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# Estimates of duck and Stubble Quail harvests in Victoria for 2020

Results from surveys of Victorian Game Licence holders in 2020

P. D. Moloney and J. O. Hampton





#### Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.



Arthur Rylah Institute for Environmental Research Department of Environment, Land, Water and Planning PO Box 137 Heidelberg, Victoria 3084 Phone (03) 9450 8600 Website: <u>www.ari.vic.gov.au</u>

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# Estimates of duck and Stubble Quail harvests in Victoria for 2020

Results from surveys of Victorian Game Licence holders in 2020

Paul D. Moloney<sup>1</sup> and Jordan O. Hampton<sup>2</sup>

<sup>1</sup>Arthur Rylah Institute for Environmental Research 123 Brown Street, Heidelberg, Victoria 3084

<sup>2</sup>Game Management Authority 535 Bourke Street, Melbourne, Victoria 3000



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### Summary

#### Context:

To effectively manage game species, it is important to quantify the number of animals harvested. Since 2009, the Victorian State Government game management agency has commissioned a series of regular telephone surveys of randomly selected Game Licence holders. Each year, telephone surveys are conducted during the various game harvest seasons for deer, ducks and Stubble Quail (*Coturnix pectoralis*). This report focuses only on the duck and Stubble Quail harvests for 2020.

#### Aims:

The aim of this report is to provide estimates of the total harvests of ducks and Stubble Quail by Victorian Game Licence holders during the 2020 hunting seasons.

#### Method:

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 during the period for which the survey applied, and (if applicable) the number and species of birds harvested. Additional information was obtained on hunting methods and locations. Data collected during these telephone interviews was analysed to estimate the total harvest and days spent hunting for ducks and Stubble Quail. Additional metrics related to hunter effort and efficiency were also estimated.

#### Results:

The total estimated duck harvest in 2020 was 60,400 (95% confidence interval (CI) = 47,500-76,800). This was the lowest recorded harvest since the telephone surveys were introduced in 2009. It was less than one-sixth of the average annual duck harvests revealed by previous surveys (373,000). The total estimated number of duck hunting days was 29,500 (95\% CI = 22,900-38,100) and was the lowest recorded, less than one-third of the average annual duck hunting days in previous surveys (95,000).

The two most commonly harvested species were Pacific Black Duck (*Anas superciliosa*) (which comprised 46% of the total harvest) and Australian Wood Duck (*Chenonetta jubata*) (30% of the total harvest). The remaining ducks harvested were Grey Teal (*Anas gracilis*) (10%), Chestnut Teal (*Anas castanea*) (7%), Mountain Duck (*Tadorna tadornoides*) (6%) and Pink-eared Duck (*Malacorhynchus membranaceus*) (0%). There were no reports of Hardhead (*Aythya australis*) being harvested during the telephone survey. Hunting of Blue-winged Shoveler (*Anas rhynchotis*) was prohibited for the 2020 season.

Game Licence holders endorsed to hunt ducks who actively hunted ducks during the 2020 duck season harvested an average of 8.1 ducks (95% CI = 6.1-10.7) over an average of 3.9 days (95% CI = 2.9-5.3).

The total estimated Stubble Quail harvest in 2020 was 4,800 (95% CI = 2,300–10,200) and was the lowest recorded since the telephone surveys were introduced in 2009, and less than 3% of the average annual Stubble Quail harvest in the previous surveys (173,000). The total estimated number of Stubble Quail hunting days was 3,800 (95% CI = 2,300–6,300) and was the lowest recorded, less than one-fifth of the average annual Stubble Quail hunting days in the previous surveys (22,000).

Game Licence holders endorsed to hunt Stubble Quail who actively hunted during 2020 harvested an average of 5.1 (95% CI = 6.1-10.7) Stubble Quail, over an average of 3.9 (95% CI = 2.9-5.3) days.

The total number of hunter days during the 2020 hunting season for ducks and Stubble Quail combined was estimated to be 33,300 (95% CI = 25,500-41,100).



#### Conclusions and implications:

- 1. In 2020, both duck and Stubble Quail hunting was affected by governmentimposed COVID-19 restrictions which impeded hunters' movement within Victoria, limited the size of social gatherings and prevented overnight camping at times. Combined, these restrictions limited hunters' ability to actively participate in the field. Before COVID-19 emerged, the duck season had already been reduced, with a duration of approximately 5 weeks (instead of the prescribed 12) and bag limit of 3 ducks per day (instead of the prescribed 10) due to ongoing drought conditions which reduced game duck abundance and habitat availability. The Stubble Quail seasonal arrangements remained unchanged from the regulations (i.e. 3 months in length and a 20 bird per day bag limit).
- 2. The COVID-19 restrictions reduced the ability of hunters to travel to go hunting and likely played a central role in the following findings:
  - The proportion of active duck hunters (Game Licence holders who actually hunted) was only 32%, down from 55% in 2018 and 2019;
  - The proportion of active Stubble Quail hunters was only 4%, down from 17% in 2018 and 8% in 2019;
  - The number of both ducks and Stubble Quail harvested was the lowest recorded;
  - The number of hunting days was the lowest recorded for both ducks and Stubble Quail.

3. Performing telephone surveys throughout the year is likely to minimise memory bias and non-response bias. However, sources of bias will remain (due to overand under-reporting), and the estimates of total harvest must be interpreted with care. Additionally, surveys were only conducted when hunters were permitted to travel to hunt on public or private property (i.e. after 13 May 2020). Therefore, duck hunters hunting on their own properties between 2-12 May were not surveyed, nor were Stubble Quail hunters hunting on their own properties between 4 April – 12 May. The number of hunters doing so was considered to be very low and unlikely to be picked up in the telephone survey.



