Hunting for optimality: preferences for Sika deer hunting experiences

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Abstract

Introduced ungulate game animals are managed as pests on New Zealand public lands. Open access recreational hunting and commercial harvests have resulted in negative externalities as individuals and groups with competing interests have sought to maximise their own benefits. The revocation of pest status for these species in the Game Animal Council Act 2013 and the possibility of managing herds of special interest have brought into focus the lack of information on recreational hunter motivations, resource use, harvests and satisfactions. Recreational hunters were surveyed each month for a year about these matters, and participated in a choice experiment to identify characteristics of preferred hunts for Sika deer. The choice experiment used travel distance as the numeraire of value to overcome resistance to the commodification of recreational hunting, using an adaptive pivot design to address the wide variance in distances travelled. The study identified significant non-market benefits of recreational hunting. Hunters were highly heterogeneous, both in their hunting behaviours and preferences, which has important implications for management. Spatial and temporal separation of different types of hunters, as well as management of harvest and activity levels provide opportunities for significantly enhancing the value of recreational hunting.

Keywords

Choice experiment, Sika deer, recreation, hunting, management

Introduction

Sika deer (*Cervus nippon*) were first introduced to the North Island of New Zealand in 1905 to establish a hunting resource (Davidson, 1973). In the year 2000 Sika deer occupied about 6000 km^2, principally in the Kaimanawa and Kaweka Ranges, of the central North Island (Fraser et al., 2000). Sika deer range continues to expand accompanied by displacement of Red deer (Davidson and Fraser, 1991; Nugent et al., 2001). Sika deer hunting now accounts for a significant proportion of New Zealand big-game hunting effort. Thirty one percent of big-game hunters responding to a national survey had targeted Sika deer in the previous year, with hunts targeting Sika deer accounting for eleven percent of annual big-game hunting effort (Kerr and Abell, in press). As with other big-game hunting on New Zealand public land, Sika deer hunting is open-access, subject to trivial permit requirements. Whilst this is highly egalitarian, it means that deer hunting areas are akin to Hardin's (1968) commons which, along with the implications of competing aerial hunting of the same resource, partly explains the comparatively low value of New Zealand deer hunting experiences (Kerr and Woods, 2010).

In ultimate response to the findings of a ministerial panel to review the status of big game animals and their management (Anonymous, 2008), the Game Animal Council Act 2013 was given Royal assent in November 2013. This legislation creates the opportunity to manage large game animals, including Sika deer, to enhance economic and recreational benefits within environmental constraints. Where a herd of game animals has particular importance they may be designated as a "herd of special interest" and managed for hunting purposes consistent with broad overriding environmental considerations.

Recreational Sika deer hunting is extremely popular, raising the question of whether that popularity is adequate to justify designation as a herd of special interest and, if so, how Sika deer (and Sika deer hunters) should be managed to enhance the benefits of recreational hunting. Measures of the importance of recreational Sika deer hunting include expenditures made in order to hunt, and consumer surplus obtained by hunters. One purpose of this paper is to estimate the current value of Sika deer hunting as an indicator of the importance of the activity to hunters.

Illustrating the importance of recreational hunting to hunters now may be sufficient to justify management. However, it does not provide guidance on either the gains potentially available from improved management or the objectives of management, which should presumably seek to enhance desirable hunt attributes whilst diminishing undesirable attributes. However, management objective setting is not straightforward because of the heterogeneity of hunters, whose motivations, capabilities and opportunities vary greatly. This study also seeks to inform objective setting for recreational Sika deer hunting management by identifying hunter heterogeneity, classifying hunters into groups with similar preferences, and identifying the relative importance of key hunt attributes for each group. In measuring the potential value gains from changing hunt attributes this paper also seeks to identify potential benefits of enhanced management of Sika deer hunting.

Methods

A choice experiment was conducted to assess hunter heterogeneity and the relative value of hunt attributes for different types of hunter. Information on individual hunter attributes and behaviours collected in two earlier surveys (Kerr and Abell, in press) were combined with

choice experiment data collected from Sika deer hunters who participated in the earlier surveys to provide a comprehensive overview of hunters and their preferences. The choice experiment was run as an internet survey using the Qualtrics platform with a call-out to bespoke choice experiment software run on an alternative server. The transitions between the two systems were invisible to participants.

