Marginal Satisfaction of Recreational Hunters' Red Deer Harvests

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Game Animal Council Act 2013

- Deer were formerly “pests”
  - Open access resource
    - Competition to harvest
    - No incentives to invest in quantity or quality
      - Low deer numbers
      - Poor trophy prospects
      - ⇒ Low value of recreational hunting
- Deer are now “game” that can be managed as a hunting resource
    - What are the costs and benefits of management?
    - How can management “add value”?

Managing for Satisfaction

Would a bag limit increase aggregate hunter satisfaction?

- What makes a hunt satisfying?
  - Seeing game, killing game, social, scenery, etc.
- What role do motivations play?
  - Is motivation important *per se*?

Research question

- Is more better?
  - Gossen's Law implies equal marginal utilities for efficiency, does it apply?
  - Does marginal utility diminish significantly with harvest?

Photo: Geoff Kerr

Seeing & killing game: prior studies, different contexts

1980s *Wildlife Society Bulletin*

Decker, D. et al. (1980). Further insights into the multiple-satisfactions approach for hunter management. *Wildlife Society Bulletin* 8: 323-331.

McCullough, D.R. & Carmen, W.J. (1982). Management goals for deer hunter satisfaction. *Wildlife Society Bulletin* 10: 49-52.

Rollins, R. & Romano, L. (1989). Hunter satisfaction with the selective harvest system for moose management in Ontario. *Wildlife Society Bulletin* 17: 470-475.

Hammitt, W.E., et al. (1990). Determinants of multiple satisfaction for deer hunting. *Wildlife Society Bulletin* 18: 331-337.

2000s *Human Dimensions of Wildlife*

Gigliotti, L. (2000). A classification scheme to better understand satisfaction of Black Hills deer hunters: The role of harvest success. *Human Dimensions of Wildlife* 5: 32-51.

Heberlein, T.A. & Kuentzel, W.F. (2002). Too many hunters or not enough deer? Human and biological determinants of hunter satisfaction and quality. *Human Dimensions of Wildlife* 7: 229-250.

Frey, S.N., et al. (2003). Factors influencing pheasant hunter harvest and satisfaction. *Human Dimensions of Wildlife* 8: 277-286.

Fulton, D.C. & Manfredo, M.J. (2004). A panel design to assess the effects of regulatory induced reductions in opportunity on deer hunters' satisfaction. *Human Dimensions of Wildlife* 9: 35-55.

Data

- Tracked ~900 big game hunters for a year (June 2011/June 2012)
- Chose one hunt at random each month
- Measured specific hunt motivations, sightings, kills
- Measured satisfaction on a single item scale
  - Rate this hunt: (1) very unsatisfied to (5) very satisfied
  - A measure of overall satisfaction
- Already had information on demographics, motivations for hunting in general, relative importance of aspects of hunting, and hunting avidity
- Data on 2,917 red deer hunts by 698 different hunters

Data: 698 hunters

Variable	N	Mean	SD	Median
Age	697	39.74	13.05	40
Years of big game hunting experience	696	22.04	14.36	21
Days spent big game hunting per year	697	32.66	29.63	25
Big game hunts per year	696	16.97	21.53	12
Red deer killed per year	531	3.09	5.13	2
Male	698	97.9%		
Maori	698	8.3%		
North Island resident	698	50.1%		
NZ Deerstalkers' Association member	698	35.0%		
Primary motivation to hunt: Enjoy outdoors	698	50.0%		
Primary motivation to hunt: Meat	698	19.1%		
Primary motivation to hunt: See wild animals	698	7.2%		
Primary motivation to hunt: Excitement	698	6.6%		
Primary motivation to hunt: Get away from civilisation	698	6.2%		
Primary motivation to hunt: Trophy	698	5.6%		

