



Monitoring trends in waterfowl wounding 2023

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1 Executive Summary

The Victorian Sustainable Hunting Action Plan 2021 – 2024 (SHAP) committed to implementing a monitoring program to measure the success of management interventions to reduce waterfowl wounding in duck hunting. In 2022, the Game Management Authority (GMA) commenced a monitoring program using radiography (x-ray) to detect embedded shotgun pellets in ducks as an index of the incidence of wounding. This monitoring program continued in 2023.

Following the end of the 2023 duck season, trapping was conducted at six sites in Victoria. In total, 632 game ducks were captured and radiographed. Six species of game duck were examined: Australian Wood Duck, Grey Teal, Chestnut Teal, Pacific Black Duck, Hardhead and Pink-eared Duck.

In total, 2.4 per cent (15) of the ducks were shown to be carrying embedded pellets. This was lower than the infliction rate of 3.4 per cent recorded in 2022. Two of the six game duck species that were examined (Pacific Black Duck and Grey Teal) were found to carry embedded pellets. Adult birds had almost four times the infliction rate of first year birds (4.2 per cent vs 1.1 per cent, respectively). Pacific Black Ducks were found to have the highest rate of infliction, with 4.9 per cent of trapped Pacific Black Ducks carrying embedded pellets.

The overall infliction rate of 2.4 per cent cannot be interpreted as the actual rate of wounding as the birds sampled in this study are representative of the apparently small proportion that survive being wounded and are available for examination. The infliction rate can only be used as a proxy index to monitor trends in waterfowl wounding. Direct studies, such as observations of hunters in the field, should be used to determine the actual rate of wounding more accurately.

2 Background and purpose

Wounding can be an unintended consequence of duck hunting. A wounded bird is defined as one that is struck by shotgun pellets and not recovered by the hunter. Factors that can contribute to wounding include poor shooting skills, long-range shooting, incorrect equipment choices, shooting into flocks and the lack of an effective retrieval strategy (Roster 1998a; Roster 1998b; Clausen *et al.* 2017).

The SHAP committed to implementing a monitoring program to measure the success of management interventions to reduce waterfowl wounding in duck hunting. A strong-evidence base will help to ensure informed community discussion on waterfowl wounding, guide management actions and allow the success of actions to be reviewed.

The Danish Hunter's Association developed and implemented a program to monitor wounding by x-raying live trapped birds to identify the proportion carrying embedded shot (Noer *et al.* 2007). This has been used effectively to measure the success of a targeted plan to reduce waterfowl wounding caused by hunting in Denmark. In response to the SHAP commitment, an ongoing wounding monitoring program using radiography (x-rays) commenced in 2022. While this approach cannot be used to determine actual level or rate of wounding, it can be used as a proxy measure to monitor trends in the rates of wounding in a less resource intensive way than some other forms of monitoring (Clausen *et al.* 2017).

The wounding monitoring program commenced with a trial in June 2021 to test methods and techniques to capture and x-ray wild-caught game ducks. Learnings were then applied, and large-scale monitoring began in 2022. In 2023, the monitoring program continued, with ducks trapped immediately following the end of the duck season and radiographed to document the proportion of birds carrying embedded shotgun pellets (the infliction rate). In 2023, additional capture sites were added to increase geographic coverage of the state and included areas where significant amounts of duck hunting occur.

The monitoring program aims to focus on immature (first year) birds, as they provide a more accurate measure of the incidence of

wounding compared to adult birds that can accumulate pellets over several hunting seasons (Norman 1976; Noer and Madsen 1996, Noer *et al.* 2007).

To raise awareness, ensure transparency and motivate hunters to act, findings of this monitoring program are reported annually on the GMA website. This is the second report on monitoring trends in waterfowl wounding in Victoria.

