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# Estimate of duck and Stubble Quail harvest in Victoria for 2024

**Results from surveys of Victorian Game  
Licence holders in 2024**

P.D. Moloney and J.S. Flesch

### 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 their 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.



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# Estimate of duck and Stubble Quail harvest in Victoria for 2024

Results from surveys of Victorian Game Licence holders in 2024

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# Summary

## Context

To effectively manage game species, it is important to quantify the number of individuals harvested. Since 2009, the Victorian State Government game management agency has commissioned a series of regular telephone surveys of randomly selected Game Licence holders to help quantify the harvest. Three sets of telephone surveys are conducted each year during the various game harvest seasons for deer, duck and Stubble Quail (*Coturnix pectoralis*). This report focuses only on the duck and Stubble Quail harvests for 2024.

In 2024, the duck season was reduced to just under nine weeks in length, compared to the prescribed 12 weeks. The start of the season was delayed and commenced in mid-April. The daily bag limit for ducks was reduced to six down from the prescribed 10 birds. The Stubble Quail season was as prescribed, 12 weeks in length and a daily bag limit of 20 birds per day.

## Aim

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 2024 hunting seasons.

## Methods

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, locations and experience. 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 2024 was 391,900 (95% confidence interval (CI) = 345,200–444,800), which is 22% above the average annual duck harvest in the previous surveys (320,000) and is a 22% increase from 2023 (320,000). The total estimated number of duck hunting days was 115,400 (95% CI = 101,200–131,600) which is 34% above the average annual duck hunting days in previous surveys (86,000). The three most commonly harvested species were Pacific Black Duck (*Anas superciliosa*, which comprised 39% of the total harvest), Grey Teal (*Anas gracilis*, 25%) and Australian Wood Duck (*Chenonetta jubata*, 24%). The remaining ducks harvested were Chestnut Teal (*Anas castanea*, 9%), Mountain Duck (*Tadorna tadornoides*, 2%) and Pink-eared Duck (*Malacorhynchus membranaceus*, 1%). Hunting of Blue-winged Shoveler (*Anas rhynchotis*) and Hardhead (*Aythya australis*) was prohibited for the 2024 season.

Game Licence holders endorsed to hunt ducks who actively hunted ducks during the 2024 duck season harvested an average of 30.3 ducks (95% CI = 26.1–35.2), over an average of 8.9 days (95% CI = 7.7–10.4).

The total estimated Stubble Quail harvest in 2024 was 457,400 (95% CI = 362,300–577,500), which was close to triple the average annual Stubble Quail harvest from previous surveys (159,000). The total estimated number of Stubble Quail-hunting days was 49,200 (95% CI = 38,300–63,200), which was 146% more than the annual average from previous surveys (20,000 days).

Game Licence holders endorsed to hunt Stubble Quail who actively hunted Stubble Quail during the 2024 Stubble Quail season harvested an average of 79.4 (95% CI = 60.3–104.7) quail, over an average of 8.5 (95% CI = 6.4–11.4) days.

The total number of hunter days during the 2024 hunting season for ducks and Stubble Quail was estimated to be 164,600 (95% CI = 145,000–184,100).

### **Conclusions and implications**

The duck harvest in 2024 exceeded the long-term average, even though the length of the season and the daily bag limit were both reduced. This can be partially explained by:

- total hunting days being 34% higher than average;
- the proportion of active duck hunters (60%) being the third highest recorded since 2017;
- hunter efficiency being at 3.4 ducks per hunting day was just below the average (3.5 ducks per hunting day), but the number of hunting days (115,000) was the highest recorded and 31% higher than average.

The Stubble Quail harvest in 2024 was more than double the long-term average, and the second largest estimated harvest recorded. The increase can be partially explained by:

- total hunting days being the highest recorded;
- the proportion of active Stubble Quail hunters being the highest recorded;
- hunter efficiency being the third highest recorded.

The number of Game Licence holders that were endorsed to hunt Stubble Quail and were surveyed in 2024 was a total of 1,400 respondents (200 per survey over 7 surveys). In 2023 the total was 2,400 (480 per survey over 5 surveys). The reduction in total surveys resulted in a reduction in relative accuracy from 2023 to 2024. The relative accuracy could be increased by surveying 250 respondents per survey (1750 total respondents).

The number of Game Licence holders who are endorsed to hunt Stubble Quail but do not hunt Stubble Quail is affecting the accuracy of the activity indices. Either the end-of-season survey needs to ask if the respondent is a Stubble Quail hunter, or survey a greater number of Game Licence holders.

Performing telephone surveys throughout the hunting season is likely to minimise memory bias and non-response bias. However, sources of bias will remain (due to over- and under-reporting), and the estimates of total harvest must be interpreted with care.

# 1 Introduction

To effectively manage game species, it is important to quantify the numbers of animals harvested. Since 2009, the Victorian State Government game management agency (currently the Game Management Authority, GMA) 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 (*Coturnix pectoralis*). However, this report focuses only on the duck and Stubble Quail harvests. Deer harvests are addressed in a separate report.

The 2024 duck season was reduced to nine (9) weeks (12 week is prescribed), running from 10 April to 5 June (Game Management Authority, 2024). Six species could legally be hunted in 2024: 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*) and Pink-eared Duck (*Malacorhynchus membranaceus*). Hunting of Blue-winged Shoveler<sup>3</sup> (*Anas rhynchos*) and Hardhead<sup>4</sup> (*Aythya australis*) (both declared game species) was prohibited for the 2024 season due to the species threatened status. The bag limit for the 2024 season was six game ducks per hunter per day, reduced from the maximum prescribed daily bag limit of 10 birds.

The 2024 duck hunting survey used a similar method (i.e. telephone surveys) as those followed during the 2005, 2006 and 2009 - 2023 duck hunting seasons (Barker, 2006; Gormley & Turnbull, 2009-2011; Moloney & Flesch, 2021-2023; Moloney & Hampton, 2020; Moloney & Powell, 2019; Moloney & Turnbull, 2012-2018). However, since 2021 (Moloney & Flesch, 2021) there was no official opening weekend as the season started mid-week on a Wednesday. Additional hunting experience and club affiliation questions were asked in the 2024 telephone surveys.

The 2024 Stubble Quail hunting season ran for the prescribed 12 weeks, running from 6 April to 30 June (Game Management Authority 2024). The daily bag limit for the 2024 season was 20 Stubble Quail per hunter.

The 2024 Stubble Quail hunting survey used a similar method (i.e. telephone surveys) as those conducted during the 2009 - 2015 and 2017 - 2019 and 2021 to 2023 Stubble Quail hunting seasons (Gormley, 2009; Gormley & Turnbull, 2009-2011; Moloney & Flesch, 2021-2023; Moloney & Powell, 2019; Moloney & Turnbull, 2012-2018). Due to a clerical error, the 2016 Stubble Quail-hunting survey used a slightly different method (Moloney & Turnbull, 2016). Due to the COVID-19 restrictions in 2020, the surveys of Game Licence holders endorsed to hunt Stubble Quail started on the first weekend that hunting was allowed on public 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) (Moloney & Hampton, 2020).

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

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

<sup>3</sup> Blue-winged Shoveler is also referred to as Australasian Shoveler.

<sup>4</sup> Hardhead is also referred to as White-eyed Duck.

## 2 Method

### 2.1 General methodology

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 1 and 2). Estimates of total harvest by Game Licence holders were based on the hunting activities reported by the survey respondents<sup>5</sup>.

A slightly different methodology was used for estimating duck and Stubble Quail harvests for 2024 compared to other years (e.g. Moloney & Flesch (2021)). For ducks, surveys were performed after the end of the first week of the season (the season opened on a Wednesday) and from then on, fortnightly throughout the 9-week season. The main difference is that historically, the season started on a Saturday and there was a specific "Opening weekend" survey and the remaining surveys were performed at the end of each month for the rest of the season. For Stubble Quail, surveys were performed after the opening weekend (as previously) and then fortnightly for the rest of the season, whereas typically, after the opening weekend, they were performed at the end of each month for the rest 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 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 and 600 Game Licence holders were surveyed immediately after the conclusion of the duck and Stubble Quail hunting seasons respectively. 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 2024 duck hunting season and Stubble Quail hunting season, respectively. The number of post-Stubble Quail season surveys was increased from 400

to 600 in an attempt to increase the accuracy of the activity index.