Data: 2,917 hunts

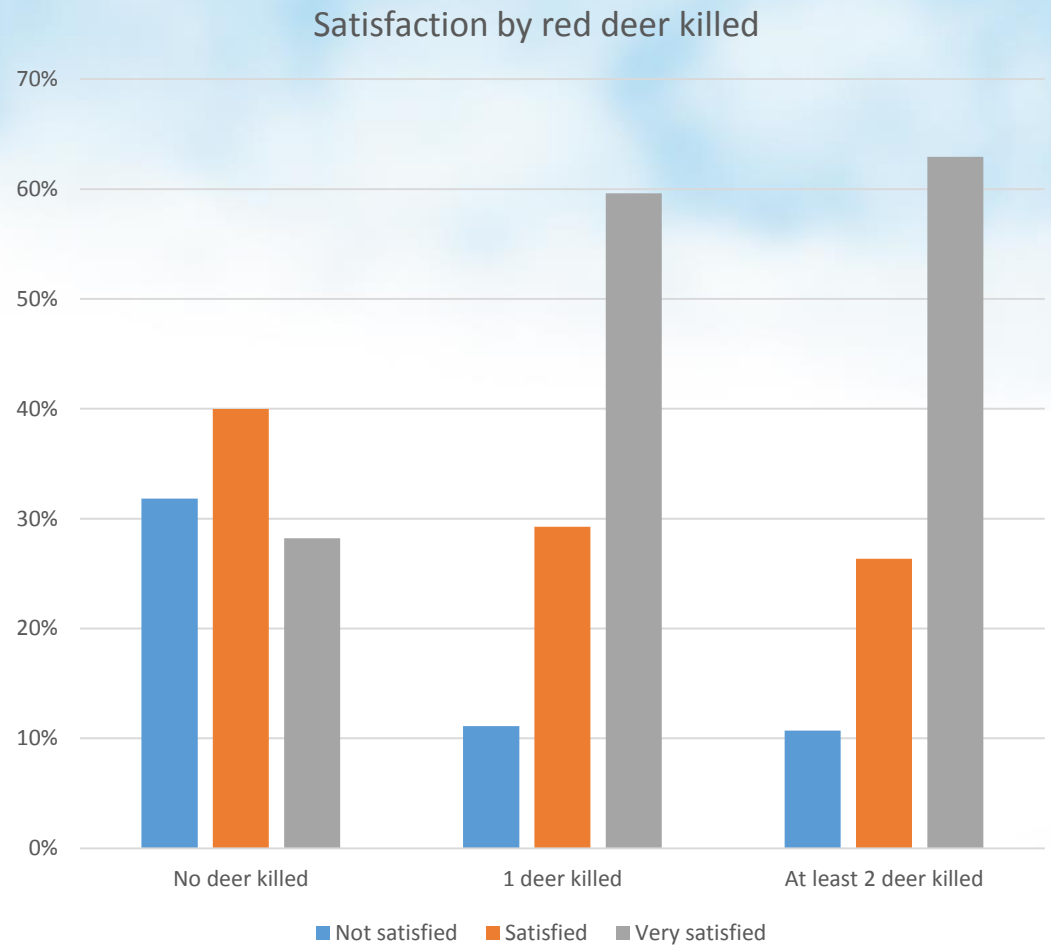
Variable	N	Mean	SD	Median
One way travel distance (km)	2910	136.95	184.01	80
One way travel time (hours)	2910	3.23	9.27	1.5
Cost of travel (NZ$)	2912	118.87	238.35	50
Days hunted	2909	2.16	2.00	1
Number of hunters in the party	2912	2.07	1.17	2
Number of red deer the individual killed	2763	0.44	0.88	0
Primary motivation for this hunt: Enjoy outdoors	2917	33.5%		
Primary motivation for this hunt: Meat	2917	29.4%		
Primary motivation for this hunt: Trophy	2917	10.9%		
Saw red deer	2917	64.0%		
Didn't kill a red deer	2763	68.2%		
Killed 1 red deer	2763	23.7%		
Killed 2 red deer	2763	6.0%		
Killed 3 or more red deer	2763	2.1%		
Didn't kill a red deer, but another party member did	2756	10.0%		

Killing deer affects satisfaction

$\chi^2 = 287.7, P << .0001$

- Very satisfied hunters are more likely to have killed a deer
- Not much difference if more than 1 kill

Photo: Geoff Kerr



Data analysis

Latent class ordered logit model

- Preference heterogeneity is endemic
- Latent class better than RPL
- Accounts for correlated responses in panel data and for multivariate correlations

Similar to Frey, S.N., et al. (2003). Factors influencing pheasant hunter harvest and satisfaction. *Human Dimensions of Wildlife* 8: 277-286.

