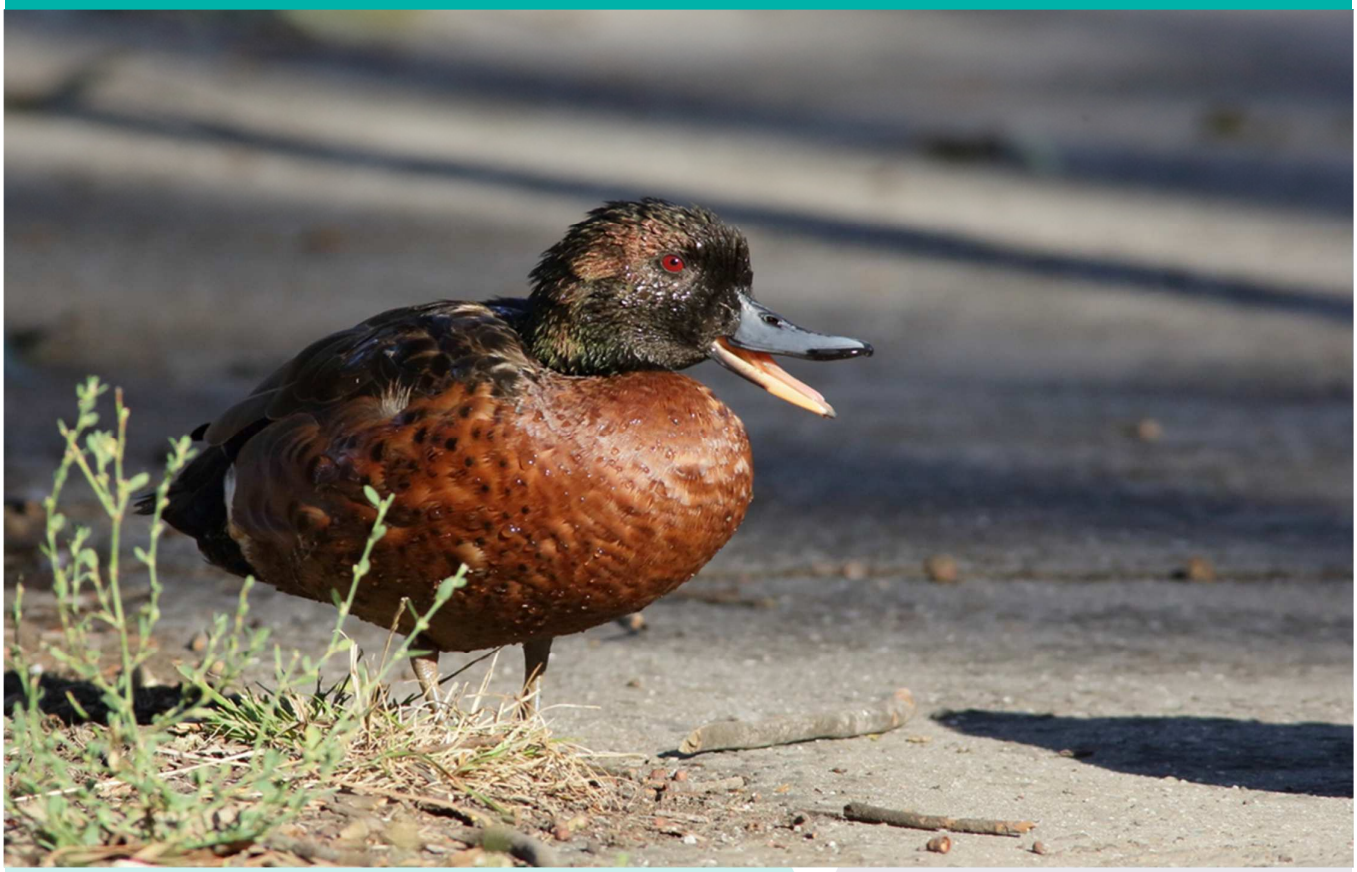
Hunters' Bag Survey:

2018 Victorian duck hunting season

P. Menkhorst, K. Stamation and G. Brown

June 2018



Arthur Rylah Institute for Environmental Research
Unpublished Report

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VICTORIA State Government | Environment, Land, Water and Planning

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Citation: Menkhorst, P., Stamation, K. and Brown, G. (2018). Hunters' Bag Survey: 2018 Victorian duck hunting season. Arthur Rylah Institute for Environmental Research Unpublished Report for the Ecological Policy Branch, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Front cover photo: A male Chestnut Teal (Photo: P. Menkhorst)

Edited by Organic Editing

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Acknowledgements

Funding for preparation of this report was provided by the Ecological Policy Section of the Department of Environment, Land, Water and Planning. We are grateful to Kirsty Greengrass, Manager, Biodiversity Policy and Regulation, for this support.

Thanks are due to those hunters who freely allowed inspection of their bags. The Hunters' Bag Survey is a collaborative effort involving staff from several government agencies—the Victorian Game Management Authority, the Department of Environment, Land, Water and Planning, and the Department of Economic Development, Jobs, Transport and Resources—we thank those agencies for their cooperation, and all staff involved.

Helpful comments on drafts were provided by Dr Jemma Cripps and Claire Moxham.