3 Methods

3.1 Target species

In Victoria, there are eight species of game ducks which may be hunted during the prescribed open season. These are: Grey Teal (*Anas gracilis*), Australasian Shoveler (*Spatula rhynchotis*), Pacific Black Duck (*Anas superciliosa*), Australian Wood Duck (*Chenonetta jubata*), Chestnut Teal (*Anas castanea*), Australian Shelduck (*Tadorna tadornoides*), Pink-eared Duck (*Malacorhynchus membranaceus*) and Hardhead (*Aythya australis*). Restrictions preventing the hunting of Australasian Shoveler and Hardhead were imposed for the 2023 duck season. While all eight game species of duck were targeted for capture, six

game duck species were successfully captured and examined during the 2023 monitoring program.

3.2 Survey locations

All birds were wild caught at six locations in Victoria, which can be generalised as the north-east (Oxley and Thoona), south (Lara and Point Wilson), west (Donald) and east (Sale). At the north-east sites (Oxley and Thoona), ducks were trapped using cage traps on small dams (< one hectare) on private property. In the south, cannon-netting was carried out at a wetland at Point Wilson and cage trapping was conducted at a wetland at Lara. Cage trapping was conducted in the west (Donald) and east (Sale) on private property. Site locations are shown in Figure 1.

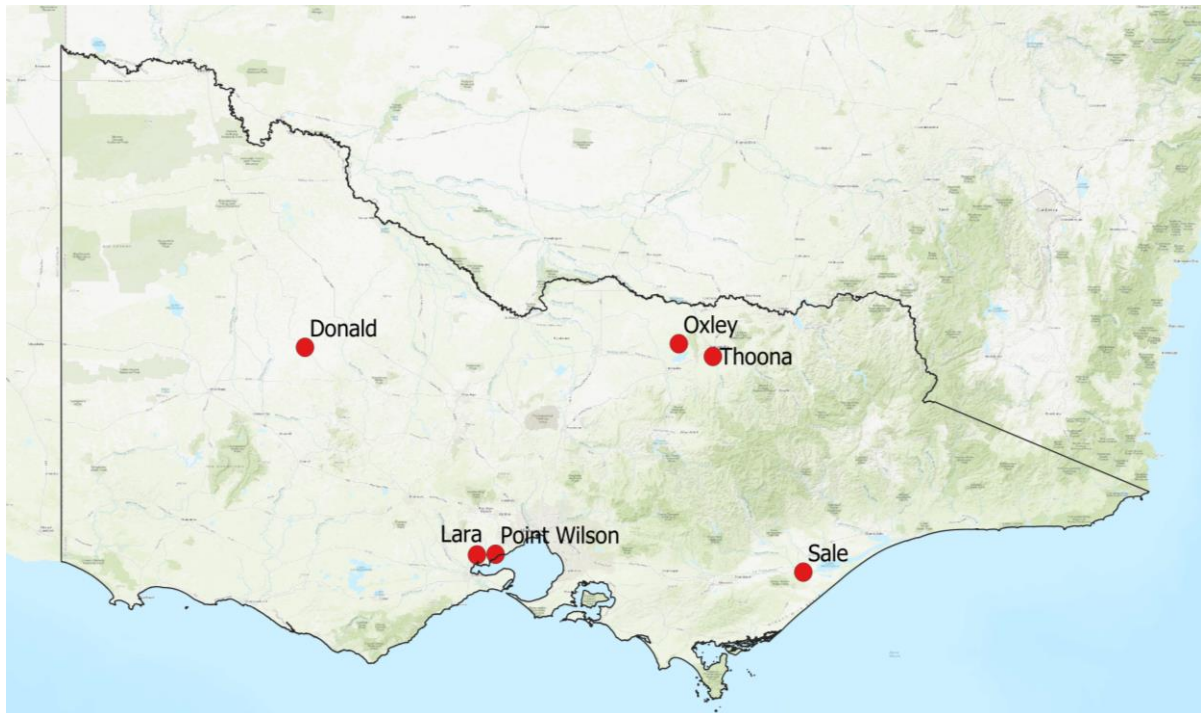


Figure 1: Location of sites where trapping and radiography was conducted in 2023

3.3 Capture systems and methods

3.3.1 Cage traps

Sites for duck capture were selected based on access to secure trap sites and where large concentrations of ducks had been previously observed and/or captured in 2022. Trapping occurred immediately after the conclusion of the duck season to ensure that ageing of first-year (immature) birds from plumage characteristics was more achievable and while immature birds still retain certain plumage characteristics, prior to moulting into their adult plumage. Given trapped birds were approaching 12-months of age, this was not always possible and multiple characteristics were considered to determine age using Rogers *et al.* (2019) as a guide.

Trapping commenced at the end of May and was completed by the end of July. The bulk of trapping was completed by the end of June 2023. Wire mesh cage traps were used to capture game ducks at five sites across Victoria (Lara, Oxley, Thoona, Sale and Donald). Traps were baited with grain (corn, wheat or barley) for up to two weeks prior to trapping, to familiarise ducks with the equipment and trapping site. Baiting continued throughout the trapping period with the use of a game feeder and with grain placed directly in and around the traps by hand. The feeder was programmed to automatically dispense a small amount of grain at times that coincided with duck feeding activity and when trapping was planned to be undertaken (generally early-morning and late-afternoon). Once trapped, birds were extracted by hand or using a handheld net and were placed into poultry transport crates prior to processing.

