Manaaki Whenua
Landcare Research

Comparison of deer abundance in 1080-poisoned and unpoisoned areas on Molesworth Station

TBfree New Zealand – R-10810

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Comparison of deer abundance in 1080-poisoned and unpoisoned areas on Molesworth Station

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Manaaki Whenua – Landcare Research

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Project and client

Manaaki Whenua – Landcare Research, Lincoln, was commissioned by OSPRI to compare the relative abundance of red deer in part of Molesworth Station that had been subject to aerial 1080 baiting for possum control in spring 2017, and their abundance in nearby unbaited areas of the station. The primary aim was to establish a baseline deer population estimate against which the effectiveness of future efforts to mitigate deer by-kill could be measured. Deer were counted by experienced observers in a helicopter flown at low level at times when deer were most likely to be active. The work was undertaken between February and April 2018.

Objectives

- To design an aerial survey methodology suitable for estimating the relative abundance of red deer in unforested mountainland.
- To compare the relative abundance of red deer in parts of Molesworth Station poisoned in October 2017 and in unpoisoned areas.

Methods

- The operational areas (poisoned, unpoisoned) were divided into 9 km^2 blocks, and then a random selection of these were surveyed (unpoisoned: 11 blocks; poisoned: 13 blocks), totalling c. 20% of the whole area.
- In each of the 9 km^2 blocks an observer and pilot in a Hughes 500 helicopter searched the area at low altitude and recorded any live deer seen. Searches were carried out during the first 2 and last 2 hours of daylight, when deer are most active and visible.
- Incidental observations of chamois were also recorded to compare density in the poisoned and unpoisoned areas.
- The estimates of live deer abundance in the poisoned and unpoisoned areas were compared with deer density in the poisoned area found during a survey undertaken by the Marlborough branch of the New Zealand Deerstalkers Association (NZDA).

Results

- A total of 193 deer sightings was recorded. The live deer counts in the poisoned area were 87.6% lower than in the unpoisoned areas. Extrapolating the sighting data for the total area derives a minimum number alive (MNA) estimate of more than 1,000 deer in the 60,000 ha scheduled for future possum control compared to about 120 in the recently poisoned area.
- The percentage of stags among the deer seen in the poisoned area was much higher than in the unpoisoned areas.
- Low numbers of chamois were seen, with 17 counted in the poisoned area and three in the unpoisoned area.

- The NZDA search recorded 94 (92 carcasses and 2 live) deer during their helicopter survey, which was focused on deer-favoured habitat. That data suggested a deer density of about 1.5 deer/km^2.

Conclusions

- If it is assumed that before the 1080 operation in 2017 the deer densities in the poisoned area were similar to those in the unpoisoned area, the results suggest the operation caused an 87.6% reduction in deer density. We conclude that the low MNA estimate (120) for the entire poisoned area, coupled with observations of many dead deer soon after the operation, suggests at least three-quarters of the deer were killed.
- The difference in age–sex composition between the poisoned and unpoisoned areas suggests that hinds and yearlings were more vulnerable to poisoning than stags. If so, this probably reflects lower susceptibility of stags.
- The higher counts of chamois in the poisoned area compared to the unpoisoned area may indicate that the poison operation had minimal impact on this species, but the data are too sparse to be conclusive.
- The counts provide a readily repeatable measure of baseline deer abundance data. Re-survey of the poisoned area at a similar time of year in 2020 or 2021 could be used to assess the recovery of the deer population. Likewise, once the unpoisoned area is controlled, surveys can be used to assess the impact on deer of the planned operation.

Recommendations

- If OSPRI want to minimise deer by-kill during future possum control operations on Molesworth Station and similar habitat elsewhere in the region, in order to avoid hunter angst, bad publicity and/or a reduction in goodwill they should use deer-repellent bait and/or lower sowing rates.
- The baseline deer abundance estimates reported here should be used to assess the efficacy of current or new formulations of deer repellent bait and, potentially also to assess the rate of deer population recovery in the poisoned area.