Contents

Summary

Estimating the numbers of ducks taken by hunters is an important component of assessing the impact of the duck hunting season on populations of game species. One method of sampling the level of take by hunters is to conduct surveys of hunters' bags, that is, to examine carcasses in the possession of hunters after a hunting session. Such surveys have been conducted on opening weekend at Victorian wetlands in 39 of the 46 years since 1972 (the exceptions are mostly years in which no hunting season was declared). Hunters' bag surveys aim to determine hunter success and the species, sex and age composition of birds shot during opening weekend.

In addition to checking species in hunters' possession, whole wings and tail feathers were collected from a sample of birds for later examination in the laboratory to estimate the frequency of wing (primary feather) moult, and to estimate the proportion of immature birds and the sex ratio of the sample.

On the 2018 opening weekend, Hunters' Bag Surveys were conducted at 13 public wetlands on Day 1 (Saturday, 17 March) and 9 wetlands on Day 2 (Sunday, 18 March), of which 3 had also been surveyed on Day 1, giving a total of 19 wetlands with some level of coverage. At these 19 wetlands, about 70% of the estimated number of hunters present had their bag checked.

Key findings

- Hunter success in the sample analysed across opening weekend was 2.7 birds per hunter, close to the long-term mean of 2.9 (N = 40 years), as determined by Hunters' Bag Surveys.
- The collection and retention of wings and tail feathers for later analysis was well received by hunters and resulted in increased confidence in the resulting estimates of age class and sex ratios compared to the previous method of scoring these parameters in the field.
- There had clearly been successful breeding in the months prior to the season opening, with almost one-quarter of bagged birds being juvenile.
- The species found in hunters' bags and their relative proportions were: Grey Teal (41.5%), Australian Wood Duck (26.9%), Pacific Black Duck (22.4%), Chestnut Teal (4.9%), Pink-eared Duck (2.9%), Australian Shelduck (1.3%), Hardhead (0.2%) and Australasian Shoveler (0.04%). This species composition was broadly similar to that of recent seasons.

Recommendations

1. The Hunters' Bag Survey needs to include a larger number of wetlands, more evenly spread across the state, if it is to provide reliable information on which to base management decisions.
2. A statistical power analysis of the accumulated data should be carried out to derive estimates of the sample sizes required to achieve scientifically robust estimates of opening weekend harvest for each species, the sex and age structure of the harvested birds by species, and the incidence of primary moult in each sex and age class of each game species.
3. If an estimate of total take during opening day or weekend is an aim of the Hunters' Bag Survey, then greater attention needs to be given to estimating the number of hunters present at a wetland during the survey.
4. A long-term dataset of recruitment and age-related survival is required to reliably assess the impact of hunting on game duck population trends. The new system of sampling wings and tail feathers for sexing and age estimation should be retained and expanded with the aim of developing a long-term dataset of these key population parameters.

1 Introduction

Duck hunting is provided for under the Victorian *Wildlife Act 1975* and regulated under the Wildlife (Game) Regulations 2012. In Victoria, eight duck species are declared game species: Australasian Shoveler *Anas rhynchotis*, Australian Shelduck *Tadorna tadornoides*, Australian Wood Duck *Chenonetta jubata*, Chestnut Teal *Anas castanea*, Grey Teal *Anas gracilis*, Hardhead *Aythya australis*, Pink-eared Duck *Malacorhynchus membranaceus* and Pacific Black Duck *Anas superciliosa*.

Estimating the daily take by hunters is an important component of assessing the impact of an open season on populations of game species. One method of estimating the level of take by hunters is to conduct surveys of hunters' bags; that is, to examine carcasses possessed by hunters as they return to their camp or vehicle after a hunt. Such surveys (hereafter called Hunters' Bag Surveys) have been conducted on opening weekend at Victorian wetlands in 40 of the 46 years since 1972 (5 of the 6 exceptions were years in which no open season was declared). The aims of the Hunters' Bag Survey are to:

- determine the species, sex and age composition of birds shot during opening weekend
- estimate the number of birds taken on opening weekend
- estimate hunter success during opening weekend
- determine the incidence of birds actively moulting flight feathers at the time[1].

Hunters' Bag Surveys are coordinated by the Victorian Game Management Authority (GMA) and are undertaken by staff of the GMA, the Victorian Department of Environment, Land, Water and Planning (DELWP) and the Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR).

This report provides a summary of information obtained during the opening weekend of the 2018 duck hunting season. Its focus is to quantify opening weekend harvest, the species taken and any records of non-game waterbirds in the harvest. Details of age class (i.e. juvenile vs adult) of a sample of birds harvested and the incidence of wing moult are also summarised. These are important demographic parameters that help to estimate the impact of opening weekend take on populations of game species (Ramsey et al. 2010 p. 29).

1.1 The 2018 hunting season and restrictions

As prescribed in the Wildlife (Game) Regulations (2012), the 2018 duck hunting season in Victoria ran for 86 days, from 17 March through to 11 June. One game species, the Australasian Shoveler, was prohibited from being hunted for the 2018 duck hunting season.

[1] Moulting of flight feathers can be a management issue when flocks of flightless moulting birds may be vulnerable to overharvesting. The Australian Shelduck, in particular, gathers to moult at specific locations in mid-summer (Frith 1982), and this is one reason for holding the hunting season during autumn, when most birds have completed their moult.

2 Methods

2.1 Hunter and wetland surveys

The survey of hunters' bags and collection of wing and tail feathers took place on the Saturday and Sunday of the opening weekend (17–18 March) at 19 wetlands spread across five DELWP regions (Table 1). No Hunters' Bag Surveys were conducted in Port Phillip Region as it includes few public wetlands open to hunting. Three of the 19 wetlands were surveyed on both days of the opening weekend. Decisions on which wetlands would be targeted for Hunters' Bag Surveys were made by the GMA based on logistical and compliance needs, rather than statistical sampling requirements.