Salient hunt attributes were identified from researcher field experience, a review of hunter motivations (Woods and Kerr, 2010), and discussions with experienced Sika deer hunters, managers and researchers. The survey was pre-tested by hunters with varying Sika deer hunting experience and skill.

The vast majority of Sika deer are on public land, where hunting is permitted year round subject to possessing a hunting permit from the Department of Conservation. Obtaining a free hunting permit takes only a few minutes over the internet. However, historically it is common to hunt without a permit (Fraser, 2000). It was not practical to have a money-related attribute within the choice experiment design because of the emotionally and politically charged context of recreational hunting management. A significant section of the hunting community favours retention of the existing spontaneous, essentially open-access, hunting permit system. There has been strong resistance to the possibility that hunters may have to pay or use more onerous permitting systems to hunt on public lands. At the time of the choice experiment the possibility of such changes was a matter of strong speculation based on proposals for reform of recreational hunting management under the aegis of the proposed Game Animal Council.

However, hunters are familiar with making decisions about where to hunt based on their perceptions of alternative site attributes, including differences in travel distance. That experience was the basis for the choice experiment, in which hunters were faced with three alternative Sika deer hunts described by different attribute levels entailing, *inter alia*, different road travel distances. In addition to the three Sika hunts in each choice situation, hunters could choose not to hunt Sika deer (Holmes and Adamowicz, 2003). Hence, the value of alternative attribute levels could be measured in terms of willingness to travel. A pivot design was used to add realism to the survey (Boxall et al., 1996; Rose et al., 2008). The distances that hunters travel are largely determined by the individual hunter's residential location. It would not have been realistic to propose hunts that were closer than the nearest Sika deer habitat, nor would it have been realistic to propose travel distances that would have taken hunters beyond Sika deer habitat. To overcome this difficulty the levels for the distance attribute were pivoted off the distance travelled by the individual hunter on a recent Sika deer hunt. The three levels used for this attribute (0 km, 150 km, 250 km) were added to the distance each individual respondent stated they travelled to hunt Sika deer (X_i km), so that an individual hunter observed the attribute levels X_i km, X_i+150 km, and X_i+250 km in their personal choice scenarios.

The choice experiment was conducted in two phases in order to obtain efficiency gains from a revised experimental design based on responses to the first phase (Kerr and Sharp, 2010). Ngene software (Choicemetrics, 2009) was used to develop a D-efficient design for a multinomial logit model based on the relevant priors at each round. Attributes and their levels are summarised in Table 1. Sixty four choice scenarios were blocked into groups of eight that were offered sequentially to ensure equal numbers of responses to each block.

Table 1: Choice experiment attributes (Base levels of variables are in bold)

Attribute	Description	Levels
Days	Time in the hunting area (days)	1,2,**3,5**,7
Hut	Hut in the hunting area	**No**, Yes
Access	Options available to access the hunting site	**Walk only**, Walk or 4WD, Walk or aircraft
Terrain	Difficulty of hunting terrain	Easy, **Moderate**, Difficult
Others	Other hunters in the area	No, **Possibly**, Yes
Density	Sika deer density	Low, **Moderate**, High
Trophy	Trophy Sika stag potential	Low, **Moderate**, High
Distance	Extra one way distance to the hunting site relative to the distance of a recent hunt (km)	**0**, 150, 250

Surveying occurred between 12th November and 10th December 2012, with 150 email invitations sent in two rounds to hunters who had indicated previously that they had hunted Sika deer. One hundred and fifty seven surveys were returned from the 300 invitations sent (56.3%). After removal of incomplete surveys and responses from people who had not hunted Sika deer in the previous year, 128 surveys were available for analysis. In total six individual choice scenarios were not answered, providing 1018 choices for analysis from 1024 opportunities.

Results

Two, three and four class latent class models were fitted. Goodness of fit statistics for each of these models are reported in Table 2.

Table 2: Latent class model fit statistics (the best fit on each criterion is shaded)

	2 Classes	**3 Classes**	**4 Classes**
Adjusted Rho^2	.190	.215	.228
AIC	2.197	2.150	2.137
AIC3	2.226	2.194	2.196
CAIC	2.371	2.412	2.486
BIC	2.342	2.368	2.428
aBIC	2.248	2.227	2.240
Entropy	.984	.817	.877
Log likelihood	-1088.152	-1049.337	-1027.836
Class probabilities	.87, .13	.48, .38, .13	.55, .20, .12, .13
Estimated parameters	29	44	59

Higher scores are preferred for Adjusted Rho^2 and Entropy. Lower scores are preferred for AIC, AIC3, CAIC, BIC and aBIC.