### 1 Introduction

To effectively manage game species, it is important to quantify the numbers of animals harvested. Since 2009, the Victorian State Government game management agency (currently the Game Management Authority) has commissioned a series of regular telephone surveys of randomly selected Game Licence holders. Telephone surveys were conducted during the various game harvest seasons for deer, ducks and Stubble Quail. However, this report focuses only on the duck and Stubble Quail harvests. Deer harvests are addressed in a separate report.

In response to sustained dry conditions and low observed abundance of game ducks in 2019, the duration of the 2020 duck-hunting season was reduced from the usual 12 weeks to approximately 5 weeks (38 days), from 2 May to 8 June 2020 (Game Management Authority 2020). However, due to Victorian Government policies related to the response to the COVID-19 global pandemic, at the start of the season, travel restrictions meant that Game Licence holders could only hunt ducks on their own properties as travel to hunt on public land or other peoples' private property was prohibited. Restrictions were later eased which allowed hunters to travel and hunt on public and private land between 13 May -8 June 2020, inclusive, however, hunters were not permitted to gather in groups of larger than 10 and overnight camping was not permitted.

Seven game duck species could legally be hunted in 2020: Pacific Black Duck (*Anas superciliosa*), Australian Wood Duck<sup>1</sup> (*Chenonetta jubata*), Mountain Duck<sup>2</sup> (*Tadorna tadornoides*), Grey Teal (*Anas gracilis*), Chestnut Teal (*Anas castanea*), Pink-eared Duck (*Malacorhynchus membranaceus*) and Hardhead<sup>3</sup> (*Aythya australis*). Blue-winged Shoveler<sup>4</sup> (*Anas rhynchotis*, a declared game species) was prohibited from hunting for the 2020 season due to continuing low abundance. The bag limit for the 2020 season was 3 game ducks per hunter per day.

The 2020 duck hunting survey used a similar method (i.e. telephone surveys) to that followed during the 2005, 2006 and

2009–2019 duck-hunting seasons (Barker 2006; Gormley and Turnbull 2009, 2010, 2011; Moloney and Turnbull 2012, 2013, 2014, 2015, 2016, 2017, 2018; Moloney and Powell 2019). However, due to the unusual circumstances of 2020, the surveys of Game Licence holders endorsed to hunt ducks started on the first weekend that hunters were permitted to travel to hunt on public and private land, 16 May (13 May was a Wednesday), and surveys were then conducted weekly, rather than the usual fortnightly, for the remaining 3 weeks of the season.

The 2020 Stubble Quail (Coturnix pectoralis) hunting season lasted 12 weeks, from 4 April to 30 June 2020 (Game Management Authority 2020). The daily bag limit for the 2020 season was 20 Stubble Quail per hunter. As for ducks, Victorian Government policies related to COVID-19 meant that Stubble Quail hunting was only permitted on a person's own private property at the start of the season. Hunters could not travel to another person's private property or public land to go hunting. Hunters were allowed to travel to hunt on public and private land from 13 May, but only in groups of no more than 10 and no overnight camping was permitted. From 1 June, hunters were allowed to camp overnight and group sizes were increased to 20. These arrangements stayed in place until the end of the season.

The 2020 Stubble Quail hunting survey used a similar method (i.e. telephone surveys) to that followed during the 2009-2015 and 2017–2019 Stubble Quail hunting seasons (Gormley 2009; Gormley and Turnbull 2009, 2010, 2011; Moloney and Turnbull 2012, 2013, 2014, 2015, 2017, 2018; Moloney and Powell 2019). Due to a clerical error, the 2016 Stubble Quail hunting survey used a slightly different method (Moloney and Turnbull 2016). However, due to the unusual circumstances in 2020 arising from the COVID-19 restrictions, the surveys of Game Licence holders endorsed to hunt Stubble Quail started on the first weekend that hunters were allowed to travel to hunt on public and private land (i.e. 16 May) and surveys were then conducted at the end of the month for the remainder of the season (i.e. 3 surveys in total).

<sup>&</sup>lt;sup>1</sup> Australian Wood Duck is also referred to as Wood Duck, Maned Duck and Maned Goose.

<sup>&</sup>lt;sup>2</sup> Mountain Duck is also referred to as Australian Shelduck.

<sup>&</sup>lt;sup>3</sup> Hardhead is also referred to as White-eyed Duck.

<sup>&</sup>lt;sup>4</sup> Blue-winged Shoveler is also referred to as Australasian Shoveler.



### 2 Method

#### 2.1 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 (see Appendices A and B). Estimates of total harvest by Game Licence holders were based on the hunting activities reported by the survey respondents.

Duck and Stubble Quail harvest surveys were performed from the first weekend in which COVID-19 travel restrictions allowed licenced hunters to travel to hunt on public and private land (i.e. 16 May) and then for ducks every week (usually fortnightly) thereafter and for Stubble Quail at the end of every month thereafter for the remainder of 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<sup>5</sup> 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 seasons. The number of active hunters was estimated using the survey question in the final survey on whether they had hunted at any stage of the 2020 duck season and Stubble Quail season, respectively.

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 active hunters for that survey period.

For each survey period, the average harvest per hunter<sup>6</sup> 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 active 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 on which 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 C. Information relating to describing and interpreting boxplots is provided in Appendix D.

<sup>&</sup>lt;sup>5</sup> Respondent refers to a Game Licence holder who was contacted and agreed to take part in the survey.

<sup>&</sup>lt;sup>6</sup> 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.



