



Estimates of deer harvest in Victoria

Results from surveys of Victorian Game Licence holders in 2016

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Estimates of harvest for deer in Victoria: results from surveys of Victorian game Licence holders in 2016.

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Front cover photo: Hog Deer on Snake Island (GMA Image Library)

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Summary

From January to December 2016, telephone surveys of Victorian hunters were conducted to estimate the deer harvest. Game Licence holders endorsed to hunt deer were randomly sampled and interviewed by telephone at two-month intervals throughout the year. In all surveys, respondents were asked whether they had hunted or not during the period for which the survey applied and (if applicable) the number and species of deer harvested. Additional information was obtained on hunting methods and locations.

The 2016 deer hunting season had a higher than average harvest, compared with the previous survey years. The total harvest in 2016 (97,776, 95% confidence interval (CI) = 78,296–122,102) was considerably greater than the average since 2009 (55,681). The average number of deer harvested per Game Licence holder (3.1) was greater than the average since 2009 (2.2). This was due (in large part) to the increase in harvest efficiency. The average number of deer harvested per hunting day (0.47) was greater than the average since 2009 (0.33), while the effort (hunting days per Game Licence endorsed to hunt deer) was about average (6.6 in 2016, compared with the 6.9 average since 2009). Since 2009, the total reported number of deer harvested has increased each year by an average of around 14%. The most commonly harvested species was Sambar Deer (with an estimated total harvest of 80,875), followed by Fallow Deer (15,059).

An estimated 36,725 Sambar Deer were harvested by Game Licence holders endorsed to hunt deer with scent-trailing hounds. They accounted for 37.5% of the total deer harvest, but only 13.7% of total hunting days. For hunters using scent-trailing hounds in 2016, the efficiency was 1.29 deer per hunting day, compared with 0.34 deer per hunting day for stalking, which clearly indicates a greater efficiency for hunting using scent-trailing hounds. However, as this was based only on 22 respondents who used scent-trailing hounds, these results need to be interpreted with care.

The approach used here explicitly accounts for the possibility that not every holder of a Game Licence endorsed for deer will hunt during every survey period. The total number of Game Licence holders who hunted was estimated for each survey period and combined with the harvest per hunter to derive the total harvest for each survey period.

The methodology of performing telephone surveys throughout the year is likely to minimise memory bias and non-response bias, compared with the previous survey method of end-of-financial-year postal surveys. However, sources of bias will remain (due to over- and under-reporting), and the estimates of total harvest must be interpreted with care.

1. Introduction

To effectively manage game species, it is important to quantify the numbers harvested. Since 2009, the State Government and its game management agency has commissioned a series of regular telephone surveys of randomly selected Game Licence holders. Three sets of telephone surveys were conducted during the various game harvest seasons for deer, duck and quail, respectively. This report focuses only on the deer harvests.

Deer hunting occurs all year round in Victoria for some species (Game Management Authority 2017). The 2016 deer hunting reporting periods were defined by the calendar year. Sambar Deer (*Rusa unicolor*) can be hunted all year by stalking. Use of scent-trailing hounds is restricted to hunting Sambar Deer between 1 April and 30 November. There is no limit on the number of Sambar Deer that can be taken. Hog Deer (*Axis porcinus*) can only be hunted during April (excluding out of season ballot hunting) and is subject to additional restrictions, such as one male and one female per hunter. All other species can be hunted all year with no bag limit, including: Fallow Deer (*Dama dama*), Red Deer (*Cervus elaphus*), Chital Deer (*Axis axis*) and Rusa Deer (*Rusa timorensis*).

The survey methods employed here are the same as those used in the telephone surveys conducted during the 2009 to 2015 deer-hunting seasons (Gormley and Turnbull 2009, 2010, 2011; Moloney and Turnbull 2012, 2013, 2014, 2016).

2. Methods

All surveys were conducted by the telephone survey company Marketing Skill on behalf of the Game Management Authority. Estimates of total harvest by Game Licence holders were based on the reported hunting activities of the survey respondents.

A telephone survey was conducted every two months, involving 200 respondents from a random sample of Game Licence holders endorsed to hunt deer. Respondents were asked to report their hunting activities for that period, including the number and sex of each species harvested. The answers only covered the period (i.e. two months) of that survey. Therefore, although a respondent may have hunted during the periods covered by Surveys 2 and 3, if they were contacted as part of Survey 3, then information was only collected that pertained to the period covered by Survey 3. During each survey, 200 respondents were interviewed, regardless of whether they had hunted or not.

The information from the respondents was used to generate an estimate for the whole population of Game Licence holders for deer. Estimates of harvest were determined for each of the survey periods and were summed to give an estimate of the total season harvest. For each survey period, the proportion of respondents who hunted was used as an estimate of the proportion of Game Licence holders who hunted. The proportion of the Game Licence holders surveyed who had hunted during each survey period was multiplied by the total number of Game Licence holders for that period, yielding the estimated total number of hunters for that survey period.

For each survey period, the average harvest per hunter was estimated from the total reported harvest divided by the number of respondents who hunted. The total harvest for each survey period was estimated by multiplying the average harvest per hunter by the previously estimated total number of hunters for that survey period. Finally, the total season harvest was estimated from the sum of the survey-specific total harvests.

The annual harvest per Game Licence holder endorsed to hunt deer was also estimated. For each survey period, the average harvest per survey respondent was estimated by multiplying the average harvest per hunter by the proportion of respondents that hunted. The sum of these estimates across the year provided an estimate of the annual harvest per Game Licence holder endorsed to hunt deer.

Respondents who hunted were also asked to provide information on whether hunting was conducted on private land or public land, the name of the town nearest to where they hunted, what hunting methods they had used (i.e. stalking, scent-trailing hounds, or gun dogs), and the number of days they hunted during the survey period. Regional harvest estimates were calculated by summing the reported harvest for each town, then aggregating these for the corresponding Victorian Catchment Management Authority (CMA) region.

Any further mentions of Game Licence holders in this document are implicitly referencing Game Licence holders endorsed to hunt deer, even if it is not explicitly stated. Additional details of the methods, as well as examples of the calculations, are provided in Appendix 1. Information describing and interpreting boxplots is provided in Appendix 2.

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1. A *Respondent* refers to a Game Licence holder who was contacted and agreed to take part in the survey.
 2. A *Hunter* refers to a Game Licence holder who actually went out and hunted (successfully or unsuccessfully) at some point during the period with which the survey was concerned.

