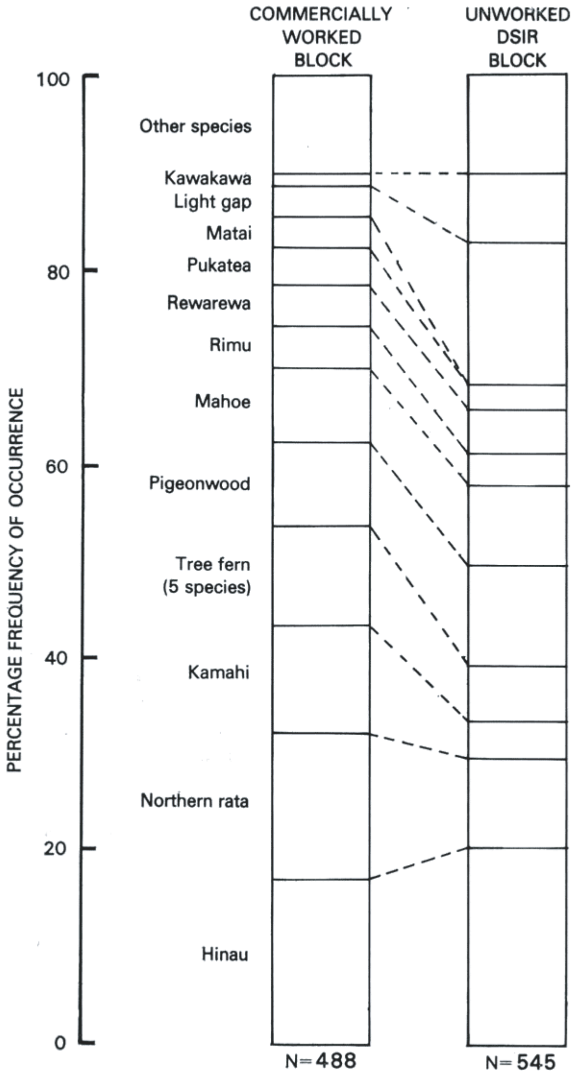

FIGURE 2. *Composition of the forest canopy in the commercially worked and unworked DSIR blocks of Orongorongo Valley, 1980-81. Based on point intercepts directly above possum pellet-sampling plots.*

from 20% to 36%. In contrast, 63 (12.9%) of the 490 plots in the commercially worked blocks contained pellets, with a percentage frequency of occurrence ranging from 6 % to 20 % over the eight transects. A 2 x 2 chi-squared test on the plots with and without pellets inside and outside the unworked DSIR block reveal highly significant differences (X^2 = 31.5, $P < 0.001$), and suggests that the commercially worked blocks supported about half as many possums as the unworked DSIR block (Fig. 3).

Relative abundance based on the number of pellets

The 768 plots on the unworked DSIR block contained 534 pellets (0.35 pellets/m^2). The 490 plots on the commercially worked block contained 212 pellets (0.22 pellets/m2). Superficially, these figures could be interpreted as showing that the commercially worked block supported 62.9% of the number of animals supported by the unworked DSIR block.

Statistical treatment of the pellet counts

Pellets were not distributed at random on the forest floor but were frequently clustered into groups. These clustered groupings, and the large number of plots without pellets, cast doubt on statistical tests which rely on normal and equal variances. But the results are amenable to non-parametric tests.

A Mann-Whitney U test, using combined data to compare the numbers of pellets in the two blocks, gave z = 4.05, which showed a highly significant difference ($P < 0.01$). A total of 121 pairwise Mann Whitney U tests between all 16 samples revealed that where significant differences occurred at the 5 % level these were always between blocks and never within blocks.