Survey responses were used to generate a harvest 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 average 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, the number of days on which they hunted during the survey period, their self-reported level of hunting experience, and if they belonged to a hunting club. 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.

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

<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.

There were differences in the number and length of survey periods 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 3. Information relating to describing and interpreting boxplots is provided in Appendix 4.

## 2.2 Duck

Samples were drawn from hunters who held a Game Licence endorsed to hunt ducks during the 2024 season. An independent random sample of 200 licence holders was interviewed by telephone immediately after the first weekend (Duck Survey 1), and this was followed up by surveys of independent random samples of licence holders at 2-week intervals for the remainder of the duck season (Duck Surveys 2–5). Respondents were also asked to report the number of each species harvested. An additional independent random sample of 400 Game Licence holders endorsed to hunt ducks were surveyed immediately after the conclusion of the duck hunting season. They were asked if they had hunted duck 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 2024 season. A random sample of 200 licence holders was interviewed by telephone after the opening weekend (Quail Survey 1), and this was followed up by surveys of independent random samples of licence holders at 2-week intervals for the remainder of the Stubble Quail season (Quail Surveys 2–7). The size of the random sample per survey was decreased in 2024 from 300 (prior to 2023), but surveys were conducted fortnightly rather than monthly. In 2023, 480 surveys were conducted weekly. 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 600 Game Licence holders were surveyed immediately after the conclusion of the Stubble Quail hunting season. They were asked if they had hunted Stubble Quail at any stage during the season.

When a Game Licence holder is endorsed for duck, they are automatically endorsed for Stubble Quail (licence holders can be endorsed for just 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 2024 Stubble Quail hunter survey, all respondents were asked whether they hunt Stubble Quail, even if they did not necessarily hunt Stubble Quail during the 2024 Stubble Quail Season. This information was used to increase the precision of the estimates for the total Stubble Quail harvest and number of hunting days.

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<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 remained relatively constant throughout the shortened season (Table 1). In order to achieve the required sample size of respondents, slightly more than 200 licence holders were contacted for each survey, with typically 98% of those contacted being willing to take part in the survey.

**Table 1. Summary of responses for duck surveys in 2024.**

Duck survey	Period	Licence holders	Respondents	Respondents who hunted	Days hunted <sup>8</sup>	Ducks harvested <sup>9</sup>
1	10-14 April	21,170	200	97	263	844
2	15-29 April	21,170	200	95	321	1,070
3	30 April-12 May	21,319	200	62	196	558
4	13-26 May	21,319	200	52	168	649
5	27 May-5 June	21,383	200	55	138	567

The proportion of duck Game Licence holders who hunted in each survey period varied over the season. During the initial 5 days, 48% of licence holders hunted, corresponding to approximately 10,300 hunters (Table 2). After April, the proportion (and therefore total hunters) dropped to under one-third.

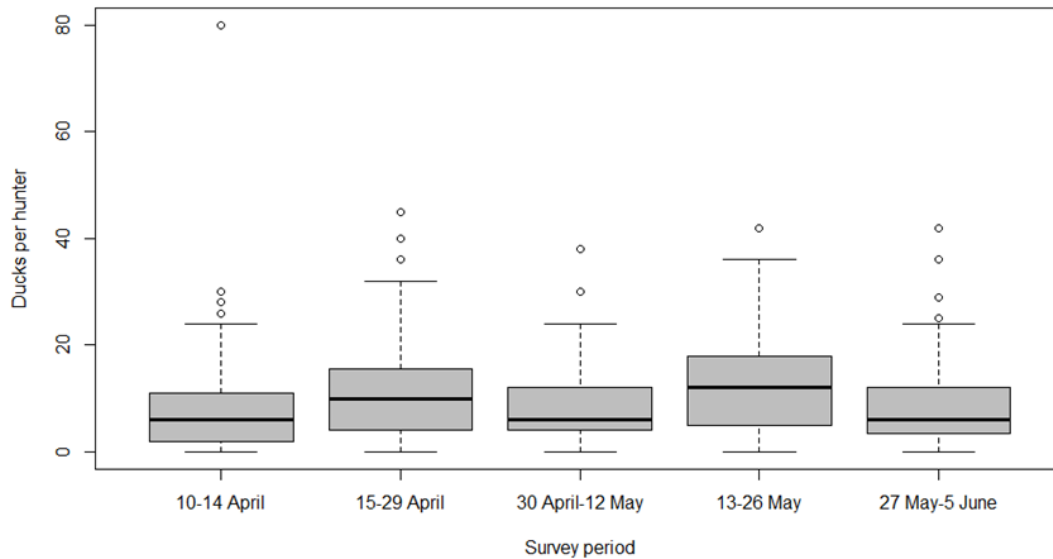
**Table 2. Proportion and corresponding total number of duck licence holders who hunted in each survey period in 2024.**

Period	Proportion	SE	95% CI		Total hunters	SE	95% CI	
			Lower	Upper			Lower	Upper
10-14 April	0.48	0.035	0.42	0.56	10,267	748	8,903	11,841
15-29 April	0.48	0.035	0.41	0.55	10,056	748	8,694	11,631
30 April-12 May	0.31	0.033	0.25	0.38	6,609	697	5,377	8,122
13-26 May	0.26	0.031	0.21	0.33	5,543	661	4,391	6,997
27 May-5 June	0.28	0.032	0.22	0.34	5,880	675	4,699	7,359

The reported harvest of ducks per hunter (i.e. per Game Licence holder who hunted) was greatest in the weeks after the opening and the final weeks of the season (over 10 ducks per hunter in Survey 2 and the last 2 surveys). 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 fluctuated over the season from just under 9 to over 12 ducks per hunter (Table 3).

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

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



**Figure 1. Boxplot of the number of ducks reported harvested by individual hunters for each survey period in 2024.**

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.

**Table 3. Average harvest of ducks per hunter (Game Licence holders who hunted) for each survey period in 2024.**

Period	Average harvest per hunter <sup>10</sup>	SE	95% CI	
			Lower	Upper
10-14 April	8.70	1.12	6.77	11.19
15-29 April	11.26	0.91	9.61	13.20
30 April-12 May	9.00	1.00	7.24	11.19
13-26 May	12.48	1.26	10.25	15.19
27 May-5 June	10.31	1.34	7.99	13.29

There were an estimated 89,337 ducks harvested during opening 5 days (95% CI = 66,923–119,258), which constituted 23% of the total seasonal harvest (Table 4). The harvest in the second survey period was the largest (113,259), accounting for 29% of the total seasonal harvest. The total season harvest estimate was 391,878 (95% CI = 345,237–444,819; Table 4).

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

**Table 4. Estimates of the total duck harvest in Victoria in 2024 by holders of a Game Licence endorsed for duck.**

Period	Total harvest <sup>11</sup>	SE	95% CI	
			Lower	Upper
10-14 April	89,337	13,239	66,923	119,258
15-29 April	113,259	12,464	91,344	140,433
30 April-12 May	59,480	9,153	44,071	80,276
13-26 May	69,180	10,826	51,001	93,840
27 May-5 June	60,621	10,566	43,188	85,090
<b>Total</b>	<b>391,878</b>	<b>25,362</b>	<b>345,237</b>	<b>444,819</b>

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 5). The most frequently harvested species was Pacific Black Duck, comprising 39% of the total reported harvest, followed by Grey Teal (25%) and Australian Wood Duck (24%). The remaining three species comprised 12% of the total harvest.