3. Results

Summary of responses for deer surveys in 2016

The number of Game Licence holders endorsed to hunt deer increased throughout 2016, from 25,752 in January to 34,822 at the end of the year (Table 1). To achieve the required sample size of respondents, slightly more than 200 licence holders were contacted each survey, with an average of 98% of those contacted being willing to take part.

Table 1

Deer Survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted*	Deer harvested**
1	Jan–Feb	25,752	200	38	165	51
2	Mar–Apr	29,824	200	73	357	233
3	May–Jun	31,609	200	53	229	91
4	Jul–Aug	32,648	200	47	213	81
5	Sep–Oct	34,131	200	54	248	113
6	Nov–Dec	34,822	200	33	114	55

* Days hunted indicates the combined number of days that hunting took place by respondents.

** Deer harvested indicates total number of deer harvested by respondents.

Proportion and corresponding total number of Game Licence holders who hunted in each survey period in 2016

The proportion of Game Licence holders who hunted in each survey period varied throughout the season: almost 11,000 (or 37% of) licence holders hunted in March–April; approximately 5,000 hunters (or less than 20% of) licence holders hunted in January–February and November–December (Table 2). The proportion who hunted during other survey periods was approximately 25% (Table 2).

Table 2

Period	Proportion	SE	95%CI		Total hunters	SE	95%CI	
			Lower	Upper			Lower	Upper
Jan–Feb	0.19	0.028	0.14	0.25	4,893	714	3,681	6,504
Mar–Apr	0.37	0.034	0.30	0.44	10,886	1,015	9,071	13,064
May–June	0.27	0.031	0.21	0.33	8,376	986	6,655	10,543
Jul–Aug	0.24	0.030	0.18	0.30	7,672	979	5,981	9,842
Sep–Oct	0.27	0.031	0.22	0.34	9,215	1,071	7,343	11,565
Nov–Dec	0.17	0.026	0.12	0.22	5,746	914	4,215	7,832

Average harvest of deer per hunter (Game Licence holders who hunted) for each survey period in 2016

Within each survey period, there was great variation in the reported harvest of deer per hunter (i.e. per Game Licence holder who hunted). Some hunters harvested more than 10 deer in a survey period, whereas at least one-quarter did not harvest any deer in all bar the November–December period (Figure 1). The median number of deer harvested per hunter in each two-month period was one deer. The average number of deer per hunter varied throughout the season (Table 3). The average harvest per hunter in 2016 ranged from a high of 3.19 deer in March–April to a low of 1.34 in January–February.

Table 3

Period	Average harvest per hunter who hunted*	SE	95%CI	
			Lower	Upper
Jan–Feb	1.34	0.41	0.75	2.40
Mar–Apr	3.19	0.64	2.17	4.70
May–June	1.72	0.40	1.10	2.68
Jul–Aug	1.72	0.38	1.12	2.65
Sep–Oct	2.09	0.51	1.31	3.35
Nov–Dec	1.67	0.40	1.04	2.66

* Average harvest per hunter = Deer harvested divided by respondents who hunted (Table 1).

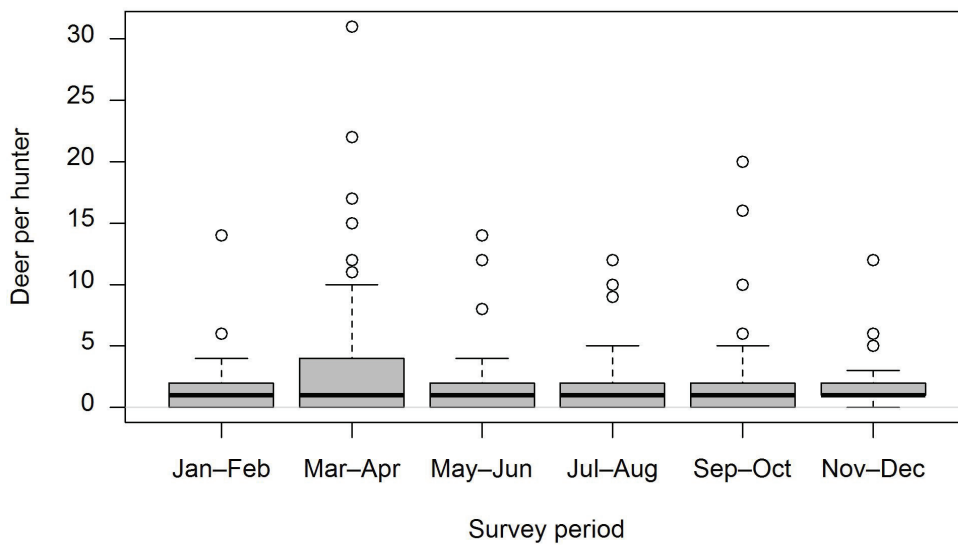


Figure 1: Boxplot of the number of deer reported harvested by individual hunters for each survey period in 2016. The bottom and top of each 'box' indicate the 25th and 75th percentiles, respectively, and the black horizontal line indicates the median reported value. For more details on how to interpret boxplots, see Appendix B.

Estimates of the total deer harvest in Victoria in 2016 by holders of a deer Game Licence

There was an estimated total of 97,776 deer harvested from January 2016 to December 2016, inclusive, by Game Licence holders endorsed to hunt deer (95% CI = 79,296–122,102; Table 4). Harvest was greatest in the autumn to mid-spring months and lowest in the summer months.

Table 4

Period	Total harvest*	SE	95%CI	
			Lower	Upper
Jan–Feb	6,567	2,209	3,457	12,475
Mar–Apr	34,745	7,658	22,673	53,245
May–June	14,382	3,719	8,734	23,681
Jul–Aug	13,222	3,389	8,065	21,679
Sep–Oct	19,284	5,208	11,465	32,437
Nov–Dec	9,576	2,771	5,493	16,693
Season total	97,776	11,119	78,296	122,102

* Total harvest = Harvest per hunter (Table 3) × Total hunters (Table 2). Numbers may differ slightly due to rounding of average harvest per hunter.

Estimated average harvest of deer per Game Licence holder in each survey period in 2016

The total average season harvest was 3.12 deer per Game Licence holder (95% CI = 2.49–3.90; Table 5). Note that, for each survey period, the average deer harvest per Game Licence holder (Table 5) was much lower than the average deer harvest per Game Licence holder who hunted (Table 3), because the former included those respondents who did not hunt during the survey period.

