Estimates of harvest for deer in Victoria

Results from surveys of Victorian Game Licence holders in 2014 and 2015

VICTORIA State Government

Game Management Authority

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Estimates of harvest for deer in Victoria: results from surveys of Victorian game Licence holders in 2015.

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Front cover photo: Sambar hind near Eildon (Steve McMonigle)

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Summary

Between January 2014 and December 2015, telephone surveys of hunters licensed to hunt deer in Victoria 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 two-year period. 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.

During 2014, each holder of a Game Licence endorsed for deer hunted on approximately 6.7 days between January 2014 and December 2014, with an average yearly harvest of 2.2 deer per Game Licence holder. Based on the total number of holders of a Game Licence endorsed for deer, this corresponds to an estimated 62,165 deer harvested during the 2014 deer-hunting season in Victoria (95% confidence interval (CI) = 49,457–78,136). The most commonly harvested species was Sambar Deer (with an estimated total harvest of 51,390), followed by Fallow Deer (7,870).

During 2015, each holder of a Game Licence endorsed for deer hunted on approximately 6.8 days between January 2015 and December 2015, with an average season harvest of 2.4 deer per Game Licence holder. Based on the total number of holders of a Game Licence endorsed for deer, this corresponds to an estimated 71,142 deer harvested during the 2015 deer-hunting season in Victoria (95% CI = 56,567 – 89,471). The most commonly harvested species was Sambar Deer (with an estimated total harvest of 55,094), followed by Fallow Deer (14,488).

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 end-of-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's 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 is permitted all year round in Victoria for some species (Game Management Authority 2015). For this report, the 2014 and 2015 deer-hunting reporting periods were defined by calendar years. Earlier reports (Gormley and Turnbull 2009, 2010, 2011; Moloney and Turnbull 2012, 2013, 2014) were based on financial years (July to June). The move to calendar year reporting for deer will bring the report into line with the duck and quail reports, which reflect activity that occurred in the calendar year. Sambar Deer (*Rusa unicolor*) can be hunted all year by stalking. Hunting Sambar Deer using scent-trailing hounds is restricted to between 1 April and 30 November. 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, including: Fallow Deer (*Dama dama*), Red Deer (*Cervus elaphus*), Chital Deer (*Axis axis*) and Rusa Deer (*Rusa timorensis*). With the exception of Hog Deer, there is no limit to the number of deer that can be taken.

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

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 2 months, involving 200 respondents[1] 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 two-month period 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 that hunted was used as an estimate of the proportion of Game Licence holders that hunted. The proportion of the Game Licence holders surveyed that had hunted during each survey period was multiplied by the total number of Game Licence holders, yielding the estimated total number of hunters for that survey period.

For each survey period, the average harvest per hunter[2] 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.

1. Respondent refers to Game Licence holders who were contacted and agreed to take part in the survey.
2. 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

2014 deer harvest

Summary of responses for deer surveys in 2014

The number of Game Licence holders endorsed to hunt deer increased throughout 2014, from 23,830 in January to 30,244 at the end of the year (Table 1). In order 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	23,830	200	15	66	17
2	Mar–Apr	25,860	200	61	283	66
3	May–Jun	27,259	200	58	338	134
4	Jul–Aug	28,813	200	44	299	114
5	Sep–Oct	29,806	200	39	211	77
6	Nov–Dec	30,244	200	36	140	36

* 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 2014

The proportion of Game Licence holders who hunted in each survey period varied throughout the season: approximately 30% of licence holders hunted in each of the March–April and May–June survey periods in 2014, corresponding to approximately 7,900 hunters in each period, compared with 8% in January–February, or approximately 1,800 hunters (Table 2). The proportion who hunted during other survey periods was approximately 20% (Table 2).

Table 2

Period	Proportion	SE	95%CI		Total hunters	SE	95%CI	
			Lower	Upper			Lower	Upper
Jan–Feb	0.08	0.019	0.05	0.12	1,787	444	1,107	2,887
Mar–Apr	0.31	0.033	0.25	0.38	7,887	842	6,402	9,717
May–June	0.29	0.032	0.23	0.36	7,905	875	6,368	9,813
Jul–Aug	0.22	0.029	0.17	0.29	6,339	844	4,888	8,220
Sep–Oct	0.20	0.028	0.15	0.26	5,812	835	4,392	7,691
Nov–Dec	0.18	0.027	0.13	0.24	5,444	822	4,057	7,306

Average harvest of deer per hunter (Game Licence holders who hunted) for each survey period in 2014

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 a quarter did not harvest any deer (Figure 1). The average number of deer per hunter varied throughout the season (Table 3). The average harvest per hunter in 2014 ranged from a high of 2.59 deer in July–August to a low of 1.00 in November–December.