**Table 5. Reported numbers of ducks harvested by hunters, proportions of the total harvest, and estimates of total 2024 harvest for each duck species.**

Species	Reported harvest	Proportion of harvest	SE	Estimated harvest	SE	95% CI	
						Lower	Upper
Pacific Black Duck	1,441	0.39	0.008	153,117	10,398	92,648	253,052
Grey Teal	931	0.25	0.007	98,926	6,989	59,279	165,088
Australian Wood Duck	887	0.24	0.007	94,250	6,694	56,404	157,493
Chestnut Teal	338	0.09	0.005	35,915	2,978	20,655	62,450
Mountain Duck	72	0.02	0.002	7,651	1,021	3,823	15,309
Pink-eared Duck	19	0.01	0.001	2,019	480	816	4,992
Blue-winged Shoveler <sup>12</sup>	NA	NA	NA	NA	NA	NA	NA
Hardhead <sup>13</sup>	NA	NA	NA	NA	NA	NA	NA

Using a telephone survey immediately after the 2024 duck season ended, it was estimated that 60% (95% CI = 56%–65%) of Game Licence holders endorsed for ducks actively hunted for ducks during the 2024 season (Table 6). That equates to an estimate of 12,937 (95% CI = 11,952–14,002) active duck hunters in the 2024 season. The average duck harvest per active duck hunter was estimated to

<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.

<sup>12</sup> Game Licence holders were not permitted to harvest Blue-winged Shoveler (*Anas rhynchos*), also referred to as Australasian Shoveler, in 2024.

<sup>13</sup> Game Licence holders were not permitted to harvest Hardhead (*Aythya australis*), also referred to as White-eyed Duck, in 2024.



be 30.3 (95% CI = 26.1–35.2). The average number of duck hunting days per active duck hunter was estimated to be 8.9 (95% CI = 7.7–10.4).

**Table 6. Estimates of the overall average active duck hunter<sup>14</sup> in Victoria in 2024 by holders of a Game Licence endorsed for duck.**

Statistic	Annual estimate	SE	95% CI	
			Lower	Upper
Proportion active	0.60	0.02	0.56	0.65
Estimated active hunters	12,937	523	11,952	14,002
Average harvest per active hunter	30.29	2.31	26.09	35.17
Average hunting days per active hunter	8.92	0.70	7.65	10.40

Game Licence holders endorsed to hunt duck hunted an average of 5.4 days during the 2024 duck-hunting season (Table A2). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 115,371 hunter days (95% CI = 101,164–131,574, Table 7).

**Table 7. Total hunter days for ducks in 2024.**

Period	Days hunted	SE	95% CI	
			Lower	Upper
10-14 April	27,839	3,263	22,142	35,001
15-29 April	33,978	4,101	26,843	43,009
30 April-12 May	20,893	3,698	14,807	29,479
13-26 May	17,908	3,322	12,487	25,682
27 May-5 June	14,754	2,791	10,216	21,308
<b>Total hunting days</b>	<b>115,371</b>	<b>7,744</b>	<b>101,164</b>	<b>131,574</b>

During the survey period, greater duck hunting effort was expended on private land (55.2%) than on public land (44.8%), with similar proportions to those for the ducks being harvested solely on private land (58.1%) and public land (41.9%). Of the hunting on public land, approximately half occurred on State Game Reserves (Table 8).

<sup>14</sup> Active duck hunter is defined as a Game Licence holder endorsed to hunt ducks who hunted for ducks at least once during the 2024 duck season.

**Table 8. Percentage of days hunted and associated duck harvest by land tenure in 2024.**

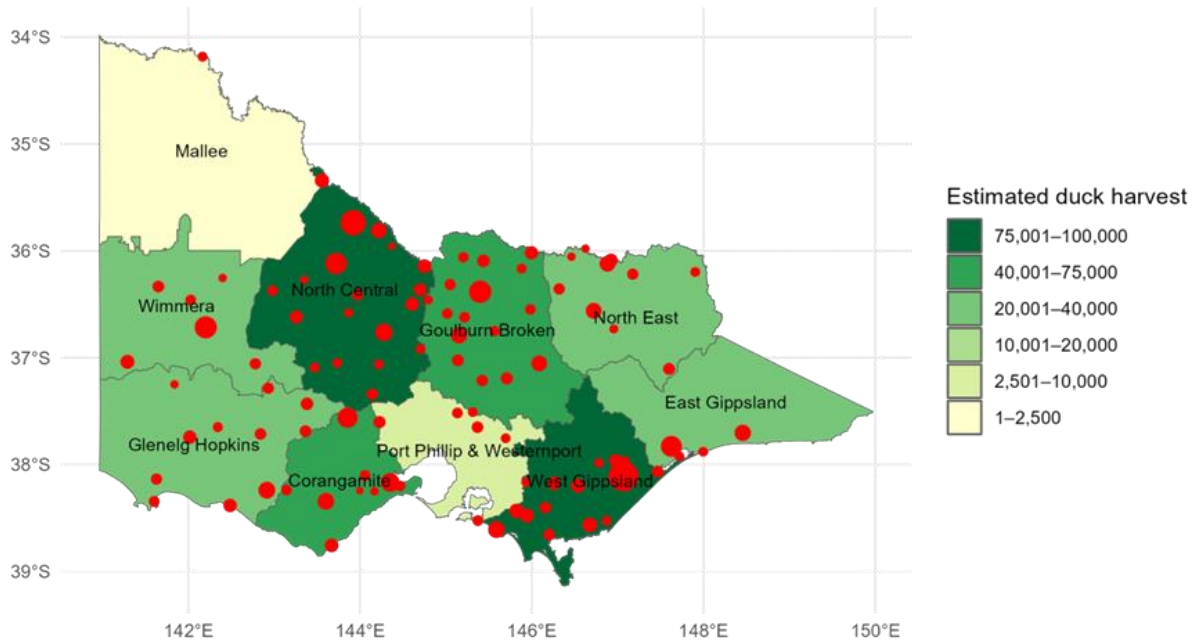
Land tenure	Days (%)	Duck harvest (%)
Private land only	55.2	58.1
Public land only	21.8	20.3
State Game Reserve	22.9	21.7
<b>Total</b>	<b>100.0</b>	<b>100.0</b>

The new demographics questions showed that the majority (59%) of licence holders surveyed considered themselves advanced hunters, with less than 8% considered themselves novice or beginner (Table 9). Most licence holders (57%) said they belonged to a hunting club. In general, experience positively influenced efficiency, while being a club member didn't seem to influence efficiency.

**Table 9. Overall demographic data from duck hunter surveys in 2024.**

Experience	Club member	Percentage of Respondents	Proportion of respondents that were active hunters	Percentage of overall active hunters	Total hunting days (%)	Total harvest (%)	Mean days per active hunter	Mean harvest per active hunter	Hunter efficiency
Novice	No	1.6	0.12	0.6	0.6	0.4	3.5	7.5	2.14
	Yes	1.3	0.10	0.6	1.0	0.5	5.5	8.5	1.55
Beginner	No	3.3	0.27	2.5	2.5	1.2	3	4.89	1.63
	Yes	1.4	0.43	1.7	2.0	0.6	3.67	3.5	0.96
Intermediate	No	16.2	0.26	11.9	11.3	8.1	2.86	6.93	2.42
	Yes	17.3	0.26	12.5	11.3	10.9	2.73	8.93	3.27
Advanced	No	21.9	0.42	25.2	25.7	26.4	3.07	10.7	3.49
	Yes	36.9	0.44	45.2	45.5	52.0	3.03	11.8	3.88

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



**Figure 2. Estimates of total duck harvest in 2024 by CMA region.**

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

Ducks were reported shot but lost on 4% of duck hunting trips (32 out of 796) for a total of 36 ducks in the survey. The estimated season total of ducks shot and lost in 2024 is 3,828 (95% CI = 2,200–6,660), which would increase the harvest by 1%.

In 2024 at least 28% of duck hunting trips reported reaching their daily bag limit (6). A total of 8 respondents (or 2.2% of active hunters) reported average daily harvests exceeding the 2024 daily duck bag limit of 6. They accounted for 1.5% of duck hunting trips.

### 3.2 Stubble Quail

The number of Game Licence holders endorsed to hunt Stubble Quail remained relatively constant throughout the season, increasing marginally from 25,377 at opening weekend to 25,788 at the end of the season (Table 10). In order to achieve the required sample size of respondents, slightly more than 200 licence holders were contacted each survey, with typically 98% of those contacted being willing to take part in the survey.