Table 5

Period	Average harvest per Game Licence holder*	SE	95%CI	
			Lower	Upper
Jan–Feb	0.26	0.09	0.13	0.48
Mar–Apr	1.17	0.26	0.76	1.79
May–June	0.46	0.12	0.28	0.75
Jul–Aug	0.41	0.10	0.25	0.66
Sep–Oct	0.57	0.15	0.34	0.95
Nov–Dec	0.28	0.08	0.16	0.48
Annual total	3.12	0.36	2.49	3.90

* Average harvest per Game Licence holder = Deer harvested divided by respondents (Table 1).

Estimated total harvest per deer species for each survey period in 2016

Separate harvest estimates for each deer species are presented in Figure 2 and Table 6a; 6b; 6c; and 6d. The most frequently harvested species was Sambar Deer, comprising 82% of the total reported harvest, followed by Fallow Deer (15%), Red Deer (2%) and Chital Deer (<1%). No Hog Deer or Rusa Deer was reported harvested in the 2016 telephone survey. Even though no survey respondent reported harvesting Hog Deer in 2016, a total of 138 Hog Deer (117 stags and 21 hinds) were recorded at checking stations, with an additional 43 Hog Deer (24 stags and 19 hinds) harvested on Sunday Island (which is managed by a private cooperative).

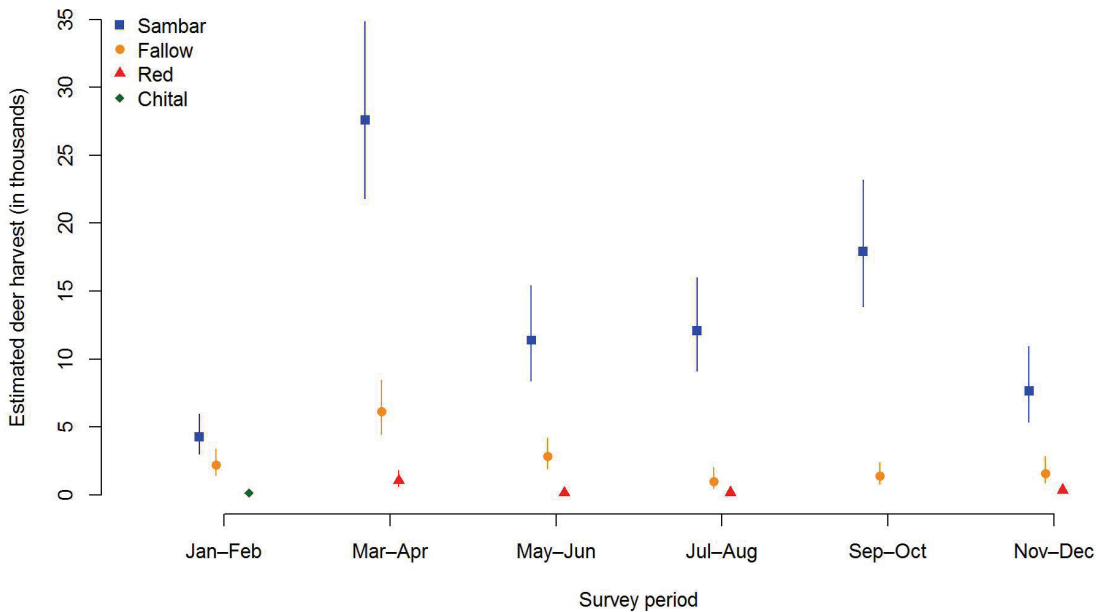


Figure 2: Estimated total deer harvest for each two-month survey period in 2016 by species. Vertical bars indicate 95% confidence intervals. Species were only included in surveys periods when they were reported.

Table 6a: Sambar Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	33	4,249	744	3,023	5,972
Mar–Apr	185	27,587	3,306	21,830	34,862
May–June	72	11,379	1,767	8,408	15,400
Jul–Aug	74	12,080	1,742	9,119	16,002
Sep–Oct	105	17,919	2,363	13,852	23,179
Nov–Dec	44	7,661	1,404	5,365	10,939
Annual total	513	80,875	5,020	71,619	91,326

Table 6b: Fallow Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	17	2,189	492	1,417	3,382
Mar–Apr	41	6,114	1,006	4,438	8,422
May–June	18	2,845	569	1,929	4,195
Jul–Aug	6	979	375	475	2,021
Sep–Oct	8	1,365	389	790	2,360
Nov–Dec	9	1,567	484	867	2,831
Annual total	99	15,059	1,450	12,475	18,179

Table 6c: Red Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	0	0	NA	NA	NA
Mar–Apr	7	1,044	298	603	1,806
May–June	1	158	96	53	473
Jul–Aug	1	163	97	55	480
Sep–Oct	0	0	NA	NA	NA
Nov–Dec	2	348	155	152	800
Annual total	11	1,713	362	1,137	2,581

Table 6d: Chital Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	1	129	75	45	369
Mar–Apr	0	0	NA	NA	NA
May–June	0	0	NA	NA	NA
Jul–Aug	0	0	NA	NA	NA
Sep–Oct	0	0	NA	NA	NA
Nov–Dec	0	0	NA	NA	NA
Annual total	1	129	75	45	369

Reported numbers and percentages of each sex of deer species harvested in 2016

There was a statistically significant sex bias favouring females for the harvest of Sambar Deer and Fallow Deer (Table 7). There was no statistically significant sex bias for the harvest of Red Deer or Chital Deer. Standard errors for the percentages are shown in parentheses.

Table 7

Species	Males			Females		
	<i>n</i>	%	SE	<i>n</i>	%	SE
Sambar Deer	232	45.3%	(2.2)	280	54.7%	(2.2)
Fallow Deer	36	36.7%	(4.9)	62	63.3%	(4.9)
Red Deer	6	54.5%	(15.0)	5	45.5%	(15.0)
Chital Deer	1	100%	NA	0	0%	NA

Number of days deer were hunted per Game Licence holder for 2016

The average number of days hunted in each survey period varied throughout the season, with most hunting occurring from autumn to spring. Each Game Licence holder endorsed to hunt deer hunted an average of 6.6 days during 2016, corresponding to a total of 207,614 hunter days (95% CI = 175,941–244,988; Table 8).

