



Estimates of harvest for duck and Stubble Quail in Victoria

Results from surveys of Victorian Game Licence holders in 2017

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Estimates of harvest for deer, duck and Stubble Quail in Victoria: results from surveys of Victorian game Licence holders in 2017

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Front cover photo: Stubble Quail harvested in western Victoria (Photo: Heath Dunstan)

Contents

Summary	4
1 Introduction.....	5
2 Methods	6
General methodology	6
Duck.....	7
Stubble Quail	7
3 Results.....	8
Duck.....	8
Stubble Quail	13
4 Discussion.....	18
Duck.....	18
Stubble Quail	20
Locations with the most hunting days.....	21
Assumptions	21
References	23
Appendix A: Additional method details.....	24
Appendix B: Boxplot explanation	26
Appendix C: Surveys	27

Summary

Between March and July 2017, during the hunting seasons for duck and Stubble Quail, telephone surveys of Victorian hunters were conducted to estimate the total harvest for each game type. Game Licence holders for each game type were randomly sampled and interviewed by telephone at intervals during their respective game seasons. 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 animals harvested. Additional information was obtained on hunting methods and locations.

Each holder of a Game Licence endorsed for ducks hunted on approximately 3.8 days during the 2017 duck hunting season, with an average season harvest of 17.4 ducks per Game Licence holder. Based on the total number of Game Licence holders, this equates to an estimated 438,353 ducks harvested during the 2017 duck hunting season in Victoria (95% confidence interval [CI] = 365,549–525,657). The three most commonly harvested species were Grey Teal (which comprised 40% of the total harvest), Pacific Black Duck (27%) and Australian Wood Duck (21%). The remaining ducks harvested were Pink-eared Duck (5%), Chestnut Teal (3%), Mountain Duck (3%) and Hardhead (2%). Blue-winged Shoveler were prohibited from being hunted in 2017.

Each holder of a Game Licence endorsed for Stubble Quail (*Coturnix pectoralis*) hunted on approximately 0.8 days during the 2017 Stubble Quail hunting season, with an average season harvest of 6.5 Stubble Quail per Game Licence holder. Based on the total number of Game Licence holders, this equates to an estimated 186,691 Stubble Quail harvested during the 2017 Stubble Quail hunting season in Victoria (95% CI = 138,651–251,376).

The total number of hunter days during the 2017 hunting season for ducks was estimated to be 96,508 (95% CI = 83,097–112,084) and for Stubble Quail the total number of hunter days was 22,052 (95% CI = 16,270–29,887).

The total combined number of hunter days during the 2017 hunting season for ducks and Stubble Quail was estimated to be 118,560 (95% CI = 102,603–134,516).

The approach used here explicitly accounts for the possibility that not every holder of a Game Licence 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 season 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.

Note: Numbers within the text have been rounded.

1. Introduction

To effectively manage game species, it is important to quantify the numbers harvested. Since 2009, the State Government 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 Stubble Quail. However, this report focuses only on the duck and Stubble Quail harvests.

The 2017 duck hunting season lasted 12 weeks, from 18 March to 12 June (Game Management Authority 2017). Seven species could legally be hunted in 2017: Pacific Black Duck (*Anas superciliosa*), Australian Wood Duck (*Chenonetta jubata*), Mountain Duck (*Tadorna tadornoides*), Grey Teal (*Anas gracilis*), Chestnut Teal (*Anas castanea*), Pink-eared Duck (*Malacorhynchus membranaceus*) and Hardhead (*Aythya australis*). Blue-winged Shoveller, a declared game species (*Anas rhynchos*), was prohibited from hunting for the 2017 season. The bag limit for the 2017 season was ten game ducks per hunter per day.

The 2017 duck hunting survey used the same methods (i.e. telephone surveys) as those followed during the 2005, 2006 and 2009 to 2016 duck hunting seasons (Barker 2006; Gormley and Turnbull 2009; 2010; 2011; Moloney and Turnbull 2012; 2013; 2014; 2015; 2016).

The 2017 Stubble Quail (*Coturnix pectoralis*) hunting season lasted 13 weeks, from 1 April to 30 June (Game Management Authority 2017). The daily bag limit for the 2017 season was 20 Stubble Quail per hunter.

The 2017 Stubble Quail hunting survey used the same methods (i.e. telephone surveys) as those followed during the 2009 to 2015 Stubble Quail hunting seasons (Gormley 2009; Gormley and Turnbull 2009; 2010; 2011; Moloney and Turnbull 2012; 2013; 2014; 2015). Due to a clerical error, the 2016 Stubble Quail hunting survey used a slightly different method (Moloney and Turnbull 2016).

1. Australian Wood Duck is also referred to as Wood Duck, Maned Duck and Maned Goose.

2. Mountain Duck is also referred to as Australian Shelduck.

3. Hardhead is also referred to as White-eyed Duck.

4. Blue-winged Shoveler is also referred to as Australasian Shoveler.

2. Methods

General methodology

Slightly different methodology was used for estimating duck and Stubble Quail harvests. All surveys were conducted by the telephone survey company Marketing Skill Pty Ltd (Mt Eliza, Victoria) on behalf of the Game Management Authority. Estimates of total harvest by Game Licence holders were based on the hunting activities reported by the survey respondents.

For duck, surveys were performed for the opening weekend and then every fortnight thereafter throughout the season. For Stubble Quail, surveys were performed for the opening weekend and then every month thereafter throughout the season. Each survey involved telephoning a random sample of Game Licence holders and asking them to report their hunting activities for the periods covered by that survey only. 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 only information that pertained to the period covered by Survey 3 was collected. An additional random sample of 400 Game Licence holders were surveyed immediately after the conclusion of the duck and Stubble Quail hunting seasons. They were asked if they had hunted at any stage during the duck and Stubble Quail seasons, respectively. The number of active hunters was estimated from this survey.

Survey responses were used to generate an estimate for the whole population of Game Licence holders for each game type. 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 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, 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 season harvest per Game Licence holder 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 who hunted. The sum of these estimates across the season provided an estimate of the total season harvest per Game Licence holder.

Respondents who hunted were also asked to provide information on whether hunting was conducted on private land or public land (such as State Game Reserves), the name of the town nearest to where they hunted, 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.

There were differences in the number and length of surveys between the duck and Stubble Quail surveys, as indicated in the following sections. Additional details of the methods, as well as examples of the calculations, are provided in Appendix A. Information describing and interpreting boxplots are provided in Appendix B.

4. Respondent refers to a Game Licence holder who was contacted and agreed to take part in the survey.

5. 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.

Duck

Samples were drawn from hunters who held a Game Licence endorsed to hunt ducks during the 2017 season. A random sample of 200 licence holders was interviewed by telephone immediately after opening weekend (Duck Survey 1), followed by surveys of independent random samples 200 of licence holders at two-week intervals for the remainder of the duck season (Duck Surveys 2–7).