Typical of latent class analysis, there is no clearly optimal number of classes. The four class model is best on AIC, adjusted Rho^2 and entropy criteria, whereas the three class model is

best on the AIC3 and aBIC criteria. CAIC and BIC favour the two class model. The three class model beats the two class model on four of seven criteria and beats the four class model on four criteria. The four class model beats the two class model on four criteria. All models have about 13% of hunters in their smallest class. The high entropy scores of all models indicate very good ability to classify individuals into classes. The two class model improves on the three class model on CAIC and BIC scores, and has higher entropy. The four class model appears to offer little if any statistical improvement over the three class model. The four class model is dominated by the three class model on the three strictest criteria (CAIC, BIC, aBIC), whilst AIC has little discriminatory power (Nyland et al., 2007). In the interests of parsimony, the three class model is preferred to the four class model. The three class model is retained for further analysis.

Some choice experiment attributes were not significant for any class. These were: the presence of a hut at the hunting site, difficulty of the terrain, and availability of helicopter or 4WD access. The number of days on site was modelled as a series of dummy variables, with a three day hunt as the base. Alternatives were one, two, five and seven day hunts. The five day hunt coefficients were never significant, so were dropped, making the base for analysis three and five day hunts. The remaining choice experiment attributes (total distance to the site, one day hunt, two day hunt, seven day hunt, the presence of other hunters, Sika deer density, and trophy stag potential) were significant for at least one class in all models, irrespective of the number of classes in the model. The three class model is reported in Table 3.

Table 3: Three class latent class model

	Class 1	**Class 2**	**Class 3**
Total Distance	-0.00183***	-0.00298***	-0.02145***
ASC Hunt	3.16328***	4.39308***	2.12724***
1 Day hunt	-1.45361***	-1.03488***	-0.34081
2 Day hunt	-0.14108	-0.65578***	1.60845***
7 Day hunt	-0.37987**	0.46946*	-2.89828***
No other hunters	0.08352	0.42683**	0.50194
Definitely other hunters	-0.50788***	-0.93163***	-0.40558
Low numbers of Sika	-1.07874***	-0.47990**	-1.93035***
High numbers of Sika	0.39093***	0.52866**	0.36266
Low trophy potential	0.68126***	-1.73550***	-1.13030**
High trophy potential	0.01596	1.05529***	1.42944***
Meat motivation	0.83608	-3.54848***	3.29389***
Exit civilization motivation	1.54614	-3.91038***	-3.77872***
Not employed full time	-0.96995*	30.35950	2.09288***
Class probability	0.48349***	0.38376***	0.13275***

* for significance at 10% level, ** for 5%, *** for 1%

Personal characteristics affected utility within the classes. Primary motivation to harvest meat increased hunt utility for Class 2 hunters, but reduced it for Class 3. Primary motivation to exit civilization reduced hunt utility for members of Classes 2 and 3. Not being in full-time employment increased hunt utility for Class 3 hunters.

The influence on class membership of a number of person-specific characteristics was investigated through incorporation of class membership variables as endogenous parameters

in the latent class models. Characteristics tested were: main reason for hunting, age, hunting experience, occupation, income, educational qualifications, and employment status. None of these was significant.

Class membership differences were further evaluated through comparison of member attributes, after allocation of hunters to classes was made according to maximum class membership probabilities for each hunter (Table 4). Class allocation is probabilistic in the latent class model, so this process is somewhat limited. The 13.3 percent of hunters allocated to Class 3 in this manner are reasonably reliable. The maximum probabilities of Class 1 and Class 2-allocated hunters belonging to Class 3 are .008 and .058 respectively. Similarly, the probabilities of Class 3-allocated hunters belonging to Classes 1 and 2 are .032 and .064 respectively. Discrimination between Classes 1 and 2 is not nearly as powerful, with probabilities of membership of the other class very close to 0.5 for some hunters in both cases. In Table 4 Significance $_{XY}$ is the significance of differences between means or proportions x and y based on relevant Z tests. Personal attributes were collected in the earlier demographic survey, described in detail in Kerr and Abell (in press). Sika hunt attributes refer to a hunt in the previous year, randomly selected by the survey software after the hunter had stated how many Sika hunts they had been on in the previous year.