GMA staff were responsible for the administration and coordination of surveys according to standard operating procedures, including maintaining the accuracy and integrity of the data and samples collected. Sites where surveys had been undertaken previously were identified, and these 'long-term' sites were prioritised for surveys, as were some wetlands that had been surveyed in the preceding Summer Waterbird Count conducted in February 2018. Procedures closely followed those used in Victorian surveys since 1972 (Loyn 1991), with the exception that wing and tail feather samples were collected and stored for future analysis, rather than being scored in the field. Staff from the Waterbirds and Wetlands Program at the Arthur Rylah Institute for Environmental Research (ARI) provided training in the ageing and sexing of ducks based on wing and tail feather samples (Rogers et al. 2018) before the samples were scored by GMA staff.

Standardised survey forms, instruction sheets, and envelopes for wing and feather samples were provided to surveyors. Surveyors interviewed individual hunters at wetlands between mid-morning and early afternoon, after most hunting had ceased for the day, although some hunters may have hunted again in the evening. Interviewers sought information from individual hunters where practical, though consolidated data from groups of hunters were acceptable if group size was recorded. Surveyors were asked to provide estimates of the total number of hunters present at each of the wetlands surveyed. Details regarding numbers and species of birds bagged, and the time birds were taken, were obtained during interviews. Hunters were also asked whether they had finished hunting for that day. A single wing and a sample of tail feathers were removed from each duck in most bags and retained for later analysis. The same survey methods were repeated on the second survey day.

Details regarding the shooting of non-game species were obtained by examination of bags as well as by shoreline surveys in which the water's edge was searched for unrecovered shot birds. Carcasses (or injured birds) were identified and, to avoid duplication, the place and method of disposal of such birds were recorded.

2.2 Assessment of age class and primary moult

In 2017, a new procedure was introduced for the collection of data on the age of birds examined and their stage of wing-moult. When bags were examined, a wing and the tail feathers were removed and stored in a paper envelope for later analysis of sex and age. Details of the location, date and collector were recorded on the envelope at the time of collection.

In 2018, a wing and the tail feathers were retained from approximately 15% of bagged birds (374 of 2550). The retained tail feathers were later categorised as either adult or juvenile based on ageing characters defined by Rogers et al. (2018). The wings of birds classified as adults were then examined for the presence of wing (primary or secondary feather) moult.

2.3 Estimates of opening-weekend harvest

Multiplying the mean bag size for a given wetland by the estimated number of hunters present gives a coarse estimate of the total take from that wetland over the opening weekend or part thereof. Although that figure can then be compared with the total number of game ducks recorded at that wetland during the preceding Summer Waterbird Count to give a rough estimate of the opening-weekend harvest for the wetland, there are significant shortcomings with this calculation and Menkhorst et al. (2017) recommended that it be discontinued. Therefore, it is not included in this report (see sections 3.6 and 4.1).

3 Results

3.1 Survey coverage and effort

On opening day of the 2018 duck hunting season (Saturday, 17 March), 1983 ducks were examined in 583 hunters' bags on 13 public wetlands (Table 1). On Day 2 (Sunday, 18 March) of opening weekend, 567 ducks were recorded in 372 hunters' bags on 9 public wetlands, 3 of which had also been surveyed on the Saturday (Table 1). Survey effort (wetlands surveyed) varied regionally, being greatest in the Hume Region (8 wetlands) and least in Barwon South West (1 wetland) (Table 2).

Estimates of total hunters present were made at 12 wetlands at which Hunters' Bag Surveys were conducted on opening day. At these 12 wetlands, 583 hunters were interviewed, comprising 68% of the estimated 859 hunters present at those wetlands. On Sunday at 9 wetlands, 372 of the estimated 390 hunters (95%) were interviewed. The proportion surveyed for the weekend was 76% of the estimated total hunters present on wetlands where surveys were carried out.

3.2 Species composition of bags

Grey Teal was by far the most numerous species in hunters' bags—1059 were recorded, representing 41.5% of the birds examined over the opening weekend (Table 3)—and three other species (Australian Wood Duck, Pacific Black Duck and Chestnut Teal comprised most of the remainder (54.2%) (Table 3). Together, these four species accounted for 95.7% of the bagged sample. Four species comprised the remaining 4.3% of the bagged sample—Australian Shelduck, Australasian Shoveler (prohibited for hunting in 2018), Pink-eared Duck and Hardhead.

The species composition in bags on each day of the opening weekend was similar (Table 3).

Historically, Grey Teal has been by far the predominant species in hunters' bags in Victoria (annual mean frequency 36.4%), followed by Pacific Black Duck (19.4%) and Australian Wood Duck (19.5%) (Table 4, Figure 1).

3.3 Hunter success

On opening day, the 583 bags examined had an average of 3.4 ducks per hunter (Table 3). Empty bags were held by 21 hunters (3.6% of hunters surveyed) at the time they were interviewed on opening day. The prescribed bag limit of 10 had been reached by only 2 hunters (0.3%), both in Hume Region.

On the Sunday, 372 hunters were found to have an average of 1.5 ducks (Table 3). Forty-three hunters (11.6%) held empty bags and no hunters had reached the legal bag limit of 10 game ducks.