Respondents were also asked to report the number of each species harvested. An additional random sample of 400 Game Licence holders were surveyed immediately after the conclusion of the duck hunting season. They were asked if they had hunted at any stage during the season.

Stubble Quail

Samples were drawn from hunters who held a Game Licence endorsed to hunt Stubble Quail during the 2017 season. A random sample of 300 licence holders was interviewed by telephone after the opening weekend (Survey 1) and in April (excluding opening weekend, Survey 2), May (Survey 3) and June (Survey 4).

Respondents were asked to report the number of Stubble Quail harvested, the type of grassland where hunting occurred (native, stubble or introduced) and whether gundogs were used. An additional random sample of 400 Game Licence holders were surveyed immediately after the conclusion of the Stubble Quail hunting season. They were asked if they had hunted at any stage during the season.

Note: The authority to hunt Stubble Quail on a Game Licence is covered under a general game bird endorsement. This endorsement also allows the hunting of other non-indigenous quail, pheasants and partridge. The hunting of non-indigenous game birds is generally restricted to a small number of private game bird farms with no known wild sustaining populations. For the purpose of this survey, only information on Stubble Quail is collected.

3. Results

Duck

Summary of responses for duck surveys in 2017

The number of Game Licence holders endorsed to hunt ducks remained relatively constant throughout the season, increasing from 24,146 at opening weekend to 26,324 at the end of the season (Table 1). To achieve the required sample size of respondents, slightly more than 200 licence holders were contacted each survey, with an average of 97.9% of those contacted being willing to take part.

Table 1

Duck Survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted*	Ducks harvested**
1	18 – 19 Mar	24,146	200	86	139	614
2	20 Mar – 2 Apr	24,146	200	118	124	506
3	3 – 16 Apr	25,136	200	109	122	498
4	17 – 30 Apr	25,136	200	109	106	527
5	1 – 14 May	26,217	200	113	91	406
6	15 – 28 May	26,217	200	89	86	487
7	29 May – 12 Jun	26,324	200	107	98	435

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

** Ducks harvested indicates total number of ducks harvested by respondents.

Proportion and corresponding total number of duck licence holders who hunted in each survey period in 2017

The proportion of Game Licence holders endorsed to hunt duck who hunted in each survey period varied throughout the season. During opening weekend 43% of licence holders hunted, corresponding to approximately 10,383 hunters (Table 2). During other survey periods, the proportion who hunted was up to 59% (Table 2).

Table 2

Period	Proportion	SE	95%CI		Total hunters	SE	95%CI	
			Lower	Upper			Lower	Upper
18 – 19 Mar	0.43	0.035	0.37	0.50	10,383	845	8,854	12,176
20 Mar – 2 Apr	0.59	0.035	0.53	0.66	14,246	840	12,693	15,989
3 – 16 Apr	0.55	0.035	0.48	0.62	13,699	885	12,071	15,546
17 – 30 Apr	0.55	0.035	0.48	0.62	13,699	885	12,071	15,546
1 – 14 May	0.56	0.035	0.50	0.64	14,813	919	13,118	16,726
15 – 28 May	0.44	0.035	0.38	0.52	11,667	921	9,996	13,616
29 May – 12 Jun	0.54	0.035	0.47	0.61	14,083	928	12,378	16,024

Average harvest of ducks per hunter (Game Licence holders who hunted) for each survey period in 2017

Within each survey period, there was large variation in the reported harvest of ducks per hunter (i.e. per Game Licence holder who hunted). Some hunters harvested more than 30 ducks in a survey period, whereas some did not harvest any ducks (Figure 1). The average number of ducks per hunter varied throughout the season (Table 3). The average harvest per hunter was 7.1 ducks on opening weekend, which was greater than the average harvest per hunter for any other survey period. The smallest average harvest per hunter was 3.6 ducks (in the fifth survey period).

Table 3

Period	Average harvest per hunter*	SE	95%CI	
			Lower	Upper
18 – 19 Mar	7.14	0.52	6.18	8.24
20 Mar – 2 Apr	4.29	0.62	3.23	5.69
3 – 16 Apr	4.57	0.98	3.01	6.94
17 – 30 Apr	4.83	1.36	2.82	8.29
1 – 14 May	3.59	0.94	2.17	5.96
15 – 28 May	5.47	1.78	2.93	10.20
29 May – 12 Jun	4.07	1.14	2.37	6.97

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

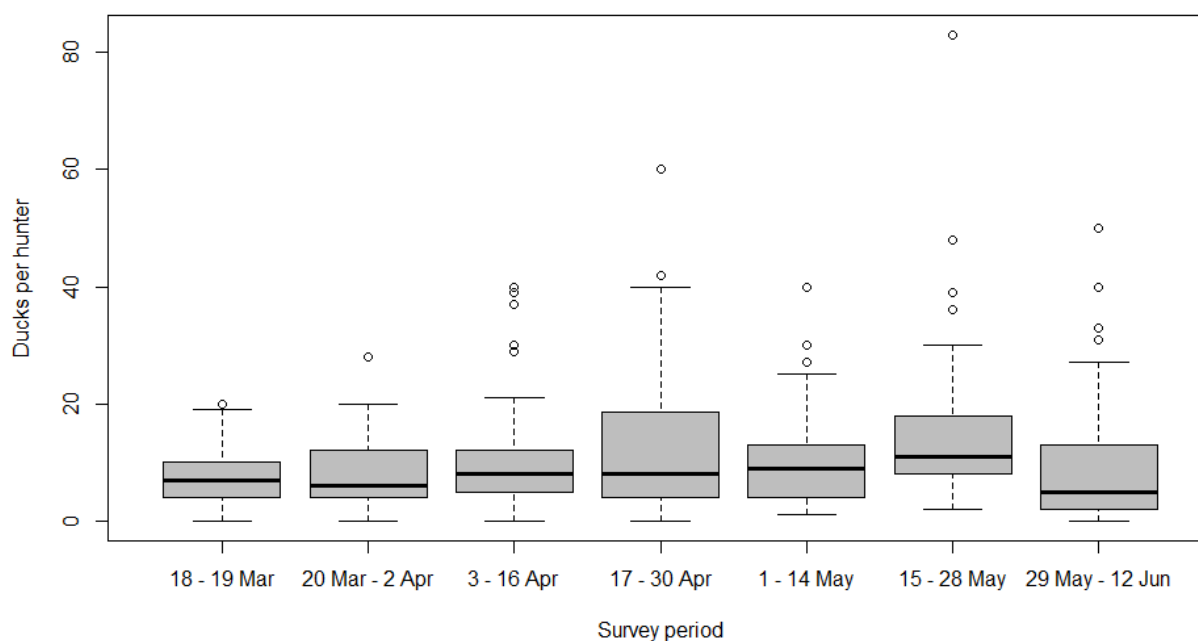


Figure 1: Boxplot of the number of ducks reported harvested by individual hunters for each survey period in 2017. The bottom and top of each 'box' indicate the 25th and 75th percentiles, respectively, with the black horizontal line indicating the median (50th percentile) reported value.