1 Introduction

Manaaki Whenua – Landcare Research, Lincoln, was commissioned by OSPRI to compare the relative abundance of red deer in part of Molesworth Station that had been subject to aerial 1080 baiting for possum control in spring 2017 and their abundance in nearby unbaited areas of the station. The primary aim was to establish a baseline deer population index against which the effectiveness of future efforts to mitigate deer by-kill could be measured. Deer were counted by experienced observers in a helicopter flown at low level at times when deer were most likely to be active. The work was undertaken between February and April 2018.

2 Background

In October 2017 OSPRI conducted an aerial 1080-baiting operation over 62,000 ha of semi-arid mountainous shrub- and grassland on Molesworth Station. For this operation, 6 g RS5 cereal 1080 (0.15%) baits were sown at 2 kg/ha following pre-feeding with 6 g non-toxic RS5 baits (1 kg/ha) 16 days earlier. The toxic sowing rate was somewhat higher than is now standard OSPRI practice in such unforested landscapes (where possum densities are typically low and there are few rats) because the aim was to attain a very high possum kill in order to quickly break the TB cycle in possums.

As well as possums, red deer are also present on Molesworth Station, and subsequently, large numbers of dead red deer were observed during a survey undertaken by the Marlborough branch of the New Zealand Deerstalkers Association (NZDA). These observations strongly suggested that a high proportion of the deer within the poisoned area had been killed. Given this likely outcome, the current survey was commissioned by OSPRI to provide a more quantitative assessment of deer abundance on Molesworth Station, primarily as a baseline against which to measure outcomes of future operations (which may include the use of deer-repellent bait), but also to corroborate the NZDA findings.

The survey design involved comparing the number of deer seen under standardised search conditions in the area poisoned with the number of deer seen in unpoisoned areas of similar habitat nearby. Because the survey was not conducted until after the 1080 operation, the secondary objective (corroboration of by-kill) is subject to the largely unverifiable assumption that deer were equally countable in the two areas, and that densities in the poisoned and unpoisoned areas were similar before the 1080 operation.

3 Objectives

- To design an aerial survey methodology suitable for estimating the relative abundance of red deer in unforested mountainland.
- To compare the relative abundance of red deer in parts of Molesworth Station poisoned in October 2017 and in unpoisoned areas.

4 Methods

4.1 Operational background and survey design

Approximately 60% of Molesworth Station has been or is scheduled for possum control using aerial 1080 baiting (Figure 1). The operational area has been split into three: East Acheron, 62, 000 ha east of the Acheron Road, poisoned October 2017 (hereafter referred to as the poisoned area); and Bush Gully and Tarndale (totalling 56,155 ha west of the Acheron Rd (hereafter referred to as the unpoisoned area), provisionally scheduled for control in winter 2018 but now delayed for at least a year.

Permission to carry out an aerial deer survey was granted by the joint land managers, Landcorp Farming Ltd and the Department of Conservation, in early February 2018.

The survey design comprised unreplicated counts of deer in two samples of 9 km^2 sampling units.

4.2 The survey

A 1 km buffer inside the area boundaries was created to try to minimise edge effects (i.e. deer moving between the poisoned and unpoisoned areas), and the remaining core areas were divided into 9 km^2 blocks. A random selection of these were surveyed (13 in the poisoned area and 11 in the unpoisoned area), comprising 15–20% of the total area. Four selected blocks in the unpoisoned area could not be surveyed because cattle had recently been put in these areas, so replacement blocks were selected following a second random selection.

In each of the 9 km^2 blocks an observer and pilot in a Hughes 500 helicopter ‘hunted’ (observing not shooting) the area at low altitude travelling at 60 km/h and recorded any live deer seen. A third person was in the back seat of the helicopter recording animal sightings by the pilot and front observer. A Tracmap GPS guidance unit, with the swath width set at 200 m, was used to record the area surveyed and coverage. The searchers aimed to fully cover each 9 km^2 block, initially searching optimal deer habitat, and then searching the remainder of the block in a way they considered should have enabled them to potentially see all of the deer (Figure 2). Searches were carried out only during the first 2 and last 2 hours of daylight, when deer are most likely to be active and visible. The start and end time of each survey in each block were recorded, along with a subjective estimate of percentage of tall vegetation cover, wind speed and ambient temperature. Tall vegetation cover was defined as being tall enough to obscure deer from observers.