3.3.2 Cannon netting

Cannon-netting is a technique widely used to capture live birds and other animals and can capture many birds in a single event. The GMA commissioned the Victorian Wader Study Group (VWSG) to use cannon netting to capture ducks on two occasions at Point Wilson in 2023. As with cage trapping, roosting locations were observed at potential capture sites and pre-baited with grain for two weeks prior to the planned day of capture with a programmable game feeder and by hand. When sufficient birds had congregated in the 'catch zone', the cannons were deployed and a large net cast over the birds. Investigators

then extracted the ducks and placed them into poultry transport crates before being moved a short distance to be processed.

A detailed description of trap design and capture methods can be found in the [Monitoring trends in waterfowl wounding 2022](#) report, which is available on the GMA website.

3.4 Determination of sex and age

Where sexual dimorphism and plumage variations between the sexes were not apparent, sex was determined where possible using plumage characteristics detailed in Rogers *et al.* (2019). Morphometric and weight measurements were collected as part of this process, which may assist in ageing and sexing birds once a sufficient body of data has been collected.

3.5 Radiography procedure

Radiography was undertaken to identify the presence/absence of embedded shotgun pellets. The number and anatomical location of embedded pellets in each wounded duck was recorded and will be used to monitor trends in wounding over time.

Upon removal from the poultry transport crates, each duck was contained in a breathable cotton pillow slip and placed in a clear plastic tub to minimize movement and keep the bird in the x-ray field. The duck and tub were then placed on a 25 x 30cm digital x-ray plate (Exprimer EVS 2430) and radiographed with an Atomscope TR9020B portable veterinary x-ray unit suspended on a surveyor's tripod. Settings of 68 kV and 1.05 mAs, with a focal distance of approximately 50cm, were used. Each digital image was immediately viewed and, if necessary, subsequent radiographs were taken. Each radiograph was dorso-ventral in orientation as conscious animals will automatically 'right' themselves, eliminating the possibility of lateral images being taken without chemical or more stressful physical restraint methods being employed. All radiography was performed in a discrete area where personnel access was restricted and at least five metres away from other investigators.

3.6 Other procedures independent of wounding assessment

Researchers from Deakin University under their own authorisation banded birds and collected blood samples and buccal and vent swabs to screen for avian influenza as a part of a long-term waterbird disease surveillance program.