Estimates of the duck harvest in Victoria in 2017 by holders of a Game Licence endorsed for duck

There were an estimated 74,128 ducks harvested during opening weekend (95% CI = 59,828–91,846), which was more than the estimate for any fortnight in April to May and constituted 17% of the total seasonal harvest (Table 4). The harvest throughout the remainder of the season varied between surveys, with fortnightly estimates ranging from 53,221 to 66,233 ducks harvested. The total season harvest estimate was 438,353 (95% CI = 365,549–525,657; Table 4).

Table 4

Period	Total harvest*	SE	95%CI	
			Lower	Upper
18 – 19 Mar	74,128	8,130	59,828	91,846
20 Mar – 2 Apr	61,089	9,588	44,996	82,939
3 – 16 Apr	62,589	14,078	40,494	96,740
17 – 30 Apr	66,233	19,076	38,087	115,179
1 – 14 May	53,221	14,356	31,658	89,469
15 – 28 May	63,838	21,422	33,653	121,098
29 May – 12 Jun	57,255	16,491	32,924	99,567
Total	438,353	40,707	365,549	525,657

* 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 ducks per Game Licence holder in each survey period in 2017

The total average season harvest per licence holder was estimated to be 17.4 birds (95% CI = 14.5–20.8; Table 5). Note that, for each survey period, the average duck harvest per Game Licence holder was lower than the average duck harvest per hunter (Table 3), as the former includes those respondents who did not hunt during the survey period, whereas the latter includes only those who hunted.

Table 5

Period	Average harvest*	SE	95%CI	
			Lower	Upper
18 – 19 Mar	3.07	0.34	2.48	3.80
20 Mar – 2 Apr	2.53	0.40	1.86	3.43
3 – 16 Apr	2.49	0.56	1.61	3.85
17 – 30 Apr	2.63	0.76	1.52	4.58
1 – 14 May	2.03	0.55	1.21	3.41
15 – 28 May	2.44	0.82	1.28	4.62
29 May – 12 Jun	2.17	0.63	1.25	3.78
Total	17.36	1.59	14.52	20.77

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

Reported numbers of ducks harvested by hunters, proportions of the total harvest, and estimates of total 2017 harvest for each duck species

Using a telephone survey immediately after the 2017 duck season ended, it was estimated that 66% (95% CI = 61%–70%) of Game Licence holders actually hunted for ducks during the 2017 duck season. That equates to an estimate of 17,242 (95% CI = 16,059–18,513) active duck hunters in the 2017 duck season. The average duck harvest per active duck hunter was estimated to be 25.4 (95% CI = 20.9–30.9).

The total harvest was estimated for each species by multiplying the total estimated duck harvest by the percentage of the total harvest for that species (Table 6). The most frequently harvested species was Grey Teal, comprising 40% of the total reported harvest, followed by Pacific Black Duck (27%) and Australian Wood Duck (21%). The remaining four species comprised 13% of the total harvest.

Table 6

Species	Reported harvest	Proportion of harvest	SE	Estimated harvest	SE	95%CI	
						Lower	Upper
Australian Wood Duck	720	0.21	0.007	90,929	8,967	49,849	165,862
Blue-winged Shoveler*	0	NA	NA	NA	NA	NA	NA
Chestnut Teal	108	0.03	0.003	13,639	1,809	6,829	27,240
Grey Teal	1,386	0.40	0.008	175,038	16,658	96,935	316,071
Hardhead	64	0.02	0.002	8,083	1,251	3,843	17,001
Mountain Duck	96	0.03	0.003	12,124	1,660	6,008	24,467
Pacific Black Duck	938	0.27	0.008	118,460	11,486	65,256	215,042
Pink-eared Duck	159	0.05	0.004	20,080	2,428	10,355	38,938

* Game Licence holders were not permitted to harvest Blue-winged Shoveler (*Anas rhynchos*), also referred to as Australasian Shoveler, in 2017.

Average number of days on which ducks were hunted per Game Licence holder for 2017

Each Game Licence holder hunted an average of 3.8 days during the 2017 duck-hunting season (Table 7). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 96,508 hunter days (95% CI = 83,097–112,084).

Table 7

Period	Days hunted	SE	95%CI	
			Lower	Upper
18 – 19 Mar	0.70	0.06	0.59	0.83
20 Mar – 2 Apr	0.62	0.09	0.47	0.82
3 – 16 Apr	0.61	0.12	0.41	0.91
17 – 30 Apr	0.53	0.12	0.34	0.81
1 – 14 May	0.46	0.10	0.30	0.70
15 – 28 May	0.43	0.11	0.27	0.70
29 May – 12 Jun	0.49	0.11	0.32	0.75
Total per licence holder	3.83	0.27	3.33	4.40
Total hunting days	96,507	7,377	83,096	112,083

Percentage of days hunted and associated duck harvest by land tenure in 2017

Greater duck hunting effort was expended on public (51.7%) than on private (46.1%) land, while the proportion of ducks being harvested solely on private land (49.4%) and public land (47.7%) were similar (Table 8).

Table 8

Land tenure	Days (%)	Duck harvest (%)
Private land only	46.1	47.7
Public land only	51.7	49.4
Both	1.8	2.6
Total	99.6	99.7

Estimates of total duck harvest in 2017 by CMA region

Total harvest was estimated to be greatest in the North Central CMA, followed by the Goulburn Broken CMA and the West Gippsland CMA (Figure 2). The top five towns for the total reported number of ducks harvested were (in descending order) Sale, Shepparton, Boort, Horsham and Kerang. The top five towns for the total number of reported duck hunting days were (in descending order) Sale, Shepparton, Boort, Horsham and Geelong.