Because of the high proportion of zero values and the odd outlying count (e.g. 60 pellets in one plot), mean values have a limited use as measures of relative abundance and it is more useful to rank the data by the percentage of plots with or without pellets, or by using the median. Using either cri-

TABLE 2. *Ground cover of possum sampling plots along transect lines* in *lower Orongorongo Valley, December 1980-May 1981.*

	Percentage frequency of occurrence	
	Unworked DSIR block	Commercially worked block
Leaf litter	74.0	77.6
Ferns	10.1	10.5
Kiekie	3.7	1.4
Logs	3.5	1.4
Bare soil and rocks	3.0	5.2
Fallen branches	1.8	2.1
Roots	1.3	2.1
Nettle	1.3	0
Seedlings	0.7	0.4
Grass	0.5	0
Number of plots	596	419

TABLE 3. *Summary of possum pellet counts made in the unworked DSIR block (hunting banned) and the commercially worked block (hunting permitted) of Orongorongo Valley, 1980-81.*

No. of pellets per plot	Unworked DSIR block 1 Wootons 22.11.80	2 Wootons 5-6.1.81	3 Wootons 11.5.81	4 Station Grid 15.12.80	5 Station Grid 9.1.81	6 Station Grid 11-12.5.81	7 North Station Ridge 15.12.80	8 East Waerenga Hut 16.12.80	Total	Commercially worked block 9 Jacobs Ladder 11.5.81	10 North Browns Stm 12.5.81	11 N. Goat Stream 17.12.80	12 South of Hut 78 17.12.80	13 West Manuka Flats 9.1.81	14 South Whakanui Stm 12.5.81	15 East Baines Hut 6.1.81	16 East Baines Hut 7.1.81	Total
0	35	92	76	77	78	77	64	67	566	48	52	21	41	75	27	81	81	426
1	5	15	11	14	12	11	16	15	99	4	7	0	3	3	1	6	14	38
2	0	10	5	3	4	2	7	6	37	1	1	0	2	1	0	2	1	8
3	1	2	3	4	2	3	4	1	20	1	0	0	0	1	0	1	3	6
4	0	2	2	0	2	0	2	4	12	0	0	0	1	0	1	0	0	2
5	3	0	0	1	0	1	4	2	11	1	0	0	1	0	0	0	0	2
6	0	0	0	0	0	2	0	1	3	1	0	0	1	0	0	0	0	2
7	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
8	0	2	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0
9	0	0	0	1	1	0	0	2	4	0	0	0	0	0	1	0	0	1
10	0	0	1	0	0	2	1	0	4	0	0	1	0	0	0	0	0	1
12	0	1	1	0	1	0	2	0	5	0	0	0	1	0	0	0	1	2
16	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
20	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
No. of sample plots	44	124	100	100	100	100	100	100	768	56	60	23	51	80	30	90	100	490
% plots with pellets	20	26	24	23	22	23	36	33	26.3	14	13	9	20	6	10	10	19	12.9
No. of pellets in sample	23	77	76	46	55	89	104	94	534	20	9	29	94	8	14	13	37	212

TABLE 4. *Statistically significant (at 5% level or less) differences and homogeneities between 16 samples of pellets from lower Orongorongo Valley as revealed by Mann-Whitney U tests. Statistically homogeneous samples are linked by horizontal lines.*

	Unworked DSIR block								Commercially worked block							
% with pellets	36	33	26	24	23	23	22	21	20	9	19	10	14	13	10	6
Transect or grid number	7	8	2	3	6	4	5	1	12	11	16	14	9	10	15	13

terion, the unworked DSIR block provides one set of eight high-scoring transects and the commercially worked block the second eight low-scoring transects (Table 4), an arrangement of the samples which again shows highly significant differences between the two blocks (M-W U, $P < 0.01$). When samples are ranked as in Table 4, significant differences are revealed at the 5 % level.

DICSUSSION

The northern block of forest, containing more acceptable food plants in the form of rata and kamahi, could be expected to support more possums than the southern block. But all the evidence, based on the proportion of plots with pellets, or on the number of pellets on the ground, suggests the reverse, with the commercially worked block supporting 49 % - 63 % of the numbers on the unworked DSIR block. If the unworked DSIR block supported 8.8 - 12.3 possums/ha and the number of pellets directly reflects the number of possums, the commercially worked block supported 4.31 -7.75 animals/ha. The most plausible explanation for the differences is that hunters were holding the numbers down.

However, this explanation must be accepted with several reservations.

Patchiness of forest types

The transects and grids sampled only a very small part of each block yet each block contained a diversity of forest types and structure. D. J. Campbell (pers. comm.) distinguishes no fewer than 25 vegetation types in the un worked DSIR block.