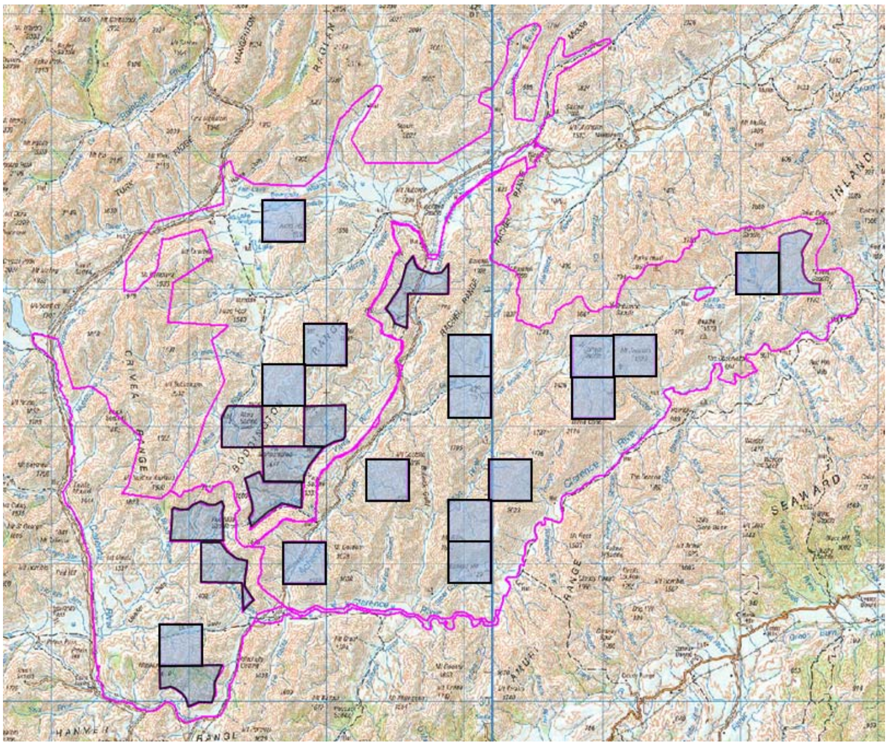

Figure 1. Blocks surveyed for live deer in Molesworth Station, February 2018. Each block's area was 9 km^2. The left pink boundary lines are Bush Gully (bottom) and Tarndale (top) operational areas, scheduled for possum control in winter 2018 (now delayed to winter 2019). The right pink boundary line is East Acheron, which was poisoned in October 2017.

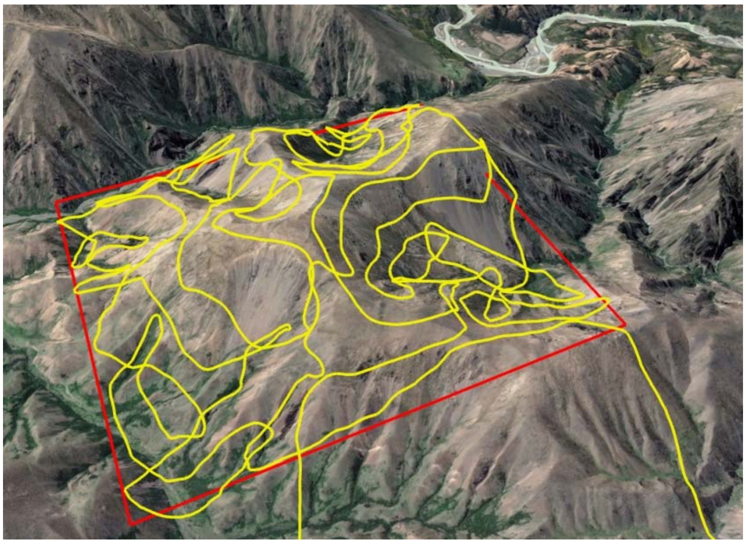

Figure 2. An example survey block in the poisoned area, including Mt Jackson and part of the Tweed River, with the Clarence River visible in the background. The yellow line is the flightline of the helicopter searching for deer. Two chamois and no deer were seen in this block when surveyed on 8 February 2018.

Surveys were conducted over 7–14 February 2018. Deer sightings were classified by sex and age class, as follows: stag, hind and fawn. Chamois sightings were also recorded. The number of deer counted in each block was expressed as the minimum number alive

(MNA), and the means for each area were compared with a simple *t*-test. The difference in mean MNA between blocks was used as corroborative evidence of deer by-kill, under the assumptions noted in section 2 above.