**Table 10. Summary of responses for Stubble Quail surveys in 2024.**

Stubble Quail survey	Period	Licence holders	Respondents	Stubble Quail hunters <sup>15</sup>	Respondents who hunted	Days hunted <sup>16</sup>	Quail harvested <sup>17</sup>
1	6-7 April	25,377	200	136	10	12	155
2	8-21 April	25,377	200	127	33	85	628
3	22 April-5 May	25,377	192	122	27	70	598
4	6-19 May	25,643	200	86	27	87	891
5	20 May-2 June	25,643	200	109	22	53	403
6	3-16 June	25,788	200	101	12	36	420
7	17-30 June	25,788	266 <sup>18</sup>	136	14	52	608

The percentage of endorsed Game Licence holders who hunted Stubble Quail was consistent over the first two months of the season, before reducing in June. That higher rate was over 10%, while the lower rate was 5%, corresponding to over 2800 hunters or under 1600 active hunters respectively (Table 11).

<sup>15</sup> Respondents who self-report as Stubble Quail hunters.

<sup>16</sup> Days hunted indicates the combined number of days on which Stubble Quail hunting took place by respondents.

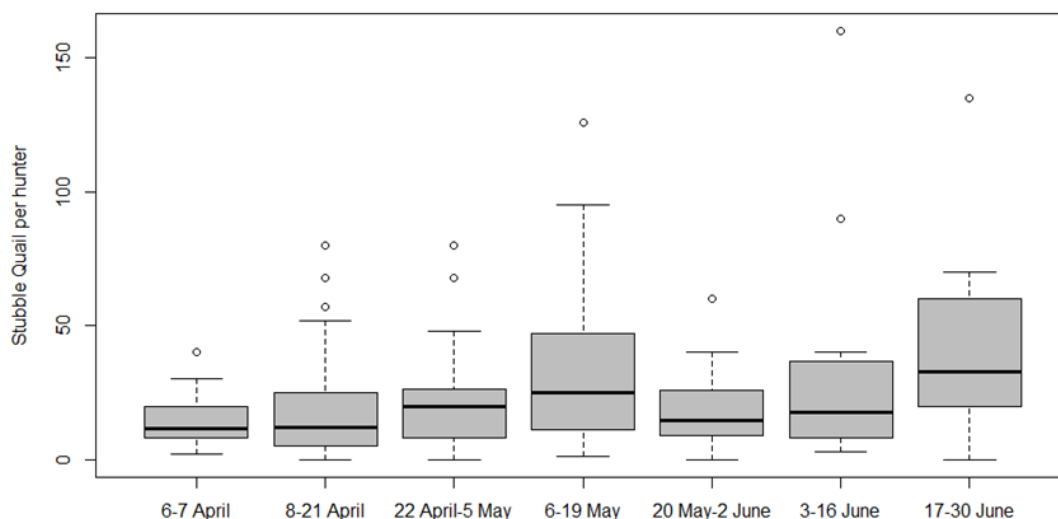
<sup>17</sup> Stubble Quail harvested indicates total number of Stubble Quail harvested by respondents.

<sup>18</sup> Survey contractors sampled in excess of the minimum target sample of 200.

**Table 11. Proportion and corresponding total number of Stubble Quail licence holders who hunted in each survey period in 2024.**

Period	Proportion	SE	95% CI		Total hunters	SE	95% CI	
			Lower	Upper			Lower	Upper
6-7 April	0.05	0.015	0.03	0.09	1,269	391	703	2,290
8-21 April	0.16	0.026	0.12	0.22	4,187	666	3,072	5,708
22 April-5 May	0.14	0.025	0.10	0.20	3,569	637	2,522	5,049
6-19 May	0.14	0.024	0.10	0.19	3,462	620	2,444	4,903
20 May-2 June	0.11	0.022	0.07	0.16	2,821	567	1,909	4,167
3-16 June	0.06	0.017	0.04	0.10	1,547	433	903	2,651
17-30 June	0.05	0.014	0.03	0.09	1,357	353	822	2,241

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). A similar proportion of active hunters harvested more than 60 Stubble Quail in a survey period (13%), as harvested less than 5 Stubble Quail in a survey period (14%) (Figure 3). The average number of Stubble Quail per hunter varied throughout the season (Table 12). In the opening weekend, the average harvest per hunter was 15.5 (95% CI = 9.7–24.6) Stubble Quail, while in the last survey the average was almost triple that amount (43.4, with 95% CI = 28.4–66.4).



**Figure 3. Boxplot of the number of Stubble Quail reported harvested by individual hunters for each survey period in 2024.**

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.

**Table 12. Average harvest of Stubble Quail per hunter (Game Licence holders who hunted) for each survey period in 2024.**

Period	Average harvest per hunter <sup>19</sup>	SE	95% CI	
			Lower	Upper
6-7 April	15.50	3.72	9.75	24.64
8-21 April	19.03	3.53	13.27	27.28
22 April-5 May	22.15	3.91	15.71	31.22
6-19 May	33.00	5.87	23.35	46.64
20 May-2 June	18.32	3.18	13.07	25.67
3-16 June	35.00	13.31	17.03	71.92
17-30 June	43.43	9.51	28.42	66.36

There were an estimated 457,399 Stubble Quail harvested by all holders of a Game Licence for Stubble Quail during the 2024 Stubble Quail season (95% CI = 362,288–577,479). During the opening weekend the Stubble Quail harvest was 4% of the total season harvest (Table 13).

**Table 13. Estimates of the total Stubble Quail harvest in Victoria in 2023 by holders of a Game Licence endorsed for Stubble Quail.**

Period	Total harvest <sup>20</sup>	SE	95% CI	
			Lower	Upper
6-7 April	19,667	7,818	9,283	41,666
8-21 April	79,684	19,605	49,546	128,154
22 April-5 May	79,039	19,989	48,517	128,762
6-19 May	114,240	29,054	69,938	186,602
20 May-2 June	51,671	13,844	30,840	86,571
3-16 June	54,155	26,208	22,037	133,080
17-30 June	58,944	20,319	30,564	113,678
<b>Total</b>	<b>457,399</b>	<b>54,595</b>	<b>362,288</b>	<b>577,479</b>

A telephone survey immediately after the 2024 Stubble Quail season ended estimated that 22% (95% CI = 19%–26%) of Game Licence holders hunted during the 2024 Stubble Quail season (Table 14). The estimated number of active Stubble Quail hunters in the 2024 Stubble Quail season is 5,759 (95% CI = 4,962–6,685). The average active Stubble Quail hunter was estimated to have harvested 79.4 Stubble Quail (95% CI = 60.3–104.7) over an average of 8.5 hunting days (95% CI = 6.4–11.4) during the Stubble Quail hunting season.

<sup>19</sup> Average harvest per hunter = Stubble Quail harvested divided by Respondents who hunted (Table 10).

<sup>20</sup> Total harvest = Harvest per hunter (Table 12) × Total hunters (Table 11). Numbers may differ slightly due to rounding of average harvest per hunter.

**Table 14. Estimates of the overall statistics for active Stubble Quail hunters<sup>21</sup> in Victoria in 2024.**

Period	Annual estimate	SE	95% CI	
			Lower	Upper
Proportion active quail hunters	0.22	0.02	0.19	0.26
Estimated active quail hunters	5,759	438	4,962	6,685
Average harvest per active hunter	79.42	11.24	60.26	104.67
Average hunting days per active quail hunter	8.54	1.27	6.39	11.42

Stubble Quail hunters had a total of 49,193 hunter days (95% CI = 38,310–63,167) days during the 2024 Stubble Quail hunting season (Table 15).

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<sup>21</sup> 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 2024 Stubble Quail season.