Mean hunter success in the sample for the opening weekend was 2.7, close to the long-term mean bag size of 2.9 (Table 5, Figure 2). Mean bag size was highest on the Saturday in the Hume Region (3.8 ducks per hunter) and between 2.9 and 3.4 ducks per hunter in the other regions (Table 3). On the Sunday, hunter success was lower—between 2.0 and 1.4 ducks per hunter per region, with a mean of 1.5 ducks.

Table 1. Wetlands at which Hunters' Bag Surveys were conducted on the opening weekend of the 2018 waterfowl hunting season in Victoria

*Wetlands surveyed on both days. Wetlands for which both a Hunters' Bag Survey on opening day (including an estimate of the number of hunters present) and a Summer Waterbird Count (SWC) were conducted are shaded grey: these wetlands were used to estimate the total harvest on opening day.

Day	Wetland name	DELWP region	Bags counted	Estimated number of hunters present	SWC conducted?
17/03/2018	Dowd Morass	Gippsland	171	152	Y
17/03/2018	Toolondo Reservoir	Grampians	61	200	Y
17/03/2018	Pine Lake	Grampians	11	35	Y
17/03/2018	Taylors Lake	Grampians	4	—	N
17/03/2018	Buffalo Dam	Hume	64	60	Y
17/03/2018	Lake Hume	Hume	112	105	N
17/03/2018	Lake Eildon (Delatite Arm)	Hume	22	40	N
17/03/2018	Doctors Swamp	Hume	21	40	N
17/03/2018	Lake Nillahcootie	Hume	23	40	N
17/03/2018	Nagambie waterway	Hume	22	50	Y
17/03/2018	Wallenjoe	Loddon Mallee	31	27	Y
17/03/2018	Green Lake	Loddon Mallee	1	60	Y
17/03/2018	Groves Weir	Loddon Mallee	40	50	N
Day total			**583**		
18/03/2018	Hospital Swamp	BSW	34	12	NA
18/03/2018	Heart Morass	Gippsland	124	153	NA
18/03/2018	Lake Yallakar	Grampians	61	40	NA
18/03/2018	Toolondo Reservoir*	Grampians	12	50	NA
18/03/2018	Broken Creek	Hume	14	—	NA
18/03/2018	Lake Hume*	Hume	20	25	NA
18/03/2018	Parolas	Hume	61	50	NA
18/03/2018	Lake Eildon (Delatite Arm)*	Hume	9	20	NA
18/03/2018	Sandhill Lake	Loddon Mallee	37	40	NA
Day total			**372**		

3.4 Age classes of bagged birds

An entire wing and a sample of tail feathers were collected from 373 of the ducks examined in hunters' bags, and these were subsequently scored for age class and the presence of moulting flight feathers (Table 6). This sample size, representing 15% of all birds examined in bags, is about half the sample achieved in 2017, the reduction due mainly to reduced staff capacity.

One Australasian Shoveler, a prohibited species in 2018, was included in the 373 wings examined but is not considered further here. Juveniles were recorded in all seven remaining species in the sample and comprised 24% of the total, reflecting breeding by all species during the preceding 6 months or so. In 2017, the proportion of juveniles was highest in Pink-eared Duck (63%) and lowest in Australian Shelduck and Australian Wood Duck (8% and 10%, respectively) (Table 6); however, we emphasise that sample sizes were small.

Table 2. Distribution of Hunters' Bag Survey effort across the two days of opening weekend and across DELWP regions

Note that there are no significant wetlands on public land in Port Phillip Region that are open to hunting.

Day	DELWP region	Number of wetlands surveyed	Number of bags examined (% of day total)	Number of birds examined (% of day total)
Saturday 17 March	Barwon South West	0	—	—
	Gippsland	1	171 (29.3)	578 (29.1)
	Grampians	3	76 (13.0)	235 (11.8)
	Hume	6	264 (45.3)	989 (49.9)
	Loddon Mallee	3	72 (12.3)	181 (9.1)
Day total		**13**	**583**	**1,983**
Sunday 18 March	Barwon South West	1	34 (9.1)	60 (10.6)
	Gippsland	1	124 (33.3)	138 (24.3)
	Grampians	2	73 (19.6)	108 (19.0)
	Hume	4	104 (28.0)	186 (32.8)
	Loddon Mallee	1	37 (9.9)	75 (13.2)
Day total		**9**	**372**	**567**
Weekend total		**22**	**955**	**2,550**

3.5 The incidence of primary moult

Moulting primary feathers were found in 8 of the 283 birds classed as adult (2.8%) (Table 6). Of species for which a sample size of >20 was achieved, the frequency of primary moult was highest in Grey Teal (4.6%) and lowest in Australian Shelduck (0) (Table 6).

3.6 Estimates of harvest on opening weekend

There were six wetlands surveyed during the opening day of the 2018 Hunters' Bag Survey at which birds had been surveyed during the 2018 Summer Waterbird Count, and for which an estimate of the number of hunters present was also provided (Table 1): 1 in each of the Gippsland and Hume Regions, 2 in each of the Grampians and Loddon Mallee Regions. In previous years, an estimate of the total harvest over opening day was made by extrapolating the mean bag size to the estimated number of hunters and comparing that total harvest estimate with the estimated number of game ducks present during the Summer Waterbird Count. However, in 2018 the necessary information was collected at only six wetlands, and we have chosen to discontinue presenting this estimate in this report, as recommended by Menkhorst et al. (2017).