Table 8

Period	Days hunted	SE	95%CI	
			Lower	Upper
Jan–Feb	0.83	0.18	0.54	1.25
Mar–Apr	1.79	0.24	1.38	2.31
May–June	1.15	0.17	0.86	1.52
Jul–Aug	1.07	0.18	0.76	1.49
Sep–Oct	1.24	0.20	0.90	1.70
Nov–Dec	0.57	0.13	0.37	0.88
Total per licence holder	6.63	0.45	5.80	7.58
Total hunting days	207,614	17,565	175,941	244,988

Percentage of days of hunting and associated deer harvest by land tenure in 2016

More deer hunting occurred exclusively on public land (63.7%) compared with exclusively on private land (25.5%), with correspondingly similar proportions of deer harvested (Table 9). Most Sambar Deer were harvested on Public land (71.5%), while Fallow Deer harvest was predominantly on private land only (62.6%).

Table 9

Land tenure	Days	Total Deer harvest	Sambar Deer harvest	Fallow Deer harvest	Red Deer harvest	Chital Deer harvest
Private land only	25.5%	23.2%	15%	62.6%	54.5%	0%
Public land only	63.7%	65.5%	71.5%	37.4%	36.4%	100%
Both	10.9%	11.2%	13.5%	0%	9.1%	0%

Estimated total deer harvest in 2016 by Catchment Management Authority Regions

Total harvest was estimated to be greatest in the Goulburn Broken CMA, followed by the North East CMA (Figure 3). The top five towns for the total reported number of deer harvested were (in descending order) Myrtleford, Mansfield, Dargo, Jamieson and Licola. The top five towns for the total number of reported deer hunting days were (in descending order) Dargo, Mansfield, Licola, Jamieson and Myrtleford.

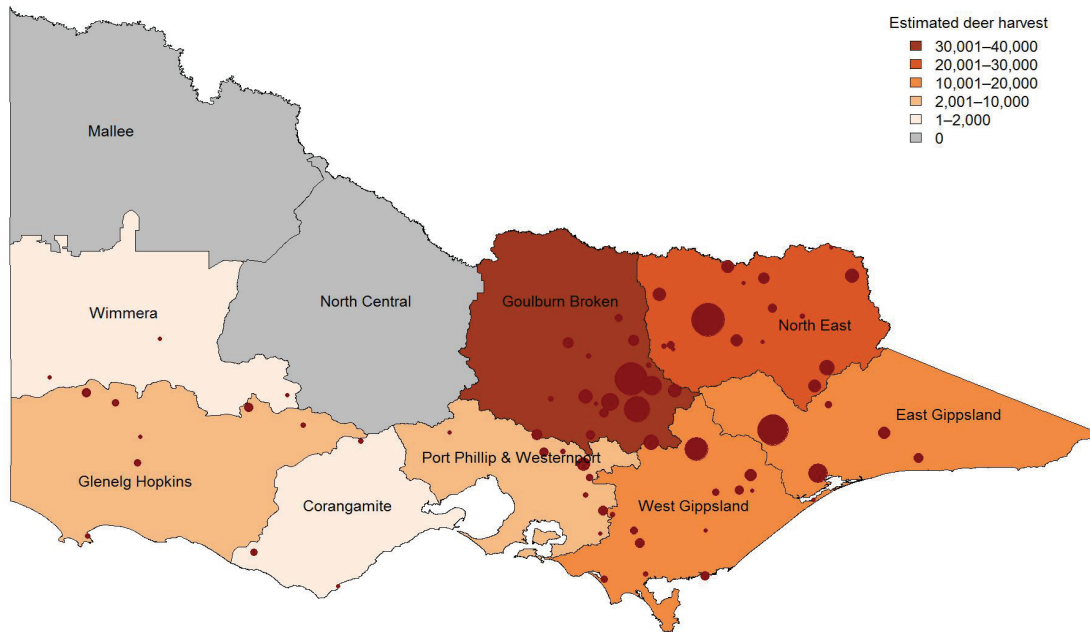


Figure 3: Red circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest.

Summary of responses for deer surveys in 2016 from respondents who hunted using scent-trailing hounds

The number of Game Licence holders endorsed to hunt deer using scent-trailing hounds increased slightly throughout 2016, from 4,240 in April to 4,672 in November (Table 10). As we do not know how many Game Licence holders endorsed to hunt deer using scent-trailing hounds were surveyed, we cannot determine the proportion of those who hunted, or their overall deer harvest with confidence intervals. All future surveys will collect this information. Hunting using scent-trailing hounds is conducted by a team of up to 10 hunters, so some of the responses may reflect the team harvest and not just the individual who was surveyed. We have assumed that the respondent was talking about the number they personally harvested. Future surveys will verify this. Additionally, with so few respondents who hunted using scent-trailing hounds (only 22), the results should be interpreted with care.

Table 10

Deer Survey	Period	Licence holders	Respondents	Days hunted	Deer harvested
1	*				
2	Apr	4,240	8	64	131
3	May–Jun	4,412	2	18	16
4	Jul–Aug	4,518	5	34	25
5	Sep–Oct	4,629	7	66	62
6	Nov	4,672	0	0	0

* No hunting with scent-trailing hounds in this survey period. Hound hunting is only permitted between April and November each year.

Average harvest of deer per hunter using scent-trailing hounds (Game Licence holders who hunted using scent-trailing hounds) for each survey period in 2016

Within each survey period, there was large variation in the reported harvest of deer per hunter who used scent-trailing hounds [i.e. per Game Licence holder (who was endorsed to hunt deer using scent-trailing hounds) who hunted with hounds]. Some of these hunters harvested more than 15 deer in a survey period. None of them reported using scent-trailing hounds in November, even though the permitted hound hunting season didn't close until 30 November. In April, the smallest number of Sambar Deer reported as harvested using scent-trailing hounds was 10. The average number of deer per hunter varied throughout the season (Table 11). The average harvest per hunter using scent-trailing hounds in 2016 ranged from a high of 16.4 deer in April to a low of zero in November.