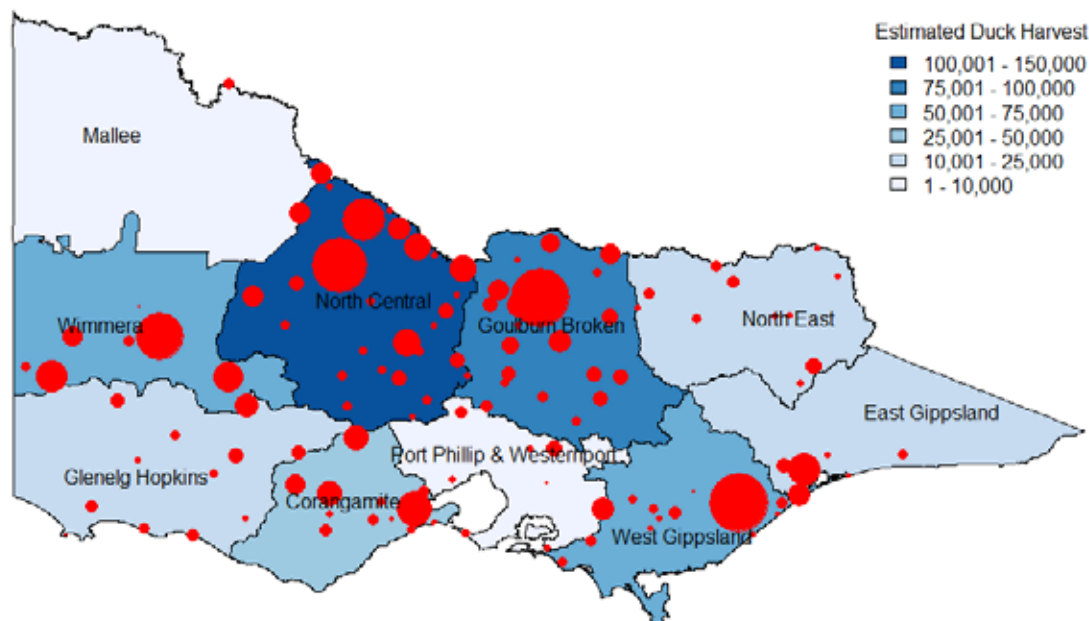


Figure 2: Red circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest.

Stubble Quail

Summary of responses for Stubble Quail surveys in 2017

The number of Game Licence holders endorsed to hunt Stubble Quail remained relatively constant throughout the season, increasing from 27,929 at opening weekend to 29,387 at the end of the season (Table 9). To achieve the required sample size of respondents, slightly more than 300 licence holders were contacted each survey, with an average of 98.5% of those contacted being willing to take part.

Table 9

Stubble Quail survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted*	Stubble Quail harvested**
1	Opening weekend	27,929	300	15	20	107
2	April ***	27,929	300	31	91	752
3	May	29,203	300	26	60	563
4	June	29,387	300	25	60	530

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

** Stubble Quail harvested indicates total number of Stubble Quail harvested by respondents.

*** During April, after the opening weekend.

Proportion and corresponding total number of Stubble Quail licence holders who hunted in each survey period in 2017

The proportion of Game Licence holders endorsed to hunt Stubble Quail who hunted in each survey period varied throughout the season. During opening weekend, 5% of licence holders hunted, corresponding to approximately 1,396 hunters (Table 10). The proportion who hunted during other survey periods was up to 10% (Table 10).

Table 10

Period	Proportion	SE	95%CI		Total hunters	SE	95%CI	
			Lower	Upper			Lower	Upper
Opening weekend	0.05	0.013	0.03	0.08	1,396	351	859	2,270
April	0.10	0.018	0.07	0.14	2,886	491	2,073	4,018
May	0.09	0.016	0.06	0.12	2,531	474	1,758	3,643
June	0.08	0.016	0.06	0.12	2,449	469	1,688	3,552

Average harvest of Stubble Quail per hunter (Game Licence holders who hunted) for each survey period in 2017

Within each survey period, there was large variation in the reported harvest of Stubble Quail per hunter (i.e. per Game Licence holder who hunted). Some hunters harvested more than 40 Stubble Quail in a survey period, whereas some did not harvest any Stubble Quail (Figure 3). The average number of Stubble Quail per hunter varied throughout the season (Table 11). The average harvest per hunter was 7.1 Stubble Quail on opening weekend, which was approximately a third of the average harvest per hunter for any other survey period. The largest average harvest per hunter was 24.3 Stubble Quail (in the remainder of April after the opening weekend).

Table 11

Period	Average harvest per hunter*	SE	95%CI	
			Lower	Upper
Opening weekend	7.13	2.42	3.73	13.64
April	24.26	5.09	16.15	36.43
May	21.65	3.72	15.50	30.25
June	21.20	4.90	13.55	33.16

* Average harvest per hunter = Quail harvested divided by Respondents who hunted (Table 9).

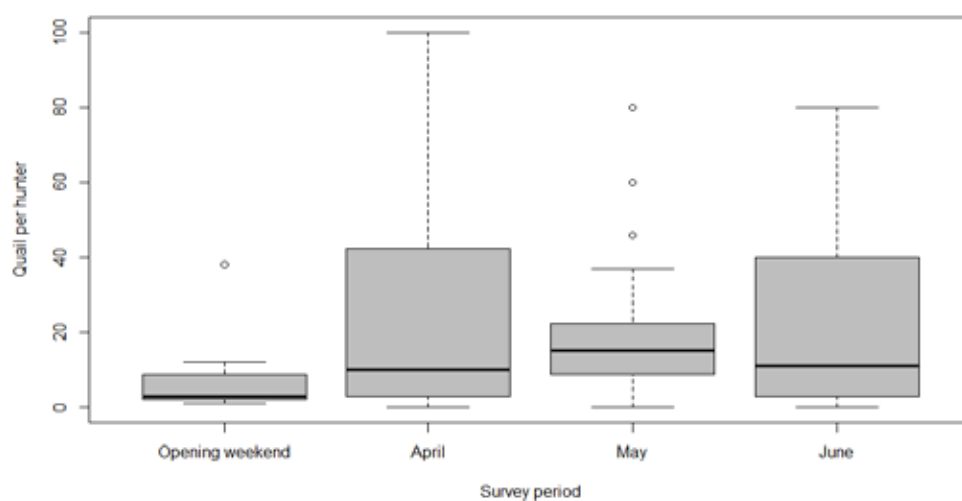


Figure 3: Boxplot of the number of Stubble Quail reported harvested by individual hunters for each survey period in 2017. The bottom and top of each 'box' indicates the 25th and 75th percentiles, respectively, with the black horizontal line indicating the median reported value.

Estimates of the total Stubble Quail harvest in Victoria in 2017 by holders of a Game Licence endorsed for Stubble Quail

There were an estimated 186,691 Stubble Quail harvested by all holders of a Game Licence endorsed for Stubble Quail during the 2017 Stubble Quail season (95% CI = 138,651–251,376). The April harvest total was greater than the May and June harvest totals (Table 12).

Table 12

Period	Total harvest*	SE	95%CI	
			Lower	Upper
Opening weekend	9,961	4,212	4,499	22,057
April	70,009	18,904	41,623	117,753
May	54,804	13,937	33,552	89,517
June	51,917	15,586	29,192	92,333
Total	186,691	28,500	138,651	251,376

* Total harvest = Harvest per hunter (Table 11) × Total hunters (Table 10). Numbers may differ slightly due to rounding of average harvest per hunter.