4.3 Comparison with other data

Some additional data on the number of dead deer seen after the 1080 operation were obtained from the Marlborough branch of the NZDA, who had intended to conduct a formal assessment of actual densities of live and dead deer in the poisoned area using two mark−recapture methods. The first method they used was based on the differing proportions of deer seen by two pairs of observers, and the second method was based on deployment of 'fake' deer carcasses, a method previously used for assessing deer by-kill in forested habitat (Morriss & Nugent 2008; Nugent et al. 2012). The number of fake carcasses found during follow-up searches is used to estimate the actual number of deer carcasses present using a mark–recapture framework.

The required design for the first approach proved impractical in steep, mountainous country, but some data were gathered from the second approach and provided by K. Pinney. This comprised a count of the number of dead and live deer seen during helicopter-based searches by the pilot plus three observers, who also recorded sightings of fake deer carcasses. The latter were brown paper sacks filled with tussock, with 50 of these deployed at random locations through the planned search area before the survey.

5 Results

5.1 Aerial survey

A total of 193 deer were sighted (Table 1). The difference in the mean counts between the poisoned and unpoisoned areas was highly significant (Table 1; $P < 0.001$). Expressed as a percentage, the mean MNA count for the poisoned area was 87.6% lower than that for the unpoisoned area.

The proportion of stags among the deer seen in the poisoned area was much higher than in the unpoisoned areas (Figure 3), while the reverse was true for hinds and fawns. The difference was highly statistically significant (Fishers exact test, $P < 0.001$).

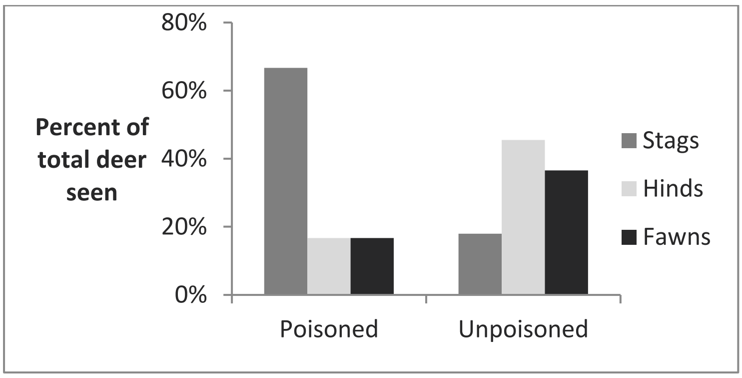

Figure 3. The sex and age class of deer observed during aerial surveys on Molesworth Station, February 2018. Twenty-four and 169 deer were observed in the poisoned and unpoisoned blocks, respectively. Yearling stags (spikers) were classified as stags.

Comparatively few chamois were seen, with 17 counted in the poisoned area and three in the unpoisoned area (mean counts per block and 95% CLs of 1.3 ± 2.1 and 0.2 ± 1.9, respectively). The difference is not significant (*t*-test, $P = 0.15$).

5.2 Integration with other observations

Ninety-four individual deer (two live) were recorded during the NZDA survey (K. Pinney, pers. comm.). The same observers also sighted 10 of the 50 randomly deployed paper sacks, so a simple mark−recapture analysis assuming random searching would suggest a total of 460 dead deer within the 298 km^2 search area nominally covered (c. 1.5 dead deer/km^2). However, the searches were neither systematic nor random, but focused on what was considered by the observers to be best deer habitat within the search area, which would have biased the estimate high. Countering that, the sacks appeared to be much more visible than dead deer (mean sighting distances from the helicopter flight path of 139 m and 53 m respectively), which would have biased the estimate low.