**Table 15. Total days on which Stubble Quail were hunted for 2024.**

Period	Days hunted	SE	95% CI	
			Lower	Upper
6-7 April	1,523	701	645	3,595
8-21 April	10,785	2,733	6,614	17,587
22 April-5 May	9,252	2,557	5,436	15,746
6-19 May	11,155	3,164	6,467	19,240
20 May-2 June	6,795	2,113	3,747	12,324
3-16 June	4,642	2,360	1,813	11,882
17-30 June	5,041	2,272	2,170	11,711
<b>Total hunting days</b>	<b>49,193</b>	<b>6,301</b>	<b>38,310</b>	<b>63,167</b>

Most Stubble Quail hunting was conducted on private land (92.4% of the hunting days) with the remaining hunting occurring on public land (Table 16). A similar percentage (92.5%) of the harvested Stubble Quail reported in the telephone surveys was on private land. The percentage of Stubble Quail hunting days where dogs were used (85.3%) was similar to the percentage of Stubble Quail harvested using dogs (87.4%). The majority of Stubble Quail hunting and Stubble Quail harvesting took place on stubble (56.5% and 56.7%, respectively, Table 17).

**Table 16. Percentage of days hunted and associated Stubble Quail harvest by land tenure and dog usage in 2024.**

Land tenure	Days (%)			Harvest (%)		
	No dogs	Dogs	Total	No dogs	Dogs	Total
Private land only	13.2	79.2	<b>92.4</b>	10.9	81.6	<b>92.5</b>
State Game Reserves only	1.5	6.1	<b>7.6</b>	1.7	5.8	<b>7.5</b>
<b>Total</b>	<b>14.7</b>	<b>85.3</b>	<b>100.0</b>	<b>12.6</b>	<b>87.4</b>	<b>100.0</b>

**Table 17. Percentage of hunting days and associated Stubble Quail harvest per grassland type in 2024.**

Habitat type	Days (%)	Stubble Quail harvest (%)
Improved Pasture (Non Native)	18.2	19.7
Native Grassland	25.1	23.2
Native and Stubble	0.3	0.5
Stubble	56.5	56.7
<b>Total</b>	<b>100.0</b>	<b>100.0</b>

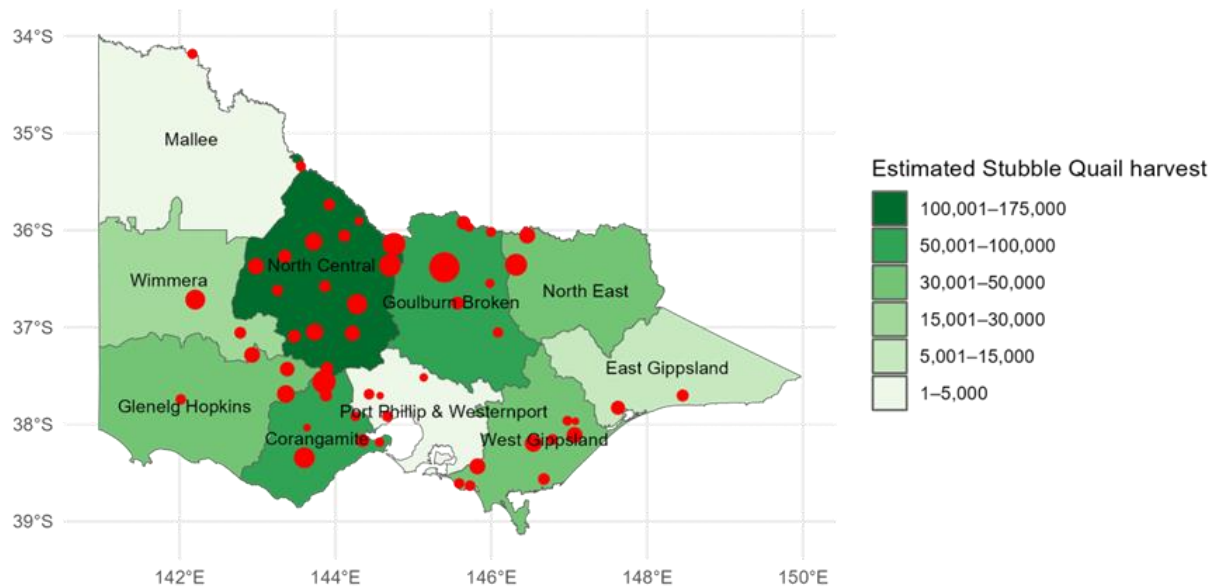


The new demographics questions showed that 56% of the licence holders surveyed considered themselves Stubble Quail hunters (Table 18). Of those, 74% self-identify as advanced hunters, with less than 1% considered themselves novice or beginner. Most licence holders (62%) said they belong to a hunting club. In general, neither self-reported experience level or being a member of a hunting club affected efficiency.

**Table 18. Overall demographic data from duck hunter surveys in 2024.**

Experience	Club member	Percentage of Respondents	Proportion of respondents that were active hunters	Percentage of overall active hunters	Total hunting days (%)	Total harvest (%)	Mean days per active hunter	Mean harvest per active hunter	Hunter efficiency
Does not hunt quail		44.0	-	-	-	-	-	-	-
Novice	No	0.5	0.00	0.0	0.0	0.0	-	-	-
	Yes	0.3	0.00	0.0	0.0	0.0	-	-	-
Beginner	No	0.6	0.00	0.0	0.0	0.0	-	-	-
	Yes	0.8	0.09	0.7	0.3	0.0	1.0	0.0	0.00
Intermediate	No	8.2	0.13	11.2	12.5	12.7	3.1	29.3	9.57
	Yes	9.4	0.15	14.0	11.7	7.2	2.3	13.3	5.78
Advanced	No	12.1	0.16	20.3	18.1	15.6	2.5	19.9	8.13
	Yes	24.0	0.22	53.8	57.5	64.5	2.9	31.0	10.60

Total harvest was estimated to be greatest in the North Central CMA, followed by the Goulburn Broken CMA and the Corangamite CMA (Figure 4). The top five towns for the total reported number of Stubble Quail harvested were (in descending order): Shepparton, Ballarat, Echuca, Rochester and Wangaratta. The top five towns for the total number of reported Stubble Quail hunting days were (in descending order): Shepparton, Echuca, Rochester, Ballarat and Colac.



**Figure 4. Estimates of total Stubble Quail harvest in 2024 by CMA region.**

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

Stubble Quail were reported shot but lost on 5% of Stubble Quail hunting trips (16 out of 300) for a total of 28 Stubble Quail in the survey. The estimated season total of Stubble Quail shot and lost in 2024 is 3,505 (95% CI = 1,831–6,711), which would increase the harvest by 0.8%.

In 2024 only 1 respondent reported a harvest that exceeded the daily Stubble Quail limit.

## 4 Discussion

### 4.1 Duck

A total of 391,900 ducks were estimated to have been harvested in Victoria during the 2024 season (95% CI = 345,200–444,800), which was 22% above the average annual duck harvest estimates in the previous surveys (320,000) (Figure 5 and Table 19) and a 22% increase over the 2023 estimate.

The estimated number of total hunting days (second highest recorded), duck harvest per licence holder (third highest recorded) and hunting days per licence holder (highest recorded) were all higher than historical levels. This possibly reflects hunters going out more frequently over a shortened season (9 weeks compared to the prescribed 12 weeks) to acquire their desired number of ducks with the reduced daily bag limit (6 ducks per day compared to the prescribed 10). Hunter efficiency (ducks per hunting day) was similar to previous years, just 4% below the average from 2009 to 2024 (3.53 ducks per hunting

day, Table 19). In 2024, the estimated efficiency was 57% of the daily bag limit (the previous seasons average is 56%), with only 45% of trips meeting their daily bag limit. The only years where hunter efficiency was higher than 2024 were when the daily bag limit was at the maximum prescribed daily bag limit (10 ducks per day).

It was estimated that 60% (95% CI = 56%–65%) of Game Licence holders hunted for ducks during the 2024 duck season. That equates to an estimate of 12,937 (95% CI = 11,952–14,002) active duck hunters in the 2024 duck season. The average duck harvest per active duck hunter was estimated to be 30.3 (95% CI = 26.1–35.2) over 8.9 (95% CI = 7.7–10.4) days of hunting. These are largest estimates since the proportion of hunters active during the season was first recorded in 2017.