3.7 Relevant licenses, permits and approvals

This project, entitled '12.20 Monitoring the frequency of waterfowl wounding in Victoria', has been approved by the Wildlife and Small Institutions Animal Ethics Committee. A Department of Environment, Land, Water and Planning (now the Department of Energy, Environment and Climate Action - DEECA) research authorisation permits the GMA to undertake this research under the *Wildlife Act 1975* (Permit No: 10009542). A *National Parks Act 1986* permit was also granted to the GMA, allowing work to be undertaken on land managed by Parks Victoria.

The Principal Investigator involved was issued a Radiation Use License issued under Section 43 of the *Radiation Act 2005* (Licence No. 100214596). The GMA was issued with a Radiation Management Licence under Section 5 of the *Radiation Act 2005* (Licence No. 300085326). A safe work plan detailed tasks, potential hazards, risks and control measures for relevant employees and volunteers.

4 Results

4.1 Total capture and demographics

A total of 632 ducks were captured and radiographed at six sites from 31 May to 20 July 2023. Of these, 64 ducks were caught using cannon-netting and 568 were caught in cage traps. Cannon-netting accounted for approximately 10 per cent of the total number of ducks captured and averaged approximately 32 ducks per capture event. Cage trapping across all sites averaged 40.6 ducks per capture day, ranging from seven to 106 birds. A small number of non-target waterbird species were captured at several sites with both cage traps and cannon netting. All non-target species were extracted and released immediately. The most commonly captured non-target species was the Eurasian Coot (*Fulica atra*).

There were 290 ducks captured and radiographed at the southern sites (Point Wilson and Lara), 169 at the north-eastern sites (Thoona and Oxley), 143 at the eastern site (Sale) and 30 at the western site (Donald). The breakdown of duck capture by site is shown in Table 1. Of the eight game duck species, six were captured and radiographed: Australian Wood Duck, Chestnut Teal, Grey Teal, Pacific Black Duck, Hardhead and Pink-eared Duck. No Australian Shelduck or Australasian Shoveler were caught during trapping operations.

Species composition varied at each site; however, Chestnut Teal, Grey Teal and Pacific Black Duck were generally the most common species captured. Grey teal were the most commonly captured species at all sites except Lara, where Chestnut Teal were trapped in slightly higher numbers. Lara also had the greatest diversity of ducks trapped, with five out of six game ducks captured. Lara was also the only site where Australian Wood Ducks were successfully captured. A single Pink-eared Duck was captured at Point Wilson during cannon netting operations. Hardhead were captured at Lara, Donald, Sale and Thoona and were all captured in cage traps.

There were higher numbers of immature or first-year birds (<1 year) captured compared to adult birds (>1 year). Immature birds represented 58.9 per cent of total catch and adult birds represented 41.1 per cent. There was some difficulty in distinguishing first (or hatch) year birds from adults given the timing of trapping (many were nearing 12-months of age) and their plumage began to resemble that of adults. Higher numbers of males compared to females were captured for Chestnut Teal (80 vs 39), Pacific Black Duck (98 vs 43) and Hardhead (7 vs 5). Equal numbers of each sex were captured for Australian Wood Duck (1 female and 1 male). It was not possible to sex Grey Teal and Pink-eared Duck from plumage characteristics. The breakdown of sex and age of ducks by species is shown in Table 2.

Table 1: Location, method of capture and number of game ducks radiographed in 2023

Location	Method	Trap days	Dates of capture	Total	Average per day
Lara	Cage trap	3	31 May, 1 June, 2 June	226	75.3
Point Wilson	Cannon net	2	6 June, 14 June	64	32
Oxley	Cage trap	3	22 June, 23 June, 30 June	86	28.7
Thoona	Cage trap	4	8 June, 9 June, 22 June, 23 June	83	20.8
Sale	Cage trap	3	3 July, 4 July, 5 July	143	47.7
Donald	Cage Trap	2	19 July, 20 July	30	15