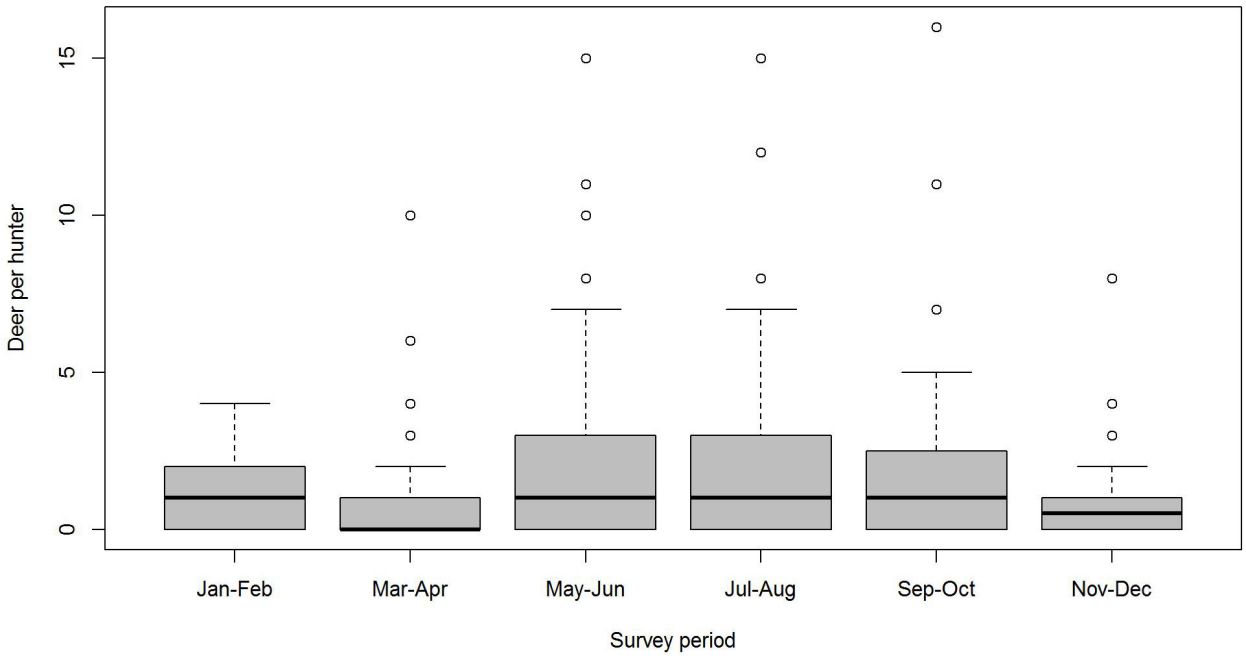

Figure 1: Boxplot of the number of deer reported harvested by individual hunters for each survey period in 2014. The bottom and top of each 'box' indicate the 25th and 75th percentiles, respectively, and the black horizontal line indicates the median reported value.

Table 3

Period	Average harvest per hunter who hunted*	SE	95%CI	
			Lower	Upper
Jan–Feb	1.13	0.31	0.67	1.91
Mar–Apr	1.08	0.22	0.72	1.61
May–June	2.31	0.44	1.60	3.34
Jul–Aug	2.59	0.57	1.70	3.96
Sep–Oct	1.97	0.52	1.19	3.29
Nov–Dec	1.00	0.26	0.60	1.66

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

Estimates of the total deer harvest in Victoria in 2014 by holders of a deer Game Licence

There was an estimated total of 62,165 deer harvested from January 2014 to December 2014, inclusive, by Game Licence holders endorsed to hunt deer (95% CI = 49,458–78,136; Table 4). Harvest was greatest in the mid-autumn to mid-spring months and lowest in the summer months.

Table 4

Period	Total harvest*	SE	95%CI	
			Lower	Upper
Jan–Feb	2,026	744	1,009	4,067
Mar–Apr	8,534	1,983	5,444	13,377
May–June	18,264	4,014	11,932	27,956
Jul–Aug	16,423	4,203	10,025	26,906
Sep–Oct	11,475	3,457	6,440	20,447
Nov–Dec	5,444	1,657	3,038	9,755
Season total	**62,165**	**7,277**	**49,458**	**78,136**

* 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 2014

The total average yearly harvest was 2.22 deer per Game Licence holder (95% CI = 1.77–2.78; 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	0.09	0.03	0.04	0.17
Mar–Apr	0.33	0.08	0.21	0.52
May–June	0.67	0.15	0.44	1.03
Jul–Aug	0.57	0.15	0.35	0.93
Sep–Oct	0.39	0.12	0.22	0.69
Nov–Dec	0.18	0.05	0.10	0.32
Annual total	**2.22**	**0.26**	**1.77**	**2.78**

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

Estimated total harvest per deer species for each survey period in 2014

Separate harvest estimates for each deer species are presented in Figure 2 and Tables 6a, 6b and 6c. The most frequently harvested species was Sambar Deer, comprising 85% of the total reported harvest of deer, followed by Fallow Deer (14%) and Red Deer (1%). No Hog Deer, Chital Deer or Rusa Deer was reported harvested in 2014. Even though no survey respondent reported harvesting Hog Deer in 2014, a total of 122 Hog Deer (96 stags and 26 hinds) were recorded at checking stations, with an additional 75 Hog Deer (30 stags and 45 hinds) harvested on Sunday Island (which is managed by a private cooperative).