3.7 Breaches of bag limits and species-specific regulations

One individual of a prohibited species, the Australasian Shoveler, was recorded in the Hunter's Bag Survey datasheets for the 2018 season.

3.8 Unrecovered and wounded birds

Searches for wounded and unretrieved ducks were conducted at only one site—Parolas on the lower Ovens River. No birds were found. One wounded Australian Wood Duck was captured from a road at Lake Buffalo and euthanased.

Table 3. Summary of individual game species found in hunters' bags on the opening weekend (17–18 March) of the 2018 duck hunting season in Victoria

Data are shown for individual DELWP Regions and as statewide totals. BSW = Barwon South West.

Day and region	No. bags examined	Species								Total identified	Mean bag size
		Australian Shelduck	Pacific Black Duck	Grey Teal	Chestnut Teal	Australasian Shoveler	Pink-eared Duck	Hardhead	Australian Wood Duck		
SATURDAY											
BSW	0	—	—	—	—	—	—	—	—	—	—
Gippsland	171	19	167	325	66	0	0	0	1	578	3.4
Grampians	76	0	19	150	0	0	13	0	53	235	3.3
Hume	264	3	97	344	15	0	0	0	530	989	3.8
Loddon Mallee	72	0	58	52	6	0	1	0	64	181	2.9
Totals	**583**	**22**	**341**	**871**	**87**	**0**	**14**	**0**	**648**	**1,983**	**3.4**
% of total		1.1	17.2	43.9	4.4	—	0.8	—	32.7		
SUNDAY											
BSW	34	1	27	10	21	0	1	0	0	60	1.9
Gippsland	124	4	70	56	7	0	0	1	0	138	1.4
Grampians	73	2	12	68	0	0	21	3	2	108	2.0
Hume	104	4	119	19	10	0	0	0	34	186	1.9
Loddon Mallee	37	0	1	35	0	1	38	0	1	76	2.0
Totals	**372**	**11**	**229**	**188**	**38**	**1**	**60**	**4**	**37**	**568**	**1.5**
% of total		1.3	40.4	33.3	6.7	0.2	10.6	0.7	6.6		
Grand total	**955**	**33**	**570**	**1059**	**125**	**1**	**74**	**4**	**685**	**2,551**	**2.7**
% of total		1.3	22.4	41.5	4.9	0.04	2.9	0.2	26.9		