Estimates of average harvest of Stubble Quail per Game Licence holder in each survey period in 2017

The total average season harvest per licence holder was estimated to be 6.5 Stubble Quail (95% CI = 4.8–8.8; Table 13). Note that, for each survey period, the average Stubble Quail harvest per Game Licence holder was lower than the average Stubble Quail harvest per hunter (Table 11), as the former includes those respondents who did not hunt during the survey period, whereas the latter includes only those who hunted.

Table 13

Period	Average harvest*	SE	95%CI	
			Lower	Upper
Opening weekend	0.36	0.15	0.16	0.79
April	2.51	0.68	1.49	4.22
May	1.88	0.48	1.15	3.07
June	1.77	0.53	0.99	3.14
Total	6.51	0.99	4.83	8.77

* Average harvest per Game Licence holder = Stubble Quail harvested divided by Respondents (Table 9).

Days on which Stubble Quail were hunted per Game Licence holder for 2017

Using a telephone survey immediately after the 2017 Stubble Quail season ended, it was estimated that 15% (95% CI = 12%–18%) of Game Licence holders actually hunted for Stubble Quail during the 2017 Stubble Quail season. That equates to an estimate of 4,268 (95% CI = 3,516–5,181) active Stubble Quail hunters in the 2017 Stubble Quail season. The average season total Stubble Quail harvest per active Stubble Quail hunter was estimated to be 43.7 (95% CI = 30.7–62.3).

Each Game Licence holder hunted an average of 0.8 days during the 2017 Stubble Quail hunting season (Table 14). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 22,052 hunter days (95% CI = 16,270–29,887).

Table 14

Period	Days hunted	SE	95%CI	
			Lower	Upper
Opening weekend	0.07	0.02	0.04	0.11
April	0.30	0.07	0.20	0.47
May	0.20	0.04	0.14	0.29
June	0.20	0.05	0.13	0.32
Total per licence holder	0.77	0.09	0.61	0.98
Total hunting days	22,052	3,441	16,270	29,887

Percentage of days hunted and associated Stubble Quail harvest by land tenure and gundog usage in 2017

Most Stubble Quail hunting was conducted on private land (87.4% of the hunting days and 89% of the harvested Stubble Quail) (Table 15). A very small proportion of hunting was conducted in public land State Game Reserves (12.1% of days and 10.8% of the harvested Stubble Quail), with less than 1% reported hunting on both private land and State Game Reserves during the same hunting trip. The percentage of Stubble Quail hunting days where gundogs were used (77.1%) was similar to the percentage of Stubble Quail harvested using gundogs (78.2%, Table 15).

Table 15

Land tenure	Days (%)			Stubble Quail harvest (%)		
	No gundogs	Gundogs used	Total	No gundogs	Gundogs used	Total
Private land only	21.2	66.2	87.4	20.3	68.6	89.0
State Game Reserves only	1.7	10.4	12.1	1.5	9.3	10.8
Both	0.0	0.4	0.4	0.0	0.3	0.3
Total	22.9	77.1	100.0	21.8	78.2	100.0

Percentage of hunting days and associated Stubble Quail harvest per grassland type in 2017

More Stubble Quail hunting and Stubble Quail harvesting took place on stubble (64.1% and 64.6%, respectively) than on other individual grassland types or combinations of grasslands (Table 16).

Table 16

Grassland	Days hunted (%)	Stubble Quail harvest (%)
Introduced grass	4.3	2.3
Native and introduced grass	0.4	0.8
Native grass	17.7	16.6
Stubble	64.1	64.6
Stubble and introduced grass	0.9	0.9
Stubble and native grass	12.6	14.8
Total	100.0	100.0

Estimates of total Stubble Quail harvest in 2017 by CMA region

Total harvest was estimated to be greatest in the North Central CMA, followed by the Corangamite CMA and the Goulburn Broken CMA (Figure 4). The top five towns for the total reported number of Stubble Quail harvested were (in descending order) Donald, Lake Bolac, Horsham, Cressy and Geelong. The top five towns for the total number of reported Stubble Quail hunting days were (in descending order) Horsham, Cressy, Yarrawonga, Lake Bolac and Bairnsdale.

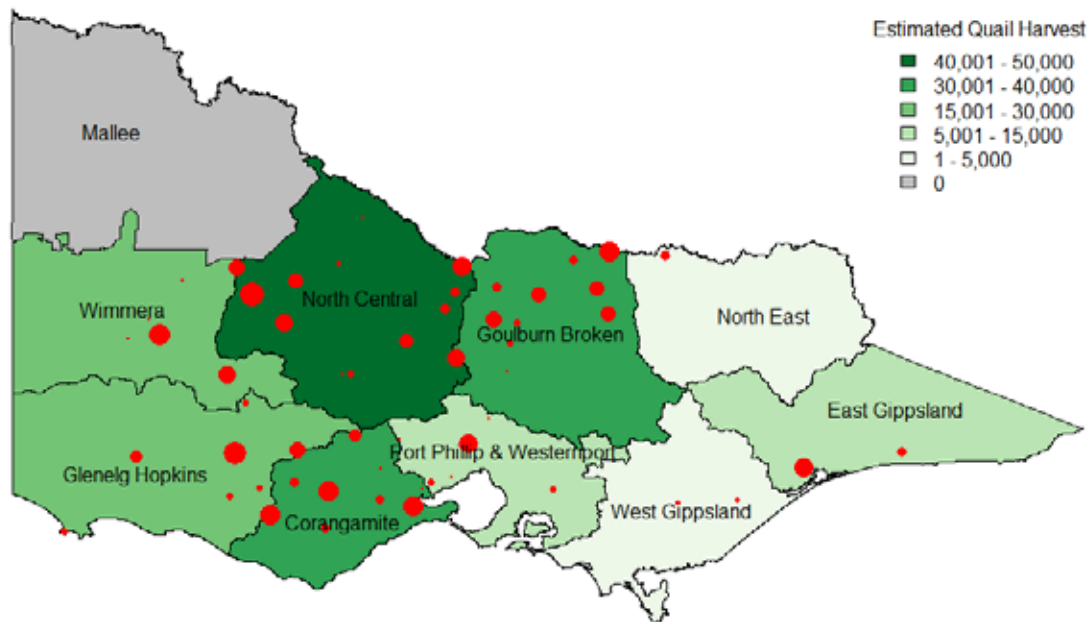


Figure 4: Red circles indicate the nearest town to harvest locations, with symbol size proportional to reported harvest.