#### 2.2 Duck

Samples were drawn from hunters who held a Game Licence endorsed to hunt ducks during the 2020 season. A random sample of 200 Licence holders was interviewed by telephone immediately after the first weekend when travel restrictions allowed hunters to hunt on public and private land (Duck Survey 1), followed by surveys of independent random samples of Licence holders at weekly intervals for the remainder of the duck season (Duck Surveys 2-4). 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 duckhunting season. They were asked if they had hunted at any stage during the season.

#### 2.3 Stubble Quail

Samples were drawn from hunters who held a Game Licence to hunt Stubble Quail during the 2020 season. A random sample of 300 Licence holders was interviewed by telephone after the first weekend when travel restrictions allowed hunters to hunt on private and public land (Survey 1) and at the end of May, excluding that first weekend (Survey 2), and at the end of June (Survey 3). Respondents were asked to report the number of Stubble Quail harvested, the type of grassland where hunting occurred (native, stubble or introduced) and whether or not dogs 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.

When a Game Licence holder is endorsed for duck, they are automatically endorsed for Stubble Quail (although you can be endorsed for Stubble Quail but not duck). Therefore, the number of Game Licence holders endorsed to hunt Stubble Quail is not representative of the number of self-reported Stubble Quail hunters<sup>7</sup>. In the 2018 Stubble Quail hunter survey, all respondents were asked if they hunted Stubble Quail. This information was used to increase the precision of the estimates for Stubble Quail harvest and hunting days. Unfortunately, in 2019 and 2020 this question was not asked for the first weekend survey, so the precision could not be increased in 2019 or 2020. Future surveys will rectify this.

<sup>&</sup>lt;sup>7</sup> Self-reported Stubble Quail hunters are Game Licence holders endorsed to hunt Stubble Quail who say that they may actually hunt Stubble Quail, regardless of whether they hunted Stubble Quail this season.



### 3 Results

#### 3.1 Duck

The number of Game Licence holders endorsed to hunt ducks was only available at the end of the season. This number was therefore used for each period (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. The proportion of duck Game Licence holders who hunted in each survey period was consistent after the first weekend. During the first weekend, 6% of Game Licence holders hunted, corresponding to approximately 1,286 hunters (Table 2). The proportion who hunted during each other survey period was 19% or ~4,400 duck hunters (Table 2).

Duck survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted <sup>8</sup>	Ducks harvested <sup>9</sup>
1	16–17 May	23,378	200	11	12	28
2	18–24 May	23,378	199	37	76	149
3	25–31 May	23,378	200	38	77	162
4	1–8 June	23,378	200	38	87	177

 Table 1: Summary of responses for duck surveys in 2020

### Table 2: Proportion and corresponding total number of holders of a Game Licence endorsed for duck who hunted in each survey period in 2020

95% CI						95%	% CI	
Period	Proportion	SE	Lower	Upper	Total hunters	SE	Lower	Upper
16–17 May	0.06	0.016	0.03	0.10	1,286	377	732	2,257
18–24 May	0.19	0.028	0.14	0.25	4,347	645	3,255	5,804
25–31 May	0.19	0.028	0.14	0.25	4,442	649	3,341	5,905
1–8 June	0.19	0.028	0.14	0.25	4,442	649	3,341	5,905

<sup>&</sup>lt;sup>8</sup> Days hunted indicates the combined number of days on which duck hunting took place by respondents.

<sup>&</sup>lt;sup>9</sup> Ducks harvested indicates total number of ducks harvested by respondents.



Within each survey period after the first weekend, there was consistency in the reported harvest of ducks per hunter (i.e. per Game Licence holder who hunted). Some hunters harvested more than 15 ducks in a survey period, whereas some did not harvest any ducks (Figure 1). The average number of ducks per hunter was also consistent throughout the season (Table 3). The average harvest per hunter was 2.5 ducks on first weekend, which was smaller than the average harvest per hunter for any other survey period. The greatest average harvest per hunter was 4.7 ducks (in the fourth survey period).



Survey period

### Figure 1: Boxplot of the number of ducks reported harvested by individual hunters for each survey period in 2020

The bottom and top of each 'box' indicate the 25th and 75th percentiles, respectively, and the black horizontal line indicates the median (50th percentile) reported value.

Table 3: Average harvest of ducks per active hunter (Game Licence holders who hunted) for each survey period in 2020

			95%	6 CI
Period	Average harvest per hunter <sup>10</sup>	SE	Lower	Upper
16–17 May	2.55	0.64	1.57	4.13
18–24 May	4.03	0.71	2.86	5.66
25–31 May	4.26	0.65	3.17	5.74
1–8 June	4.66	0.77	3.38	6.42

<sup>&</sup>lt;sup>10</sup> Average harvest per hunter = Ducks harvested divided by Respondents who hunted (Table 1).



There were an estimated 3,273 ducks harvested during first weekend (95% CI = 1,559–6,873), which constituted 5% of the total seasonal harvest (Table 4). The harvest throughout the remainder of the season was relatively consistent between surveys, with weekly estimates ranging from 17,504 to 20,690 ducks harvested. The total season harvest estimate was 60,403 (95% CI = 47,506–76,801; Table 4). Each Game Licence holder hunted for an average of 1.3 days during the 2020 duck-hunting season (Table 5). When multiplied by the total number of Game Licence holders, this equalled a total of 29,501 hunter days (95% CI = 22,868–38,058).