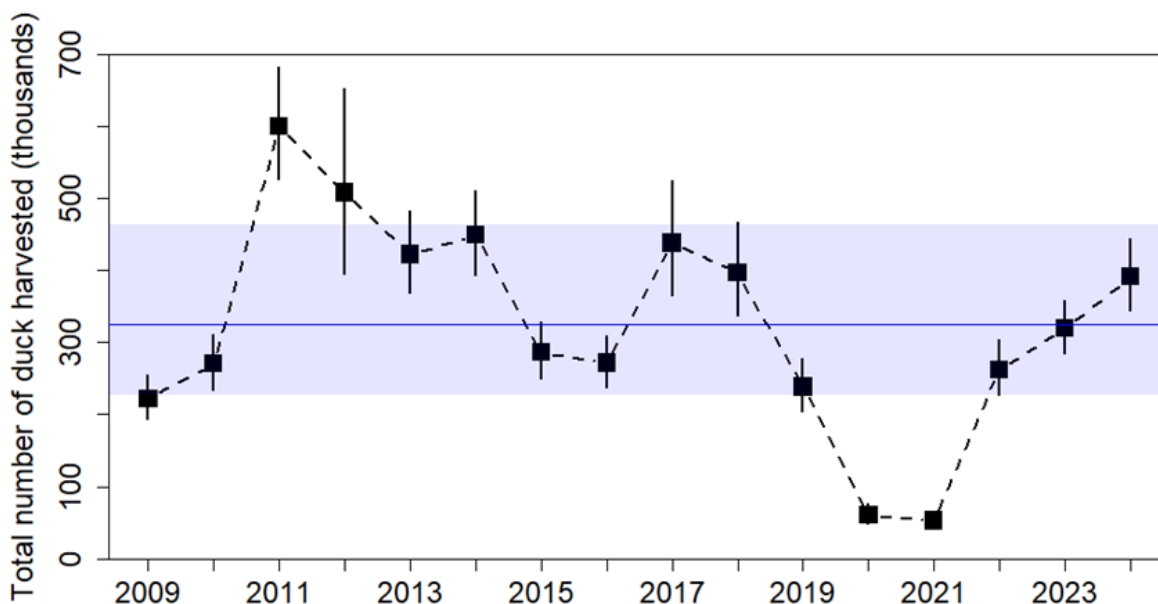


Figure 5. Estimates of total duck harvests (in thousands) from 2009 to 2024.

The square is the estimated total harvest for each season; the solid vertical line indicates the 95% confidence interval; the blue line is the average duck harvest from 2009 to 2024; the shaded area is the 95% confidence interval for the average duck harvest from 2009 to 2024.

**Table 19. Comparison of duck harvest statistics of 2009 to 2024.**

Year	Total harvest	Hunting days	Ducks per licence holder	Hunting days per licence holder	Ducks per hunting day	Proportion of active hunters	Ducks per active hunter	Season length	Daily bag limit
2009	222,302	76,659	11.10	3.98	2.78	NA	NA	7	5
2010	270,574	85,801	12.54	3.98	3.16	NA	NA	10	8
2011	600,739	103,450	26.02	4.48	5.81	NA	NA	13	10
2012	508,256	109,718	21.19	4.60	4.63	NA	NA	13	10
2013	422,294	91,748	17.24	3.75	4.60	NA	NA	13	10
2014	449,320	118,800	17.29	4.57	3.78	NA	NA	12	10
2015	286,729	90,634	11.35	3.58	3.17	NA	NA	12	5
2016	271,576	100,749	10.73	3.98	2.70	NA	NA	12	4
2017	438,353	96,508	17.36	3.83	4.53	0.66	25.40	12	10
2018	396,708	91,570	15.65	3.62	4.33	0.55	28.10	12	10
2019	238,666	81,023	9.62	3.27	2.94	0.55	17.60	9	5
2020	60,403	29,501	2.58	1.26	2.05	0.32	8.10	5	3
2021	52,456	19,720	2.16	0.81	2.66	0.32	6.90	3	5
2022	262,567	96,102	11.57	4.24	2.73	0.50	23.30	12	4
2023	319,908	99,680	14.60	4.55	3.21	0.65	22.66	5	4
2024	391,878	115,371	18.44	5.43	3.40	0.60	30.29	9	6
<b>Average</b>	<b>324,546</b>	<b>87,940</b>	<b>13.72</b>	<b>3.75</b>	<b>3.53</b>	<b>0.52</b>	<b>20.29</b>		

The estimated total harvest in 2024 of Chestnut Teal and Pacific Black Duck were 65% and 49% higher than the long-term average respectively, while for Pink-eared Duck the harvest was 79% lower (Table 20). The increase in the number of Chestnut Teal harvested could be related a marked increase in the abundance from 2023 to 2024 (Ramsey and Fanson, 2024). All other species that could be hunted were similar to their long-term averages.

**Table 20. Comparison of duck harvests by species from 2009 to 2024.**

NAs represent years where the hunting of that species was prohibited, while 0 was used if they could be harvested, but there were none reported.

Year	Australian Wood Duck	Blue-winged Shoveler	Chestnut Teal	Grey Teal	Hardhead	Mountain Duck	Pacific Black Duck	Pink-eared Duck
2009	131,084	NA	13,176	20,919	NA	2,173	55,150	NA
2010	112,390	216	14,354	26,011	324	5,936	96,487	0
2011	132,908	4,854	49,812	211,034	25,657	8,090	156,484	12,597
2012	150,150	1,319	23,506	110,574	30,222	9,234	160,704	21,587
2013	106,553	7,104	39,804	135,947	7,349	2,694	92,714	30,129
2014	131,282	4,155	29,866	127,126	6,363	8,440	127,646	14,154
2015	80,194	1,497	19,456	79,945	998	6,860	81,940	15,839
2016	77,955	NA	18,097	77,069	506	6,454	89,850	1,645
2017	90,929	NA	13,639	175,038	8,083	12,124	118,460	20,080
2018	89,354	NA	27,123	122,941	4,816	6,971	132,827	12,674
2019	57,588	NA	13,528	63,421	621	8,688	83,031	3,103
2020	18,204	NA	4,374	6,028	0	3,783	27,778	236
2021	14,301	NA	5,233	11,197	61	1,643	19,534	304
2022	68,632	NA	26,044	47,506	NA	20,567	98,700	1,118
2023	58,457	NA	14,155	91,206	NA	2,831	144,995	7,269
2024	94,250	NA	35,915	98,926	NA	7,651	153,117	2,019
<b>Average</b>	<b>88,389</b>	<b>3,191</b>	<b>21,755</b>	<b>87,806</b>	<b>7,083</b>	<b>7,134</b>	<b>102,464</b>	<b>9,517</b>

## 4.2 Stubble Quail

An estimated total of 457,399 Stubble Quail have been harvested in Victoria during the 2024 season (95% CI = 362,288–577,479). This is the second largest Stubble Quail harvest since the telephone surveys started in 2009 (Figure 6 and Table 21). The increase can be partially explained by hunting effort and efficiency.

The estimated number of total hunting days (49,193, highest recorded) and Stubble Quail per licence holder (17.89, second highest recorded) were higher than historical averages (21,805 and 6.71 respectively).

Hunter efficiency (9.29 Stubble Quail per hunting day) was the third highest recorded between 2009 to 2024 (8.08).

It was estimated that 22% (95% CI = 19%–26%) of Game Licence holders actually hunted for Stubble Quail during the 2024 Stubble Quail season. That equates to an estimate of 5,759 (95% CI = 4,962–6,685) active Stubble Quail hunters in the 2024 Stubble Quail season. The average Stubble Quail harvest per active Stubble Quail hunter was estimated to be 79.4 (95% CI = 60.3–104.7). This estimate is the second highest recorded.