Table 2: Sex and age of game ducks captured across all sites in 2023

Species	Male	Female	Sex Unknown	Adult	Immature	Total
Aust. Wood Duck	1	1	0	1	1	2
Chestnut Teal	80	39	1	54	66	120
Grey Teal	NA	NA	356	114	242	356
Pacific Black Duck	98	43	0	79	62	141
Hardhead	7	5	0	11	1	12
Pink-eared Duck	NA	NA	1	1	0	1
	186	88	358	260	372	632

4.2 Pellet infliction by species, age and location

Of the 632 ducks captured and radiographed, 15 (2.4 per cent) were shown to have embedded shotgun pellets. Pacific Black Ducks were the species found to have the highest rate of pellet infliction, with five per cent of birds (7 of 141) carrying embedded pellets. All of the Pacific Black Ducks carrying embedded pellets were identified as males. A total of 2.2 per cent of Grey Teal (8 of 356) were found to carry embedded pellets. No other species captured in 2023 were found to be carrying embedded pellets. A breakdown of pellet infliction by species, age and sex is shown in Table 3.

Of the 15 inflicted birds, four (26.7 per cent) were immature (<1 year) and 11 (73.3 per cent) were adult birds (Figure 2). All the immature birds carrying embedded pellets were Grey Teal. From the total 372 immature birds examined, the four inflicted birds represented 1.1 per cent of the total number of immature animals. From the total 260 adult

birds examined, the 11 inflicted birds represented 4.2 per cent of the total number of adults. Therefore, adult birds had almost four times the infliction rate of immature birds. All ducks had a single embedded pellet, except for one Grey Teal and two Pacific Black Ducks, which carried two embedded pellets, each of equal size. Embedded shotgun pellets were distributed in different anatomical areas. Pellets were observed in the rump, neck, wing, breast and back. Figures 3-6 show indicative images of birds carrying embedded pellets.

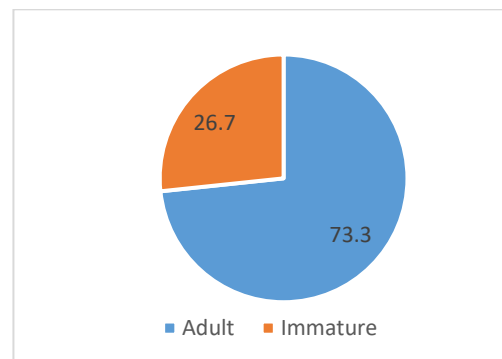


Figure 2: Age class % of inflicted birds (n=15)

Table 3: Sex and age of game ducks carrying embedded shotgun pellets

Species	Male (<1 year)	Male (>1 year)	Female (<1 year)	Female (>1 year)	Unk. (<1 year)	Unk. (>1 year)	Total
Grey Teal	0	0	0	0	4	4	8
Pacific Black Duck	0	7	0	0	0	0	7