Table 4: Mean personal characteristics of class members

	Class 1	Class 2	Class 3	Significance $_{12}$	Significance $_{13}$	Significance $_{23}$
N	59	52	17			
Personal attributes						
Days hunting per year	32.6	39.6	27.6			**
Sika hunts per year	5.07	8.60	9.47	**	**	
Years of experience	21.6	29.0	26.1	***		
Importance of trophy♦	1.71	2.33	1.76	***		**
Importance of taking a shot at game♦	1.89	1.60	1.59	**	*	
Trophy Sika last year (N)	0.12	0.40	0.12	**		*
Sika killed last year	2.22	4.56	2.12			
Sika killed per trip	0.47	0.56	0.24			
Occupation Sales (%)	11.3	6.5	0.0		***	*
Occupation Other (%)	1.9	19.6	23.1	***	**	
Sika hunt attributes						
Distance one way (km)	225	234	119		***	***
Time one way (hours)	10.7	3.9	1.7		*	***
Transport cost ($)	216	260	72		***	***
Day hunt (%)	16.9	17.3	52.9		***	***
Days in area	3.41	4.12	2.18		**	***
Access by helicopter (%)	32.2	32.7	11.8		**	**
Not K&K Ranges♣ (%)	3.4	13.5	29.4	*	**	
Sika deer density⚬	2.54	2.83	2.88	**	***	
Chance of a trophy Sika⚬	2.05	2.40	2.35	**		

* for significance at 10% level, ** for 5%, *** for 1%

♦ 1= not important, 2= somewhat important, 3= very important, 4 = extremely important

♣ Hunt was not in the Kaimanawa or Kaweka ranges

⚬ 1=nil, 2=low, 3=moderate, 4=high

There were few differences between hunt attributes for the members of classes 1 and 2. Hunters from these classes travelled similar distances and spent similar amounts on transport. They spent a similar number of days in the area, and used helicopters as frequently. Class 1 hunters were less likely to hunt outside the Kaimanawa and Kaweka Ranges, and rated Sika deer density and trophy potential in their chosen hunting locations lower than did Class 2 hunters. However, there were some highly significant differences in personal attributes. Class 1 hunters undertook fewer Sika deer hunts, had less big game hunting experience, were less likely to be in "other" occupations, placed more importance on getting a shot at game and less importance on trophy, and shot fewer trophy Sika deer the previous year.

The small group of Class 3 hunters had quite different Sika hunt attributes than the others. They travelled a short distance to hunt Sika deer, taking less time and incurring lower costs. Their hunts were shorter than those of the other classes, most commonly (53%) entailing day hunts. Helicopter use was lower than for the other classes.

Class 3 hunters hunted fewer days per year than Class 2, but took more Sika hunts than did Class 1 hunters. None of the Class 3 hunters worked in "Sales". They placed similar importance on trophy and killed about the same number of trophy Sika in the previous year as did Class 1 hunters, both Classes 1 and 2 shot significantly fewer trophies than did Class 2 hunters. Class 3 hunters kill few Sika per trip, although the difference is not significant because of the small number of hunters in Class 3. This result is unsurprising given the high frequency of short duration hunts taken by Class 3 hunters.

Trophy had significantly more importance for Class 2 hunters, who also shot more trophy Sika deer than members of the other classes. Apparent differences in annual Sika deer kills are an artefact of one particularly avid and successful hunter in Class 2 who undertook 50 hunting trips, accounting for 98 Sika deer in the previous year. The mean for Class 2 when this hunter is excluded is 2.67 Sika deer kills per year, which is similar to the other classes.

The three classes might best be described as:

- Class 1: Generalist hunters
- Class 2: Trophy-oriented, very experienced, highly active hunters
- Class 3: Local, day/overnight hunters

Willingness to Pay

Non-market hunter benefits were derived from estimates of willingness to travel. With attributes at their base levels (3 or 5 day hunt, moderate Sika numbers, moderate trophy potential, possibly other hunters present) and the utility of the non-hunt alternative defined to be zero, the ratio of the ASC to the coefficient on the total distance attribute provides an estimate of consumer surplus in terms of gross willingness to travel. Net willingness to travel was derived by subtracting the actual distance travelled.