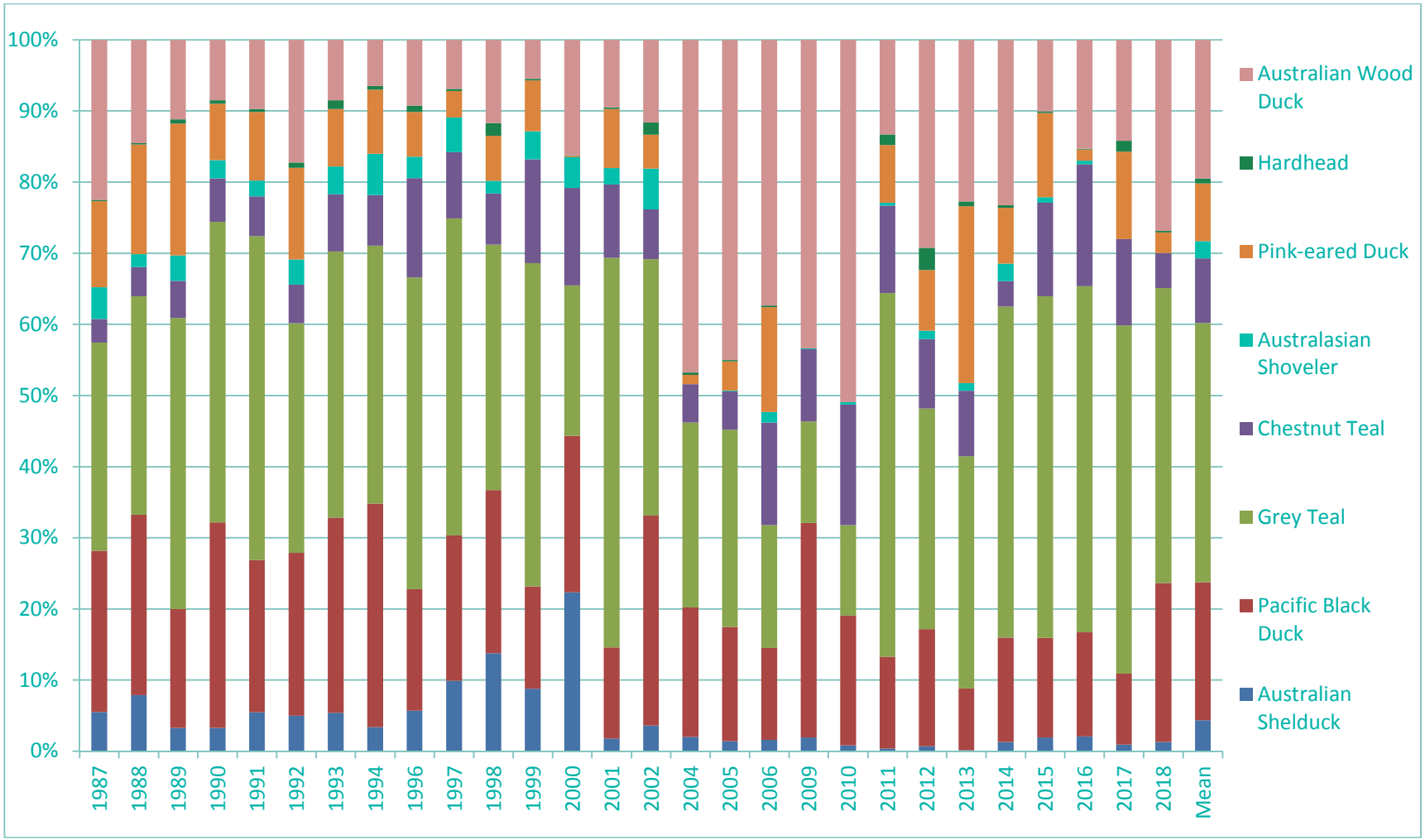

Figure 1. Species composition (% of birds examined) of hunters' bags on opening days or weekends of Victorian duck hunting seasons, 1987–2018

Data from Holmes (1994, Table 10) for the years 1987–1992 and from ARI databases subsequently. The species breakdowns for the years 1972–1987 are not available in a form suitable for analysis. Missing years are those in which no hunting season was declared.

Table 4. Species composition of hunters' bags (% of birds examined) on opening days or weekends of Victorian duck hunting seasons, 1987–2018

Data from Holmes (1994, Table 10) for the years 1987–1992 and from ARI databases subsequently. The species breakdowns for the years 1972–1987 are not available in a form suitable for analysis. Missing years are those in which no hunting season was declared. AShel = Australian Shelduck; PBD = Pacific Black Duck; GT = Grey Teal; CT = Chestnut Teal; AShov = Australasian Shoveler; PeD = Pink-eared Duck; H = Hardhead; AWD = Australian Wood Duck.

Species	Year																												Mean (sd)
	1987[a]	1988[a]	1989	1990	1991	1992	1993	1994	1996	1997	1998	1999	2000	2001	2002[c]	2004[d]	2005[e]	2006	2009[d]	2010	2011	2012	2013	2014	2015	2016	2017	2018	
AShel	5.5	7.9	3.3	3.3	5.4	4.9	5.4	3.4	5.7	9.9	13.8	8.8	22.3	1.8	3.6	2	1.4	1.6	1.9	0.8	0.4	0.7	0.1	1.3	1.9	2.1	0.9	1.3	4.3 (4.8)
PBD	22.7	25.3	16.7	28.9	21.1	22.4	27.4	31.4	17	20.4	22.9	14.4	22	12.8	29.5	18.2	16.1	12.9	29.9	18.3	12.9	16.4	8.7	14.8	13.9	14.6	10.0	22.4	19.4 (6.3)
GT	29.3	30.7	40.9	42.3	44.9	31.6	37.4	36.2	43.7	44.5	34.5	45.5	21.1	54.7	36	25.9	27.8	17.2	14.1	12.7	51.1	31	32.6	46.9	47.6	48.6	48.9	41.5	36.4 (11.3)
CT	3.3	4.1	5.2	6.1	5.5	5.3	8	7.1	13.9	9.3	7.2	14.6	13.7	10.3	7	5.4	5.4	14.4	10.1	17	12.3	9.7	9.2	3.6	13	17.1	12.1	4.9	9.1 (4.1)
AShov	4.5	1.8	3.6	2.6	2.2	3.5	3.9	5.8	3	4.9	1.8	3.9	4.3	2.3	5.7	0	0.1	1.5	0.1	0.3	0.4	1.2	1.1	2.5	0.8	0.5	—	0.04	2.3 (1.8)
PeD	12.1	15.4	18.5	7.9	9.5	12.6	8.1	9	6.3	3.7	6.3	7.2	0.2	8.3	4.8	1.3	4.1	14.7	0	0	8.1	8.5	24.8	7.9	11.7	1.6	12.5	2.9	8.1 (5.8)
H	0.2	0.2	0.6	0.5	0.4	0.7	1.2	0.5	0.9	0.3	1.8	0.2	0.1	0.2	1.7	0.3	0.2	0.2	0	0	1.5	3.1	0.7	0.4	0.2	0.1	1.5	0.2	0.6 (0.7)
AWD	22.5	14.5	11.2	8.5	9.6	16.9	8.5	6.5	9.2	6.9	11.7	5.5	16.2	9.5	11.6	46.7	45.1	37.3	43	51	13.3	29.2	22.7	23.4	10	15.3	14.1	26.9	19.5 (13.5)

Hunting regulations

Data indicates opening Saturday unless otherwise stated;

a Opening weekend

b Legal possession regulations were varied considerably in this season

c An additional five Australian Wood Duck were allowed

d Only five game species (Hardhead, Pink-eared Duck and Australasian Shoveler excluded). Bag limited to two of any species, plus an additional three Australian Wood Duck per day, or five Australian Wood Duck only per day

e Five game ducks plus five additional Australian Wood Duck per day during opening weekend