4. Discussion

Duck

A total of 438,353 ducks were estimated to have been harvested in Victoria during the 2017 season (95% CI = 365,549–525,657), which was a marked increase from the previous two seasons in 2015 and 2016, but marginally greater than average estimated harvest from 2009 to 2017 of 385,571 (Table 17 and Figure 5). Some of this increase may be explained by the change in bag limits, from four ducks per day in 2016 (except for opening day, when the limit was eight ducks) to 10 duck per day in 2017. Environmental conditions also improved moderately with a wet winter/spring in 2016, resulting in good breeding conditions and recruitment for the 2017 season. The increase in harvest from 2016 was not uniform across duck species. The Grey Teal (most commonly harvest duck species in 2017) harvest more than doubled (127% increase) and had its second largest estimated harvest (only 2011 was larger). Pacific Black Duck and Australian Wood Duck (the other most common duck species harvested) increased by a much smaller amount (32% and 17% increases respectively).

The estimated harvest numbers for Hardhead and Pink-eared Duck in 2017 were more than 12 times larger than the 2016 season. The estimated Mountain Duck harvest in 2017 was the largest recorded in the telephone surveys. Chestnut Teal was the only duck species to have a decreased estimated harvest (25% decrease), with 2017 being the second lowest recorded in the telephone surveys. The estimated number of hunting days were similar to historical levels. Hunter efficiency (ducks per hunting day) was much greater in 2017 compared to 2016 (68% increase) and a 68% increase compared to the average from 2009 to 2017.

It was estimated that 66% (95% CI = 61%–70%) of Game Licence holders endorsed to hunt duck actually hunted for ducks during the 2017 duck season. That equates to an estimate of 17,242 (95% CI = 16,059–18,513) active duck hunters in the 2017 duck season. The average duck harvest per active duck hunter was estimated to be 25.4 (95% CI = 20.9–30.9).

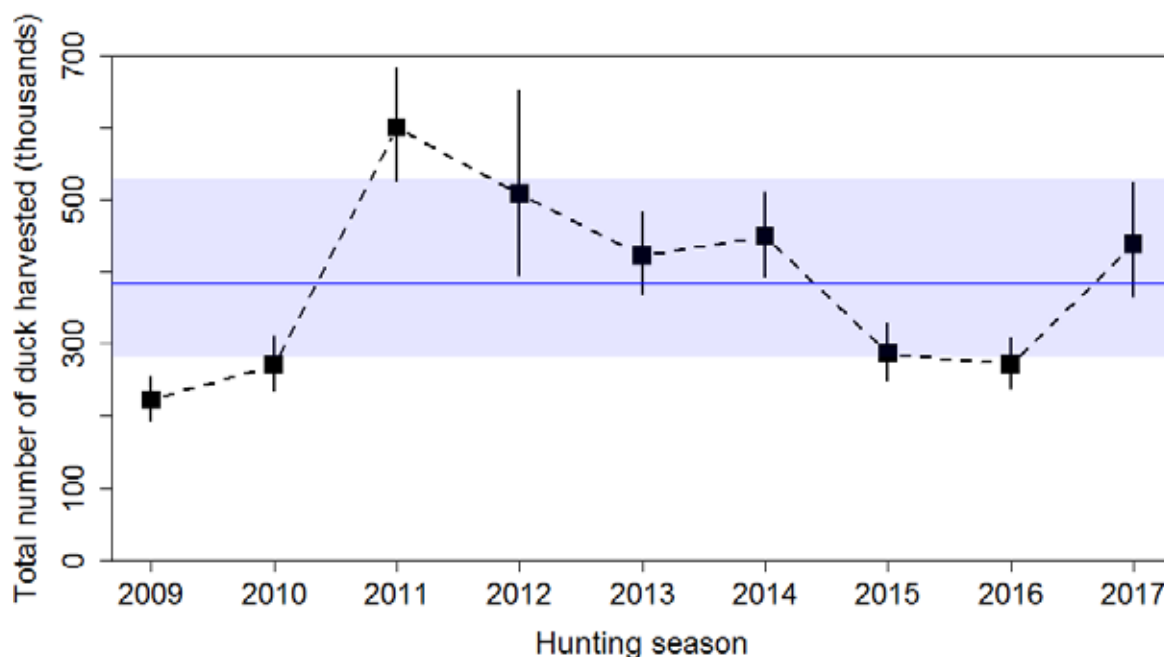


Figure 5: Estimated total duck harvests (in thousands) from 2009 to 2017. The square is the estimated total harvest for each season; the solid vertical line indicates the 95% confidence interval for each year's harvest; the blue line is the average duck harvest from 2009 to 2017; the shaded area is the 95% confidence interval for the average duck harvest from 2009 to 2017.

Table 17. Comparison of duck harvests of 2009 to 2017.

Year	Australian Wood Duck	Blue-winged Shoveler	Chestnut Teal	Grey Teal	Hardhead	Mountain Duck	Pacific Black Duck	Pink-eared Duck	Total harvest	Hunting days	Ducks per licence holder	Hunting days per licence holder	Ducks per hunting day
2009	131,084	NA	13,176	20,919	NA	2,173	55,150	NA	222,302	76,659	11.10	3.98	2.79
2010	112,390	216	14,354	26,011	324	5,936	96,487	0	270,574	85,801	12.54	3.98	3.15
2011	132,908	4,854	49,812	211,034	25,657	8,090	156,484	12,597	600,739	103,450	26.02	4.48	5.81
2012	150,150	1,319	23,506	110,574	30,222	9,234	160,704	21,587	508,256	109,718	21.19	4.60	4.61
2013	106,553	7,104	39,804	135,947	7,349	2,694	92,714	30,129	422,294	91,748	17.24	3.75	4.60
2014	131,282	4,155	29,866	127,126	6,363	8,440	127,646	14,154	449,320	118,800	17.29	4.57	3.78
2015	80,194	1,497	19,456	79,945	998	6,860	81,940	15,839	286,729	90,634	11.35	3.59	3.16
2016	77,955	NA	18,097	77,069	506	6,454	89,850	1,645	271,576	100,749	10.73	3.98	2.70
2017	90,929	NA	13,639	175,038	8,083	12,124	118,460	20,080	438,353	96,508	17.36	3.83	4.53
Average	112,605	3,191	24,634	107,074	9,938	6,889	108,826	14,504	385,571	97,119	16.09	4.08	3.94

NA represents species that were not legal to hunt during that year.

Stubble Quail

The total of 186,691 Stubble Quail estimated to have been harvested in Victoria during the 2017 season (95% CI = 138,651–251,376) is consistent with the average estimated harvest from 2009 to 2017 of 177,771 (Figure 6 and Table 18). However, that is a marked increase from the 2014 to 2016 Stubble Quail season harvests and most likely in response to improved environmental conditions following a wet winter/spring in 2016.