Table 11

Period	Average harvest per hunter	SE	95%CI	
			Lower	Upper
Apr	16.38	2.55	12.09	22.19
May–June	8.00	4.00	3.17	20.19
Jul–Aug	5.00	2.34	2.09	11.95
Sep–Oct	8.86	2.59	5.06	15.51
Nov	0.00	NA	NA	NA

Number of days deer were hunted per Game Licence holder using scent-trailing hounds for 2016

The number of days in each survey period on which hunting with scent-trailing hounds occurred varied throughout the season, with most hunting occurring in April (8.00 per month), compared with approximately 4.5 hunting days per month in May–June and September–October, while no hunting was reported in November (Table 12).

Table 12

Period	Days hunted	SE	95%CI	
			Lower	Upper
Apr	8.00	1.10	6.12	10.46
May–June	9.00	3.00	4.76	17.00
Jul–Aug	6.80	3.32	2.75	16.84
Sep–Oct	9.43	2.14	6.08	14.62
Nov	0.00	NA	NA	NA

Reported numbers of each sex of Sambar Deer harvested using scent-trailing hounds in 2016

There were 107 stags and 127 hinds harvested using scent-trailing hounds. There was no statistically significant sex bias for the harvest of Sambar Deer using scent-trailing hounds.

Percentage of days of hunting using scent-trailing hounds and associated deer harvest by land tenure in 2016

The overwhelming majority of deer hunting using scent-trailing hounds occurred exclusively on public land (82.4%), with the rest occurring on both private and public land. An even larger proportion of deer harvested using scent-trailing hounds occurred exclusively on public land (91.5%, Table 13).

Table 13

Land tenure	Days	Deer harvest
Private land only	0%	0%
Public land only	82.4%	91.5%
Both	17.6%	8.5%
Total	100%	100%

Percentage of days hunted and associated deer harvest by hunting method/land tenure in 2016

The proportion of hunting days and deer harvested varied between hunting method and land tenure. Stalking was the preferred hunting method, being used on 86.3% of the hunting days and accounting for 62.5% of the reported harvest. No stalking with a gundog was reported in the 2016 surveys. It is estimated that 45.6% (36,725) of the Sambar Deer harvest was from scent-trailing hounds.

Table 14

Land tenure	Private only		Public only		Both		Total	
	Days	Deer	Days	Deer	Days	Deer	Days	Deer
Scent-trailing hounds	0%	0%	11.3%	34.3%	2.4%	3.2%	13.7%	37.5%
Stalking	25.5%	23.2%	52.3%	31.3%	8.4%	8%	86.3%	62.5%
Stalking with gundog	0%	0%	0%	0%	0%	0%	0%	0%
Total	25.5%	23.2%	63.7%	65.5%	10.9%	11.2%	100%	100%

Location of reported Sambar Deer harvest using scent-trailing hounds in 2016.

The reported Sambar Deer harvest using scent-trailing hounds was greatest in the Goulburn Broken CMA, followed by the North East CMA (Figure 4). Only the most eastern CMAs had reports of hunters using scent-trailing hounds. The top five towns for the total reported number of deer harvested using scent-trailing hounds were (in descending order) Myrtleford, Mansfield, Dargo, Jamieson and Merrijig. It should be noted that Sambar Deer hunting with scent-trailing hounds is not permitted in the western half of the State, where few Sambar Deer are present.

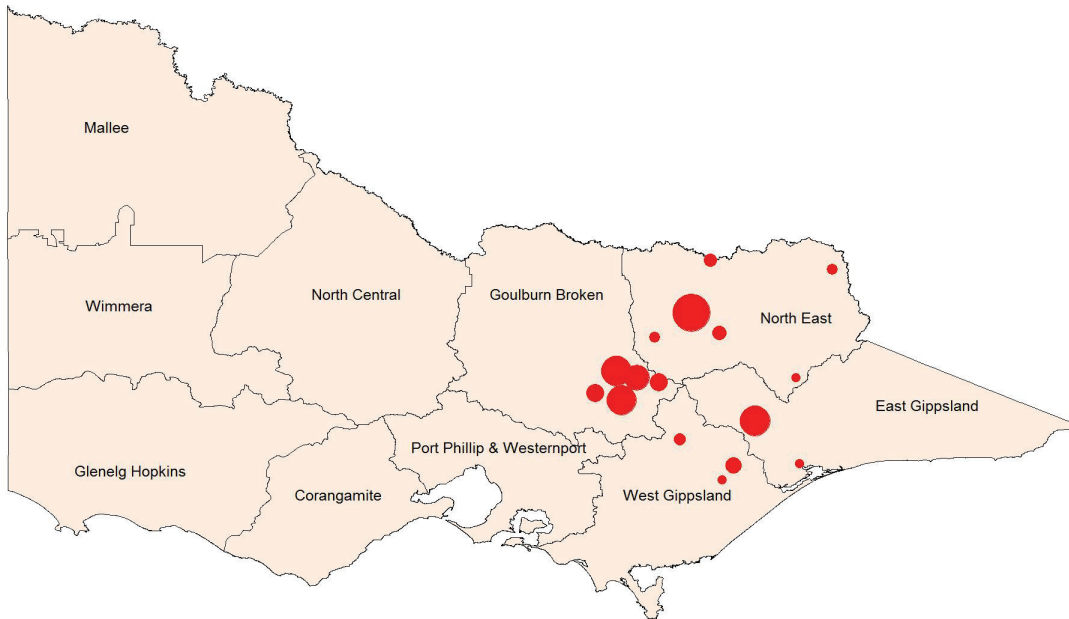


Figure 4: Red circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest using scent-trailing hounds.

4. Discussion

Deer harvests in 2016

A total of 97,776 deer were estimated to have been harvested in Victoria during the 2016 calendar year (95% CI = 78,296–122,102). The deer harvest was the largest on record (Table 15, Figure 5). The 2016 estimate was 75.6% larger than the average harvest, and 37% larger than the next highest estimated deer harvest (2015), using this survey method.

The most commonly harvested species in 2016 was Sambar Deer (80,875), followed by Fallow Deer (15,059) and Red Deer (1,713). Due to the very small harvest of Chital Deer reported harvested by surveyed Game Licence holders, it is difficult to make any inference about the harvest of that species. There are no known wild populations of Chital Deer in Victoria, and the one that was recorded may have been an escapee or misidentified. Even though no survey respondent reported harvesting Hog Deer in 2016, a total of 138 Hog Deer (117 stags and 21 hinds) were recorded at checking stations, with an additional 43 Hog Deer (24 stags and 19 hinds) harvested on Sunday Island (managed by a private cooperative).