Table 1. Counts of deer sightings by the helicopter pilot and a front-seated primary observer, recorded during an aerial survey on Molesworth Station, February 2018, showing the number of blocks searched, the mean minimum number alive (MNA) and associated confidence limits, the total number of deer sightings in each area, the area searched, and the number of sightings per km^2 of search area. A further eight deer were recorded only by the rear-seated data recorder

	N blocks searched	Mean MNA ±95% CL	Total deer seen	Total area searched (km^2)	Deer sightings/km^2
Poisoned	13	1.9 ± 2.2	24	117.6	0.20
Unpoisoned	11	15.4 ± 7.0	169	99.6	1.70
Total	24	8.0 ± 4.3	193	217.2	0.89

6 Conclusions

If it is assumed that before the 1080 operation in 2017 the deer densities in the poisoned area were similar to those in the unpoisoned area, the results suggest the operation caused an 87.6% reduction in deer density. This is consistent with the ratio of 92 dead deer to just two live deer recorded in the NZDA survey.

Again under the assumption that the deer populations in the two areas were similar before the 1080 operation (both in overall density and in age−sex composition), the significant difference in age−sex composition between areas suggests that hinds and yearlings were affected far more severely than stags. If so, this presumably reflects substantially lower susceptibility of stags, probably simply because their larger body size would have required them to find and eat more baits than the smaller-bodied hinds and yearlings in the short 'pre-toxicosis' period after they first consumed a bait (see Appendix 1 for calculations on how many 6 g 1080 baits different-sized deer would need to eat for a lethal dose).

The number of deer counted in this survey is undoubtedly somewhat lower than the actual number present (highlighted by the observation of eight deer by a third observer that were not seen by the two main observers), so the average count density of 1.7 sightings per km^2 in the unpoisoned area suggests a mean density of perhaps two deer per km^2 there. The mark−recapture estimate from the NZDA survey is of the same order. Extrapolating from the data therefore suggests there were more than 1,000 deer in the unpoisoned Bush Gully/Tarndale area compared to only about 120 in the recently poisoned East Acheron area.

The mean counts of chamois were low and highly variable, so they did not differ statistically between the poisoned and unpoisoned areas therefore the data do not allow us to make any robust inference about the effect of the poisoning on chamois.

In summary, the NZDA survey unequivocally indicated that large numbers of deer were killed. Despite the unknown magnitude and direction of the net bias in the density of carcasses calculated from the NZDA survey, it was broadly similar to the density of deer sightings in the unpoisoned area in this survey, suggesting that baseline deer densities on Molesworth Station were of the order of 1.5–2.0 deer/km^2. This baseline estimate can be used to assess the efficacy of current or new formulations of deer-repellent bait, and potentially also to assess the rate of deer population recovery in the poisoned area.

The combination of these data with those from the NZDA suggests that most hinds and fawns were killed, along with a lesser but still substantial proportion of larger-bodied stags. The strongly adult-male-biased population structure in the poisoned area makes it likely that population recovery will initially be slow (a doubling time of 4–6 years rather than the more usual 3 years for a population reduced to well below carrying capacity) unless there is substantial deer immigration from adjacent unpoisoned areas. If there is a need to assess the deer population recovery rate, this survey should be repeated in about 3 years' time.

There has been only one previous estimate of a near-total deer by-kill: a 92–93% reduction in red deer numbers in part of the Hauhungaroa Range in the central North Island (Sweetapple & Fraser 1997). That operation involved pre-feeding and then sowing of 15 kg/ha of 1080 carrot at a concentration of 0.08% or 0.15%, a far higher sowing rate than in this trial. The next-highest by-kill estimate was the two-thirds to three-quarters reduction in the population of smaller-bodied fallow deer in the Blue Mountains, Otago (Nugent & Yockney 2004). In that operation, RS5 cereal 0.15% 1080 baits were sown at 2 kg/ ha (after non-toxic pre-feeding at 1 kg/ha), the same as in the Molesworth 2017 operation.

The high by-kill on Molesworth in 2017 may reflect some combination of a higher sowing rate than is now usual and the generally sparse vegetation cover (making most baits accessible to deer).

As noted above, we infer that the lesser kill of adult stags probably reflect them having to find a larger number of baits within a few tens of minutes to be killed than did hinds and fawns (Appendix 1). If so, this implies that bait density was, on average, too low to kill a proportion of the stags that ate toxic bait, which in turn suggests that lower sowing rates would have resulted in a lower by-kill of stags at least.