Table 4: Estimates of the total duck harvest in Victoria in 2020 by holders of a Game Licence endorsed for duck

			95%	CI
Period	Total harvest <sup>11</sup>	SE	Lower	Upper
16–17 May	3,273	1,285	1,559	6,873
18–24 May	17,504	4,044	11,196	27,368
25–31 May	18,936	4,025	12,542	28,590
1–8 June	20,690	4,582	13,473	31,771
Total	60,403	7,430	47,506	76,801

Table 5: Total days on which ducks were hunted for 2020

			95%	6 CI
Period	Days hunted	SE	Lower	Upper
16–17 May	1,403	653	589	3,343
18–24 May	8,928	2,159	5,596	14,245
25–31 May	9,001	2,071	5,767	14,047
1–8 June	10,169	2,334	6,523	15,854
Total hunting days	29,501	3,850	22,868	38,058

<sup>&</sup>lt;sup>11</sup> Total harvest = harvest per hunter (Table 3) × total hunters (Table 2). Numbers may differ slightly due to rounding of average harvest per hunter.



Using a telephone survey immediately after the 2020 duck season ended, it was estimated that 32% (95% CI = 28–37%) of entitled Game Licence holders actually hunted for ducks during the 2020 duck season. That equates to an estimate of 7,481 (95% CI = 6,486-8,628) active duck hunters in the 2020 duck season. The average seasonal duck harvest per active duck hunter was estimated to be 8.1 (95% CI = 6.1-10.7). The average number of duck hunting days per active duck hunter was estimated to be 3.9 (95% CI = 2.9-5.3). The total harvest was estimated for each species by multiplying the total estimated duck harvest by the proportion of the total harvest for that species (Table 7). The most frequently harvested species was Pacific Black Duck, comprising 46% of the total reported harvest, followed by Australian Wood Duck (30%) and Grey Teal (10%). The remaining four species comprised 13% of the total harvest. Hunting of Blue-winged Shoveler (Anas rhynchotis) was prohibited for the 2020 game season due to its continuing low abundance.

Table 6: Estimates of active duck hunting<sup>12</sup> in Victoria in 2020 by holders of a Game Licence endorsed for duck

			95%	6 CI
Statistic	Annual estimate	SE	Lower	Upper
Proportion active	0.32	0.02	0.28	0.37
Estimated active hunters	7,481	545	6,486	8,628
Average seasonal harvest per active hunter	8.07	1.15	6.11	10.67
Average hunting days per active hunter	3.94	0.59	2.95	5.28

Table 7: Reported numbers of ducks harvested by hunters, proportions of the total harvest, and estimates of total 2020 harvest for each duck species

	Reported	Proportion		Estimated		95%	% CI
Species	harvest	of harvest	SE	harvest	SE	Lower	Upper
Australian Wood Duck	154	0.30	0.020	18,204	2,553	8,949	37,027
Blue-winged Shoveler	0	NA	NA	NA	NA	NA	NA
Chestnut Teal	37	0.07	0.011	4,374	877	1,892	10,109
Grey Teal	51	0.10	0.013	6,028	1,091	2,710	13,410
Hardhead	0	0.00	0.000	0	NA	NA	NA
Mountain Duck	32	0.06	0.011	3,783	797	1,605	8,913
Pacific Black Duck	235	0.46	0.022	27,778	3,667	13,930	55,392
Pink-eared Duck	2	0.00	0.003	236	169	56	998

<sup>&</sup>lt;sup>12</sup> An active duck hunter is defined as a Game Licence holder endorsed to hunt ducks who hunted for ducks at least once during the 2020 duck season.



During the survey period, greater duck hunting effort was expended on private land (60.7%) than on public land (35.3%), with a similar proportion of ducks being harvested solely on private land (65.1%) and public land (31.6%) (Table 8).

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

Table 8: Percentage of days hunted and associated duck harvest by land tenure in2020.

Land tenure	Days (%)	Duck harvest (%)
Private land only	60.7	65.1
Public land only	35.3	31.6
Both	4.0	3.3
Total	100.0	100.0



#### Figure 2: Estimates of total duck harvest in 2020 by CMA region

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



#### 3.2 Stubble Quail

The number of Game Licence holders endorsed to hunt Stubble Quail was only available at the end of the season. This number was therefore used for each period (Table 9). In order to achieve the required sample size of respondents, slightly more than 300 Licence holders were contacted each survey, with an average of 99.2% of those contacted being willing to take part. The percentage of endorsed Game Licence holders who hunted Stubble Quail was consistent in each survey period throughout the season. During the first weekend, the percentage of Game Licence holders who hunted was 4%, corresponding to approximately 1,167 hunters (Table 10). The percentage who hunted during subsequent two survey periods was 3–4% (Table 10).

Table 9: Summary of responses for Stubble Quail surveys in 2020

Stubble Quail survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted <sup>13</sup>	Quail harvested <sup>14</sup>
1	16–17 May	26,936	300	13	13	15
2	18–31 May	26,936	300	12	13	19
3	1–30 June	26,936	300	9	16	20

Table 10: Proportion and corresponding total number of self-reportedStubble Quail hunters who hunted in each survey period in 2020

			95%	6 CI	Total		95%	6 CI
Period	Proportion	SE	Lower	Upper	hunters	SE	Lower	Upper
16–17 May	0.04	0.012	0.03	0.07	1,167	317	692	1,968
18–31 May	0.04	0.011	0.02	0.07	1,077	305	626	1,856
1–30 June	0.03	0.010	0.02	0.06	808	265	432	1,513

<sup>&</sup>lt;sup>13</sup> Days hunted indicates the combined number of days on which Stubble Quail hunting took place by respondents.

<sup>&</sup>lt;sup>14</sup> Stubble Quail harvested indicates total number of Stubble Quail harvested by respondents.



