Preliminary results from the 2021 survey of game ducks in Victoria.

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1.1 Preamble

The survey of game duck species across Victoria employed a stratified random sampling design of waterbodies with selection probabilities for each waterbody calculated proportional to their availability within each stratum. Strata consisted of waterbodies of different type including wetlands, dams, sewerage treatment ponds, streams and irrigation channels, which were also categorised according to size class (< 6 ha, 6-50 ha, >50 ha). Waterbodies were further stratified into four broad geographic regions in the state (North, South, East and West). Further details of the stratification of waterbodies across Victoria can be found in Ramsey and Fanson (2021). The survey methodology involved double observer counts of each game duck species from a helicopter. For some larger waterbodies, only a proportion of the surface area was counted, usually 50%, with counts adjusted accordingly. Double observer counts from the ground were also undertaken on some waterbodies that could not be surveyed from the air. Both aerial and ground surveys were undertaken between 19th October and 7th November 2021.

Total abundance estimates were calculated for each game species across all waterbodies within Victoria of the types specified above (the sampling frame). Estimates of the number of waterbodies of each type containing surface water were based on analysis of recent satellite imagery (Landsat and Sentinel-2). The following report provides preliminary results from the analysis of the 2021 survey data. A more comprehensive analysis and presentation of methods and results will be made available in the final report.

1.2 Methods

1.2.1 Surface water availability

To extrapolate local abundance estimates from sampled waterbodies to obtain total abundance estimates for the sampling frame (i.e., Victoria), requires an estimate of surface water availability for the period near when the aerial surveys were undertaken. In the present study, surface water estimates included wetlands, dams, sewage treatment ponds, streams and irrigation channels. Surface water availability was estimated from analysis of Landsat and Sentinel-2 satellite imagery using the most recent images obtained prior to the survey dates, mostly within the Spring period (September – November). Estimates of surface water used the same methodology as detailed in Ramsey and Fanson (2021) with calibration of Sentinel-2 images undertaken to improve classification accuracy. Calibration used actual observations of surface water within each sampled waterbody obtained during the aerial and ground surveys.

1.2.2 Sampling of game ducks

A total of 787 of the randomly selected waterbodies were sampled from a helicopter (Squirrel AS-350) with two observers on the left side of the aircraft (one forward and one rear) conducting counts of game ducks at each waterbody independently. A total of 66 waterbodies, including sewage treatment ponds, dams and large wetlands, were subject to ground surveys using a similar double-observer methodology with two observers working independently with the aid of a spotting scope. For large wetlands subject to ground surveys, counts were obtained from multiple vantage points to

maximise the coverage of the surface water of the wetland. Where coverage was incomplete, counts were again adjusted using the same imputation method as used for aerial surveys.

Counts of Chestnut teal on waterbodies surveyed from the ground were partitioned separately into adult male and females. These counts were then used to determine the mean ratio of male/female Chestnut teal. This ratio was subsequently used to adjust the counts of Chestnut teal counted from the helicopter, which only included observations of males. This is because female Chestnut teal are very similar to Grey teal and hence, aerial observations are likely to confuse female Chestnut teal with Grey teal. Only waterbodies where both Grey teal and male Chestnut teal were counted from aerial surveys were subject to this adjustment. This was undertaken by using the male/female Chestnut teal ratio to determine the expected number of Grey teal that were likely female Chestnut teal.

A total of 704 of the 787 waterbodies subject to aerial survey were observed with surface water (89%) with the remaining either dry or not present at the identified location. Only a single waterbody was observed to be completely dry during ground surveys. Only 4 of the irrigation channels that were sampled contained water at the time of the survey. Since this was considered insufficient for analysis, the data from irrigation channels were not analysed further and hence, no estimates were obtained for ducks on irrigation channels.

Table 1. Waterbodies sampled by aerial and ground surveys during 2021. The number of these waterbodies observed with surface water are given in parenthesis.