As recent trials in similar habitat in the Clarence Valley have achieved very high or total kills of radio-collared possums using 75–85% lower 1080 sowing rates (0.29–0.50 kg/ha (Morriss et al. 2014, 2015), the risk of high deer by-kill in future operations in this area could be mitigated by reducing sowing rates to 1 kg/ha or lower without significantly jeopardising possum kill. Alternatively, a deer repellent could be used to reduce the attractiveness of the 1080 bait to deer.

7 Recommendations

- If OSPRI want to minimise deer by-kill during future possum control operations in Molesworth Station and similar habitat elsewhere in the region in order to avoid hunter angst, bad publicity and/or reduction in goodwill, they should use deer-repellent bait and/or lower sowing rates.
- The baseline deer population estimates reported here should be used to assess the efficacy of current or new formulations of deer-repellent bait, and potentially also to assess the rate of deer population recovery in the poisoned area.

8 Acknowledgements

We thank Mark Watson and Lynda Harrap from Wyndon Aviation for assistance with the survey. Thanks to Molesworth Station farm manager Jim Ward, and to Chris Wooton and Phil Bradfield from DOC Wairau/Renwick, for access and permission to carry out the survey. We also thank Dave Latham for reviewing a draft of the report, and Ray Prebble for editing.

9 References

Morriss GA, Nugent G 2008. Monitoring the impact of aerially sown 1080 EDR cereal bait on fallow deer in the Blue Mountains, Otago. Landcare Research Contract Report LC0809/032 for the Animal Health Board.

Morriss G, Yockney I, Nugent G 2014. Low cost aerial poisoning V: cost and efficacy of fixed-wing strip sowing at two different flight path spacings, Clarence Valley, 2014. Landcare Research Contract Report LC2083 for TBfree New Zealand.

Morriss G, Yockney I, Nugent G 2015. Low cost aerial poisoning VI: cost and efficacy of fixed-wing strip sowing at two different flight path spacings, Clarence Valley, 2015. Landcare Research Contract Report LC2423 for TBfree New Zealand.

Nugent G, Morriss G, Fitzgerald N, Innes J 2012. Bait aggregation and deer repellent effects on efficacy, and non-target impacts on deer and birds, during aerial 1080 baiting: Hauhungaroa 2011. Landcare Research Contract Report LC1011 for Animal Health Board (R-10710).

Nugent G, Yockney I 2004. Fallow deer deaths during aerial-1080 poisoning of possums in the Blue Mountains, Otago, New Zealand. New Zealand Journal of Zoology 31: 185–192.

Sweetapple PJ, Fraser KW 1997. Assessment of red deer and possum kills during an aerial 1080 control operation in the Rangitoto Range. Landcare Research Contract Report LC9697/139 for the Animal Health Board.

Appendix 1 – Estimated number of 6 g 1080 cereal baits required to kill a deer

Table A1. The estimated number of 6 g 0.15% 1080 cereal baits that a deer of a certain live weight would need to eat to have a 50% chance of dying (LD50)

LD50 (mg/kg)	**Deer live weight (kg)**					
	50	**60**	**70**	**80**	**90**	**100**
0.3	*1.7*	*2.0*	*2.3*	*2.7*	*3.0*	*3.3*
0.4	*2.2*	*2.7*	*3.1*	*3.6*	*4.0*	*4.4*
0.5	*2.8*	*3.3*	*3.9*	*4.4*	*5.0*	*5.6*
0.6	*3.3*	*4.0*	*4.7*	*5.3*	*6.0*	***6.7***
0.7	*3.9*	*4.7*	*5.4*	*6.2*	*7.0*	*7.8*
0.8	*4.4*	*5.3*	*6.2*	*7.1*	*8.0*	*8.9*
0.9	*5.0*	*6.0*	*7.0*	*8.0*	*9.0*	*10.0*

LD50s reported:

0.5 mg/kg in: Rammell CG, Fleming PA 1978. Compound 1080. Properties and use of sodium monofluoroacetate in New Zealand. Wellington, Ministry of Agriculture and Fisheries.

0.27–0.9 for mule deer in: Tucker RK, Crabtree DG 1970. Handbook of toxicity of pesticides to wildlife. United States Department of the Interior, Bureau of Sport Fisheries and Wildlife, Resource Publication No. 84.

Average LD50 = 0.6

Stag live weight	c. 100kg
Hind live weight	c. 70−80 kg
Fawn live weight	40−50kg