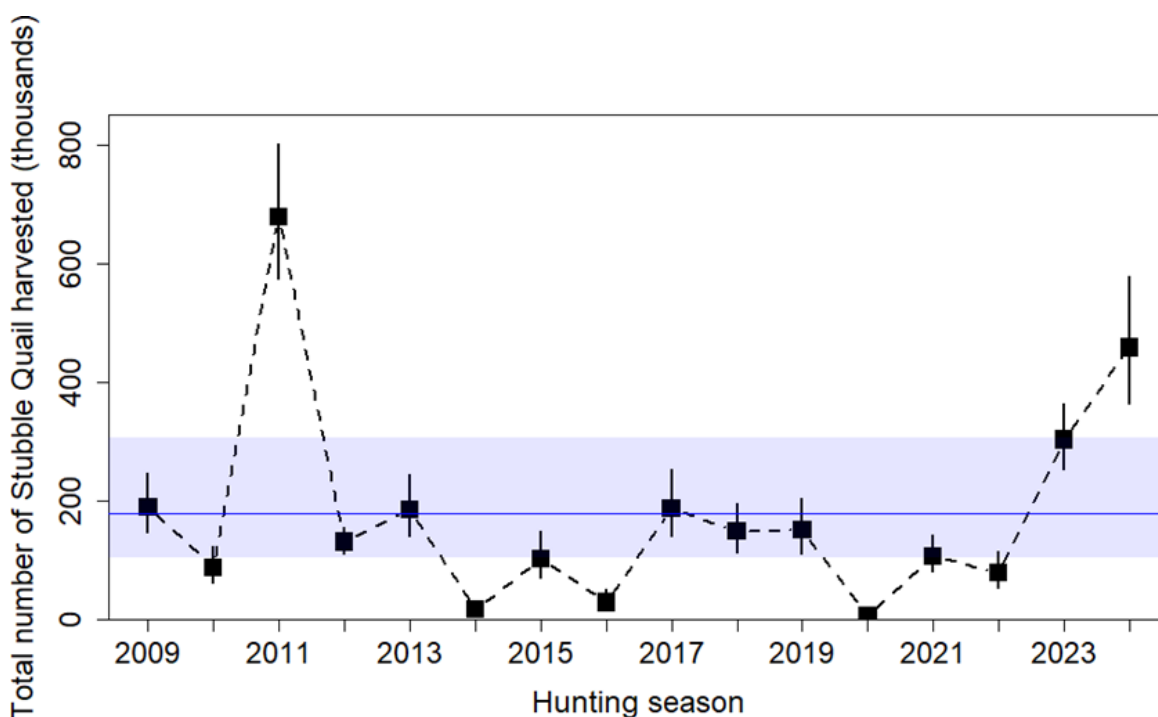


Figure 6. Estimates of total Stubble Quail harvests (in thousands) from 2009 to 2024.

The square is the estimated total harvest for each season; the solid vertical line indicates the 95% confidence interval; the blue line is the average Stubble Quail harvest from 2009 to 2024; the shaded area is the 95% confidence interval for the average Stubble Quail harvest from 2009 to 2024.

**Table 21. Comparison of Stubble Quail harvests of 2009 to 2024.**

Year	Total harvest	Hunting days	Quail per licence holder	Hunting days per licence holder	Quail per hunting day	Proportion of active hunters	Quail per active hunter
2009	189,155	24,648	7.89	1.03	7.97	NA	NA
2010	86,302	24,739	3.59	1.03	3.48	NA	NA
2011	678,431	46,719	26.17	1.80	14.52	NA	NA
2012	129,711	22,262	4.80	0.82	5.81	NA	NA
2013	184,123	21,958	6.69	0.98	8.39	NA	NA
2014	16,243	10,852	0.56	0.38	1.47	NA	NA
2015	101,244	22,432	3.58	0.79	4.51	NA	NA
2016 <sup>22</sup>	28,043	6,559	1.00	0.23	4.29	NA	NA
2017	186,691	22,052	6.51	0.77	8.45	0.15	43.7
2018	148,500	17,772	5.19	0.62	8.36	0.18	28.5
2019	149,736	22,351	5.30	0.79	6.70	0.08	87.2
2020	4,848	3,771	0.18	0.14	1.29	0.04	5.1
2021	105,968	16,381	3.70	0.57	6.49	0.06	59.4
2022	77,590	10,214	2.84	0.37	7.60	0.09	30.4
2023	302,824	26,981	11.42	1.02	11.23	0.18	63.6
2024	457,399	49,193	17.89	1.93	9.29	0.22	79.4
<b>Average</b>	<b>177,926</b>	<b>21,805</b>	<b>6.71</b>	<b>0.83</b>	<b>8.08</b>	<b>0.13</b>	<b>49.7</b>

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. In 2024 it was estimated that 56% (95% CI = 41–77%) of Game Licence holders endorsed for Stubble Quail self-identified as ‘Stubble Quail hunters’. That includes those who did not actively hunt Stubble Quail in 2024. This equates to an estimate of 14,386 (95% CI = 10,534–19,648) ‘Stubble Quail hunters’ in the 2024 Stubble Quail season. 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.

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.

<sup>22</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.



### 4.3 Locations with the most hunting days

The top five towns for the total number of reported duck hunting days in 2024 were (in descending order): Sale, Kerang, Boort, Horsham and Shepparton.

The top five towns for the total number of reported Stubble Quail hunting days in 2024 were (in descending order): Shepparton, Echuca, Rochester, Ballarat and Colac.

Combining duck and Stubble Quail, Sale had the most hunting days during the 2024 hunting seasons, followed by Shepparton, Kerang, Horsham 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.

### 4.4 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 (e.g. exceeded bag limit, or conversely, did not harvest anything), memory recall (e.g. respondents not remembering their harvest), and deliberate over- or under-reporting (e.g. harvest 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% (Barker, 1991; Wright, 1978). It is likely, however, that the sampling strategy of telephone interviews after each two-week period in the case of ducks and Stubble Quail (in 2024), 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 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.

The methodology used here explicitly accounts for the possibility that not every Game Licence holder hunts in every survey period (see Gormley & 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 200 - 300 respondents per fortnightly 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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## Appendices

### Appendix 1: Questionnaire for Game Licence holders endorsed to hunt duck

1. How would you describe your level of hunting experience?
  - a. Novice
  - b. Beginner
  - c. Intermediate
  - d. Advanced
  
2. Are you a member of a hunting organisation? If so which ones?
  - a. Sporting Shooters Association of Australia (SSAA)
  - b. Australian Deer Association (ADA)
  - c. Victorian Hound Hunters (VHH)
  - d. Field and Game Australia (FGA)
  - e. Prefer not to say
  - f. Other \_\_\_\_\_
  
3. Have you been duck hunting in the last two weeks? If 'Yes', proceed to question 4. If 'No', end the survey and thank them for their time.
  
4. How many duck hunting trips have you been on in the last two weeks?  
Enter number \_\_\_\_\_
  
5. Starting with trip 1, how many days was this hunting trip?  
Enter number \_\_\_\_\_
  
6. What was the number of each species of duck you harvested? Enter the number of each species harvested.
  - a. Australian wood duck \_\_\_\_\_
  - b. Pacific Black Duck \_\_\_\_\_
  - c. Grey teal \_\_\_\_\_
  - d. Chestnut teal \_\_\_\_\_
  - e. Pink-eared duck \_\_\_\_\_
  - f. Hardhead \_\_\_\_\_
  - g. Mountain duck \_\_\_\_\_
  - h. Other (name and no.) \_\_\_\_\_

7. Did you shoot and lose any animals? If so how many?

Enter number \_\_\_\_\_

8. Did you hunt with a gundog on this trip?

a. Yes

b. No

9. What was the closest major town to the area you hunted in? Enter the name of the town.  
Please ensure it is a town (eg, Bairnsdale) and not a region (eg, Gippsland)

Enter town name \_\_\_\_\_

10. Did you hunt predominantly on private or public land on this trip?

a. Public

b. Private

c. State Game Reserve

Repeat questions 5-10 for each duck hunting trip taken.

## Appendix 2: Questionnaire for Game Licence holders endorsed to hunt Stubble Quail

How would you describe your level of hunting experience?

- a. Novice
- b. Beginner
- c. Intermediate
- d. Advanced

Do you use a gundog when you hunt for quail?