Photo: Jamie Carle

Latent class ordered logit model

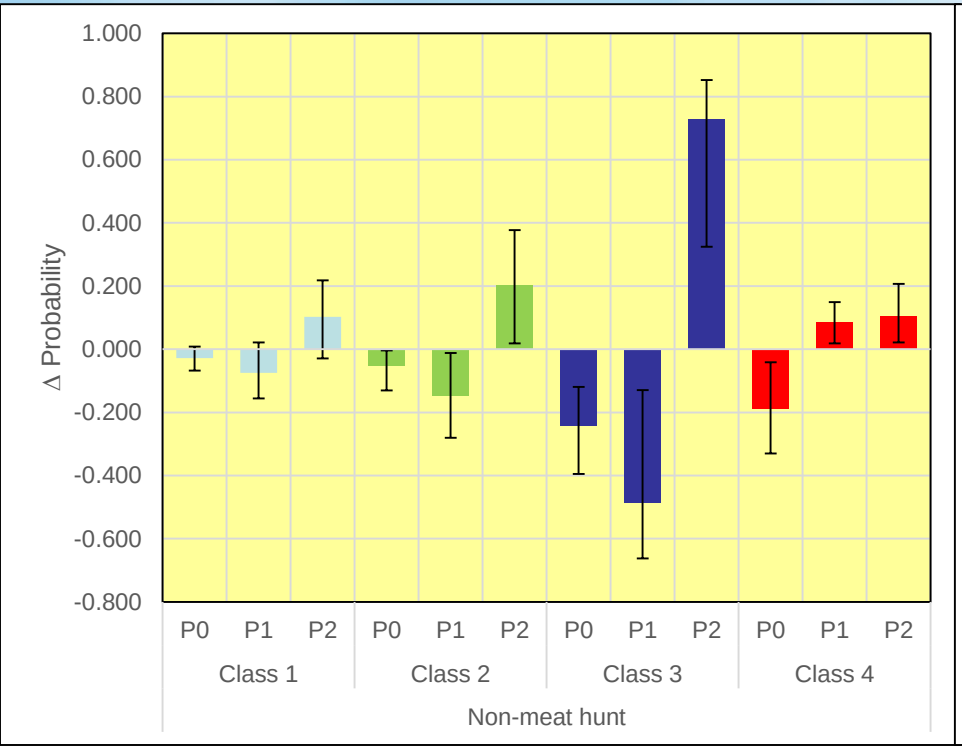
Parameter	**Class 1**	**Class 2**	Class 3	Class 4
Constant	1.49***	2.05***	-0.31	-1.38***
Category threshold	1.62***	3.38***	4.57***	1.66***
Saw a red deer	1.33***	0.22	1.43***	1.01***
Killed one red deer	0.71	0.91**	4.59***	0.77**
Killed two or more red deer	0.29	1.67***	-1.09	-0.11
Individual did not kill red deer, but party did	0.64	0.07	5.71***	0.62*
Meat hunt	-1.18***	-0.85**	-1.37**	-1.07**
Interaction: Meat hunt x killed a red deer	1.52***	-1.16**	0.38	1.97***
NZ Deerstalkers Association member	0.25	0.21	0.09	0.87***
Class probability	0.31***	0.23***	0.19***	0.26***
N hunts	2756			
N hunters	698			
LL (restricted)	-2984.141			
LL (model)	-2527.055			
BIC/N	1.946			
aBIC/N	1.901			
Adjusted Rho^2	0.140			