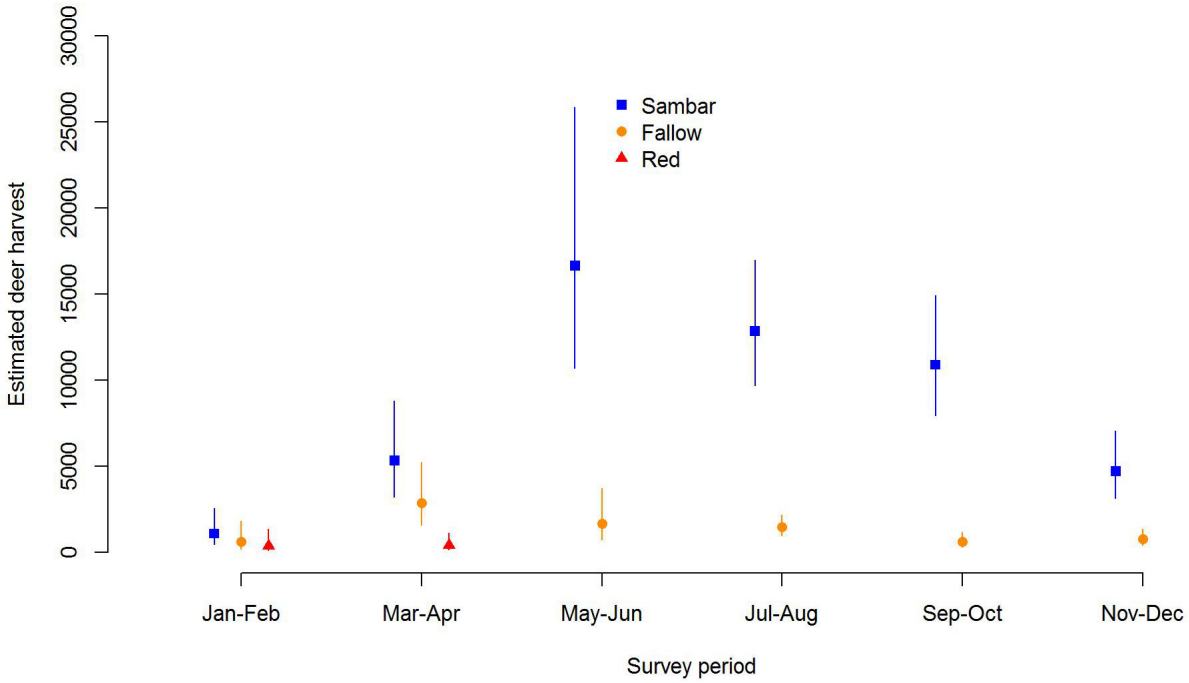

Figure 2: Estimated total deer harvest for each 2-month survey period in 2014 by species. Vertical bars indicate 95% confidence intervals.

Table 6a: Sambar Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	9	1,072	497	451	2,547
Mar–Apr	41	5,301	1,394	3,194	8,799
May–June	122	16,628	3,791	10,696	25,851
Jul–Aug	89	12,822	1,839	9,694	16,959
Sep–Oct	73	10,879	1,756	7,944	14,898
Nov–Dec	31	4,688	987	3,117	7,051
Annual total	**365**	**51,390**	**4,899**	**42,649**	**61,923**

Table 6b: Fallow Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	5	596	365	197	1,803
Mar–Apr	22	2,845	898	1,554	5,206
May–June	12	1,636	718	719	3,723
Jul–Aug	10	1,441	303	958	2,165
Sep–Oct	4	596	201	314	1,133
Nov–Dec	5	756	225	427	1,339
Annual total	**58**	**7,870**	**1,280**	**5,732**	**10,801**

Table 6c: Red Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	3	357	274	94	1,352
Mar–Apr	3	388	224	136	1,110
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	**6**	**745**	**354**	**308**	**1,802**

Reported numbers and percentages of each sex of deer species harvested in 2014

Table 7 shows there was no statistically significant sex bias for the harvest of Sambar Deer, Fallow Deer or Red Deer.

Table 7

Species	Males			Females		
	n	%	SE	n	%	SE
Sambar Deer	192	52.9	2.6	171	47.1	2.6
Fallow Deer	31	56.4	6.7	24	43.6	6.7
Red Deer	3	50.0	20.4	3	50.0	20.4

Days hunted per Game Licence holder for 2014

The number of days hunted in each survey period varied throughout the season (see Table 8), with most hunting occurring from April to October. Each Game Licence holder hunted an average of 6.7 days during 2014, corresponding to a total of 186,213 hunter days (95% CI = 155,046–223,647).

Table 8

Period	Days hunted	SE	95%CI	
			Lower	Upper
Jan–Feb	0.33	0.09	0.19	0.57
Mar–Apr	1.42	0.19	1.08	1.85
May–June	1.69	0.28	1.23	2.32
Jul–Aug	1.50	0.26	1.06	2.10
Sep–Oct	1.06	0.19	0.74	1.51
Nov–Dec	0.70	0.14	0.47	1.03
Total per licence holder	**6.69**	**0.50**	**5.78**	**7.74**
Total hunting days	**186,213**	**17,441**	**155,046**	**223,647**

Percentage of days of hunting and associated deer harvest by land tenure in 2014

More deer hunting occurred exclusively on public land (58%) compared with exclusively on private land (29%), with correspondingly similar proportions of deer harvested, see Table 9.

Table 9

Land tenure	Days	Total Deer harvest	Sambar Deer harvest	Fallow Deer harvest	Red Deer harvest
Private land only	29%	31%	29%	42%	83%
Public land only	58%	56%	56%	40%	17%
Both	13%	13%	15%	18%	0%

Percentage of days hunted and associated deer harvest by hunting method/land tenure in 2014

Stalking was the preferred hunting method, being used on 56.2% of the hunting days and accounting for 59.7% of the reported harvest. Stalking with a gundog was proportionately similarly productive. Hunting with scent-trailing hounds was the most productive hunting method, with the proportion of the harvest being roughly double the respective proportion of days (Table 10). It should be noted that the hunting method was not specified for 25.6% of the hunting days, and this was associated with 0.7% of the harvest. This has occurred due to the hunting method not being recorded on unsuccessful hunting days. In future, the hunting method will be recorded for all hunting days.

Table 10

Land tenure	Private only		Public only		Both		Total	
Hunting method	Days	Deer	Days	Deer	Days	Deer	Days	Deer
Stalking	20.3%	27.7%	28.4%	23.6%	7.5%	8.3%	56.2%	59.7%
Stalking with gundog	0.4%	0.5%	1.0%	1.6%	0.0%	0.0%	1.4%	2.0%
Scent-trailing hounds	1.3%	3.6%	12.6%	27.3%	2.9%	6.8%	16.8%	37.6%