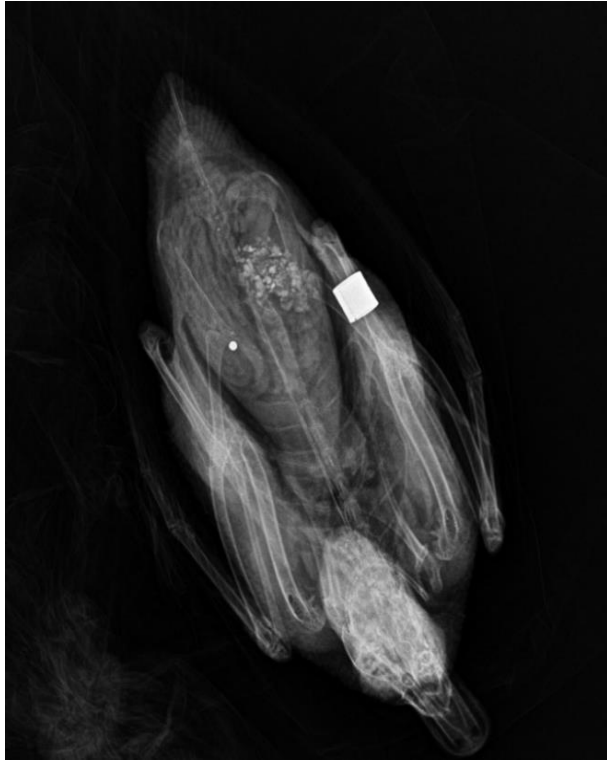


Figure 3: Grey Teal with pellet embedded in back



Figure 4: Pacific Black Duck with pellet embedded in the back leg



Figure 5: Pacific Black Duck with embedded pellets in the back and neck

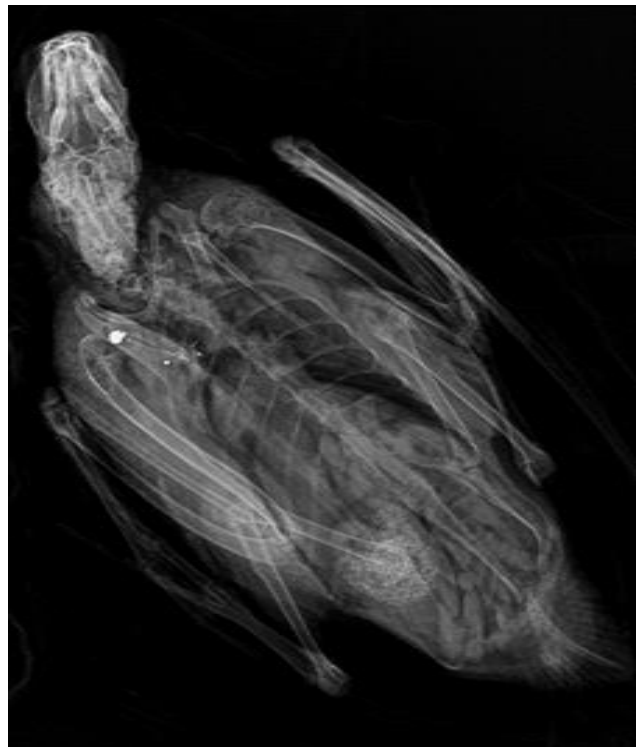


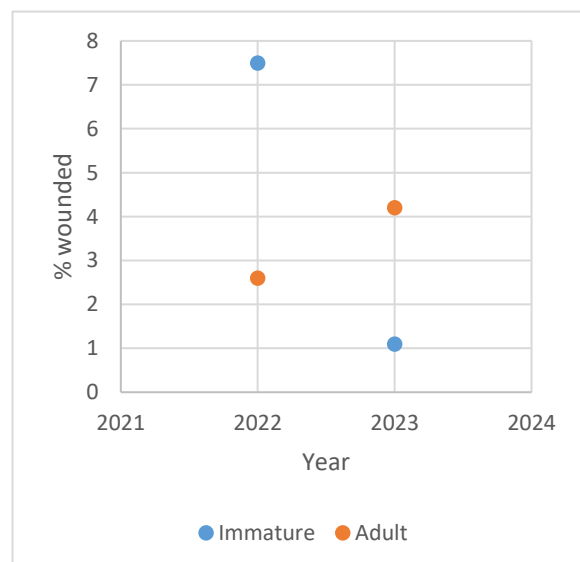
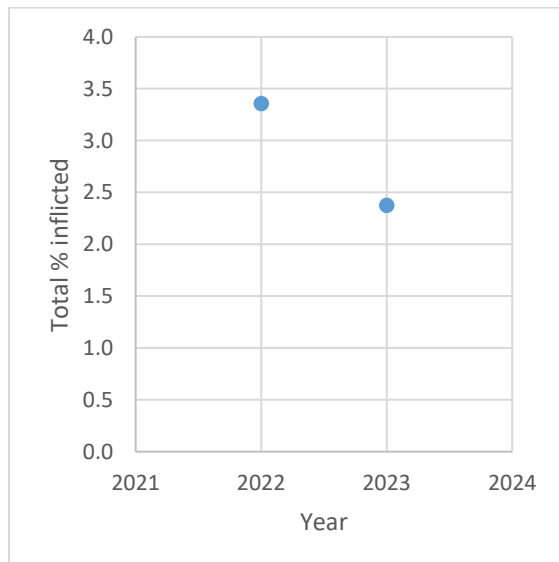
Figure 6: Grey Teal with possible bismuth shot indicated by the presence of pellet fragments