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 5 Stubble Quail in a survey period, whereas 71% of people who hunted did not harvest any Stubble Quail (Figure 3). The average number of Stubble Quail harvested per hunter varied throughout the season (Table 11). The average harvest per hunter was 1.2 Stubble Quail on the first hunting weekend, which was less than the average harvest per hunter for any other survey period. The largest average harvest per hunter was 2.2 Stubble Quail (in June).



### Figure 3: Boxplot of the number of Stubble Quail reported harvested by individual hunters for each survey period in 2020

The bottom and top of each 'box' indicate the 25th and 75<sup>th</sup> percentiles, respectively, and the black horizontal lines indicate the median (50th percentile) reported value.

Table 11: Average harvest of Stubble Quail per active hunter (Game Licence holders who hunted) for each survey period in 2020

			95%	CI
Period	Average harvest per hunter <sup>15</sup>	SE	Lower	Upper
16–17 May	1.15	0.62	0.43	3.09
18–31 May	1.58	0.69	0.70	3.59
1–30 June	2.22	1.57	0.64	7.74

<sup>&</sup>lt;sup>15</sup> Average harvest per hunter = Stubble Quail harvested divided by Respondents who hunted (Table 9).



There were an estimated 4,848 Stubble Quail harvested during the 2020 season (95% CI = 2,302–10,214). The first weekend on which Stubble Quail could be legally hunted on land other than a hunter's own private property accounted for approximately a quarter of the season's total harvest. Including the first hunting weekend, the May harvest total was greater than the June harvest total (Table 12). Stubble Quail hunters had a total of 3,771 hunter days (95% CI = 2,263-6,284) during the 2020 season (Table 13).

Table 12: Estimates of the total Stubble Quail harvest in Victoria in 2020 by holders of a Game Licence endorsed for Stubble Quail

			95% CI			
Period	Total harvest <sup>16</sup>	SE	Lower	Upper		
16–17 May	1,347	833	442	4,107		
18–31 May <sup>17</sup>	1,706	911	639	4,555		
1–30 June	1,796	1,460	445	7,254		
Total	4,848	1,912	2,302	10,214		

Table 13: Days on which Stubble Quail were hunted per self-reported Stubble Quail hunter for 2020

			95%	% CI
Period	Days hunted	SE	Lower	Upper
16–17 May	1,167.23	456	557	2,445
18–31 May	1,167.23	485	534	2,551
1–30 June	1,436.59	745	552	3,740
Total hunting days	3,771.04	999	2,263	6,284

<sup>&</sup>lt;sup>16</sup> Total harvest = Harvest per hunter (Table 11) × Total hunters (Table 10). Numbers may differ slightly due to rounding of average harvest per hunter.

<sup>&</sup>lt;sup>17</sup> May after the opening weekend.



Using a telephone survey immediately after the 2020 Stubble Quail season closed, it was estimated that 4% (95% CI = 2-5%) of Game Licence holders actually hunted for Stubble Quail during the 2020 Stubble Quail season (Table 14). The estimated number of active Stubble Quail hunters in the 2020 Stubble Quail season was 943 (95% CI = 622-1428). The average active Stubble Quail hunter was estimated to have harvested 5.1 (95% CI = 2.2-11.9) Stubble Quail during the season over an average of 4 (95% CI = 2.1-7.7) hunting days.

Table 14: Estimates of active Stubble Quail hunting<sup>18</sup> in Victoria in 2020 for holders of a Game Licence endorsed for Stubble Quail

	Annual	95% CI					
Statistic	estimate	SE	Lower	Upper			
Proportion of active quail hunters	0.04	0.01	0.02	0.05			
Estimated active quail hunters	942.76	202.09	622.27	1,428.32			
Average seasonal harvest per active hunter	5.14	2.31	2.22	11.91			
Average hunting days per active hunter	4.00	1.36	2.09	7.66			

Most Stubble Quail hunting was conducted on private land (95.2% of hunting days), with the remaining hunting happening on public land (Table 15). However, 100% of the harvested Stubble Quail reported in the telephone surveys were taken on private land. The percentage of Stubble Quail hunting days where dogs were used (38.1%) was similar to the percentage of the harvest for which dogs were used (44.4%, Table 15). The overwhelming majority of Stubble Quail hunting and harvesting took place in stubble paddocks (71.4% and 79.6%, respectively, Table 16).

Table 15: Percentage of days hunted and associated Stubble Quail harvest by land tenure and dog usage in 2020

	Days (%)			H	Harvest (%)			
Land tenure	No dogs	Dogs	Total	No dogs	Dogs	Total		
Private land only	40.5	38.1	95.2	8.0	31.5	93.8		
State Game Reserves only	4.8	0.0	4.8	1.6	0.9	5.0		
Both	0.0	0.0	0.0	0.0	1.1	1.1		
Total	45.2	38.1	100.0	9.6	33.6	100.0		

<sup>&</sup>lt;sup>18</sup> An active Stubble Quail hunter is defined as a Game Licence holder endorsed to hunt Stubble Quail who hunted for Stubble Quail at least once during the 2020 duck season.



### Table 16: Percentage of hunting days and associated Stubble Quail harvest per grassland type in 2020

Habitat type	Days (%)	Stubble Quail harvest (%)
Introduced grass	11.9	20.4
Native grass	9.5	0.0
Stubble	71.4	79.6
Stubble and native grass	7.1	0.0
Total	100.0	100.0

The total harvest was estimated to be greatest in the Glenelg Hopkins CMA, followed by the Wimmera CMA and the North Central CMA (Figure 4). The top five towns for the total reported number of Stubble Quail harvested were (in descending order) Warrnambool, Horsham, St Arnaud, Derrimut and Korumburra. The top five towns for the total number of reported Stubble Quail hunting days were (in descending order) Horsham, Warrnambool, Charlton, Echuca and Korumburra.