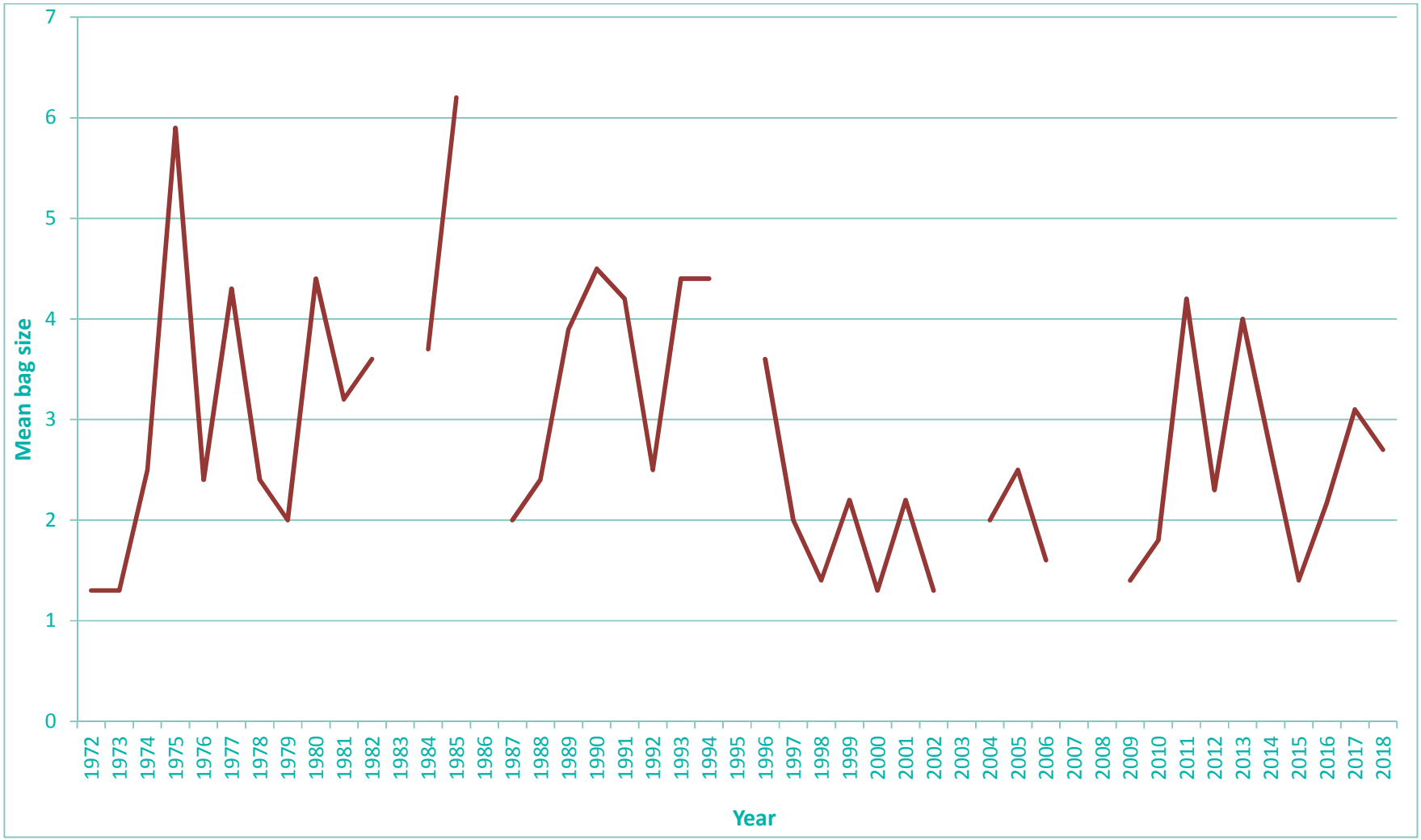

Figure 2. Mean bag size obtained by hunters on the opening day of the duck hunting season, 1972–2018

The data from which this figure is generated are listed in Table 5. Gaps represent years in which no hunting season was declared except for 1986, when no Hunters' Bag Survey was conducted.

Table 5. Mean bag size obtained by hunters on the opening day of the duck hunting season, 1972–2018 [data from Norman and Nicholls (1991), Holmes (1994) and ARI database thereafter]

The data in this table are presented graphically in Figure 2.

Year	Mean bag size	Year	Mean bag size
1973	1.3	1997	2.0
1974	2.5	1998	1.4
1975	5.9	1999	2.2
1976	2.4	2000	1.3
1977	4.3	2001	2.2
1978	2.4	2002	1.3
1979	2.0	2003	no season
1980	4.4	2004	2.0
1981	3.2	2005	2.5
1982	3.6	2006	1.6
1983	no season	2007	no season
1984	3.7	2008	no season
1985	6.2	2009	1.4
1986	no data	2010	1.8
1987	2.0	2011	4.2
1988	2.4	2012	2.3
1989	3.9	2013	4.0
1990	4.5	2014	2.7
1991	4.2	2015	1.4
1992	2.5	2016	2.2
1993	4.4	2017	3.1
1994	4.4	2018	2.7
1995	no season		
1996	3.6	**Mean (sd)**	**2.9 (1.26)**

Table 6. Summary of age classes and primary moult status of ducks examined during the 2018 opening weekend Hunters' Bag Surveys (all sites combined)

Species	Sample size	Age class			Number of adults showing primary moult (%)
		Juvenile (%)	Adult (%)	Unsure (%)	
Australian Shelduck	24	2 (8)	22 (92)	0	0
Pacific Black Duck	80	15 (19)	65 (81)	0	2 (2.5)
Grey Teal	128	41 (32)	87 (68)	0	4 (4.6)
Chestnut Teal	18	4 (22)	14 (78)	0	1 (5.5)
Australasian Shoveler	1	0	1	0	0
Pink-eared Duck	24	15 (63)	9 (38)	0	0
Hardhead	2	1 (50)	1 (50)	0	0
Australian Wood Duck	96	10 (10)	86 (90)	0	1 (1)
Totals	**373**	**88 (24)**	**285 (76)**	**0**	**8 (2)**