Estimated total deer harvest in 2014 by Catchment Management Authority Regions

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

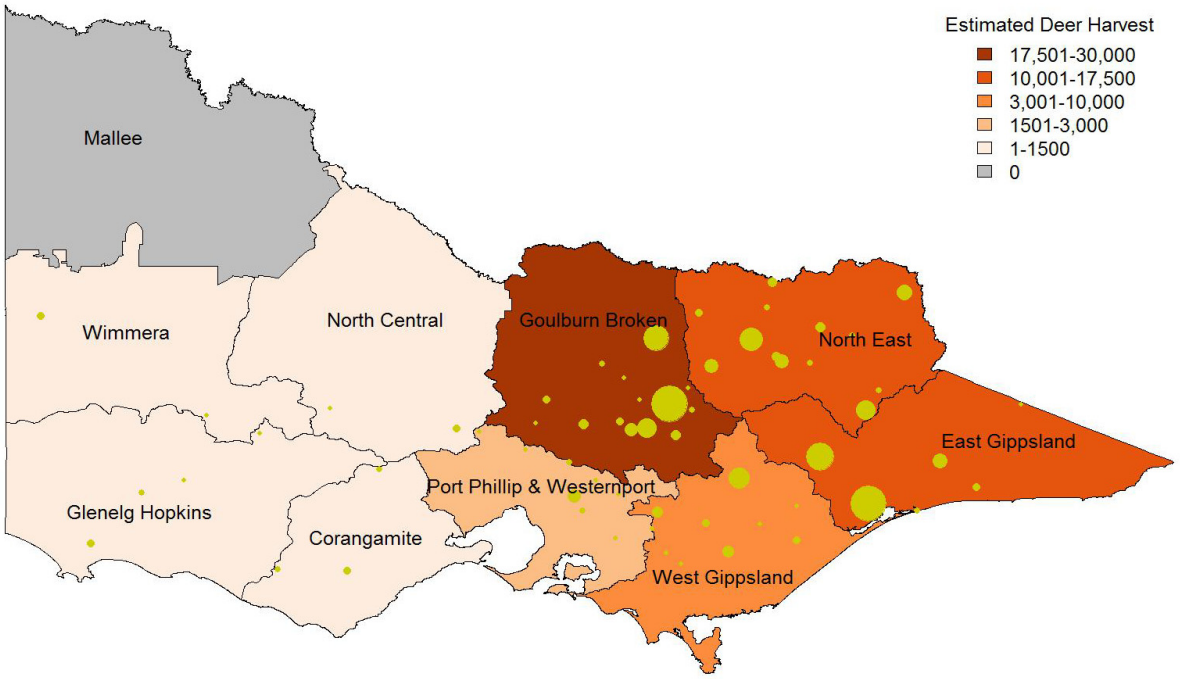

Figure 3: Yellow circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest.

2015 deer harvest

Summary of responses for deer surveys in 2015

The number of Game Licence holders endorsed to hunt deer increased throughout 2015, from 25,299 in January to 32,870 at the end of the year (Table 11). In order 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 11

Deer survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted*	Deer harvested**
1	Jan–Feb	25,299	200	29	139	37
2	Mar–Apr	27,699	200	55	273	58
3	May–June	29,417	200	57	233	73
4	Jul–Aug	30,908	200	70	416	215
5	Sep–Oct	32,134	200	48	152	44
6	Nov–Dec	32,870	200	35	141	45

* 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 2015

The proportion of Game Licence holders who hunted in each survey period varied throughout the season: 35% of licence holders (approximately 10,800 hunters) hunted in the July–August survey period, compared with 15% (approximately 3,700 hunters) in January–February (Table 12). The proportion that hunted during other survey periods was approximately 20% (Table 12).

Table 12

Period	Proportion	SE	95%CI		Total hunters	SE	95%CI	
			Lower	Upper			Lower	Upper
Jan–Feb	0.15	0.025	0.10	0.20	3,668	630	2,626	5,124
Mar–Apr	0.28	0.032	0.22	0.34	7,617	875	6,087	9,533
May–June	0.29	0.032	0.23	0.35	8,384	939	6,736	10,435
Jul–Aug	0.35	0.034	0.29	0.42	10,818	1,042	8,960	13,061
Sep–Oct	0.24	0.030	0.19	0.31	7,712	970	6,032	9,860
Nov–Dec	0.18	0.027	0.13	0.24	5,752	883	4,265	7,758

Average harvest of deer per hunter (Game Licence holders who hunted) for each survey period in 2015

Within each survey period, there was large 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 a quarter did not harvest any deer (Figure 4). The average number of deer per hunter varied throughout the season (Table 13). The average harvest per hunter in 2015 ranged from a high of 3.07 deer in July–August to a low of 0.92 in September–October.

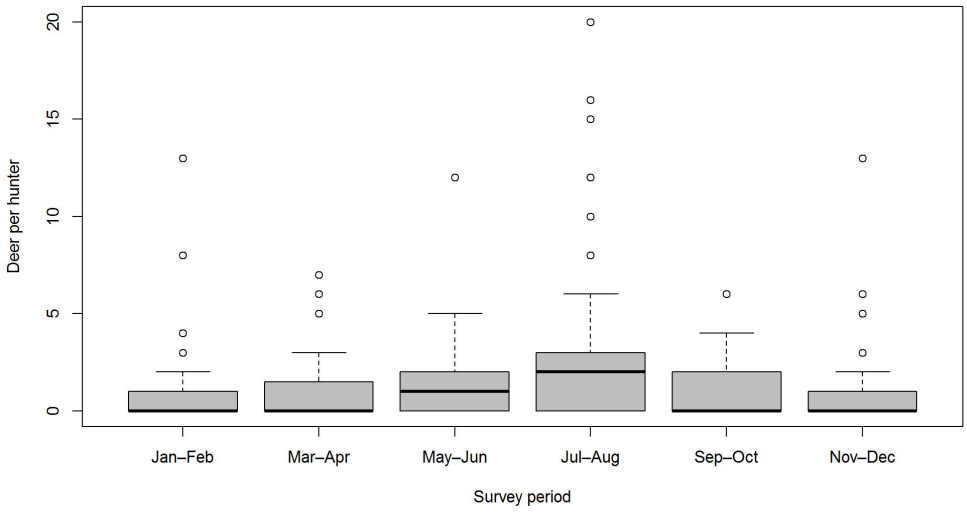

Figure 4: Boxplot of the number of deer reported harvested by individual hunters for each survey period in 2015. The bottom and top of each 'box' indicates the 25th and 75th percentiles, respectively, and the black horizontal line indicates the median reported value.