#### Figure 4: Estimates of total Stubble Quail harvest in 2020 by CMA region

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



### 4 Discussion

#### 4.1 Duck

A total of 60,403 ducks were estimated to have been harvested in Victoria during the 2020 season (95% CI = 47,506-76,801), which was the lowest estimated harvest recorded from telephone surveys, which began in 2009 (Table 17 and Figure 5). The estimated harvest of most duck species available to harvest in 2020 was less than 30% of their average estimated harvest from 2009-2020. Only Mountain Ducks had a smaller relative reduction in 2020, with 56% of the average harvest since 2009 reported in 2020. Given there was a lower bag limit and a shortened duck season as well as COVID-19 restrictions, a reduction in harvest was to be expected. However, the surveys were only conducted during the period Game Licence holders were permitted to travel to hunt on public and private land, and therefore it is likely that the harvest has been underestimated.

The estimated number of total hunting days and ducks harvested per Game Licence holder were much lower than historical levels. The lowest number of hunting days recorded (about one-third of the average) was to be expected, due to the restrictions in 2020, which meant the duck season on public land and private land owned by another person lasted for approximately 4 weeks rather than the typical 12 weeks. Hunter efficiency (ducks harvested per hunting day) was about half the average from 2009–2020. This was also to be expected, given the bag limit in 2020 was 3 ducks per day, down from a more typical bag limit of 10 ducks per day.

It was estimated that 32% (95% CI = 28-37%) of Game Licence holders hunted for ducks during the 2020 duck season. That equates to an estimate of 7,481 (95% CI = 6486-8628) active duck hunters in the 2020 duck season. The average harvest per active duck hunter for the season was estimated to be 8.1 (95% CI = 6.1-10.7) over 3.9 (95% CI = 2.9-5.3) days. These estimates are all lower than in previous years, reflecting the unusual duck season in 2020.



Figure 5: Estimates of total duck harvests (in thousands) from 2009–2020

Squares are the estimated total harvest for each season; the solid vertical lines indicate the 95% confidence intervals for each year; the horizontal blue line is the average duck harvest from 2009–2020; the shaded area is the 95% confidence interval for the average duck harvest from 2009–2020.



Ducks per hunting day	2.79	3.15	5.81	4.61	4.60	3.78	3.16	2.70	4.53	4.32	2.94	2.05	3.84
Hunting days per licence holder	3.98	3.98	4.48	4.60	3.75	4.57	3.59	3.98	3.83	3.62	3.27	1.26	3.74
Ducks per licence holder	11.10	12.54	26.02	21.19	17.24	17.29	11.35	10.73	17.36	15.65	9.62	2.58	14.39
Hunting days	76,659	85,801	103,450	109,718	91,748	118,800	90,634	100,749	96,508	91,570	81,023	29,501	89,680
Total harvest	222,302	270,574	600,739	508,256	422,294	449,320	286,729	271,576	438,353	396,708	238,666	60,403	347,160
Pink-eared Duck	NA	0	12,597	21,587	30,129	14,154	15,839	1,645	20,080	12,674	3,103	236	12,004
Pacific Black Duck	55,150	96,487	156,484	160,704	92,714	127,646	81,940	89,850	118,460	132,827	83,031	27,778	101,923
Mountain Duck	2,173	5,936	8,090	9,234	2,694	8,440	6,860	6,454	12,124	6,971	8,688	3,783	6,787
Hardhead	NA	324	25,657	30,222	7,349	6,363	998	506	8,083	4,816	621	0	7,722
Grey Teal	20,919	26,011	211,034	110,574	135,947	127,126	79,945	77,069	175,038	122,941	63,421	6,028	96,338
Chestnut Teal	13,176	14,354	49,812	23,506	39,804	29,866	19,456	18,097	13,639	27,123	13,528	4,374	22,228
Blue-winged Shoveler	NA	216	4,854	1,319	7,104	4,155	1,497	NA	NA	NA	NA	NA	3,191
Australian Wood Duck	131,084	112,390	132,908	150,150	106,553	131,282	80,194	77,955	90,929	89,354	57,588	18,204	98,216
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average

Table 17: Comparison of duck harvests from 2009–2020



#### 4.2 Stubble Quail

The total of 4,848 Stubble Quail estimated to have been harvested in Victoria during the 2020 season (95% CI = 2,302–10,214) is the lowest estimated harvest since the telephone surveys started in 2009 (Figure 6 and Table 18). Given the restrictions on hunting due to COVID-19, this reduction was not unexpected. However, the surveys were only conducted during the period Game Licence holders could hunt on public land and private land owned by someone else, and therefore this value is likely to be an underestimate.

The estimated number of total hunting days and Stubble Quail harvested per Game Licence holder were much lower than historical levels. The lowest number of hunting days recorded (about one-fifth of the long-term average) was to be expected due to COVID-19 restrictions in 2020. Even hunter efficiency (Stubble Quail harvested per hunting day) was less than one-fifth of the average from 2009–2020 (Table 18), with many hunters (71%) unable to harvest any Stubble Quail on their hunting trips.

Of the Game Licence holders entitled to hunt Stubble Quail, it is estimated that only 4% (95% CI = 2–5%) hunted for Stubble Quail during the 2020 Stubble Quail season. That equates to an estimate of 943 (95% CI = 622– 1428) active Stubble Quail hunters in the 2020 Stubble Quail season. The average seasonal Stubble Quail harvest per active Stubble Quail hunter was estimated to be 5.1 (95% CI = 2.2–11.9). These estimates are all lower than in previous years, reflecting the unusual Stubble Quail season in 2020.