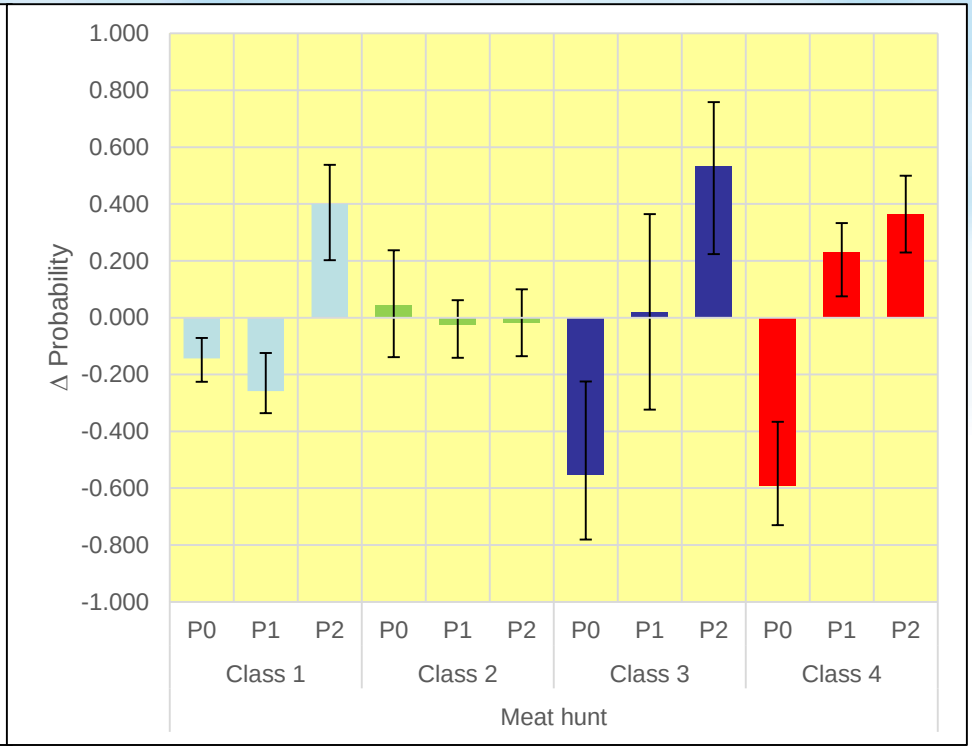
* $\alpha < .10$

** $\alpha < .05$

*** $\alpha < .01$

Marginal effects, first deer killed





Non-meat hunt: Significant positive effects for Classes 2, 3 and 4

Meat hunt: Significant positive effects for Classes 1, 3 and 4

P0 ≡ Probability not satisfied
P1 ≡ Probability satisfied
P2 ≡ Probability very satisfied

Are two kills better than one?

