Lake Sumner Recreational Hunting Area Management Project

Final Report

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Game Animal Council
NEW ZEALAND

Lake Sumner Recreational Hunting Area Management Project

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We are extremely grateful to all the hunters and volunteers who took part in the hunt and assisted with this project. A big thank you to John DeLury and Dr Geoff Asher for their assistance with the analysis. We also want to acknowledge the Department of Conservation staff, New Zealand Deerstalkers Association members, relevant landowners, helicopter operators and others that assisted to make it all happen.

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Project outline

Context

The Lake Sumner Recreational Hunting Area (RHA) is an important hunting, tramping and family recreation area close to Christchurch that, according to observers, has seen an increase in the red deer population in recent years. If left unchecked this population increase could result in over-browsing of native vegetation and deterioration in deer condition.

There are various reasons for the rise in deer numbers, but most stakeholders agreed that a deer management programme was required to mitigate impacts on native species, prevent reduction of quality of this important hunting resource, and allow time to develop a long-term plan for managing the deer in the RHA.

The project to undertake deer management through the targeting of hinds in the RHA was achieved through collaboration between the Department of Conservation, the Game Animal Council, New Zealand Deerstalkers' Association, adjoining landowners, and recreational hunters.

This project was pursuant to the Game Animal Council Act 2013, section 7(b)(g) and (h).

Objectives

The Lake Sumner Recreational Hunting Area Management Operation's objectives were to contribute to:

- Shifting the demographics of the Lake Sumner RHA red deer herd by removing a proportion of the breeding hinds.
- Gathering baseline data from the animals observed and removed to inform future decision-making with regards to red deer management in the Lake Sumner RHA.
- Comparing the costs of deer removal by organised, experienced volunteer ground hunters against the cost of commercial aerial control alternatives.

Operations that were recommended to achieve the objectives

1. Undertake an animal management hunt in late May/early June 2022 by suitably experienced recreational hunters to remove a proportion of the breeding hind population.
2. If necessary, in late June 2022, harvest deer through hunter-managed aerial hunting to remove a proportion of the breeding hind population. Meat from the animals harvested would be processed and distributed for charitable purposes.
3. If weather prevented the organised recreational hunt occurring then consideration would be given to conducting both operations in the spring of 2022.

Pre-hunt engagement

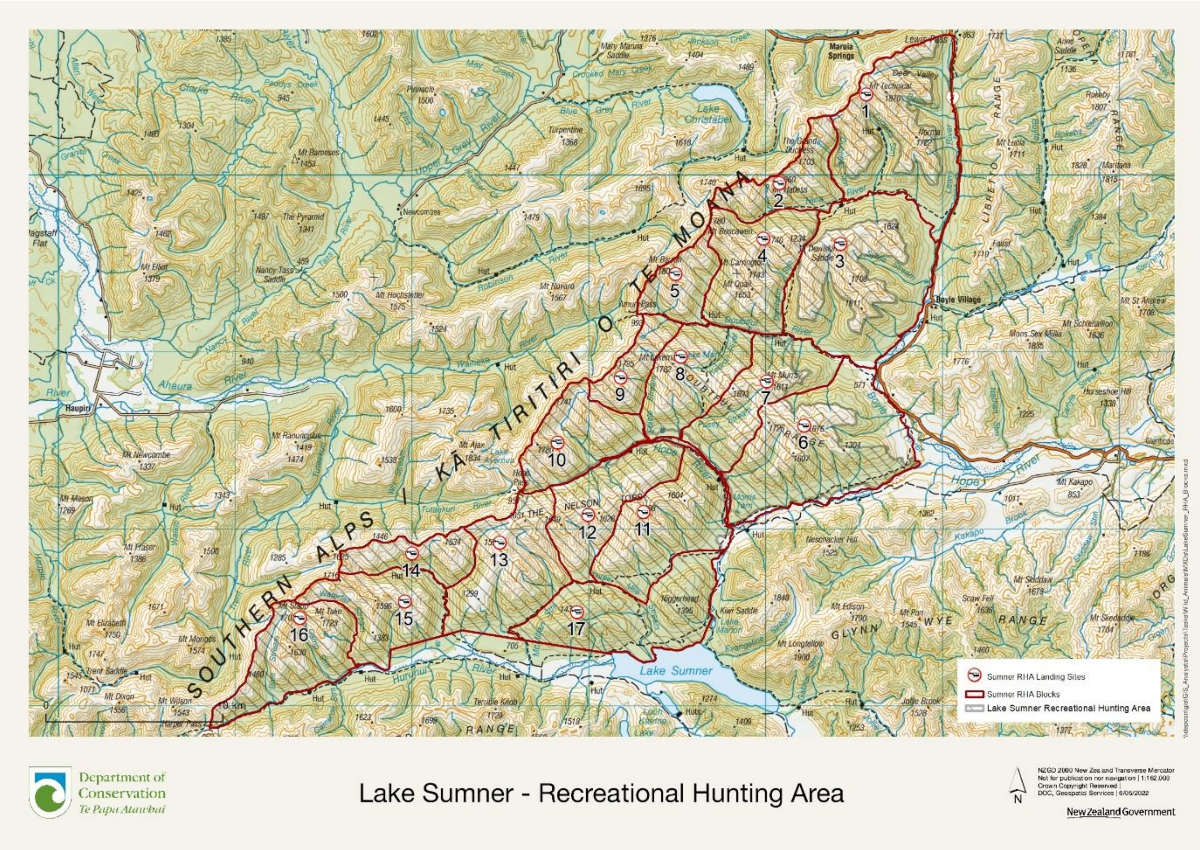
The Department of Conservation undertook initial engagement with local Runanga, who did not wish to participate in the operation. Further engagement would be required for any future discussions around management of Lake Sumner RHA.