The percentage of ducks with embedded pellets varied between study sites. Sale had the greatest number of inflicted birds with 5.6 per cent (8 of 143) of total birds carrying embedded pellets. At Oxley, 2.3 per cent (2 of 86) were inflicted with pellets. Lara and Point Wilson had infliction rates of 1.8 per cent (4 of 226) and 1.6 per cent (1 of 64), respectively. None of the ducks captured at Donald and Thoona displayed embedded pellets. Infliction rates at each location are detailed in Table 4. Overall, the percentage of ducks carrying embedded pellets in 2023 was lower than what was observed in 2022 (2.4 vs 3.4 per cent as shown in Figure 7).

Pellets were also observed in fewer species in 2023 with only Pacific Black Duck and Grey Teal displaying embedded pellets (pellets were also observed in Chestnut Teal in 2022). Pacific Black Duck were again found to have the highest infliction rates (7.5 per cent in 2022 and 5 per cent in 2023). In contrast to 2022, adult birds were found to have a higher infliction rate than immature birds (Figure 8), which is expected as birds can accumulate pellets over time and may be exposed to multiple duck seasons.

Table 4: Infliction rates at different locations in Victoria

Location	Total catch	Number inflicted	% inflicted
Lara	226	4	1.8
Point Wilson	63	1	1.6
Oxley	86	2	2.3
Thoona	83	0	0.0
Sale	143	8	5.6
Donald	30	0	0.0



Figures 7 & 8: Total percentage of game ducks carrying embedded shotgun pellets and percentage of game ducks carrying embedded pellets for different age classes in 2022 and 2023

5 Discussion

This program is the first direct large-scale assessment of waterfowl wounding conducted in Victoria since the 1950-70s (Norman 1976). In 2023, 632 game ducks were examined for signs of wounding (embedded pellets) at six sites in Victoria. This work is part of an ongoing monitoring program to track trends in waterfowl wounding over time and builds on the monitoring conducted in 2022.

Slightly more game ducks were trapped in 2023 compared to 2022 (596 vs 632), especially in cage traps. In addition, a greater proportion of game duck species were captured and radiographed in 2023, including a single Pink-eared Duck and a small number of Hardhead (12 in total). The increase in trapping efficiency for cage traps is likely due to learnings being applied from 2022, including trap setup, location, bait type and baiting duration. Cannon netting was less successful in 2023 compared to 2022 (64 vs 380) and was resource intensive. The use of a pneumatic cannon net for future trapping is being investigated.

In total, 2.4 per cent (15) of the 632 ducks examined were shown to be carrying embedded pellets. Two species were affected: Pacific Black Duck and Grey Teal. Small numbers of Australian Wood Duck, Hardhead and Pink-eared Duck were captured and radiographed, and none were found to be carrying embedded pellets. Australasian Shoveler and Australian Shelduck were not captured in 2023.

Pacific Black Ducks were found to have the highest rate of pellet infliction, with 4.9 per cent of trapped birds carrying embedded pellets. This may be due to larger species of duck being more likely to survive wounding than smaller species and, therefore, are more likely to record a higher rate of pellet infliction (Norman 1976; Loyn 1989). Pacific Black Ducks are also highly sought after by recreational hunters and are regularly among the three most harvested species (Moloney and Flesch 2023).