Medians of hunter-provided estimates of money cost per kilometre and time per kilometre, combined with a value of travel time were used to derive an estimate of the cost of travel of $0.826 per one-way kilometre. The cost of travel (C_T) was estimated from survey responses.

$$C_T = C_M + 2kC_W$$

Where C_M is the median transport cost per one-way kilometre per hunter, C_W is the median time (in hours) hunters took to travel one kilometre[1], and k is the mean of the values of travel time for drivers and passengers in non-commuting, non-work travel in 2012 ($8.47 per hour, NZTA 2013a and 2013b). Means of benefit estimates per day of hunting for the respective classes are reported in Table 5. Standard errors are Monte Carlo estimates from 10,000 draws. Significance of the consumer surplus estimates is identical to the corresponding entries for net willingness to travel. Hence, standard errors are not reported for the consumer surplus estimates, but may be derived by scaling net willingness to travel standard errors by 0.826. Mean consumer surplus estimates and 95% confidence intervals are displayed in Figure 1.

Table 5: Benefit estimates based on median actual distance [Standard errors]

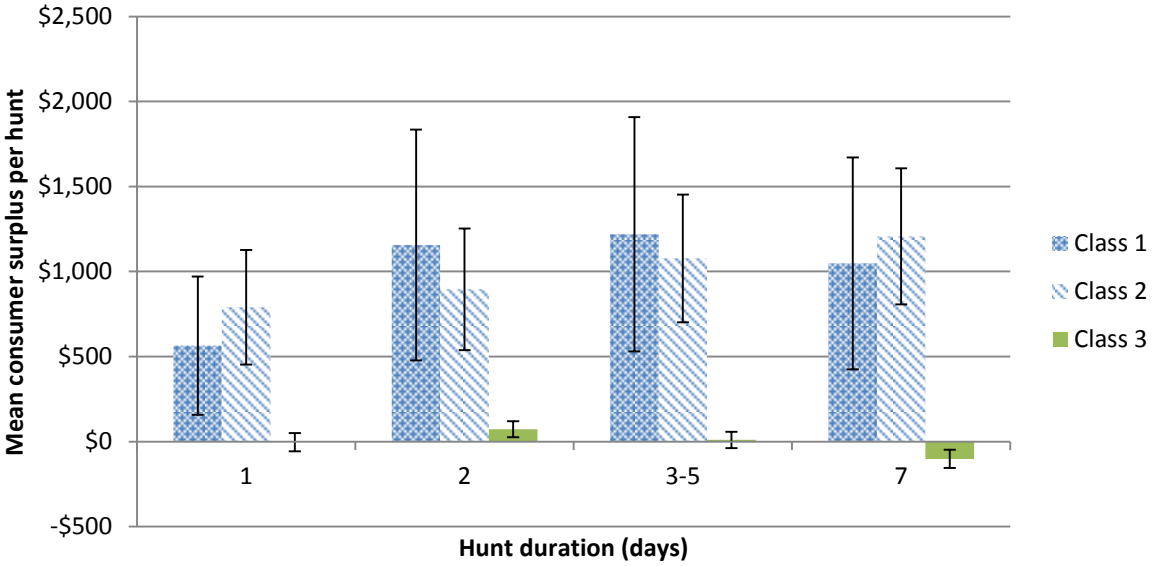
	Days	Class 1	Class 2	Class 3
Net Willingness to Travel (km one way)	1	683*** [251]	957*** [208]	-4 [33]
	2	1399*** [419]	1084*** [221]	87*** [29]
	3&5	1476*** [426]	1304*** [232]	12 [30]
	7	1269*** [385]	1461*** [247]	-123*** [33]
Consumer Surplus per Trip ($)	1	564	790	-3
	2	1156	895	72
	3&5	1219	1077	10
	7	1048	1207	-102
Consumer Surplus per Day ($)	1	564	790	-3
	2	578	448	36
	4	305	269	3
	7	150	172	-15

* for significance at 10% level, ** for 5%, *** for 1%

Consumer surplus for Class 3 is small and positive for two day hunts, is not significant for one day or three/five day hunts, and is significant and negative for seven day hunts. Class 3 hunters have a clear preference for shorter duration hunts. Classes 1 and 2, comprising 87% of hunters in our sample, place much higher value on Sika hunting, and longer duration hunts do not diminish the value of the experience. For these hunters, mean consumer surplus is large, positive and highly significant for hunts of all durations.