- a. Yes
- b. No

Are you a member of a hunting organisation? If so which ones?

- a. Sporting Shooters Association of Australia (SSAA)
- b. Australian Deer Association (ADA)
- c. Victorian Hound Hunters (VHH)
- d. Field and Game Australia (FGA)
- e. Prefer not to say
- f. Other \_\_\_\_\_

Have you been quail hunting in the last two weeks? If 'Yes', proceed to question 5. If 'No', end the survey and thank them for their time.

How many quail hunting trips have you been on in the last two weeks?

Enter number \_\_\_\_\_

Starting with trip 1, how many days was this hunting trip?

Enter number \_\_\_\_\_

How many quail did you harvest on this hunting trip?

Enter number \_\_\_\_\_

What type of habitat did you hunt in?

- a. Native grassland
- b. Stubble
- c. Improved pasture (non-native)

Did you shoot and lose any animals? If so how many?

Enter number \_\_\_\_\_

What was the closest major town to the area you hunted in? Enter the name of the town. Please ensure it is a town (eg, Bairnsdale) and not a region (eg, Gippsland)

Enter town name \_\_\_\_\_

Did you hunt predominantly on private or public land on this hunting trip?

- a. Public
- b. Private
- c. State Game Reserve

Repeat questions 6-11 for each quail hunting trip taken.

## Appendix 3: Definitions and calculations

### Definitions

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

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

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

### Calculations

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

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

e.g. for Deer Survey 4 in 2015, we obtained: obtained:

$$\frac{70}{200} = 0.350$$

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

$$H_j = p_j L$$

eg. for Deer Survey 4 in 2015, we obtained:  $0.35 \times 30,908 = 10,818$ .

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

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

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

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

$$W_j = w_j H_j$$

e.g. for Deer Survey 4 in 2015, we obtained:

$$3.07 \times 10,808 = 33,226.$$

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

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

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

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

e.g. for Deer Survey 4 in 2015, we obtained:

$$\sqrt{\frac{0.35 \times .65}{200}} = 0.034.$$

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

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

e.g. for Deer Survey 4 in 2015, we obtained:

$$\frac{4.55}{\sqrt{70}} = 0.54$$

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

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

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

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

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  $\geq 0$ . A consequence is that the confidence intervals were asymmetric and could not be reported as the estimate plus or minus a fixed value. For some estimates, denoted as  $\hat{X}$ , 95% confidence interval limits were calculated using:

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

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

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

E.g. for the total duck harvest we have

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

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



Therefore, upper and lower confidence limits are given by:

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

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

## Appendix 4 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 contained within the box. Any unusual data are highlighted as outliers. As an example, using duck-hunting data, Figure A4.1 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.

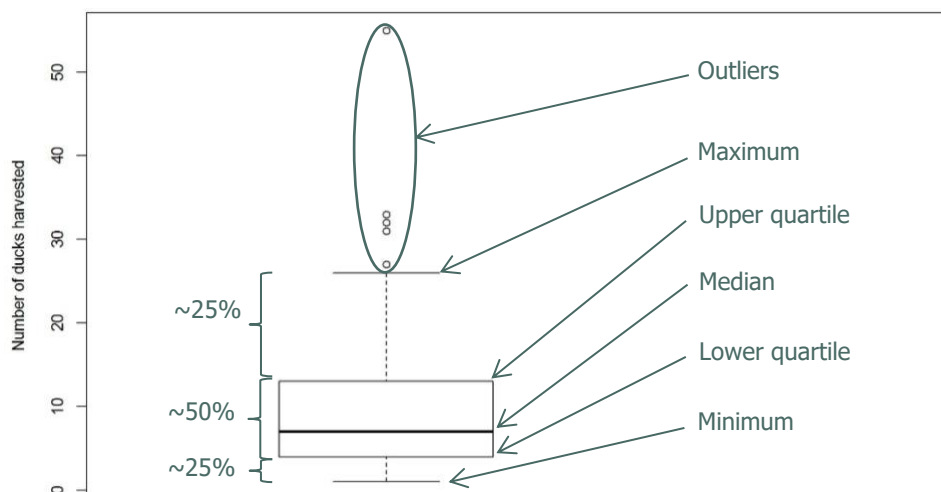


Figure A4.1. Example boxplot, with labels.

## Appendix 5 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 duck. 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 18.4 birds (95% CI = 16.2–20.9; Table A1). 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 A5.1. Estimates of average harvest of ducks per Game Licence holder in each survey period in 2024.**

Period	Average harvest <sup>23</sup>	SE	95% CI	
			Lower	Upper
10-14 April	4.22	0.63	3.16	5.63
15-29 April	5.35	0.59	4.31	6.63
30 April-12 May	2.79	0.43	2.07	3.77
13-26 May	3.24	0.51	2.39	4.40
27 May-5 June	2.84	0.49	2.02	3.98
<b>Total</b>	<b>18.44</b>	<b>1.19</b>	<b>16.25</b>	<b>20.93</b>

Each Game Licence holder hunted an average of 5.4 days during the 2024 duck-hunting season (Table A2). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 115,371 hunter days (95% CI = 101,164–131,574).

**Table A5.2. Days on which ducks were hunted per Game Licence holder for 2024.**

Period	Days hunted	SE	95% CI	
			Lower	Upper
10-14 April	1.31	0.12	1.10	1.57
15-29 April	1.60	0.15	1.33	1.93
30 April-12 May	0.98	0.14	0.74	1.29
13-26 May	0.84	0.12	0.64	1.11
27 May-5 June	0.69	0.10	0.52	0.92
<b>Total per licence holder</b>	<b>5.43</b>	<b>0.29</b>	<b>4.90</b>	<b>6.02</b>
<b>Total hunting days</b>	<b>115,371</b>	<b>7,744</b>	<b>101,164</b>	<b>131,574</b>

<sup>23</sup> Average harvest per Game Licence holder = Duck harvest divided by Respondents (Table 1).

## Appendix 6 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 17.9 birds (95% CI = 14.2–22.6; Table A3). However, if you limit the respondents to only those who say they hunt Stubble Quail, then the total average season harvest per self-reported Stubble Quail hunter is estimated to be 15.5 birds (95% CI = 10.4–23.2; Table A3). 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 A6.1. Estimates of average harvest of Stubble Quail per Game Licence holder in each survey period in 2024.**

Period	Average harvest <sup>24</sup>	SE	95% CI	
			Lower	Upper
6-7 April	0.78	0.31	0.37	1.64
8-21 April	3.14	0.77	1.95	5.05
22 April-5 May	3.11	0.79	1.91	5.07
6-19 May	4.46	1.13	2.73	7.28
20 May-2 June	2.02	0.54	1.20	3.38
3-16 June	2.10	1.02	0.85	5.16
17-30 June	2.29	0.79	1.19	4.41
<b>Total</b>	<b>17.89</b>	<b>2.13</b>	<b>14.17</b>	<b>22.57</b>

Each Game Licence holder hunted an average of 1.9 days during the 2024 Stubble Quail-hunting season (Table A4). When multiplied by the total number of Game Licence holders in each survey period, this equalled a total of 49,193 hunter days (95% CI = 38,310–63,167).

<sup>24</sup> Average harvest per Game Licence holder = Stubble Quail harvested divided by Respondents (Table 11).

**Table A6.2. Days on which Stubble Quail were hunted per Game Licence holder for 2024.**

Period	Days hunted	SE	95% CI	
			Lower	Upper
6-7 April	0.06	0.02	0.03	0.11
8-21 April	0.42	0.08	0.29	0.62
22 April-5 May	0.36	0.08	0.24	0.55
6-19 May	0.44	0.09	0.29	0.66
20 May-2 June	0.26	0.06	0.17	0.42
3-16 June	0.18	0.07	0.08	0.39
<b>Total per licence holder</b>	<b>1.73</b>	<b>0.18</b>	<b>1.42</b>	<b>2.11</b>
<b>Total hunting days</b>	<b>44,152</b>	<b>5,877</b>	<b>34,052</b>	<b>57,248</b>