Although the sampling transects and grids were restricted to rimu-rata forest growing in riverside patches, it is hazardous to extrapolate from these to larger areas outside. Only an enormously amplified sampling programme could overcome this deficiency. impossible to measure precisely the effectiveness of

Decay rate of pellets

The higher annual rainfall in the upstream commercially worked block could be expected to decay possum pellets faster than in the downstream unworked DSIR block. Decay rates were not measured in this study so we can only speculate about this variable. If a decay gradient operated, it would show up in declining pellet numbers along gradients running upstream in both blocks. No such gradual declines were detected in either block (Figs. 3 and 4) so it appears that differential decay rates were too small to detect, or other factors were so overwhelming as to mask their effects. Pellet counts also fell abruptly across the boundary between the two blocks, unmatched by any corresponding rise in rainfall, suggesting that factors other than differential decay rates were largely responsible for differences in pellet numbers.

Hunters' tallies

Hunters may have exaggerated or played down the size of their catch. Some hunters included every animal caught, others reported only the numbers of skins submitted to the auctioneers. The trappers set limits to their catches in various ways–some trapping until they reached a convenient round figure, other worked until a certain date, others kept trapping until their return for effort dropped below a profitable level. The catch fluctuated 'between about 1500 and 3000 skins annually and could not have been seriously affected by 50 of the 70 hut owners who reported killing a total of 67 possums/year (Palmer, 1976), or by poachers, who took a few animals. The casual hunters may, however, have contributed to any trap- or poison-shyness in the possums.

The plant cover, pellet numbers and trappers' tallies varied greatly from place to place, making it impossible to measure precisely the effectiveness of

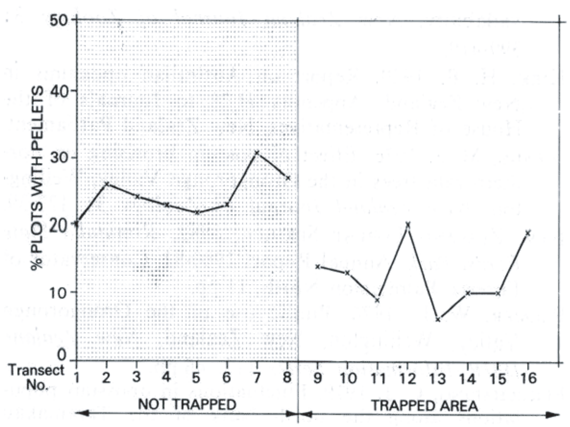

FIGURE 3. *Percentage frequency of occurrence oj possum pellets in the commercially worked (trapped) and un worked DS1R (not trapped) blocks of Orongorongo Valley, 1980-81. The calculations are based on the presence or absence of pellets in 490 plots in the trapped block and* 768 *plots in the untrapped block.*

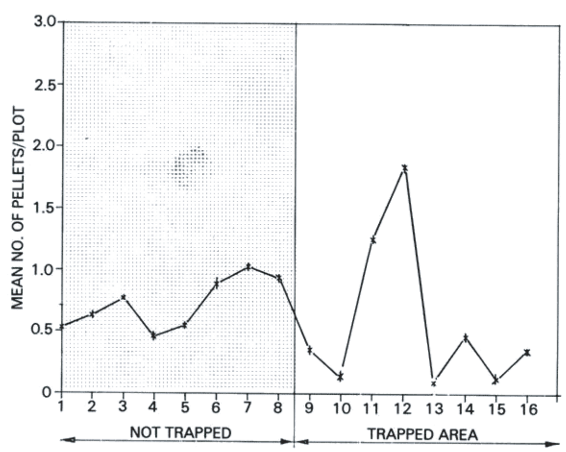

FIGURE 4. *Mean number of possum pellets/m^2 along* 16 *transect lines and grids in Orongorongo Valley, 1980-81. Lines 1-8 sampled the unworked DSIR block, lines 9-16 the commercially worked block.*

hunters. But after 50 years of trapping and poisoning, each hectare of the commercially worked block is calculated to have harboured between four and seven possums, or in the order of 19 200 to 29 400 animals over the 4800 ha.