[1] C_M = $0.600 per one-way km, C_W = 0.0133 hours per km

Figure 1: Mean consumer surplus ($ per hunt): Bars are 95% confidence intervals for the mean.



The coefficients in Table 3 provide the basis for derivation of willingness to travel for changes in hunt attributes from their base levels, which may be converted to willingness to pay simply by multiplying by the value of travel ($0.826 per one-way km). The base scenario is a three or five day hunt in an area of moderate Sika density, with moderate trophy potential and the possibility of other hunters in the area. Willingness to travel estimates for alternative attribute levels relative to base levels, measured in kilometres of one-way travel, are reported in Table 6. Standard errors are Monte Carlo estimates from 10,000 draws.

The small group of Class 3 hunters is notably different from the others. As was apparent from the consumer surplus estimates, they have a significant aversion to seven day hunts. They are less averse to the definite presence of others in the hunting area. Class 3 hunters are less willing to travel further to access an area with high Sika deer numbers, but are more willing to travel further to avoid hunting areas with low numbers of Sika. Whilst Class 3 hunters would not travel as far to hunt in an area of low trophy potential, the importance of this attribute is notably less than for other hunters.

Table 6: Mean willingness to travel (one-way km) [standard errors]

	Class 1	**Class 2**	**Class 3**
1 Day hunt	-793.22***	-347.18***	-15.89
	[252.62]	[110.56]	[30.01]
2 Day hunt	-76.98	-220.00**	74.98***
	[96.87]	[89.36]	[25.11]
7 Day hunt	-207.29*	157.50*	-135.11***
	[112.97]	[86.34]	[32.91]
No others	45.57	143.19**	23.40
	[74.93]	[64.66]	[21.51]
Definitely others	-277.144**	-312.54***	-18.91
	[114.69]	[94.55]	[23.68]
Low numbers of Sika	-588.66***	-161.00**	-89.99***
	[184.36]	[69.47]	[25.00]
High numbers of Sika	213.33**	177.36**	16.91
	[91.29]	[76.66]	[21.71]
Low trophy potential	-371.76***	-582.23***	-52.69**
	[128.78]	[130.17]	[24.63]
High trophy potential	8.71	354.03***	66.64***
	[99.25]	[81.58]	[24.11]

* for significance at 10% level, ** for 5%, *** for 1%

When Class 1 and 2 hunters are compared it is apparent that Class 1 hunters value one day hunts less, but don't value seven day hunts more than hunts of intermediate lengths. Class 2 hunters place a premium on the absence of other hunters, whereas Class 1 hunters do not. Whilst Class 1 hunters appear more averse to low Sika numbers, the differences are not significant. Both classes place a similar premium on high Sika numbers. The potential for a trophy is of great importance to Class 2 hunters, with a substantial difference in willingness to travel to hunt in a high trophy potential area rather than in a low trophy potential area. Whilst Class 1 hunters are willing to travel further to hunt in a moderate trophy potential area rather than a low trophy potential area, they are not willing to travel further to improve trophy potential from moderate to high.

There are two areas in which all hunters have similar preferences. All classes of hunters have the value of their hunt diminished in an area of low trophy potential, although the effect is much smaller for Class 3 hunters. Similarly, all classes are averse to low numbers of Sika deer in their hunting area.

In summary, Class 2 hunters have a high preference for trophies, with lower importance on Sika deer numbers. They have some preference for seven day hunts and the strongest reactions to others in the area. Class 3 hunters appear to be a group at the margin. They gain low benefits from hunting, hunt fewer days per year than other hunters, travel short distances to hunt, at low cost, and have a preference short duration hunts. Class 1 hunters travel a long way to hunt. As a consequence, their strong aversion to single day hunts is understandable. Class 1 hunters are not as trophy-focused as Class 2 hunters, but are sensitive to Sika deer numbers, being willing to travel the greatest additional distances to hunt in areas with higher deer numbers.