Hunting sector and other stakeholders were informed of the proposed operations via social media posts and an information sheet posted on the GAC website. Feedback on the proposal was overwhelmingly positive. In addition, Geoff Kerr, Tyron Southward and Garry Ottmann attended a meeting of the North Canterbury Branch of NZDA on 28 March 2022, to discuss the proposed operation. Feedback at this meeting was also very positive.

Hunt summary

The Lake Sumner RHA was divided into 17 blocks (Figure 1) but, due to snow conditions and logistics, blocks 5, 16 and 17 were not hunted.

Figure 1: Lake Sumner Recreational Hunting area management blocks



- Two person teams were allocated to each block.
- Access was via helicopter. Ahaura Helicopters Ltd and Alpine Springs Helicopters Ltd, were engaged to carry out transportation.
- There were two pick-up and delivery locations.
    1. Boyle Camp quarry, SH7 Magdalen Valley Road, Lewis Pass.
    2. The Lakes Station at the head of Lake Sumner Road.
- The hunters flew in around midday on Thursday 26 May 2022 following an operational and health and safety briefing. The hunters were extracted around midday on Sunday 29 May 2022.
- Hunters were interviewed on their return to gauge their impressions of the operation and what could be improved. All those interviewed were very positive about the organisation and operation of the hunt.
- The weather was fine and clear for the duration of the hunt.
- Steepness and snow and ice conditions meant that hunters were unable to access parts of some blocks, reducing hunter effectiveness.
- Some hunters chose to hunt independently, some hunted in pairs, and some did both at different times.

- The time constraints imposed by needing to be back at their pickup location for helicopter extraction on the final day, limited hunter access to new ground, resulting in few deer removed on that day.
- Not all hunters recorded their hunting hours, precluding a precise estimate of kills per unit of effort. While a maximum of three full days of hunting were available (84 hunter-days), total effort was somewhat less than that, but is unknown. The range of hours spent hunting by individual hunters was:
  - Day 1: 2-5 hours
  - Day 2: 6-10.75 hours
  - Day 3: 3-8.75 hours
  - Day 4: 0-3.5 hours

Results

Animal-related data

The hunters recorded 720 observations of deer during the operation. However, the number of animals seen (Table 1) is not indicative of the number of animals present.

- Not all animals would have been observable because of timing, vegetation, topography, un-hunted parts of the block, etc.
- Individual hunters may have observed the same animal multiple times, whether on the same or different days.
- Multiple hunters across different blocks could have observed the same animal.

Hence, the number of unique animals seen is unknown, but would have been somewhat less than the 720 recorded by the hunters.

Table 1: Deer sightings

	Adult hinds	Yearling hinds	Stags	Spikers	Fawns	Unknown	Total
N	296	133	142	56	84	9	720
%	41%	18%	20%	8%	12%	1%	100%

Hunters removed 126 of the 296 adult hinds seen (43%), but this "apparent success rate" understates the true success rate because of multiple sightings of some hinds. The hunters measured and recorded body fat indices (BFI) and recovered jaws and reproductive tracts from 82 of the 126 hinds shot. The remaining 44 animals could not be recovered because of inaccessible terrain, darkness, time limitations, etc. Table 2 summarises data collected from the 82 recovered hinds.