The 2016 season had the largest number of hunting days, 24% larger than average. The average number of hunting days per Game Licence holder in 2016 is consistent with the 2009–2016 average and the two previous years. Unlike previous years, more hunting happened in Autumn than in any other period. Usually the number of hunting days is largest from mid-winter to mid-spring.

The average number of deer harvested per Game Licence holder in 2016 was 3.12, the largest recorded, 38% greater than average and 19% more than the next highest year (2012). The efficiency of hunters in 2016 was 0.47 deer harvested per hunting day. That was the highest efficiency on record, 41% greater than the average.

Table 15: Comparison of annual deer harvests from 2009 to 2016.

Year	Harvest by species						Overall			
	Chital Deer	Fallow Deer	Hog Deer	Red Deer	Sambar Deer	Total harvest	Total hunting days	Deer per licence holder	Hunting days per licence holder	Deer per hunting day
2009	0	4,871	81	682	32,453	38,284	150,321	2.14	8.38	0.25
2010	0	6,085	454	1,396	34,108	42,133	149,002	2.12	7.56	0.28
2011	0	4,001	105	737	25,913	30,753	135,278	1.43	6.30	0.23
2012	0	9,788	102	555	48,048	59,206	169,721	2.62	7.55	0.35
2013	0	6,426	0	926	36,355	43,985	135,854	1.76	5.48	0.32
2014	0	7,870	0	745	51,390	62,166	186,215	2.22	6.69	0.33
2015	0	14,488	138	939	55,094	71,141	201,547	2.36	6.77	0.35
2016	129	15,059	0	1,713	80,875	97,776	207,614	3.12	6.63	0.47
Average	16	8,574	110	962	45,530	55,681	166,944	2.27	6.84	0.33

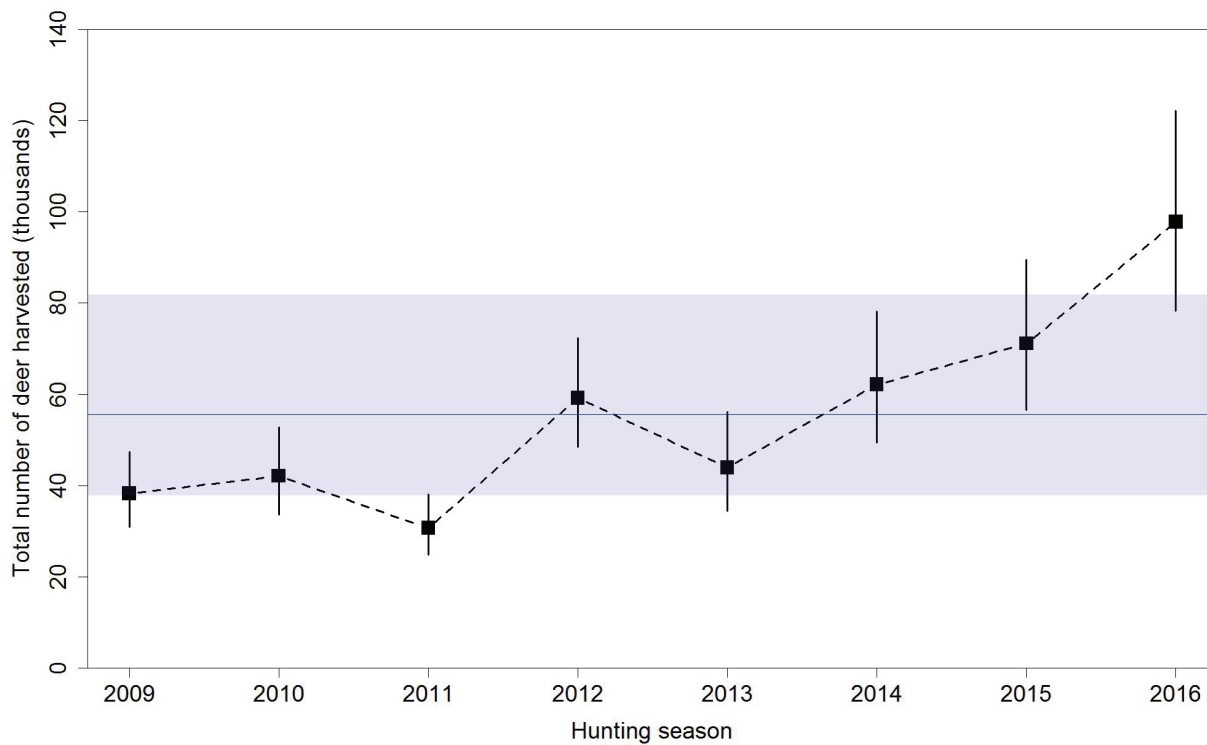


Figure 5: Estimated total annual deer harvests (in thousands) from 2009 to 2016.

The square is the estimate for each season; the solid line indicates the 95% confidence interval; the blue line is the average deer harvest from 2009 to 2016; the shaded area is the 95% confidence interval for the average deer harvest from 2009 to 2016.

From 2009 to 2016, the average increase in deer harvested was 14% per year. The increase in total number of hunting days was 6% per year. Thus, the increase in the quantity of deer harvested was larger than the increase in hunting days, which means that hunter efficiency has also been increasing (by 8% per year on average).

It is estimated that 36,725 (45.6%) of the Sambar Deer harvest were harvested using scent-trailing hounds. Game Licence holders endorsed to hunt deer using scent-trailing hounds are more efficient than those who stalk. However, it is possible that the deer harvests recorded by those using scent-trailing hounds were for the group rather than the individual, and therefore the figures may be inflated.

It should be noted that the number of hunting days is only an approximate estimate of total effort. For example, someone who hunted for two hours and someone else who hunted for 12 hours were both recorded as having hunted for one day.

Assumptions

The estimates of the harvest for each deer species were derived based on the assumption that the samples of respondents were representative of the entire population of Victorian Game Licence holders endorsed to hunt deer. This assumption may have been violated due to several factors, such as the reasons for non-response [exceeded bag limit, or (conversely) did not harvest anything], memory recall (respondents not remembering their harvest), and deliberate over- or under-reporting (reported numbers knowingly being reported incorrectly). Any bias due to non-response is likely to have been negligible, because the response rate for all surveys was above 95% (i.e. very high). Memory bias can inflate estimates of total harvest, in some cases by as much as 40% (Wright 1978; Barker 1991). It is likely, however, that the sampling strategy of telephone interviews after each 2-month period would have ensured that both memory bias and non-response bias were kept low (compared with postal surveys and complete end-of-season surveys) (Barker 1991; Barker et al. 1992). Nevertheless, some bias likely remains, and the estimates of total harvest should be interpreted with care.