Table 13

Period	Average harvest per hunter who hunted*	SE	95%CI	
			Lower	Upper
Jan–Feb	1.28	0.52	0.59	2.76
Mar–Apr	1.05	0.22	0.70	1.58
May–June	1.28	0.26	0.86	1.90
Jul–Aug	3.07	0.54	2.18	4.33
Sep–Oct	0.92	0.19	0.61	1.38
Nov–Dec	1.29	0.44	0.67	2.47

* Average harvest per hunter = Deer harvested divided by respondents who hunted (Table 11).

Estimates of the total deer harvest in Victoria in 2015 by holders of a deer Game Licence

There was an estimated total of 71,142 deer harvested from January 2015 to December 2015, inclusive, by Game Licence holders endorsed to hunt deer (95% CI = 56,567–89,471; Table 14). Harvest was greatest in the mid-autumn to winter months and lowest in the summer months.

Table 14

Period	Total harvest*	SE	95%CI	
			Lower	Upper
Jan–Feb	4,680	2,079	2,037	10,751
Mar–Apr	8,033	1,908	5,075	12,714
May–June	10,737	2,488	6,858	16,811
Jul–Aug	33,226	6,695	22,474	49,123
Sep–Oct	7,069	1,746	4,387	11,391
Nov–Dec	7,396	2,773	3,633	15,056
Annual total	**71,142**	**8,349**	**56,567**	**89,471**

* Total harvest = Harvest per hunter (Table 13) × Total hunters (Table 12). 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 2015

The total average yearly harvest was 2.36 deer per Game Licence holder (95% CI = 1.88–2.96; Table 15). Note that, for each survey period, the average deer harvest per Game Licence holder (Table 15) was much lower than the average deer harvest per Game Licence holder that hunted (Table 13), because the former included those respondents who did not hunt during the survey period.

Table 15

Period	Average harvest per Game Licence holder*	SE	95%CI	
			Lower	Upper
Jan–Feb	0.19	0.08	0.08	0.42
Mar–Apr	0.29	0.07	0.18	0.46
May–June	0.37	0.08	0.23	0.57
Jul–Aug	1.08	0.22	0.73	1.59
Sep–Oct	0.22	0.05	0.14	0.35
Nov–Dec	0.23	0.08	0.11	0.46
Annual total	**2.36**	**0.28**	**1.88**	**2.96**

* Average harvest per Game Licence holder = Deer harvested divided by Respondents (Table 11).

Estimated total harvest per deer species for each survey period in 2015

Separate harvest estimates for each deer species are presented in Figure 5 and Tables 16a, 16b, 16c and 16d. The most frequently harvested species was Sambar Deer, comprising 78% of the total reported harvest, followed by Fallow Deer (20.5%), Red Deer (1.3%) and Hog Deer (0.2%). No Chital Deer or Rusa Deer was reported harvested in 2015. However, a total of 124 Hog Deer (99 stags and 25 hinds) were recorded at checking stations, with an additional 77 Hog Deer (36 stags and 41 hinds) harvested on Sunday Island.

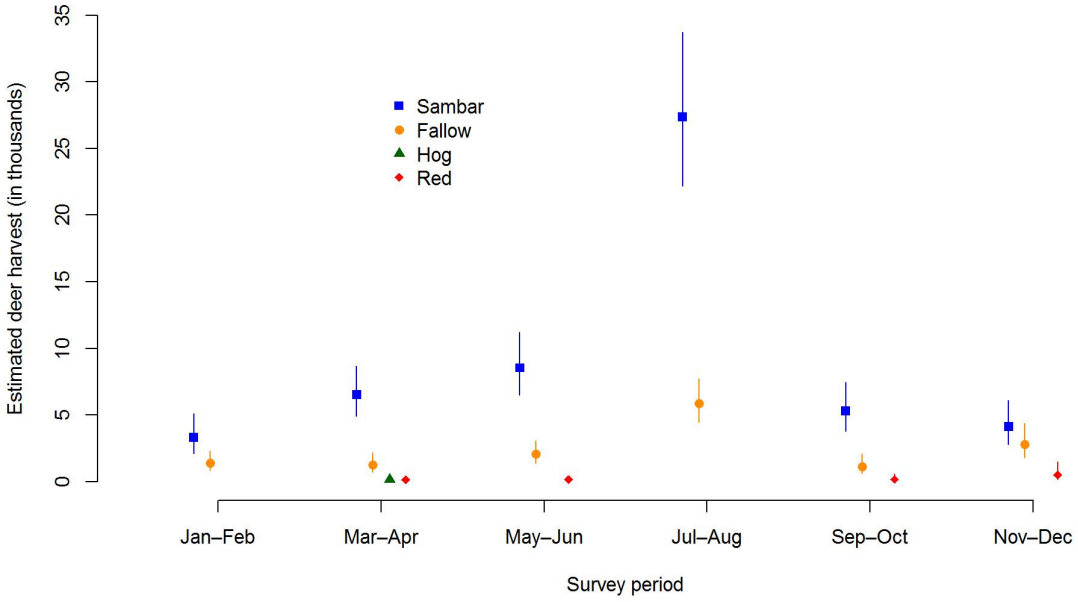

Figure 5: Estimated total deer harvest for each 2-month survey period in 2015 by species. Vertical bars indicate 95% confidence intervals.

Table 16a: Sambar Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	26	3,289	739	2,129	5,080
Mar–Apr	47	6,509	954	4,892	8,662
May–June	58	8,531	1,188	6,502	11,193
Jul–Aug	177	27,354	2,934	22,180	33,734
Sep–Oct	33	5,302	932	3,766	7,464
Nov–Dec	25	4,109	839	2,765	6,105
Annual total	**366**	**55,094**	**3,612**	**48,456**	**62,640**

Table 16b: Fallow Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	11	1,391	360	845	2,292
Mar–Apr	9	1,246	352	724	2,147
May–June	14	2,059	426	1,379	3,074
Jul–Aug	38	5,873	816	4,478	7,701
Sep–Oct	7	1,125	354	615	2,055
Nov–Dec	17	2,794	639	1,795	4,349
Annual total	**96**	**14,488**	**1,279**	**12,191**	**17,218**

Table 16c: Red Deer

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	0	0	NA	NA	NA
Mar–Apr	1	138	81	48	399
May–June	1	147	89	49	437
Jul–Aug	0	0	NA	NA	NA
Sep–Oct	1	161	113	47	555
Nov–Dec	3	493	297	166	1,468
Annual total	**6**	**939**	**340**	**473**	**1,867**

Table 16d: Hog Deer*

Species	Reported harvest	Estimated harvest	SE	95%CI	
				Lower	Upper
Jan–Feb	0	0	NA	NA	NA
Mar–Apr	1	138	81	48	399
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**	**138**	**81**	**48**	**399**

* Estimated Hog deer figures differ from the known harvest recorded by the checking stations and Sunday Island. Small sample sizes limit the ability to reflect an accurate estimate.