Table 2: Red deer hind condition data

Sample	Measure	N	n	Minimum	Mean	Maximum	Standard deviation
All hinds	Active ovaries	80	73	0	0.91	1	0.28
	Pregnant	80	72	0	0.90	1	0.30
	Foetal age (days)	68		15	52.87	75	15.46
	Body Fat Index (mm)	82		0	3.73	18	3.80
	Jaw length (Hinge, mm)	81		209	257.0	286	14.07
Hinds with two molars (< 20 months)	Active ovaries	15	12	0	0.80	1	0.41
	Pregnant	15	12	0	0.80	1	0.41
	Foetal age (days)	11		25	44.55	60	10.11
	Body Fat Index (mm)	16		0	5.00	15	3.98
	Jaw length (Hinge, mm)	16		206	243.9	267	14.98
Hinds with three molars	Active ovaries	64	60	0	0.94	1	0.24
	Pregnant	64	59	0	0.92	1	0.27
	Foetal age (days)	57		15	54.5	75	15.86
	Body Fat Index (mm)	66		0	3.42	18	3.72
	Jaw length (Hinge, mm)	65		230	260.3	286	11.73

Reproductive status

Two of the reproductive tracts were unable to be analysed. For the 80 analysable tracts, 73 had active ovaries, 72 of those were pregnant, and it was possible to age 68 foetuses. There were 16 hinds with incomplete tooth eruption (i.e., only two molars, ≈ 18 months old), one with missing reproductive data. For the remaining 15 hinds with only two molars, 12 had active ovaries, and each of those 12 animals was pregnant. For the 64 three-molar hinds (i.e., full tooth eruption, adults) with reproductive data, 60 had active ovaries, and 59 of those were pregnant.

In Norway, Wegge (1975) found only 12% of 18-month red deer hinds were ovulating, considerably less than the 80% observed here. Bonenfant et al. (2002) found that pregnancy rates of French adult red deer hinds were not density-dependent, but that pregnancy rates of first-time breeders (two-molars) was highly density-dependent, with about 6% pregnant at high density and 63% ± 15% pregnant at low density. The very high (80%) pregnancy rate for the small (n=15) sample of two-molar hinds from Lake Sumner RHA is consistent with low deer-density.

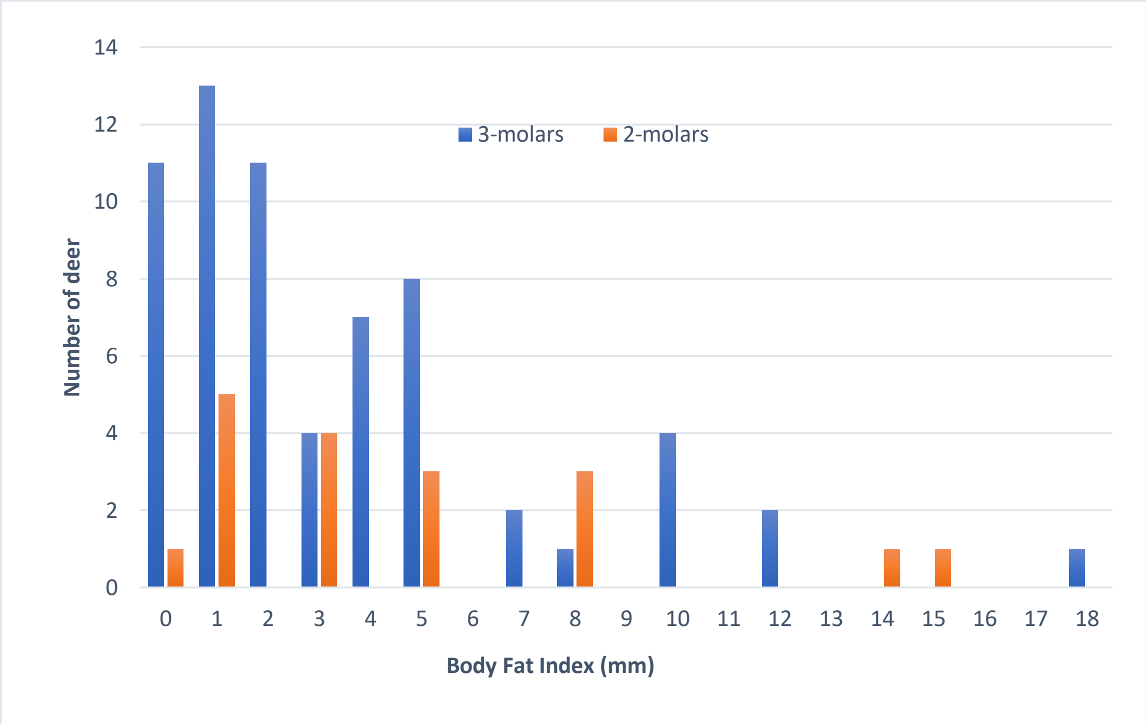
Body Fat Index (BFI)