The only directly comparable information on the effectiveness of commercial trappers in forests comes from Kapiti Island where a trapping control prow gram me was introduced in 1980 after 13 years without any control. A live-trapping study of tagged animals before and after the control programme showed that gin traps took up to 75% of the possums (Cowan, 1981). This differs from most commercial hunting operations, as patches of forest are rarely left untrapped for this length of time and, because the trapping was conducted in a bird sanctuary, the work was closely supervised and trappers encouraged to work the lines more assiduously than they might otherwise have done.

Aerial drops of carrots impregnated with 1080 (sodium monofluoroacetate) can be more effective than these commercial trapping operations. Pekelharing (1979) reported that a large-scale airdrop in rata-kamahi forest in Taramakau Valley, Westland, killed 80% of the possums. Pellet counts also showed that in nearby beech forest, 88 % of the possums were similarly killed. Aerial drops, however, are becoming increasingly expensive and can be used only in small threatened areas. Most bush country is in the hands of commercial hunters who work their blocks with varying degrees of effort and success.

The Orongorongo trapping blocks are close to the city, well-provided with tracks and huts, and the topography or weather rarely impedes trappers. These features encourage hunting effort. On the other hand, the poor-quality fur, visitors' interference with trap lines, and rules prohibiting the use of poison or traps near huts and public tracks discourage intense or prolonged commercial hunting.

If the market price for skins improves, or if the quality of Orongorongo furs improves, trappers will probably make greater inroads into the population. But if prices slump, or the condition of the animals deteriorates further, hunters will be more reluctant to work the valley. Despite the ease of access and long-term trapping and poisoning, hunters are holding the possum population of their blocks to between 49 % and 63 % of their probable carrying capacity and leaving a large breeding population-in the order of 4-7 animals/haÖto exploit the following season. These figures raise an important question: if commercial trappers working the easily accessible lowland forest blocks of Orongorongo Valley allow such large numbers of animals to survive, what greater proportion must they leave in large, remote, steep, difficult blocks?

ACKNOWLEDGEMENTS

I am grateful to Dennis Clark, Lyn Flannery, Sandra Gibbs and Neil McNaughton for helping to count pellets; to D. J. Campbell, P. E. Cowan, M. G. Elford, A. E. Fitzgerald, M. E. Hearfield, D. C. Waddington, G. D. Ward and A. J. White, for unpublished data on vegetation and trapping results; to D. G. Dawson and S. Pledger for advice on experimental design and analyses, and to J. E. C. Flux for improving the text.

References

COWAN, P. E. 1981. (unpublished). Live-trapping of possums on Kapiti Island subsequent to the winter 1980 gin-trapping. *Ecology Division, DSIR. File Report*. 10pp.

DANIEL, M. J. 1975. Preliminary account of litter production in a New Zealand lowland podocarp-rata-broadleaf forest. *New Zealand Journal of Botany* 13: 173-87.

EFFORD, M. G.; HEARFIELD, M. E. 1981. (unpublished). Possum live-trapping on the central Orongorongo Valley study area in 1980. *Ecology Division. DSIR, File Report* 25 pp.

FITZGERALD, A. E. 1976. Diet of the opossum *Trichosurus vulpecula* (Kerr) in the Orongorongo Valley, Wellington, New Zealand, in relation to food-plant availability. *New Zealand Journal of Zoology* 3: 399-419.

KIRK, H. B. 1920. Report on Australian opossums in New Zealand. Appendix H.28 to Journals of the House of Representatives, New Zealand Parliament.

MEADS, M. J. 1976. Effect of possum browsing on northern rata trees in the Orongorongo Valley, Wellington. *New Zealand Journal of Zoology* 3: 127-39.

NEW ZEALAND FOREST SERVICE. 1982. *Rimutaka State Forest Park*. Annual Report 1980-81. Conservator of Forests. Palmerston North. 11 pp.

PALMER, W. L. 1976. Public use of the Orongorongo Valley, Wellington, New Zealand. *New Zealand DSIR Information Series* 113. 46 pp.

PEKELHARING, C. J. 1979. Fluctuations in opossum populations along the north bank of the Taramakau catchment and its effect on the forest canopy. *New Zealand Journal of Forestry Science* 9(2): 212-24.

ROBBINS, R. G. 1962. The podocarp-broadleaf forests of New Zealand. *Transactions of the Royal Society of New Zealand* 1(5): 33-73.