Photo: Geoff Kerr

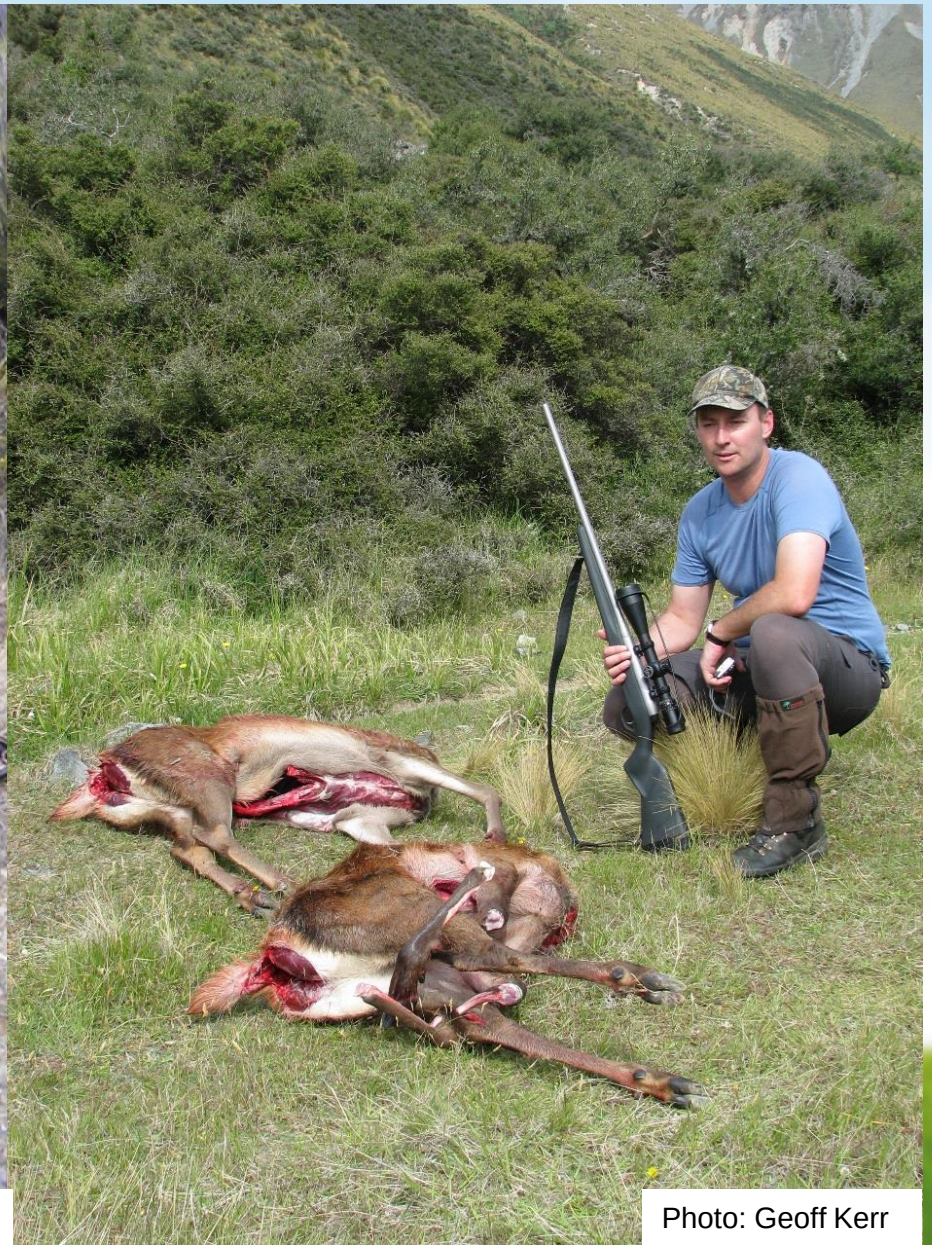
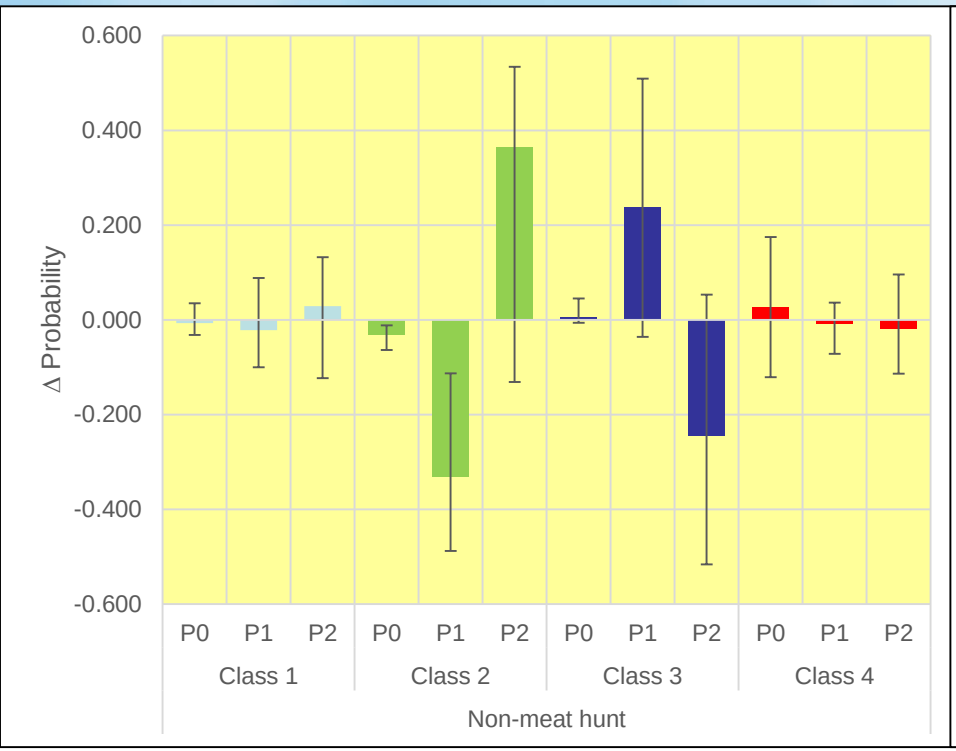


Photo: Geoff Kerr

Marginal effects, second deer killed



Non-meat hunt: Effects not significant

Meat hunt: Significant positive effects for Class 2 (positive) and Class 4(negative)

Why a second kill might be sub-optimal for a meat hunter!