The BFI is an indicator of body fat stores but is reliable only within a limited range of animal condition. Skeletal body fat is the last fat to be added, and the first to be used, so BFI has most value for differentiating condition of well-nourished animals (Mattiello et al., 2009; Riney, 1955). At the time of the study (late autumn) the hinds should have been in peak condition, and BFI the most useful indicator of condition (Riney, 1955). Figure 2 reports Lake Sumner RHA BFI measures by tooth eruption status. The means for each group were heavily influenced by a small number of animals with higher levels of body fat. The modal BFI for mature hinds was zero.

Maximum Lake Sumner RHA BFI was 18mm (Figure 3), much less than the 42mm observed in red deer by Riney (1955) and 50mm observed by Mattiello et al. (2009). When compared to the means for Italian red deer hinds (Mattiello et al., 2009) BFI was high for immature animals (2-molars LSRHA

5.00 mm versus Italian Yearlings 1.88mm) but was low for adult hinds (3-molars LSRHA 3.42 mm versus Italian Adults 6.38mm). The relatively low BFI scores indicate the Lake Sumner RHA hinds were below their potential for that time of year. However, because the BFI is limited to differentiating condition only amongst animals that are in good condition and does not differentiate reliably between good and poor condition, the BFI data does not indicate that the deer in Lake Sumner RHA were nutritionally stressed.

Figure 2: Body Fat Index frequency by tooth eruption



Jaws

Jaws were aged by a combination of tooth eruption patterns and cementum analysis of the sectioned lower first molar (M_1) (Fraser & Sweetapple, 1993). Consistent with previous New Zealand studies (Challies, 1978; Fraser, 1996; Lentle et al., 2000) jaw hinge lengths were measured by micrometer (±0.5mm). Hinge length could not be measured on one damaged jaw.

Mean hinge lengths increase rapidly with age for the first two annual increments (Table 3, Figure 3), but plateau after deer reach 3.5 years of age. This result is consistent with studies of red deer in Spain (Azorit et al., 2003) and Italy (Becciolini et al., 2016), other New Zealand red deer studies (Challies, 1978; Fraser, 1996; Lentle et al., 2000), and New Zealand fallow deer (Nugent & Frampton, 1994).

Table 3: Lake Sumner RHA female red deer hinge length by age

Age (Years)	N	Mean hinge length (mm)	Standard deviation
1.5	18	238.6	10.1
2.5	30	257.4	9.2
3.5	6	265.0	7.6
4.5	10	264.8	6.8
5.5	8	269.4	11.2
6.5	4	263.5	11.2
7.5	2	276.0	5.7
8.5	2	269.5	10.6
10.5	1	263	na

Length-at-age models were fitted to the jaw data using Stata software utilising Weibull, von Bertalanffy, logistic and Gompertz functional forms (Tables 4 & 5).

Model specifications are (Length in mm, Age in years):

Weibull	Length = L_{inf} * (1-exp(-W*Age^{Z}))
Von Bertalanffy (Typical)	Length = L_{inf} * (1-exp(-K*(Age-t_0)))
Logistic	Length = L_{inf} / (1+exp(-L*(Age-t_0)))
Gompertz	Length = L_{inf} * exp(-exp(-G*(Age-t_0)))

L_{inf} is the asymptotic mean jaw length in each model. In the von Bertalanffy model, K is the exponential rate of approach to L_{inf}. t_0 is the age at which jaw length is modelled to be zero and has no practical relevance, non-significance of the estimated coefficients on t_0 is not problematic.