Discussion

There have been three non-market valuation studies of recreational deer hunting in New Zealand (Sandrey and Simmons, 1984; Nugent and Henderson, 1990; Kerr, 1996), of which only Sandrey and Simmons valued Sika deer hunting. Using data collected in early 1982 by Groome et al. (1983a), Sandrey and Simmons used the travel costs method to estimate mean consumer surplus from hunting in the Kaimanawa and Kaweka Forest Parks to be $94 per hunt [SEM=$4][2]. A very similar result was obtained by Kerr (1996), who estimated consumer surplus from hunting in the Greenstone and Caples valleys at $107 per hunt [SEM=$10]. These results from the 1980s are much less than the aggregate mean consumer surplus for a 3 or 5 day hunt in the present study, which was in the order of $1,000 for the two most common classes. Even lower values were obtained by Nugent and Henderson (1990), who estimated consumer surplus from hunting in the Oxford Recreational Hunting area in 1986-1988 at $27 per hunt ($20 per day).

The difference between values estimated in the current study and by Sandrey and Simmons (1984) is not explained by duration of the hunt. In the current study the mean length of hunt was 3.53 days (SEM=0.21), whereas the average 1982 hunt in the Kaimanawa and Kaweka Forest Parks lasted a remarkably similar 3.4 days (Groome et al., 1983b). However, success rates have changed markedly. Groome et al. (1983a, p.167) note "Figures from hunters in the Central North Island show … [f]or deer hunters only three out of four report that they have been successful in killing one animal in the past two years. Significant numbers have not killed, and some have not even seen, their chosen game species in this time." In contrast, hunters in our study reported much more success. Seventy percent of our hunters had killed a Sika deer in the previous year, on average killing 0.477 Sika deer per hunt (SEM=0.045), amounting to 3.16 Sika deer per year (SE=0.78). The discrepancy with Nugent and Henderson (1990) can be explained by a combination of shorter duration hunts in their study (mean = 1.36 days), extremely low success rates (one deer killed per 14.5 days hunted), and better availability of substitutes for the relatively small Oxford Recreational Hunting area.

Consumer surplus in the current study of more than $150 per day, and in the order of $1,000 per hunt, indicates that Class 1 and Class 2 hunters value their Sika deer hunting very highly, and are willing to travel large distances and/or pay substantially above their present costs to hunt Sika[3]. This value is high in comparison with other recreational activities. Yao & Kaval (2011) evaluated 88 New Zealand recreation studies with mean consumer surplus of $65 per day [SEM=$12]. Estimates of the mean value of angling on premier New Zealand fishing waters (all in 2012 values) are; Tongariro River $44 per day (McBeth, 1997), Caples/Greenstone Rivers $95 per trip (Kerr, 1996), and Rangitata River $63 per trip (Kerr and Greer, 2004). All of these value estimates are considerably less than the value of Sika deer hunting estimated here. Our results support the contention that Sika deer hunting is a high value recreational activity, which underpinned calls for changes in the way that game hunting is managed and have culminated in passage of the Game Animal Council Act 2013.

Special Interest status under the Game Animal Council Act may aid retention of existing hunting opportunities, or it may serve to enable management to enhance the value of hunting. Establishment of herds of special interest will require justification of "specialness". That

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[2] All money values are expressed in Quarter 4 2012 NZ$, adjusted using the all sectors Consumers' Price Index.
[3] Note that these estimates of value are distinct from transport costs incurred to hunt ($214 per hunt, SEM=$23), or overall expenditures on hunting. See Kerr and Abell (in press) for expenditure information.

could occur for any species in a specific location by providing evidence of any of at least three matters:

1. The value of individual hunting experiences is high relative to other game hunting experiences,
2. The aggregate value of hunting is high relative to alternative uses of the resource,
3. Enhanced management could significantly increase the value of hunting experiences.

A requirement similar to 1 occurs for Wild and Scenic River designation, for which the usefulness of non-market valuation evidence has been endorsed (Kerr and Greer 2004). In the absence of information on the value of other big game hunting opportunities the high values reported here do not of themselves provide sufficient evidence of "special interest", suggesting the need for further research. However, the relatively high values of Sika deer hunting suggest there is a *prima facie* case for investigation.