It is important to note that the methodology explicitly accounts for the possibility that not every Game Licence holder hunts in every survey period (see Gormley and Turnbull 2010). Therefore, the estimate of total season bag per Game Licence holder is the sum of the 'harvest per Game Licence holder', not the sum of the 'harvest per active hunter'.

The uncertainty in the estimates of total harvest (as indicated by the confidence intervals) was due to two factors. First, there was variation in the reported numbers of animals harvested between respondents who had hunted (Figure 1 and Table 1). For example, within a given survey period, some respondents indicated that they hunted unsuccessfully, whereas others took multiple trips and indicated a total harvest of more than five deer during the same period. The second source of uncertainty was due to sampling hunters, rather than taking a complete census; however, the degree of sampling uncertainty was reduced by having sample sizes of 200 respondents per survey. Statistically, these sample sizes are considered adequate to provide reasonable estimates.

The spatial distributions of the deer harvest should also be interpreted with care. Grouping the harvest by CMA provides a broad-scale view of the distribution of the harvest. Grouping by smaller regions would provide a finer-scale representation, but this would be at the cost of increased bias in many regions. Because the data are from a sample of Game Licence holders rather than a complete census, it is likely that some areas that were actually hunted are shown as having a zero harvest if no respondents that hunted those areas were contacted. This would be increasingly likely at finer spatial scales. Furthermore, respondents were only asked to report the nearest town to where they hunted, not the actual location. It is, therefore, possible that the nearest town was in a different CMA than the hunting location.

The quantity of Sambar Deer harvested using scent-trailing hounds should also be interpreted with care. Grouping the harvest by hunting method provides an insight into the amount and efficiency of hunting being done with scent-trailing hounds versus stalking. However, the number of Game Licence holders endorsed to hunt Sambar Deer with scent-trailing hounds that either didn't hunt in each survey period, or hunted without scent-trailing hounds, was not recorded. That information is required for more reliable estimates of Sambar Deer harvest, including confidence intervals and secondary statistics, like total days spent hunting with scent-trailing hounds. This data will be collected for future reports. Because the data are from a sample of Game Licence holders rather than a complete census, it is likely that some areas where scent-trailing hounds were used are shown as having a zero harvest if no respondents that hunted those areas were contacted. If more detail about the hunting methods is desired, it may be that separate surveys should be conducted for Licence Holders endorsed to hunt deer and those that can also use scent-trailing hounds. The numbers reported for scent-trailing hounds assume that the reported harvest was for the individual and not the group. If this assumption is incorrect, this would result in over estimates of harvest. Additionally, the results were based on only 22 respondents, much fewer than would be desirable.

Note: In 2017, the methodology used to survey hunters endorsed to hunt deer will collect information from all respondents on their main method of hunting and the main deer species they hunt. This will provide more accurate information on species harvest and hunting methods applied. In 2018, the methodology will change and separate surveys will be conducted for hunters endorsed to hunt deer by stalking only and for hunters endorsed to hunt deer with the aid of scent-trailing hounds. This will provide more accurate information on harvest levels and hunting methods applied.

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Appendix 1

Common definitions used

SD = standard deviation of the data; it represents the variation in the numbers reported.

SE = standard error of the mean; it represents the variation in the estimated mean.

CV = coefficient of variation; it is calculated as: $CV = SE \div \text{mean}$. This provides an indication as to how much uncertainty is in the estimate relative to the mean.

Calculations

For each survey j , we surveyed n_j respondents, of which h_j had hunted. The proportion of respondents who hunted in each period j is given by:

$$p_j = \frac{h_j}{n_j} \quad \text{e.g. for Deer Survey 4 in 2015, we obtained: } \frac{70}{200} = 0.350$$

The total number of hunters for each survey period (H_j) was estimated by multiplying the total number of licence holders (L) by the proportion of respondents who reported having hunted during that survey period (p_j), as found previously:

$$H_j = p_j L \quad \text{e.g. for Deer Survey 4 in 2015, we obtained: } 0.35 \times 30,908 = 10,818$$

The estimated average harvest per hunter (w_j) is the total reported harvest for survey j (y_j) divided by the total number of respondents who hunted (h_j):

$$w_j = \frac{y_j}{h_j} \quad \text{e.g. for Deer Survey 4 in 2015, we obtained: } \frac{215}{70} = 3.07$$

The total harvest for each survey period (W_j) was estimated by multiplying the average harvest per hunter (w_j) by the total number of hunters (H_j):

$$W_j = w_j H_j \quad \text{e.g. for Deer Survey 4 in 2015, we obtained: } 3.07 \times 10,808 = 33,226$$

The estimate of the total harvest was calculated as the sum of the estimated harvest for each survey period:

$$W_{TOT} = W_1 + W_2 + W_3 + W_4 + W_5 + W_6$$

Standard errors (SEs) for the proportion of respondents who hunted are given by:

$$SE(p_j) = \sqrt{\frac{p_j(1-p_j)}{n_j}} \quad \text{e.g. for Deer Survey 4 in 2015, we obtained: } \sqrt{\frac{0.35 \times 0.65}{200}} = 0.034$$

Standard errors for the average harvest per hunter are given by:

$$SE(w_j) = \frac{SD(w_j)}{\sqrt{n_j}}, \text{ e.g. for Deer Survey 4 in 2015, we obtained: } \frac{4.55}{\sqrt{70}} = 0.54$$

The standard error for the total estimated harvest per survey period (W_j) was found by determining the coefficient of variation (CV) for each p_j and w_j and then calculating the square root of the sum of their squares to find the combined CV (assuming independence).