Table 4: Jaw hinge length-at-age models for Lake Sumner RHA 2022

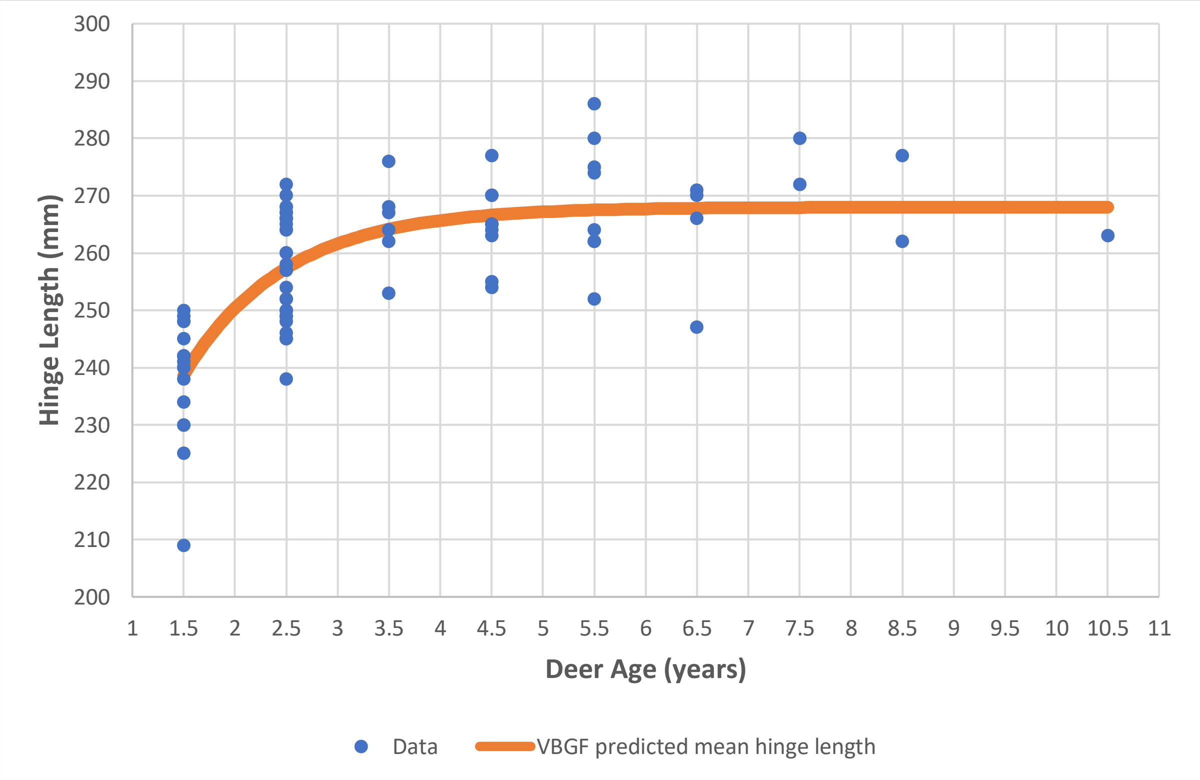
	Coefficient	SE	t	p>|t|	95% LCI	95% UCI
	Weibull					
L_{inf}	268.32	2.8481	108.04	0.000	263.45	273.34
W	-1.6340	0.1077	-15.18	0.000	-1.8483	-1.4197
Z	0.7236	0.1437	5.10	0.000	0.4466	1.0186
	von Bertalanffy (vBGF)					
L_{inf}	267.99	2.11	127.29	0.000	263.80	272.18
K	1.0182	0.2322	4.38	0.000	0.5560	1.4805
t_0	-0.6721	0.4833	-1.39	0.168	-1.6342	0.2900
	Logistic					
L_{inf}	267.87	2.0440	131.05	0.000	263.80	271.94
L	1.0993	0.2390	4.60	0.000	0.6234	1.5751
t_0	-0.4103	0.4102	-1.00	0.320	-1.2269	0.4062
	Gompertz					
L_{inf}	267.93	2.0736	129.21	0.000	263.80	272.06
G	1.0583	0.2355	4.49	0.000	0.5894	1.5272
t_0	-0.5375	0.4447	-1.21	0.230	-1.4228	0.3478

Table 5: Lake Sumner RHA length-at age model comparison

	Weibull	vBGF	Logistic	Gompertz
N	81	81	81	81
Number of fitted parameters	3	3	3	3
Log-likelihood	-293.08	-293.10	-293.11	-293.116
Akaike Information Criterion	592.156	592.203	592.228	592.215
Bayesian Information Criterion	599.340	599.387	599.411	599.399
Root Mean Square Error	9.191	9.193	9.195	9.194

The four growth models have near identical fits (Table 5). The Weibull growth function performed best on all four measures of fit reported, however differences in model fit are not significant. Within the age ranges sampled, mean jaw length at each age is visually indistinguishable when the four models are graphed. The von Bertalanffy growth function for mean length-at-age and the data are plotted in Figure 3.