Figure 6: Estimates of total Stubble Quail harvests (in thousands) from 2009 to 2020

The squares are the estimated total harvest for each season; the solid vertical lines indicate the 95% confidence intervals for harvest size for each year; the blue horizontal line is the average Stubble Quail harvest from 2009–2020; the shaded area is the 95% confidence interval for the average Stubble Quail harvest from 2009–2020.



Year	Total harvest	Hunting days	Quail per licence holder	Hunting days per licence holder	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 <sup>19</sup>	28,043	6,559	1.00	0.23	4.29
2017	186,691	22,052	6.51	0.77	8.45
2018	148,500	17,772	5.19	0.62	8.36
2019	149,736	22,351	5.30	0.79	6.70
Average	172,562	22,031	6.48	0.84	7.71

Table 18: Comparison of Stubble Quail harvests of 2009 to 2019.

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 ducks is the same as a Game Licence for game birds not including ducks. 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 Stubble Quail Game Licence holders who did not actually hunt Stubble Quail.

#### 4.3 Locations with the most hunting days

Combining ducks and Stubble Quail, Sale had the most hunting days during the 2020 hunting seasons, followed by Warrnambool, Nagambie, Geelong and Boort. 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.

<sup>&</sup>lt;sup>19</sup> The 2016 Stubble Quail surveys were conducted after the season rather than each month of the season. It is assumed that the change in methodology will produce only minor differences.



#### 4.4 Assumptions

Given the unusual conditions during the 2020 duck and Stubble Quail seasons, there are a few assumptions specific to these seasons. The estimates were only for the times when Game Licence holders could travel to hunt on public land or private land that was owned by someone else. They were therefore underestimates, because people were able to hunt on their own private land at times outside the survey period. We assume, however, that this is not the main reason that the numbers were much lower than other years and that the true numbers of ducks and Stubble Quail harvested in 2020 were only slightly higher than our estimates. The main reason for the low numbers was likely to be a combination of shortened seasons for the vast majority of hunters that do not hunt on their own property and reduced bag limits for ducks. Actual abundance of both groups of game animals may also have been reduced, but we were unable to investigate this possibility from hunter survey data.

The estimates of harvest for each game animal 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 (exceeding the bag limit, or (conversely) not harvesting anything), memory recall (respondents not remembering their harvest), and deliberate over- or underreporting (reported numbers knowingly being reported incorrectly). Any bias due to nonresponse 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 one-week period in the case of ducks, 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 & Hoover 1992). Nevertheless, some bias likely remains, and the estimates of total harvests should be interpreted with caution. Due to a clerical error, the 2016 telephone survey for Stubble Quail 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.

It should be noted that the number of hunting days was only an approximate estimate of total effort: someone who hunted for 2 hours and someone else who hunted for 12 hours were both recorded as having hunted for 1 day. However, 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 3). 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 at which they hunted. It is, therefore, possible that the nearest town was in a different CMA than the hunting location.



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### Appendix A

#### **Questionnaire for Game Licence holders endorsed to hunt ducks**

1. Did you go duck hunting over period X? Yes  $\hfill \hfill No$ 

2. Have you been duck hunting in the last week? Since last Sunday? From last Monday to Sunday Yes No (tick box, if 'Yes', proceed to question 4, if 'No' "Thank you for taking part in this survey.

3. How many Duck hunting trips have you taken over this 1-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?						
5. How many ducks did your harvest?						
6. What species	Black Duck					
	Wood Duck					
	Mountain Duck	Mountain Duck	Mountain Duck	Mountain Duck	Mountain Duck	Mountain Duck
	Grey Teal					
Include number of each species	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal	Chestnut Teal
	Pink Ear					
	Shoveler	Shoveler	Shoveler	Shoveler	Shoveler	Shoveler
	Hardhead	Hardhead	Hardhead	Hardhead	Hardhead	Hardhead
7. What type of land did you hunt	State Game Reserve					
2.uo	Private land					
"Can register more than one choice"	Public land					
8. What was the closest major town to the area you hunted?						



### Appendix B

## Questionnaire for Game Licence holders endorsed to hunt Stubble Quail

1. Do you use a dog when you hunt for quail? Yes 🗌 No 🗌

2. Have you been quail hunting last month. (during May – since the opening weekend?) Yes No (tick box, if 'Yes', proceed to question 3, 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)

How many quail hunting trips did you take last month?
 (indicate number in box)

(Each trip needs to be treated separately for question 6 - 10)

- 4. How many days did you go hunting?
- 5. How many quail did you harvest?

6. What type of land did you hunt on? State Game Reserve / Private land / Public land "Can register more than one choice"

7. What type of grasslands was the hunt on? Stubble / Native Grass / Introduced grass "Can register more than one choice"

8. What was the closest major town to the area you hunted?



### Appendix C

#### Additional method details

#### Common definitions used

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

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

 $CV = coefficient of variation. CV is calculated as: <math>CV = SE \div mean$ . 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 p who hunted in each period j is given by:

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

E.g. for Duck Survey 3, we

$$\frac{34}{200} = 0.170$$
 obtained: .

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 Duck Survey 3, we  $0.17 \times 25418 = 4,321$  obtained: .

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 Duck Survey 3, we

 $\frac{290}{34}$  = 8.53 obtained: .

The total harvest for each survey period ( $W_i$ ) was estimated by multiplying the average harvest per hunter ( $w_i$ ) by the total number of hunters ( $H_i$ ):

$$W_j = w_j H_j$$

E.g. for Duck Survey 3, we  $8.53 \times 4,321 = 36,856$  obtained: .