Photo: Hendrik Venter

Marginal utility

10,000 Monte Carlo replications

	Class 1		Class 2		Class 3		Class 4	
	Non-meat hunt	Meat hunt	Non-meat hunt	Meat hunt	Non-meat hunt	Meat hunt	Non-meat hunt	Meat hunt
MU1	0.71	2.24***	0.91**	-0.26	4.59***	4.97***	0.77**	2.73***
MU2	0.29	0.29	1.67***	1.67***	-1.09	-1.09	-0.11	-0.11
MU1-MU2	0.42	1.95*	-0.77	-1.94*	5.68***	6.06**	0.87*	2.84***
Diminishing MU?		✓		X	✓	✓	✓	✓

MU1 ≡ Marginal utility from first kill
MU2 ≡ Marginal utility from second kill

* $\alpha = 0.10$; ** $\alpha = 0.05$; *** $\alpha = 0.01$

Class 2 hunters are little different to others

Mean (SEM)	Class 1	Class 2	Class 3	Class 4	F	Sig
Annual game hunts	18.43	16.96	17.18	15.13	0.748	.524
Annual days game hunting	34.70	31.89	32.85	30.92	0.583	.626
NZDA member	0.35	0.36	0.30	0.37	0.514	.673
Experience (years)	23.19	22.42	18.98	22.42	2.320	.074
Age (years)	40.92[3]	40.38[3]	36.53[1,2]	39.80	3.116	.026
Importance of killing game	1.78	1.96	1.94	1.83	2.437	.064
Importance of trophy	1.67	1.80	1.73	1.81	1.267	.285
Importance of harvesting meat	2.53	2.47	2.53	2.51	0.233	.873
Main reason to hunt is meat	0.20	0.19	0.17	0.19	0.145	.933
Main reason to hunt is trophy	0.05	0.08	0.03	0.07	1.257	.288
Annual red deer harvest	2.83	3.29	3.28	3.06	0.213	.888
Killed one deer this hunt	0.26[3]	0.24	0.19[1]	0.24	2.912	.033
Killed 2 or more deer this hunt	0.09	0.08	0.07	0.08	0.481	.695
This hunt was a meat hunt	0.32	0.29	0.27	0.29	1.253	.289
This hunt was a trophy hunt	0.09[2]	0.14[1,4]	0.11	0.09[2]	4.505	.004

Numbered superscripts identify group mean differences using Tukey HSD test at P ≤ .05

Allocation evaluation

- Comparison of coefficients across classes is not valid
  - Cardinality of satisfaction can not be invoked
  - Problem for optimisation across classes
- Assume: Deer kills are reallocated within each category of hunter (Class x Motive)
  - i.e. the 298 deer killed in 624 non-meat hunts by class 1 hunters are reallocated across those 624 hunts
  - This is a strong assumption, but it permits evaluation of a within group one deer bag limit
- Assuming reallocation within classes (ignore motive) would permit within class optimisation

One deer bag limit

Class 1 **Non-meat hunts** N = 624	**Hunts on which no deer are killed**	**Hunts on which 1 deer is killed**	**Hunts on which 2 or more deer are killed**	**Total**
Utility per hunt	0	0.712	1.000	
Observed hunts	430	143	51	298 Deer
Utility $_{observed}$	0	101.82	51.04	152.86
Hunts under one deer bag limit	326	298	0	298 Deer
Utility $_{bag\ limit}$	0	212.19	0	212.19
Δ Utility	0	110.37	-51.04	59.32
Z(Δ Utility = 0)				0.942
p(Z)				0.346

All utility estimates are relative, U(zero kills) = 0 by assumption.
Z from 10,000 Monte Carlo simulations

What about other classes?

- 10,000 Monte Carlo utility difference simulations
- Reported statistics are (1) sign of utility change and (2) p(Z) mean utility change = zero

	Class 1	Class 2	Class 3	Class 4
Non-meat hunt	+ p=.346	- p=.780	+ p=.008	+ p=.051
Meat hunt	+ p=.047	- p=.077	+ p=.010	+ p=.000

Management Implications

- Multiple kills are not a big issue:
  - Only 8% of hunts have multiple kills, 24% kill one deer, 68% don't kill a deer
  - But, in most cases the first kill is very valuable
  - Few would be harmed by a one deer bag limit (Maybe Class 2 meat hunters)
  - But Class 3 and 4 hunters would definitely benefit
- Meat hunts are different for everybody
  - Meat hunters "need to kill" to be as satisfied as non-meat hunters without a kill

Management Implications

- Efficient to reallocate second kills from Class 4 to Class 2
  - $MS2_{Class\ 4} < 0$, $MS2_{Class\ 2} = >0$
  - But why do Class 4 hunters kill the second deer?
  - Are hunters' *ex ante* and *ex post* perspectives different?
  - More research needed
- Efficient allocation requires differentiation of class membership and motivations
  - This is not possible by observing external characteristics