Figure 3: Lake Sumner RHA red deer hind von Bertalanffy growth function, 2022



Because of potential confounding by genetic (Chesser & Smith, 1987; Hartl et al., 1991) and habitat (Nugent & Frampton, 1994; Logan, 2014) differences, comparison of jaw length-at-age models with other New Zealand studies of female red deer (Challies, 1978; Fraser, 1996) is not adequate evidence of the environmental impact of deer in any specific location.

- The effects of a dramatic reduction in deer density are reflected in the upward temporal shift of the three von Bertalanffy growth curves Challies (1978) fitted to his South Westland data (Figure 4). Nugent and Frampton (1994) identify a similar effect for New Zealand fallow deer.
- Banwell (2009) documents the significant skeletal differences in red deer sub-species. Of relevance to New Zealand are differences between *Cervus elaphus scoticus* and *Cervus elaphus hippelaphus* (the Western European form) and variants within those forms, which were the source of stock liberated in New Zealand. Banwell (2009) notes that for *scoticus*

"[b]ody size was small in its original habitat, of medium size in New Zealand" (p.95), whereas *hippelaphus* was of "medium to lower large form" (p.110). The significance is that South Westland deer are pure *scoticus*, from the Invermark, Scotland-sourced Otago herd (Banwell 2011), whereas Lake Sumner and Pureora deer are various combinations of *hippelaphus* genetics.

- Lake Sumner Recreational Hunting Area hinds are modelled to grow faster and have larger jaws at maturity than Challies' (1978) South Westland red deer hinds (Figure 4). The Lake Sumner red deer are of mixed ancestry originating from English park deer, with most influence from the Nelson herd (Banwell, 2011; Clarke, 1971; Clarke, 1973; Clarke, 1976; Donne, 1924; Logan, 2014; Logan & Harris, 1967; Sowman, 1969; Wodziki, 1950) and some from the Poulter herd[1].
- Clarke (1976, p.236) notes that *"The Nelson Thorndon Park strain red deer are described in early publications (Thomson, 1922; Donne, 1924) as inferior to other strains liberated in New Zealand because of their small body size and small antlers"*. Yerex (2001, p.13) cites Sowman' (1981) commentary on the poor quality of Nelson deer. Logan (2014, pp.108-109) provides evidence that red deer stags in the Nelson herd, a main source of the Lake Sumner deer, historically were typically shorter, lighter, and had smaller skulls than stags from Westland. He also noted that "the Scottish strain attained a much greater body weight in New Zealand than was the case in their homeland" (Logan, 2014, p.109). While the views of Clarke (1976) and Sowman (1981) are consistent with the between-herd differences illustrated in Figure 4, Logan's (2014) evidence is inconsistent with Figure 4. This apparent anomaly could be because of incomplete environmental adaptation to removal of large numbers of red deer at the time of Challies (1968) South Westland study.
- Fraser (1996) fitted a Weibull model to a sample of Pureora red deer hinds, which can be compared to the Lake Sumner RHA Weibull model (Figure 4). Young Pureora hinds were larger and grew at about the same rate as the Lake Sumner hinds. Pureora hinds were larger at maturity. Again, the Pureora and Lake Sumner deer originate from different stock which may result in genetic-based skeletal measurement differences. Logan and Harris (1967, p.21) cite a personal communication from K.M. Purdon that "the King Country herd … all of the same breed as those at west Taupo … is a large breed of deer". Purdon's observation is consistent with the Pureora model producing the largest asymptotic jaw length of the three New Zealand herds analysed here.

Length-at-age models have most value for comparing location-specific intertemporal effects, as shown by Challies' (1978) South Westland example. Numerous studies have shown that deer jaw dimensions respond to environmental condition, food availability and deer density (e.g., Hewison et al., 1996; De Marinis et al., 2019; Bertouille & De Crombrugghe, 1995; Bertouille & De Crombrugghe, 2002). There has been no previous jaw collection from the Lake Sumner RHA, so it is not possible to replicate Challies' intertemporal analysis. The Lake Sumner length-at-age models create a baseline for comparison with future samples from Lake Sumner RHA, potentially indicating changes in animal and/or environmental conditions.