It was estimated that 15% (95% CI = 12%–18%) of Game Licence holders endorsed to hunt Stubble Quail actually hunted for Stubble Quail during the 2017 season. That equates to an estimate of 4,268 (95% CI = 3,516–5,181) active Stubble Quail hunters in the 2017 Stubble Quail season. The average Stubble Quail harvest per active Stubble Quail hunter was estimated to be 43.7 (95% CI = 30.7–62.3)

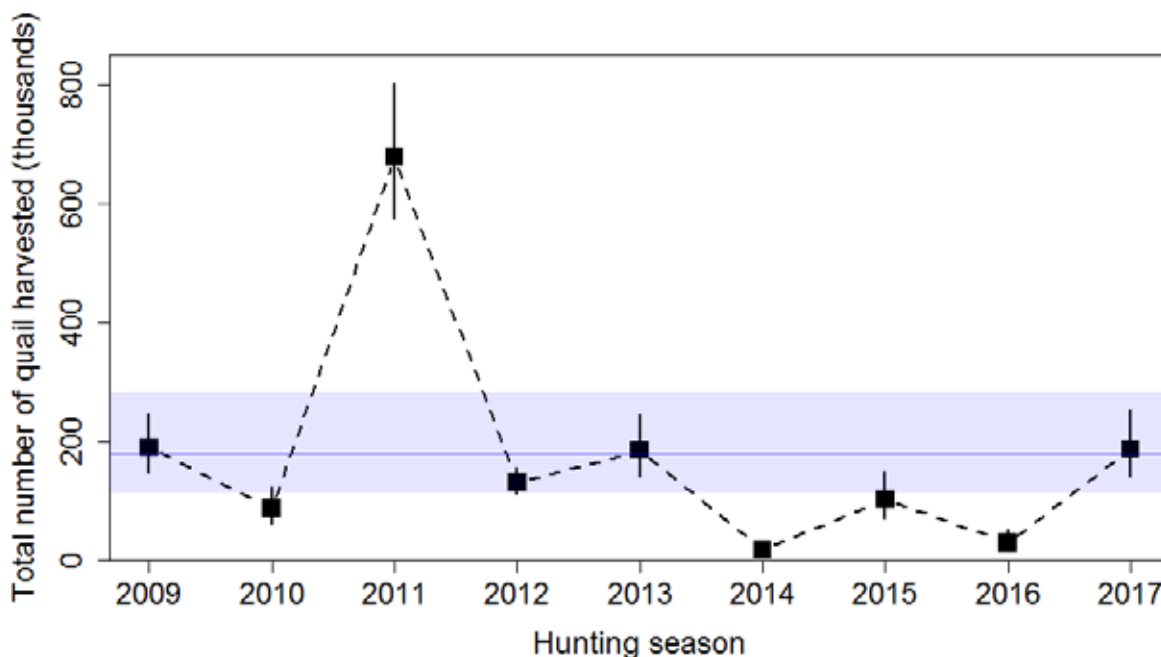


Figure 6: Estimated total Stubble Quail harvests (in thousands) from 2009 to 2017. The square is the estimate for each season; the solid line indicates the 95% confidence interval; the blue line is the average Stubble Quail harvest from 2009 to 2017; the shaded area is the 95% confidence interval for the average Stubble Quail harvest from 2009 to 2017.

Table 18. Comparison of Stubble Quail harvests of 2009 to 2017.

Year	Total harvest	Hunting days	Stubble Quail per licence holder	Hunting days per licence holder	Stubble Quail per hunting day
2009	189,155	24,648	7.89	1.03	7.97
2010	86,302	24,739	3.59	1.03	3.48
2011	678,431	46,719	26.17	1.80	14.52
2012	129,711	22,262	4.80	0.82	5.81
2013	184,123	21,958	6.69	0.98	8.39
2014	16,243	10,852	0.56	0.38	1.47
2015	101,244	22,432	3.58	0.79	4.51
2016	28,043	6,559	1.00	0.23	4.29
2017	186,691	22,052	6.51	0.77	8.45
Average	177,771	22,469	6.75	0.87	7.76

Due to the structure of Game Licences in Victoria, not every holder of a Game Licence endorsed to hunt Stubble Quail will hunt Stubble Quail. The price of a Game Licence for game birds including duck is the same as a Game Licence for game birds not including duck. Anyone who wants to hunt ducks automatically has Stubble Quail included in their licence. For many hunters, duck hunting will be their primary activity. Hence, a high proportion of Game Licence holders will be permitted to hunt Stubble Quail, even though they may not intend to do so. This does not affect the estimates of Stubble Quail harvest, because the calculations explicitly account for the proportion of Game Licence holders endorsed to hunt Stubble Quail who did not actually hunt Stubble Quail.

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

Locations with the most hunting days

The top five towns for the total number of reported duck hunting days in 2017 were (in descending order) Sale, Shepparton, Boort, Horsham and Geelong.

The top five towns for the total number of reported Stubble Quail hunting days in 2017 were (in descending order) Horsham, Cressy, Yarrawonga, Lake Bolac and Bairnsdale.

Combining duck and Stubble Quail, Sale had the most game bird hunting days during the 2017 hunting seasons, followed by Shepparton, Horsham, Boort and Geelong. This assumed that all hunting days were equal in length, even though the time spent hunting on any particular day could vary considerably for each respondent, and for game species.

Assumptions

The estimates of harvest for each game type were derived with the assumption that the samples of respondents were representative of the entire population of Victorian Game Licence holders. 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 opening weekend and every two-week period thereafter in the case of ducks, and monthly for Stubble Quail, 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, Geissler, and Hoover 1992). Nevertheless, some bias likely remains, and the estimates of total harvest should be interpreted with caution.

It needs to be noted that due to a clerical error, the 2016 telephone Stubble Quail survey did not follow the standard methodology, as all surveys happened at the end of the season. That means the results of the 2016 telephone Stubble Quail survey may have increased memory bias and may not be strictly comparable with those of other years. However, it is assumed that any difference is small enough that the 2016 Stubble Quail survey results can be used for comparisons with other years.

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 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 3). For example, within a given survey period for duck hunting, some respondents indicated that they hunted unsuccessfully, whereas others took multiple trips and indicated a total harvest of more than 50 ducks during the same period. The second source of uncertainty was due to sampling the 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 ducks and 300 respondents per survey for Stubble Quail. Statistically, these sample sizes were considered adequate for providing reasonable estimates.

The spatial distributions of the duck and Stubble Quail harvest should also be interpreted with caution. Grouping the harvest for a relatively large region (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 come 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 A: Additional method details

Common definitions used

SD = standard deviation of the data. Represents the variation in the numbers reported.

SE = standard error of the mean. Represents the variation in the estimated mean.