Conclusions

- A simple overall satisfaction question enabled identification of relative values of attributes of the hunting experience
- Diminishing marginal utility (Gossen's Law) may not apply to all hunters
- Hunter heterogeneity implies the need to manage some hunters differently
  - Since class membership is not observable, it is not clear how that could be done
- Overall, a one deer bag limit is likely to have efficiency benefits

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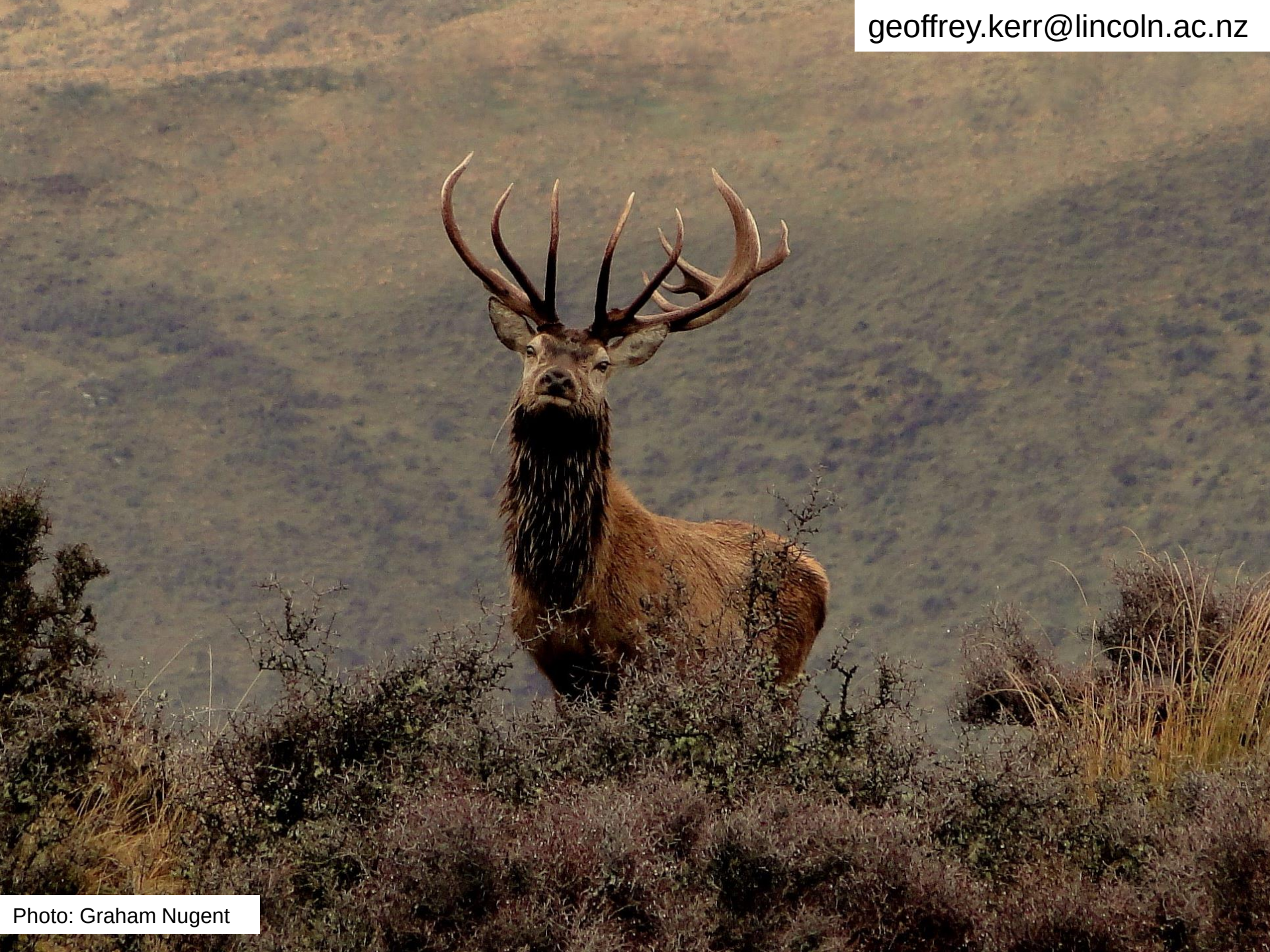

Photo: Graham Nugent