Reported numbers and percentages of each sex of deer species harvested in 2015

Table 17 shows there was no statistically significant sex bias for the harvest of Sambar Deer, Fallow Deer , Red Deer or Hog Deer.

Table 17

Species	Males			Females		
	n	%	SE	n	%	SE
Sambar Deer	174	48.7%	(2.6)	183	51.3%	(2.6)
Fallow Deer	51	58.0%	(5.3)	37	42.0%	(5.3)
Red Deer	3	50.0%	(20.4)	3	50.0%	(20.4)

Days hunted per Game Licence holder for 2015

The number of days hunted in each survey period varied throughout the season, with most hunting occurring from autumn to winter. Each Game Licence holder endorsed to hunt deer hunted an average of 6.8 days during 2015, corresponding to a total of 201,547 hunter days (95% CI = 170,410–238,372).

Table 18

Period	Days hunted	SE	95%CI	
			Lower	Upper
Jan–Feb	0.70	0.15	0.46	1.05
Mar–Apr	1.37	0.23	0.99	1.88
May–June	1.17	0.18	0.87	1.57
Jul–Aug	2.08	0.28	1.60	2.70
Sep–Oct	0.76	0.12	0.56	1.04
Nov–Dec	0.71	0.16	0.46	1.08
Total per licence holder	**6.77**	**0.47**	**5.91**	**7.75**
Total hunting days	**201,547**	**17,288**	**170,410**	**238,372**

Percentage of days of hunting and associated deer harvest by land tenure in 2015

More deer hunting occurred exclusively on public land (52%) compared with exclusively on private land (26%), with correspondingly similar proportions of deer harvested (see Table 19).

Table 19

Land tenure	Days	Total Deer harvest	Sambar Deer harvest	Fallow Deer harvest	Red Deer harvest
Private land only	27%	30%	25%	52%	17%
Public land only	52%	50%	58%	18%	33%
Both	21%	20%	17%	30%	50%

Percentage of days hunted and associated deer harvest by hunting method/land tenure in 2015

Stalking was the preferred hunting method, being used on 80.6% of the hunting days and accounting for 66.5% of the reported harvest. Stalking with a gundog was similarly proportionately productive. Hunting with scent-trailing hounds was the most productive hunting method, with the proportion of the harvest being roughly double the respective proportion of days (Table 20).

Table 20

Land tenure	Private only		Public only		Both		Total	
Hunting method	Days	Deer	Days	Deer	Days	Deer	Days	Deer
Stalking	24.7%	29.0%	40.6%	22.7%	15.4%	14.8%	80.6%	66.5%
Stalking with gundog	0.0%	0.0%	0.4%	0.6%	2.6%	2.8%	3.0%	3.4%
Scent-trailing hounds	0.7%	1.3%	10.6%	26.5%	2.5%	2.3%	13.8%	30.1%

Estimated total deer harvest in 2015 by Catchment Management Authority Regions

Total harvest was estimated to be greatest in the Goulburn Broken CMA Region, followed by the East Gippsland CMA and the North East CMA Regions (Figure 6). The top five towns for the total reported number of deer harvested were (in descending order) Mansfield, Myrtleford, Dargo, Bairnsdale and Licola. The top five towns for the total number of reported deer hunting days were (in descending order) Mansfield, Dargo, Licola, Bairnsdale and Jamieson.

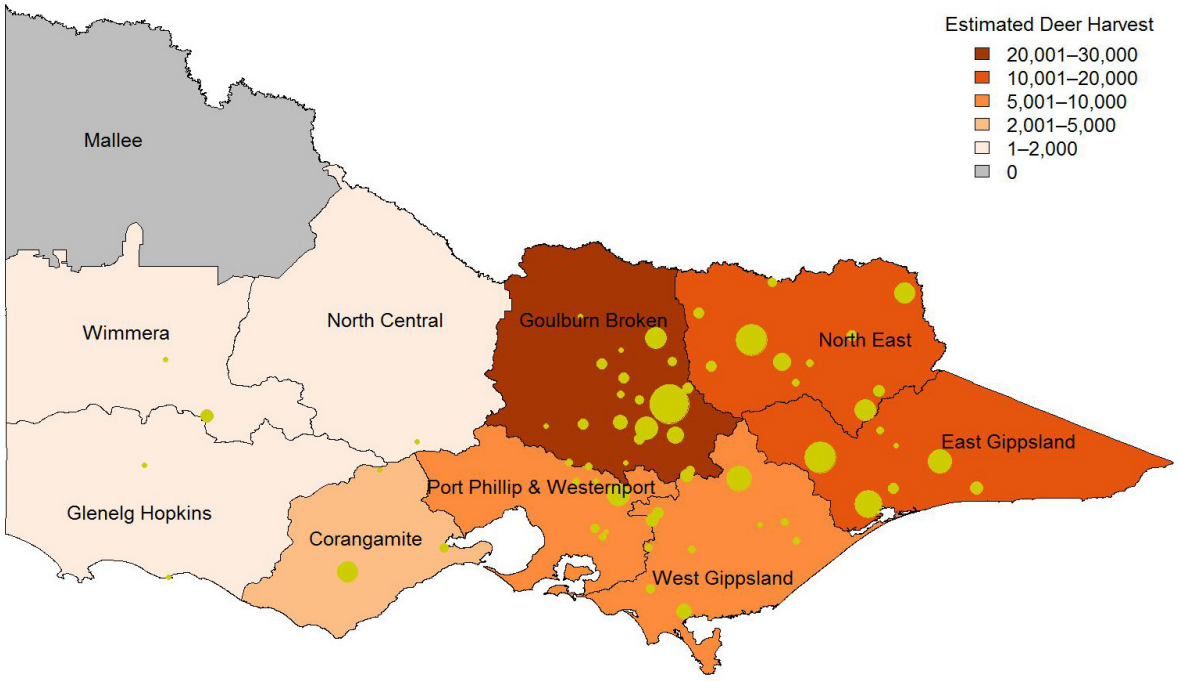

Figure 6: Yellow circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest.