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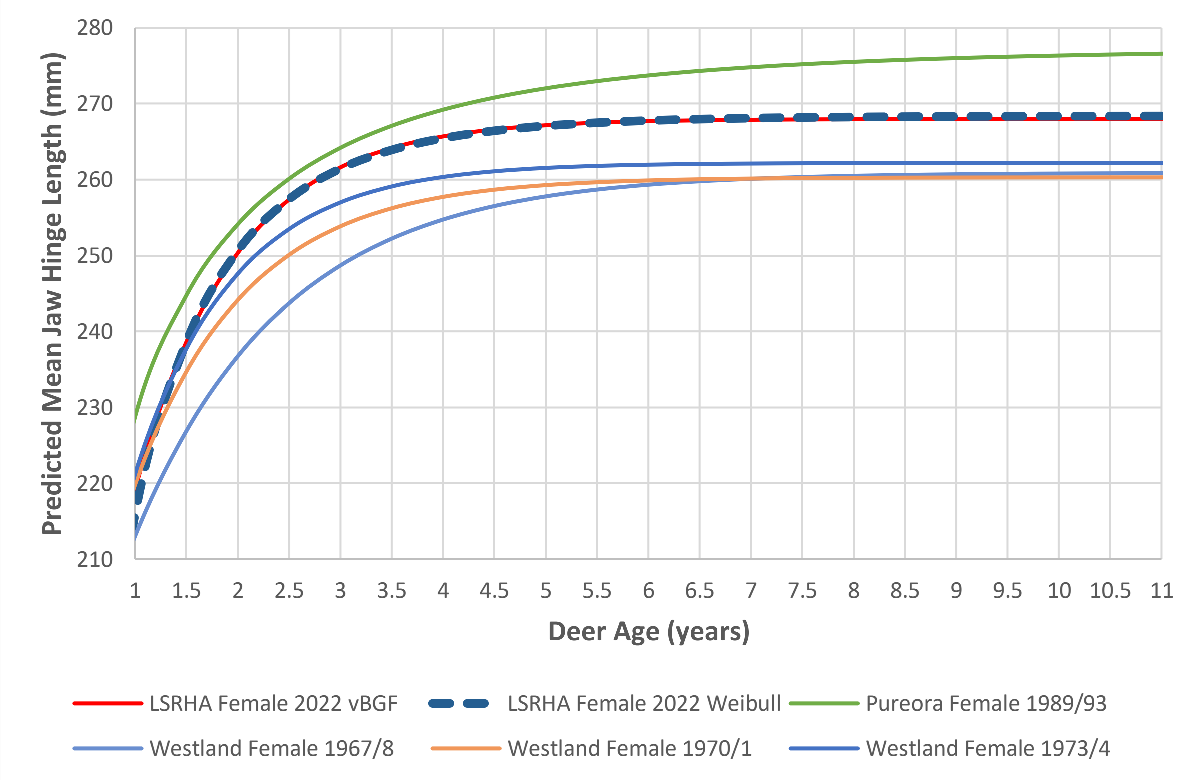
[1] Banwell (2011, p.96) recognises "*the rather complex genetic structure of the Nelson herd … There is little doubt the populations north of the Waiau watershed in Canterbury constitute one established population, an amalgamation of all the liberations that took effect in both the provinces of Nelson and Marlborough*".

Logan and Harris (1967, p.11) state *"Deer from [the Poulter] herd probably reached the Hurunui River about the same time as the Southward moving Nelson deer and mixed with them somewhere about there"*. The Hurunui River is the Southern boundary of the Lake Sumner RHA. The Poulter herd was sourced from Warnham Park, England (Banwell, 2011; Logan & Harris, 1967).

Figure 4: New Zealand red deer hind jaw hinge length-at-age models



Further Operations

With the number of deer harvested and because of the strong indications that the deer shot were in relatively good physical condition, consistent with not being nutritionally stressed, it was decided that an aerial management operation was not required.

Conclusions

A hunter-led operation to remove mature red deer hinds from the Lake Sumner Recreational Hunting Area killed 126 deer and recovered body parts and fat indices from 82 deer for scientific analysis. The reproductive tracts displayed high fertility and pregnancy rates. Seventy eight percent of the deer had deposits of body fat, which occurs only in well-conditioned animals. Young deer had reasonably high rates of jaw growth. The data indicate that Lake Sumner Recreational Hunting Area deer are not nutritionally stressed, suggesting that the deer population is not high enough to compromise the quality of recreationally hunted deer.