Measurement of total hunting effort is difficult because of the lack of monitoring and the essentially open access nature of hunting. Nugent (1992) estimated there were 5,983 (SE=1,076) Sika deer hunters in 1988. He did not estimate the number of Sika deer hunts they participated in, but estimated they spent 8.87 days per year (SE=1.34) hunting Sika deer. In 2011 the average hunter took 15.6 hunts per year (Kerr and Abell, in press), with eleven percent of those hunts targeting Sika deer (1.7 hunts per year). The same study found that 31.5% of hunters targeted Sika deer the previous year. Combining this information with estimates of the total big-game hunting population (30,000 to 50,000 hunters: Woods and Kerr, 2010), Suggests there is somewhere in the range of 50,000 to 110,000 Sika deer hunts annually. At an indicative value of $850 per hunt, aggregate consumer surplus is in the order of $42m to $93m per annum.

Gains from management can be estimated by assessing how the value of the hunting experience changes under alternative scenarios (see, for example, Bullock et al. (1998), who estimated the values for different groups of hunters of alternative hunting packages in Scotland). Table 7 reports the monetary value of changes in significant hunt attributes for each of the classes. These estimates are derived from Table 6 in the same manner as the monetary value estimates in Table 5 were derived (multiplication of one-way willingness to travel by $0.826).

Table 7: Mean willingness to pay per hunt for attributes significant at the 5% level

	Class 1	**Class 2**	**Class 3**
1 Day hunt	-$655	-$287	
2 Day hunt		-$182	$62
7 Day hunt			-$112
No others		$118	
Definitely others	-$229	-$258	
Low numbers of Sika	-$486	-$133	-$74
High numbers of Sika	$176	$146	
Low trophy potential	-$307	-$481	-$44
High trophy potential		$292	$55

Hunt duration has mixed effects. Increasing the duration of hunt from three/five to seven days does not add significant value to the hunting experience and for Class 3 hunters detracts from the experience. Allowing use of hunting areas for longer than five days will diminish the total benefits hunters in aggregate obtain from the area, all else being equal. Low numbers of Sika deer detract from the value of the experience for all classes of hunter, and high numbers of Sika enhance the experience for most hunters. This result is consistent with the findings of Bullock et al. (1998) in the Scottish Highlands. It is also consistent with concerns that management for recreational hunting has the potential to increase deer numbers with the possibility of subsequent environmental degradation. However, if more hunters hunt an area, even if they each do so for a shorter period, they may actually reduce animal numbers and thereby have a negative effect on the experience. The environmental effects of any change in Sika deer numbers would, of course, need to be considered. Further research on these trade-offs and their implications for management is indicated.

Trophy potential was important for Sika hunters, again consistent with Bullock et al. (1998). Increasing trophy potential from low to high increases the value of the hunt by over $700 for Class 2 hunters. Whilst these hunters prefer longer duration hunts, the $180 loss in benefits from restricting them to two days of hunting is more than offset by an increase in trophy potential, whether it is from low to moderate, moderate to high, or low to high. This suggests a possible management strategy to increase value by decreasing total hunting effort and managing that effort to enhance trophy potential.

The definite presence of other hunters in the area diminishes the value of the hunt substantially for all except Class 3 hunters. This appears to support a move from open access to sole occupancy hunting areas, or at least diminishing the chances of encountering others. However, that conclusion may not be valid when loss of spontaneity and the costs of securing access are considered. These matters have not been addressed in the current study.

In summary, this research has successfully identified three unique classes of Sika deer hunter. A small group of predominantly local hunters obtains low value from hunting and prefers one or two day hunts. The other hunters receive very large personal benefits from hunting, but seek somewhat different experiences. In particular, there is a significant group with a trophy focus and a preference for long duration hunts. Also of note is the non-significance of attributes that may have been considered important, notably the presence of hut accommodation and the possibility of motorised access to the hunting area. The expense of provision of huts and roads is not supported for the hunters in this study. However, they do not significantly detract from the hunting experience either, so provision for other reasons is not invalidated because of impacts on hunters, at least in the aggregate. The majority of Sika deer hunters obtain substantial benefits from hunting and their benefits are affected by attributes of the hunting experience. This situation is supportive of management of Sika deer as a recreational hunting resource, and provides some guidance as to how the resource may best be managed for the three different classes of hunter identified in the study.

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