Of the 632 ducks captured and radiographed, 372 were immature (first year) birds and had only been exposed to a single duck hunting season, providing a more accurate indication of the occurrence of wounding. Adult birds had a higher infliction rate compared to immature

birds (4.2 vs 1.1 per cent, respectively) despite representing a smaller proportion of the total number of birds examined (41 per cent vs 59 per cent). The increased number of immature birds trapped in 2023 compared to 2022 may be indicative of a productive breeding season, driven by favorable environmental conditions. The assessment of birds undertaken in 2023 to determine age class was also more rigorous than what was undertaken in 2022, resulting in greater accuracy in classifying individuals as either adult (>1 year of age) or immature (< 1 year of age).

There was variation in the rate of wounding by geographic region with the proximity to popular duck hunting areas not always correlating with the presence of wounded animals. Only two ducks captured in the north-east (Oxley) were observed to be carrying pellets in 2023 and none in the west (Donald) despite being popular duck hunting locations. Conversely, 5.6 per cent of ducks captured and radiographed at Sale (also a popular duck hunting area) were shown to be inflicted with pellets.

The overall infliction rate of 2.4 per cent cannot be interpreted as the actual rate of wounding caused by waterfowl hunting. The method of assessment used here can only sample the portion of birds that are sub-lethally wounded and survive. A limited number of studies have shown that the majority of wounded birds will die either directly or indirectly as a cause of their injuries and, as a consequence, are not available to be sampled (Van Dyke 1980; Kirby 1981). Also, radiographs can only detect those birds carrying embedded pellets but does not detect those animals that have been shot and pellets have passed through the body. Examples of this were observed in a small number of ducks that had evidence of apparent gunshot injuries to their bills and feet. Therefore, the infliction rate can only be used as a proxy index to monitor trends in wounding over time. Direct studies, such as observations of hunters in the field, should be used to determine the actual rate of wounding more accurately.

Despite being a commonly harvested game duck species, only two Australian Wood Ducks were trapped and radiographed. To capture more Australian Wood Ducks in the future, traps could be deployed specifically on farm dams or cannon netting undertaken in areas with high densities of the species. Likewise,

traps could be modified to capture Australian Shelducks by increasing the size of trap entrances. Alternatively, Australian Shelducks could be trapped when they concentrate during their annual major moult (November – January). However, it would not be possible to differentiate between adults and immature birds if trapped at this time. Increasing the sample size of both Australian Wood Duck and Australian Shelduck will be beneficial to future monitoring efforts and increase the understanding of wounding in these species.

In February, the Victorian Government announced arrangements for the 2023 duck season which included a reduction in season length to five weeks from the prescribed 12-week season and a bag limit of four birds per day, reduced from the prescribed 10 birds. The 2023 duck hunting season opened on 26 April and closed on 30 May 2023. The 2023 Stubble Quail hunting season was also modified and occurred at the same time. It was anticipated that the reduction in the possible number of hunting days, coupled with the reduced daily bag limit and coinciding duck and Stubble Quail seasons, may have reduced hunter activity and total seasonal harvest. However, results from surveys of Victorian Game Licence holders in 2023 showed that estimated duck harvest was similar to historical levels and was 22 per cent higher than the estimated harvest in 2022. The total estimated number of duck hunting days was 17 per cent above the average from previous surveys undertaken since 2009 (Moloney and

Flesch 2023a). It could be possible that uncertainty around the future of duck hunting due to a Parliamentary inquiry into native game bird hunting arrangements in Victoria may have altered hunter behaviour, resulting in the high activity levels estimated from harvest surveys during the shortened season.

This is the second year of an ongoing program to monitor the extent of pellet infliction among wild-caught game ducks in Victoria. Efforts to increase the number of study sites and sampled birds, including larger species (such as Australian Wood Duck or Australian Shelduck), are required to ensure the game duck population is adequately sampled.

6 Acknowledgements

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