Scientific information on the status of the natural environment and potential effects from deer are unavailable to guide management decisions about whether there are too many deer in the Lake Sumner RHA. It is recommended that science-based ecological monitoring should be established to supplement qualitative evaluations of excess deer causing undesirable environmental change in the Lake Sumner Recreational Hunting Area.

Costs (to management entities) of various forms of deer control are compared in the appendix. Direct comparison of costs can be misleading because the different forms of control yield different benefits, which are not compared here. For example, meat for charity projects yield significant social benefits in addition to the benefits of deer control *per* se. Department of Conservation staff time is not included for any of the methods. Further, the costs of control fall on different entities with different control methods. It should be noted that the recreational hunters and a sponsor bore 30% of the costs of the Lake Sumner RHA operation, so the cost to the Game and Animal Council and the Department of Conservation was $21,550 ($171 per deer). It is anticipated this cost will fall for future operations which will be able to replicate procedures established for the Lake Sumner RHA.

This project has successfully illustrated the capability of well-organised, experienced recreational hunters to selectively reduce deer populations by a significant amount in a short time-frame and collect valuable scientific data, allowing assessment of deer condition. Consideration should be given to application of this model in other recreational hunting areas.

Appendix

Organised Recreational Management Hunt Income and Expenditure (exclusive of GST)

Item	Budget		Actual	
	Expenditure	Income and source	Expenditure and comment	Income
Project design, management, implementation, health and safety, and final reporting etc	$13,500	$13,500 Funded by the Game Animal Council	$14,534 Administration time was slightly more than anticipated. However, should the operation be conducted again, establishment costs would be significantly reduced	$14,534
Research			$2,608 This was an unbudgeted item that involved jaw processing and analysis. Research costs are excluded from the overall cost of the control operation	$2,608
Aerial transport	$17,000	$7,000 $10,000 From individual hunt participants	$15,500 There were 2 fewer hunters than budgeted for because one block was not hunted. A few of the flight times were slightly less than originally estimated	$7,000 $8,478 hunters
Consumables	$1,000	$1,000 Sponsored by Architectural Glass Ltd	$758	$758
Totals	**$31,500**	**$31,500**	**$30,792** **[excludes research cost]** **($244 per deer)**	**$33,378**

Discussion

- Much of the cost of the organised recreational hunt was related to developing new systems and processes. Because these systems and processes can be reused, there would be a significant reduction in cost for future operations.
- The meat for charity project was not undertaken so no actual costs are available. However, on budgeted costs, removing the 126 deer taken by recreational hunters for a meat for charity project would entail a cost of $36,288 ($288 per deer)
- The estimated cost for an aerial cull without recovery operation, based on discussions with a local operator and historic costs for Fiordland Wapiti Foundation operations, would be in the order of $90 to $133 per animal ($11,340 - $16,758 for 126 deer).
- Commercial deer recovery is not permitted in the Lake Sumner RHA unless for management purposes. The direct cost for such operations would be zero.
- For comparative purposes, we also consulted a professional hunting service provider to get a perspective on this method of removing deer. The cost of a professional hunter (depending on location and the need for aerial access etc) would likely be between $650 and $1000 per

hunter per day. In a recent commercial operation in the central North Island professional hunters averaged 1 deer per day. In more open country with higher deer numbers, we would expect this kill rate to increase. The recreational hunters had 2 full days and 2 half days available for hunting and killed 1.6 deer per hunter per day. If, for comparison, professional hunters killed 2 deer per hunter per day, at the mid-point of the daily contract rate, the cost would be $412 per deer. At 3 deer per day the cost would be $275 per deer ($34,650 or $51,912 for 126 deer).

- The organised recreational management hunt had similar costs to meat for charity and commercial ground hunting. However, as noted above, future recreational management hunts would cost somewhat less than this. While aerial culling without recovery and commercial recovery are likely to be cheaper options, it should be noted that all costs of managing aerial control are met by the Department of Conservation, whereas recreational hunters bore a significant proportion of the costs of the recreational management hunt.

Estimated costs of control options

Option	Estimated Cost per deer	Estimated Cost for 126 deer
Recreational management hunt	$244	$30,792
Aerial management with meat harvested for charity	$288	$36,288
Aerial culling without recovery	$90 to $133	$11,340 to $16,758
Commercial meat recovery	Zero	Zero
Commercial ground hunting	$275 to $412	$34,650 to $51,912

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