Waterbody type	Aerial	Ground	Totals
Dams	195 (180)	17 (16)	**212 (196)**
Sewage ponds	5 (5)	34 (34)	**39 (39)**
Wetlands	533 (489)	15 (15)	**548 (504)**
Streams	26 (26)	0	**26 (26)**
Channels	28 (4)	0	**28 (4)**
Total	**787 (704)**	**66 (65)**	**853 (769)**

1.2.3 Abundance estimation

The two independent replicate counts of ducks at each sampled waterbody were used to estimate the abundance of ducks at each waterbody, corrected for imperfect detection (birds missed by the observers) using a N-mixture model approach (Ramsey and Fanson 2021). Parameters for abundance and probability of presence were estimated separately for each duck species with a common set of parameters for the detection probability component. Models were fitted in a Bayesian framework using `Stan` (Carpenter *et al.* 2017).

Prediction of game duck abundance for the entire sampling frame (i.e. waterbodies containing water within Victoria) were estimated using a design-based approach (Thompson 1992). Design-based estimates of total abundance used a Horvitz-Thompson estimator, based on the stratum-level, selection probabilities calculated for each waterbody (Horvitz and Thompson 1952). Model-based estimates of abundance are currently also being investigated and will be detailed in the final report.

Further details of the abundance estimators and their variance are given in Ramsey and Fanson (2021).

1.3 Results

1.3.1 Surface water availability

The numbers of waterbodies (dams, sewage ponds, wetlands and streams) categorised to contain surface water following calibration of the satellite imagery was estimated at 171,210 (Table 2). Excluding stream segments, the total number of waterbodies with surface water was 158,607. This was lower than estimated for the previous survey in 2020 (187,285), which was mainly due to the lower number of dams estimated with surface water than in the previous year. However, the number of wetlands estimated to contain surface water was higher than in the previous year. Results from the calibration of the Sentinel-2 satellite imagery with observations of surface water for each sampled waterbody suggest that classification accuracy was 79% for dams, 92% for wetlands and 77% for streams.