CV = coefficient of variation. 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:

$$p_j = \frac{h_j}{n_j} \quad \text{e.g. for Duck Survey 3, we obtained: } \frac{34}{200} = 0.170.$$

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:

$$H_j = p_j L \quad \text{e.g. for Duck Survey 3, we obtained: } 0.17 \times 25418 = 4,321.$$

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):

$$w_j = \frac{y_j}{h_j} \quad \text{e.g. for Duck Survey 3, we obtained: } \frac{290}{34} = 8.53.$$

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):

$$W_j = w_j H_j \quad \text{e.g. for Duck Survey 3, we obtained: } 8.53 \times 4,321 = 36,856.$$

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

$$W_{TOT} = W_1 + W_2 + W_3 + W_4 + W_5 + W_6 + W_7.$$

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

$$SE(p_j) = \sqrt{\frac{p_j(1-p_j)}{n_j}} \quad \text{e.g. for Duck Survey 3, we obtained: } \sqrt{\frac{0.17 \times 0.83}{200}} = 0.027.$$

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

$$SE(w_j) = \frac{SD(w_j)}{\sqrt{h_j}}, \text{ e.g. for Duck Survey 3, we obtained: } \frac{9.196}{\sqrt{34}} = 1.58.$$

The standard error for the total estimated harvest per survey period (W_j) was found by determining the coefficient of variation (CV) of p_j and w_j and then adding their sum of 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:

$$SE(W_{TOT}) = \sqrt{(SE(W_1))^2 + (SE(W_2))^2 + \dots + (SE(W_7))^2}.$$

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 duck harvest we have

$$CV = \frac{20,286}{286,729} = 0.071$$

$$r = \exp\left(1.96\sqrt{\ln(1 + 0.071^2)}\right) = 1.15.$$

Therefore, Upper and Lower Confidence Intervals are given by:

$$UL = 286,729 \times 1.15 = 329,321$$

$$LL = 286,729 \div 1.15 = 249,645.$$

Appendix B: Boxplot explanation

A boxplot is a way of displaying key points of the data and is especially good for comparing groups of data. They are sometimes referred to as box-and-whisker plots. 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 or 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: 25% of the data are in 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 B1 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 more than 50 ducks. Sometimes there are no whiskers because the minimum (or maximum) is the same as the lower (or upper) quartile (see Figure 3, where at least 25% of Licence Holders who hunted were unsuccessful).

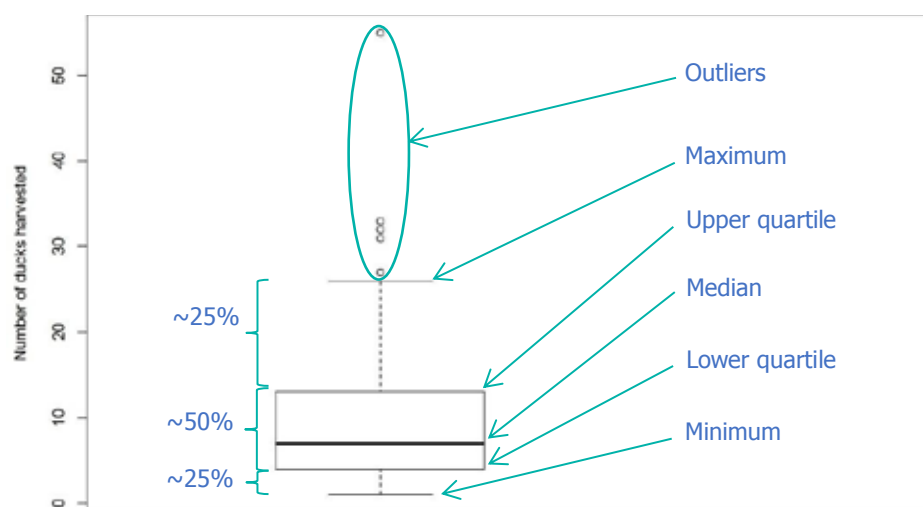


Figure B1: Example boxplot, with labels.

Appendix C: Surveys

VICTORIAN DUCK HUNTING SURVEY – IORTMIGNIUY

Introduction: Hi my name is -----and I am calling about duck season on behalf of the Game Management Authority.

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

(*use if asked to explain why*) The survey of licensed Duck Hunters over the open season will provide information on hunting practices and harvest information as part of the continued process to improve game management in Victoria.

Survey details:

Date of interview: dd / mm / 2017

Non-responsive: ☐ (tick box)

Survey questions:

1. Did you go duck hunting over the opening weekend? Yes ☐ No ☐
2. Not including opening weekend have you been duck hunting in the two weeks prior to last Sunday? 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 60437 986.
3. How many Duck hunting trips have you taken over this 2 week period? (indicate number in box)
(Each trip needs to be treated separately for question 4 - 8)

	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
4. 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"/>
5. How many ducks did your harvest?	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
6. What species were the duck?	Black duck	Black duck	Black duck	Black duck	Black duck	Black duck
	Wood duck	Wood duck	Wood duck	Wood duck	Wood duck	Wood duck
	Mountain duck	Mountain duck	Mountain duck	Mountain duck	Mountain duck	Mountain duck
	Grey Teal	Grey Teal	Grey Teal	Grey Teal	Grey Teal	Grey Teal
	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal
	Pink Ear	Pink Ear	Pink Ear	Pink Ear	Pink Ear	Pink Ear
	Shoveler	Shoveler	Shoveler	Shoveler	Shoveler	Shoveler
	Hardhead	Hardhead	Hardhead	Hardhead	Hardhead	Hardhead
7. What type of land did you hunt on? "Can register more than one choice"	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land
8. What was the closest major town to the area you hunted?	-----	-----	-----	-----	-----	-----

Victorian Quail Hunting Survey -

Introduction: Hi my name isand I am calling about Stubble Quail season on behalf of the Game Management Authority. I was hoping you had time to answer a few quick questions.

(*use if asked to explain why*) The survey of licensed Quail Hunters over the open season will provide information on hunting practices and harvest information as part of the continued process to improve game management in Victoria.

Survey details:

Date of interview: dd / mm / 2017

Non-responsive: ☐ (tick box)

Survey questions:

1. Do you use a dog when you hunt for quail?

Yes ☐ No ☐
2. Did you go hunting on the opening Saturday?

Yes ☐ No ☐ (tick box)

(if 'Yes')

(Indicate number of quail taken in box)
3. Did you go hunting on the opening Sunday?

Yes ☐ No ☐ (tick box)

(if 'Yes')

(Indicate number of quail taken in box)
4. Did you go quail hunting in 2017?

Yes ☐ No ☐ (tick box) (if yes complete questions for each month hunted)

(after opening weekend)

	Record number of trips	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6	Trip 7
5. How many trips did you go on in April?							
6. How many days did you go hunting?							
7. How many Quail did your harvest?							
8. What type of land did you hunt on? "Can register more than one choice"	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land	State Game Reserve Private land Public land
9. What type of grasslands was the hunt on? "Can register more than one choice"	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass	Stubble Native Grass Introduced grass
10. What was the closest major town to the area you hunted?	-----	-----	-----	-----	-----	-----	-----