$$CV(w_j) = \frac{SE(w_j)}{w_j}, \text{ and } CV(p_j) = \frac{SE(p_j)}{p_j}$$

$$CV(W_j) = \sqrt{(CV(w_j))^2 + (CV(p_j))^2}$$

$$SE(W_j) = CV(W_j) \times W_j$$

The standard error of the total harvest was calculated by:

$$SE(W_{TOT}) = \sqrt{(SE(W_1))^2 + (SE(W_2))^2 + \dots + (SE(W_6))^2}$$

Confidence intervals were computed on the natural logarithm scale and back-transformed to ensure that lower limits were ≥ 0 . A consequence is that the confidence intervals were asymmetric and cannot be reported as the estimate plus or minus a fixed value. In general, for some estimates denoted as \hat{X} , 95% confidence interval limits were calculated using:

$$\text{upper limit} = \hat{X} \times r$$

$$\text{lower limit} = \hat{X} \div r, \quad \text{where:}$$

$$r = \exp\left(1.96 \sqrt{\ln(1 + CV^2)}\right),$$

e.g. for the total deer harvest in 2015 we have

$$CV = \frac{8,349}{71,142} = 0.117$$

$$r = \exp\left(1.96 \sqrt{\ln(1 + 0.117^2)}\right) = 1.26$$

Therefore, Upper and Lower Confidence Intervals are given by:

$$UL = 71,142 \times 1.26 = 89,471$$

$$LL = 71,142 \div 1.26 = 56,567.$$

Appendix 2

Explanation of what goes into a boxplot

A boxplot is a way of displaying key points of the data and is especially good for comparing groups of data. It is sometimes referred to as a box-and-whisker plot. A boxplot shows the following key points:

- outliers, signified by hollow circles
- minimum, signified by the horizontal line below the box (smallest value, excluding outliers)
- lower quartile (Q1), signified by the horizontal line at the bottom of the box (25% of the data is at this point or below)
- median, signified by the thick horizontal line in the box (50% of the data is at this point or below)
- upper quartile (Q3), signified by the horizontal line at the top of the box (75% of the data is at this point or below)
- maximum, signified by the horizontal line above the box (largest value, excluding outliers)
- interquartile range (IQR; difference between the upper and lower quartiles)
- whiskers—the lines that go from the minimum or maximum to the box.

Outliers are values that are very large (or small) compared with the rest of the data. Formally, an outlier is any point that is either below $Q1 - 1.5 \times IQR$ or above $Q3 + 1.5 \times IQR$, which means that any point that lies more than one-and-a-half times the length of the box outside the box is an outlier.

The boxplot indicates the spread of the data. The data is broken into quarters: approximately 25% of the data are in the range indicated each whisker and between the edge of the box and the median line. Approximately half the data are contained within the box. Any unusual data are highlighted as outliers. As an example, Figure A2.1 shows a boxplot indicating that most hunters harvested between five and 13 ducks, and a quarter harvested more than about 27 ducks, including one who harvested over 50 ducks. Sometimes there are no whiskers because the minimum (or maximum) is the same as the lower (or upper) quartile (see Figure 1, which indicates that at least 25% of Licence Holders who hunted were unsuccessful).

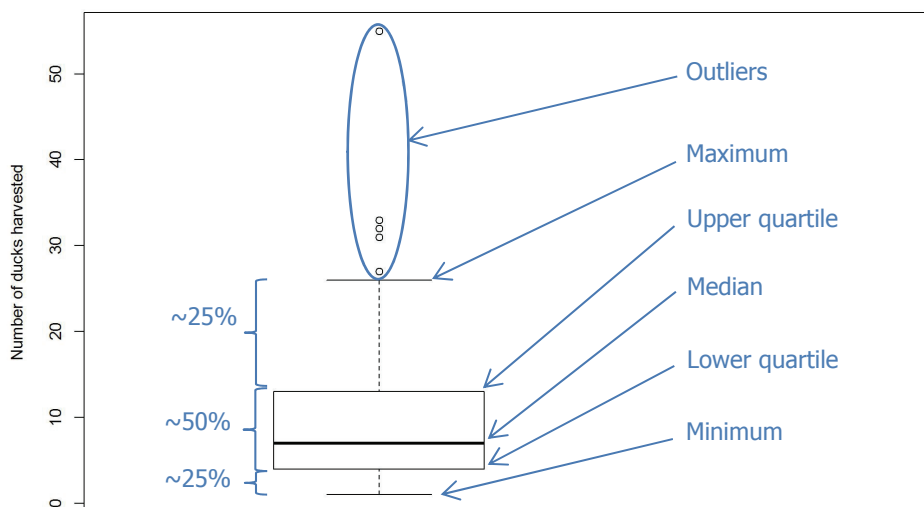


Figure A2.1: Example boxplot, with labels.

Appendix 3

Victorian Deer Hunting Survey 2017

Introduction: Hi my name is _____ and I am calling on behalf of the Game Management Authority.

We are conducting a survey of licensed Deer Hunters over 2017 that will provide information on hunting practices and harvest information as part of the continued process to improve game management in Victoria.

I was hoping you had time to answer a few quick questions.

Survey details:

Period of Survey _____ (1 to 6) Date of interview: dd / mm / 2017

Non-responsive: (tick box)

Survey questions:

1. What is the main species of deer do you hunt? (Sambar, Fallow, Red, Chital, Hog, Rusa)
2. What is the your main hunting method? (Stalking, Stalking with a gundog, Hound hunting, Bow hunting, Spotlighting)
3. Have you been deer hunting in the past two Months? (name months) Yes No (tick box, if 'Yes', proceed to question 4, if 'No' "Thank you for taking part in this survey, if you would like to discuss or view the outcomes of this data, please contact John Turnbull 02 60 437 986)
4. How many Deer hunting trips have you taken over this 2 month period. (indicate number in box)

(Each trip needs to be treated separately for question 5 - 11)

	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6	Trip 7
5. How many days did you go hunting?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
6. How many deer did you harvest?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
7. What species were the deer?	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa	Sambar Fallow Red Hog Chital Rusa
8. What was the sex of the Deer	Male No. Female No.	Male No. Female No.	Male No. Female No.	Male No. Female No.	Male No. Female No.	Male No. Female No.	Male No. Female No.
9. How were the deer taken?	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow	Stalking Scent- Hounds Stalking with a Gundog Bow
10. Did you hunt on private land or public land?	Public <input type="checkbox"/> Private <input type="checkbox"/> Both <input type="checkbox"/>	Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public <input type="checkbox"/> Private <input type="checkbox"/> Both <input type="checkbox"/>
11. What was the closest major town to the area you hunted?	_____	_____	_____	_____	_____	_____	_____