4. Discussion

Deer harvests in 2014 and 2015

A total of 62,165 deer were estimated to have been harvested in Victoria during the 2014 calendar year (95% CI = 49,458–78,136). The most commonly harvested species in 2014 was Sambar Deer (51,390), followed by Fallow Deer (7,870). Due to the very small harvest of Red Deer reported harvested by surveyed Game Licence holders, it is difficult to make any inference about the harvest of that species, except that it is likely to be small (<2,000). Even though no survey respondent reported harvesting Hog Deer in 2014, a total of 122 Hog Deer (96 stags and 26 hinds) were recorded at checking stations, with an additional 75 Hog Deer (30 stags and 45 hinds) harvested on Sunday Island (which is managed by a private cooperative).

A total of 71,142 deer were estimated to have been harvested in Victoria during the 2015 calendar year (95% CI = 56,567–89,471). The most commonly harvested species in 2015 was Sambar Deer (55,094), followed by Fallow Deer (14,488). Due to the very small harvest of Hog Deer and Red Deer reported by surveyed Game Licence holders in 2015, it is difficult to make any inference about the harvest of those species in that year, except that it is likely to be small (<2,000). However, in 2015 a total of 124 Hog Deer (99 stags and 25 hinds) were recorded at checking stations, with an additional 77 Hog Deer (36 stags and 41 hinds) harvested on Sunday Island.

Estimates of the Victorian deer harvest from the telephone surveys were previously calculated for the Australian financial year from July to June (Gormley and Turnbull (2009); Gormley and Turnbull (2010); Moloney and Turnbull (2011); Moloney and Turnbull (2012); Moloney and Turnbull (2013); Moloney and Turnbull (2014)). To bring a consistent approach on reporting game harvest, from this report onwards, the annual deer harvest is to be calculated for the calendar year (January to December). Therefore, to compare results, the earlier surveys have been converted from July–June to January–December. This was done using the results of each 2-monthly survey from January–February 2009 to November–December 2013 to calculate annual estimates, as in the 2014 and 2015 estimates. The results of these conversions are given in Table 21.

Table 21: Comparison of annual deer harvests during 2009–2015

	2009	2010	2011	2012	2013	2014	2015
Harvest by species							
Fallow Deer	4,871	6,085	4,001	9,788	6,426	7,870	14,488
Hog Deer*	81	454	99	102	0	0	138
Red Deer	682	1,396	737	555	926	745	939
Sambar Deer	32,453	34,108	25,913	48,048	36,355	51,390	55,094
Total harvest	**38,284**	**42,133**	**30,753**	**59,206**	**43,985**	**62,165**	**71,142**
Hunting days	150,321	149,002	135,279	169,721	135,854	186,213	201,547
Deer per licence holder	2.14	2.12	1.43	2.62	1.76	2.22	2.36
Hunting days per licence holder	8.38	7.56	6.30	7.55	5.48	6.69	6.77
Deer per hunting day	0.25	0.28	0.23	0.35	0.32	0.33	0.35

* Estimated Hog Deer figures differ from the known harvest recorded by the checking stations and Sunday Island. Small sample sizes limit the ability to reflect an accurate estimate.

The 2014 and 2015 annual deer harvests were the two largest on record (Figure 7). The 2015 estimate was 14% larger than the next highest estimated deer harvest (2014) using this survey method. The 2015 season had the largest number of hunting days, with 2014 second. The number of deer harvested per Game Licence holder in 2014 and 2015 was the third and second largest respectively, with only 2012 being larger. The efficiency of hunters (i.e. deer harvested per hunting day) in the last four seasons (2012 to 2015) was similar. Most deer hunting occurred from March to August.