4 Discussion

4.1 Survey effort

The original conception of the Hunters' Bag Survey was that it would be conducted widely across Victoria, thus providing a sample adequate to allow defensible estimates of the opening weekend take (Loyn 1989). For example, in 1992 Hunters' Bag Surveys were conducted at a total of 110 wetlands (108 on the Saturday and 25 on the Sunday, including 2 not surveyed on the Saturday) (Holmes 1994). This is in stark contrast to the effort expended on Hunters' Bag Surveys in recent years: 14 wetlands surveyed in 2014, 21 in 2015 and 20 in 2016. In 2017, the number of wetlands covered increased to 31, but this number fell to 19 in 2018. Given the inconsistent survey effort, it would be beneficial to conduct a statistical power analysis of the accumulated data to derive estimates of the sample sizes required to achieve a scientifically robust estimate of opening weekend harvest for each species, the sex and age structure of the harvested birds by species, and the incidence of primary moult in each sex and age class of each game species. The annual randomised telephone survey of hunters (e.g. Moloney and Turnbull 2017) provides an alternative and probably more reliable estimate of harvest rate, but does not provide any of the biological information derived from examination of shot birds in the hand, as obtained from the Hunters' Bag Survey.

While seeking increased effort in undertaking Hunters' Bag Surveys, coordinators were requested to focus effort on wetlands that had been included in the preceding Summer Waterbird Count, conducted in February 2018. During 2018, bag surveys were conducted on opening day at six wetlands that had been included in the Summer Waterbird Count and for which an estimate of the number of hunters present on the wetland had been provided (Table 1). Given the low level of confidence in estimates of total numbers of hunters present at the wetlands (some estimates were lower than the number of bags inspected—a nonsensical result) and the low sample size of six wetlands at which the required data were collected, it was judged to be not worthwhile to estimate harvest levels over opening weekend of 2018 (see Menkhorst et al. (2017) for further discussion on this issue).

4.2 Species composition in hunters' bags and a comparison with previous years

The annual survey of the contents of hunters' bags on opening weekend aims to provide an index of the annual estimated harvest of waterfowl in Victoria on opening weekend. It is intended to examine underlying trends in harvest size and in the representation of species and age classes within the harvested birds. The focus on opening weekend is arguably appropriate because about 30% of the annual harvest (and hunting effort) has been shown to occur then (Norman and Powell 1981; Loyn 1991; Moloney and Turnbull 2017).

The most numerous species in bags in 2018 were Grey Teal, Australian Wood Duck and Pacific Black Duck. Since 1987, these species have consistently been the primary game species in Victoria, with Pink-eared Duck and, to a lesser extent, Chestnut Teal also important in some years (Figure 1).

4.3 Hunter success

The mean bag size for the 2018 opening weekend (2.7 ducks) was close to the long-term average of 2.9 ($N = 38$), however, Figure 2 suggests an ongoing decline in mean bag size since the mid 1980s. The decline in mean bag size could reflect the general decline in waterfowl populations in eastern Australia over recent decades (Kingsford and Porter 2009) but may also reflect increasing numbers of hunters. The effect of the 'Millennium Drought' of 1997–2009 is also apparent in Figure 2, and bag sizes seem to have not fully recovered to pre-drought levels.

4.4 Age structure in the hunters' bag sample

The duck hunting season is timed to avoid the main breeding seasons of game species and most other waterbirds. The proportion of immature ducks in hunters' bags is the only current measure of recruitment from breeding events in the previous ~6 months, the period when notched tail feathers are retained by juvenile ducks (Rogers et al. 2018). The new system for obtaining age class data introduced in 2017 again worked well in 2018 (J. Turnbull and H. Dunstan, GMA, pers. comm.), with 100% of samples, covering all species, being assigned an age class. This improvement was largely due to the provision of detailed illustrated guides to sexing and ageing game species (reproduced in Rogers et al. 2018). However, sample sizes for most species were inadequate to provide robust estimates of age class distribution.

We recommend that the new system be maintained and expanded, including the training of more staff of DELWP and GMA in its use.

4.5 Moult in the hunters' bag sample

Moulting was considered a significant management issue in the 1970s, when duck hunting season sometimes opened as early as January (Loyn 1989), a time when moulting in some species is still taking place. However, with the season now opening later (on the third weekend in March), moult appears to be of little concern for adult birds because moulting of wing feathers is normally completed before the hunting season begins. This seems to have been the case in 2018, when 2.1% of the wing samples showed active primary moult and all cases involved only one or two feathers. This result is remarkably similar to the 2017 result (Menkhorst et al. 2017). Frequency of moulting was highest in the Grey Teal and Chestnut Teal (4.6% and 5.5%, respectively, of wings examined). We conclude that it is unlikely that moult stage unduly influenced the harvesting rate for any species.

5 Conclusions

1. The mean bag size in the 2018 bag sample (2.7 ducks) was close to the long-term mean of 2.9, indicating a reasonably good return for hunters.
2. The species composition in hunters' bags was also in line with past seasons, although the proportions of Chestnut Teal and Pink-eared Duck were slightly lower.
3. There had clearly been successful breeding in the months prior to the season opening, with almost one-quarter of bagged birds being juvenile.
4. A long-term dataset of recruitment and age-related survival is required to reliably assess the impact of hunting on game duck population trends.

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