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:

$$\operatorname{SE}(p_j) = \sqrt{\frac{p_j(1-p_j)}{n_j}}.$$

E.g. for Duck Survey 3, we obtained:  $\sqrt{\frac{0.17 \times 0.83}{200}} = 0.027$ .



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

$$\mathsf{SE}(w_j) = \frac{\mathsf{SD}(w_j)}{\sqrt{h_j}}.$$

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 sums of squares to find the combined CV (assuming independence).

$$CV(w_j) = \frac{SE(w_j)}{w_j}, \text{ and } CV(p_j) = \frac{SE(p_j)}{p_j}$$
$$CV(W_j) = \sqrt{\left(CV(w_j)\right)^2 \times \left(CV(p_j)\right)^2 + \left(CV(w_j)\right)^2 + \left(CV(p_j)\right)^2}$$
$$SE(W_j) = CV(W_j) \times W_j.$$

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  $\geq 0$ . 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:  $r = \exp(1.96 \times \sqrt{\ln(1 + CV^2)})$ .

E.g. for the total duck harvest we have

$$CV = \frac{20,286}{286,729} = 0.071$$
  
r = exp(1.96 ×  $\sqrt{\ln(1+0.071^2)}$ ) = 1.15.

Therefore, upper and lower confidence intervals are given by:



### Appendix D

#### 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. An outlier is defined as any point that is either below  $Q1 - 1.5 \times IQR$  or above  $Q3 + 1.5 \times IQR$ , which means that any point that lies more than one-and-a-half times the length of the box outside the box is an outlier.

The boxplot indicates the spread of the data. The data is broken into quarters: approximately 25% of the data are in the range between a whisker and the nearest edge of the box, and approximately 25% of the data are in the range between an edge of the box and the median line. Thus, approximately half the data are thus contained within the box. Any unusual data are highlighted as outliers. As an example, Figure D1 shows a boxplot indicating that most hunters harvested between 5 and 13 ducks, and a quarter harvested between 13 and 27 ducks. A number of outliers harvested more than 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 B1), which indicates that at least 25% of Game Licence Holders who hunted were unsuccessful).



Figure B1: Example boxplot, with labels



### Appendix E

#### Harvest rates per Game Licence endorsed for hunting duck

Historically (from 2009 to 2016) the data collected only allowed for annual harvest rates to be at the level of Game Licence holder endorsed to hunt ducks. Since 2017, when the end-of-year surveys have been conducted, it has been possible to estimate the annual harvest rate per active hunter. Therefore, the rate per Game Licence holder is not required. It has been included in this appendix to allow comparison between years before 2017.

The total average season harvest per Licence holder was estimated to be 2.6 birds (95% CI = 2–3.3; Table 19). 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 19: Estimates of average harvest of ducks per Game Licence holder in eachsurvey period in 2020

			95%	CI
Period	Average harvest <sup>20</sup>	SE	Lower	Upper
16–17 May	0.14	0.05	0.07	0.29
18–24 May	0.75	0.17	0.48	1.17
25–31 May	0.81	0.17	0.54	1.22
1–8 June	0.88	0.20	0.58	1.36
Total	2.58	0.32	2.03	3.29

Each Game Licence holder hunted an average of 1.3 days during the 2020 duck-hunting season (Table 20). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 29,501 hunter days (95% CI = 22,868–38,058).

#### Table 20: Days on which ducks were hunted per Game Licence holder for 2020

			95% CI		
Period	Days hunted	SE	Lower	Upper	
16–17 May	0.06	0.02	0.03	0.12	
18–24 May	0.38	0.07	0.26	0.55	
25–31 May	0.38	0.07	0.27	0.54	
1–8 June	0.44	0.08	0.31	0.61	
Total per Licence holder	1.26	0.13	1.04	1.54	
Total hunting days	29,500.92	3,849.68	22,867.88	38,057.94	

<sup>&</sup>lt;sup>20</sup> Average harvest per Game Licence holder = Ducks harvested divided by Respondents (Table 1).



### Appendix F

#### Harvest rates per Game Licence endorsed for hunting Stubble Quail

Historically (from 2009 to 2016) the data collected only allowed for annual harvest rates to be at the level of Game Licence holder endorsed to hunt Stubble Quail. Since 2017, when the end-of-year surveys have been conducted, it has been possible to estimate the annual harvest rate per active hunter. Therefore, the rate per Game Licence holder is not required. It has been included in this appendix to allow comparison between years before 2017.

The total average season harvest per Licence holder was estimated to be 0.2 birds (95% CI = 0.1–0.4; Table 21). 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.

			95% CI	
Period	Average harvest <sup>21</sup>	SE	Lower	Upper
16–17 May	0.05	0.03	0.02	0.15
18–31 May	0.06	0.03	0.02	0.17
1–30 June	0.07	0.05	0.02	0.27
Total	0.18	0.07	0.09	0.38

Table 21: Estimates of average harvest of Stubble Quail per Game Licence holder in each survey period in 2020

Each Game Licence holder hunted an average of 0.1 days during the 2020 Stubble Quail–hunting season (Table 22). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 3,771 hunter days (95% CI = 2,263–6,284).

Table 22: Days on which Stubble Quail were hunted per	er Game Licence holder for 2020
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			95% CI		
Period	Days hunted	SE	Lower	Upper	
16–17 May	0.04	0.01	0.03	0.07	
18–31 May	0.04	0.01	0.02	0.08	
1–30 June	0.05	0.02	0.03	0.11	
Total per Licence holder	0.14	0.03	0.10	0.20	
Total hunting days	3771	999	2,263	6,284	

<sup>&</sup>lt;sup>21</sup> Average harvest per Game Licence holder = Stubble Quail harvested divided by Respondents (Table 9).

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