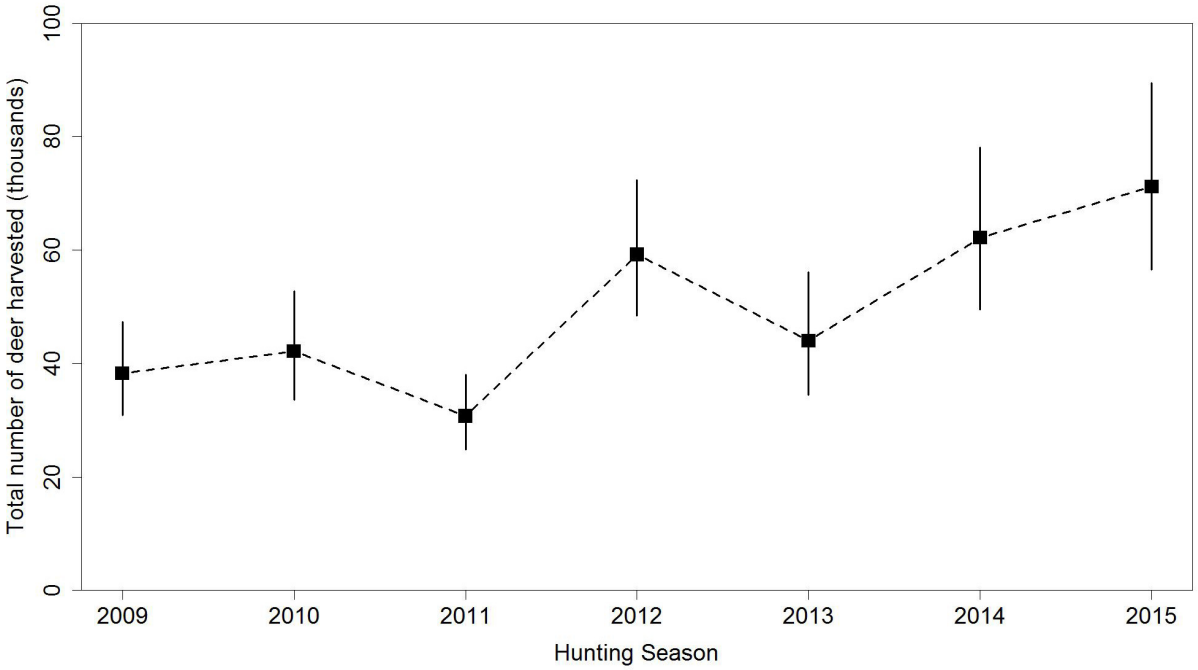

Figure 7: Estimated total annual deer harvests (in thousands) from 2009 to 2015. The square is the estimate for each season; the solid line indicates the 95% confidence interval.

There are several notable results from the analysis of the 2014 and 2015 data. First, the July–August harvest in 2015 was very large. The estimated >33,000 deer harvested is more than 45% of the 2015 annual total. That is approximately 80% larger than the next largest 2-month survey (May–June, 2014) and exceeds the estimated annual harvest in 2012. Second, the estimated 2015 Fallow Deer harvest is large, ~50% larger than the next largest annual estimate (2012) and nearly double the harvest of the previous year (2014), which itself is the third largest estimate.

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 generally 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 (see Figure 1 and Figure 4). 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 5 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 for deer. 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 Region 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.

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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 ÷ 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:

$$p_j = \frac{h_j}{n_j}$$ 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:

$$H_j = p_j L$$ 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):

$$w_j = \frac{y_j}{h_j}$$ 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):

$$W_j = w_j H_j$$ 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:

$$\mathrm{SE}(p_j) = \sqrt{\frac{p_j(1-p_j)}{n_j}}$$ 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:

$\mathrm{SE}(w_j) = \frac{\mathrm{SD}(w_j)}{\sqrt{n_j}}$, 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).

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

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

$$\mathrm{SE}(W_j) = \mathrm{CV}\left(W_j\right) \times W_j$$

The standard error of the total harvest was calculated by:

$$\mathrm{SE}(W_{TOT}) = \sqrt{\left(\mathrm{SE}(W_1)\right)^2 + \left(\mathrm{SE}(W_2)\right)^2 + \cdots + \left(\mathrm{SE}(W_6)\right)^2}$$

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:

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

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

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

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

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

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

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 × IQR or above Q3 + 1.5 × 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 5 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).

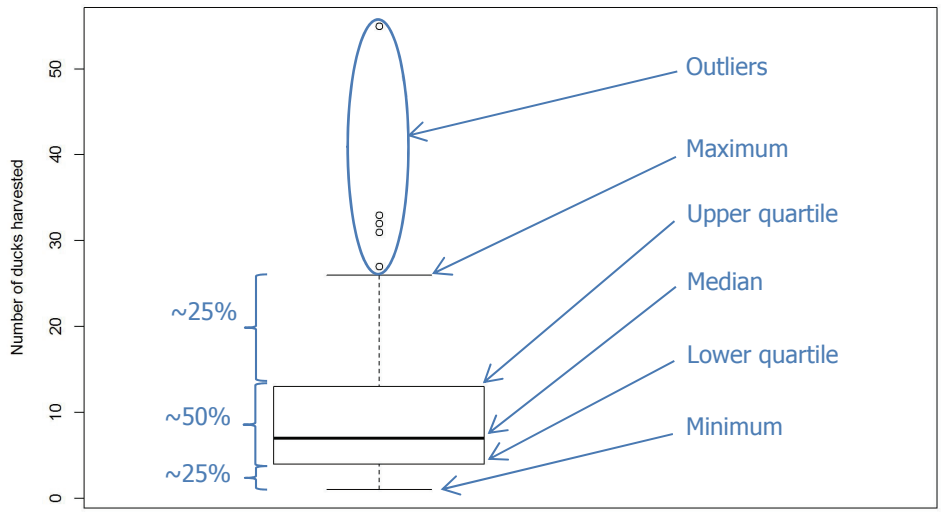

Figure A2.1: Example boxplot, with labels.

Victorian Deer Hunting Survey

Introduction: Hi my name is _____and I am calling from _____ on behalf of the Game Management Authority and Victorian hunting organisations.

We are conducting a survey of licensed Deer Hunters over a 12 month period 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 / 2014/15

Non-responsive: ☐ (tick box)

Survey questions:

1. Have you been Deer hunting in the past two Months? (name months) Yes ☐ No ☐ (tick box, if 'Yes', proceed to question 2, 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 Customer Service Centre on 136 186")

2. How many Deer hunting trips have you taken over this 2 week period? (indicate number in box)

(Each trip needs to be treated separately for question 3 - 9)

	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6	Trip 7
3. How many days did you go hunting?							
4. How many deer did your harvest?							
5. What species were the deer?	Sambar Fallow Red Hog	Sambar Fallow Red Hog	Sambar Fallow Red Hog	Sambar Fallow Red Hog	Sambar Fallow Red Hog	Sambar Fallow Red Hog	Sambar Fallow Red Hog
6. 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.
7. How were the deer taken?	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs	Stalking Scent- Hounds Gundogs
8. Did you hunt on private land?	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
9 What was the closest major town to the area you hunted?	_____	_____	_____	_____	_____	_____	_____

Thank you for your time

Survey groups to be delivered every 2 months throughout the year, with the expected number of surveys being 6.

Notes