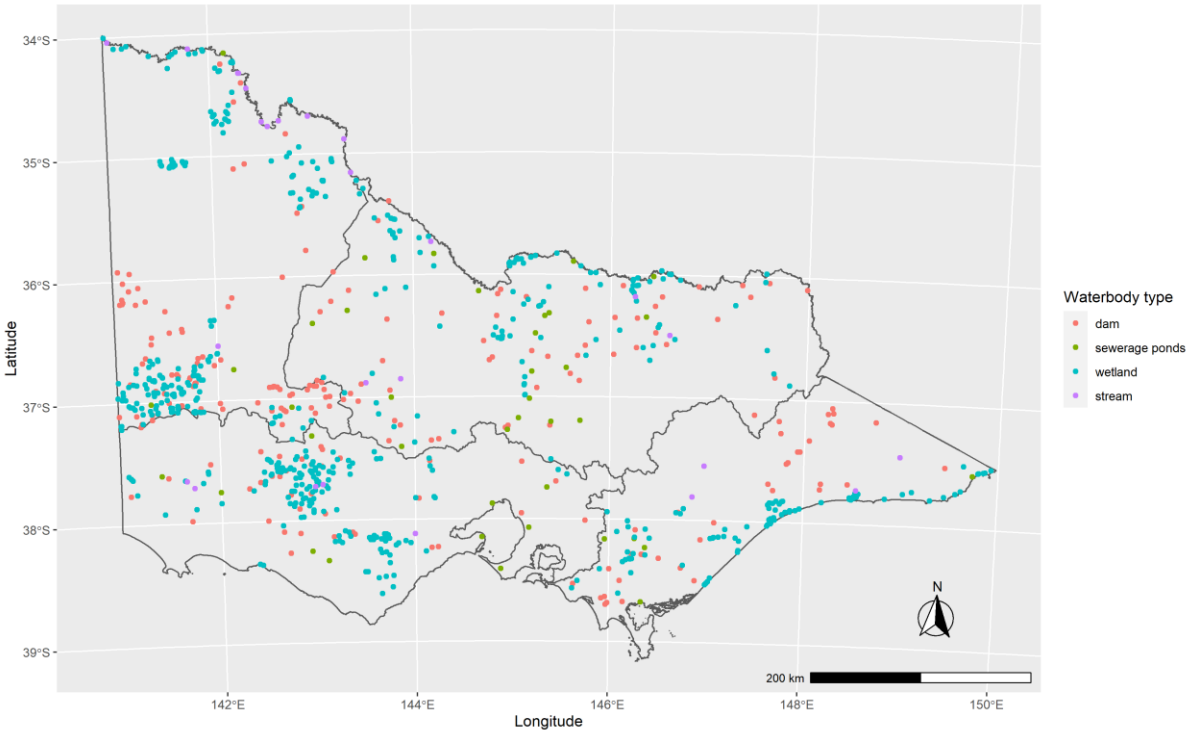

Figure 1. Locations of 825 waterbodies (dams, sewage ponds, wetlands and streams) that were subject to aerial sampling during November 2020. Irrigation channels were excluded from the current analysis.

Table 2. Number of mapped waterbodies estimated to contain surface water during the spring 2021 period.

	Size Class		
Waterbody type	**<6 ha**	**6–50 ha**	**>50 ha**
Dams	151,435	113	56
Sewage ponds	47	49	8
Wetlands	5,166	1,379	354
Streams	10,440	962	1,201

1.3.2 Game duck abundance estimates for Victoria

Aerial and ground survey data were adequate to estimate abundance for seven species of game duck, including the major game species (Table 3). Design-based estimates indicated that the population of game ducks on dams, sewage ponds, wetlands and streams in Victoria was 2,938,500 (Table 3). Wood Duck were the most numerous game species (~1,240,500), followed by Grey Teal (~609,300), Australian Shelduck (~503,900) and Pacific Black Duck (~443,700). Abundances of Chestnut teal, Pink-eared ducks and Hardhead were all less than 100,000 (Table 3). Precision of the overall estimate of abundance was good, with a 10% (0.10) coefficient of variation, well within the target threshold of 15% identified by Ramsey and Fanson (2021) as being of adequate precision. Precision of estimates for the main individual game species has also improved compared with the previous survey with coefficients of variation for Grey teal, Wood Duck and Pacific Black Duck being at, or close to, the nominal target of 15% coefficient of variation (Table 3).

Table 3: Summary of design-based estimates of total abundance of seven game duck species in Victoria. SE – Standard error; CV – coefficient of variation; L95 – lower 95% confidence interval; U95 – upper 95% confidence interval.

Species	Estimate	SE	CV	L95	U95
Australian Shelduck	503,900	188,400	0.37	248,000	1,023,700
Australian Wood Duck	1,240,500	198,000	0.16	909,000	1,692,800
Chestnut Teal	66,300	23,800	0.36	33,500	131,300
Grey Teal	609,300	82,900	0.14	467,200	794,600
Hardhead	13,200	4,000	0.30	7,400	23,500
Pacific Black Duck	443,700	69,400	0.16	327,200	601,600
Pink eared Duck	61,600	17,400	0.28	35,700	106,100
Total	2,938,500	295,400	0.10	2,414,200	3,576,600

1.4 Conclusions

Compared with the pilot survey conducted in 2020, The 2021 aerial survey of game ducks has provided estimates of abundance with improved precision for the main game species, Grey Teal, Wood Duck and Pacific Black Duck. In addition, the 2021 survey was also able to obtain separate estimates for Grey and Chestnut teal and also included additional waterbody types, with duck abundances estimated for both sewage treatment ponds and streams, in addition to dams and wetlands. However, inadequate sampling coverage was obtained for irrigation channels due to many of the channels selected for sampling being either dry or not present at the indicated location. Future surveys should modify the sampling scheme for irrigation channels to only include the major channels.

The total statewide abundance of game ducks was higher than in 2020, mainly due to the inclusion of estimates for rivers/streams and sewage treatment ponds, which were not included in the pilot survey in 2020. It should be noted that the estimates contained with this report are of a preliminary nature only and may be subject to revision in the final report. Further work is also currently being undertaken on model-based estimates of abundance, which will be detailed in the final report, due on the 28th February 2022.

1.5 References

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