Game duck AHM – Recommendations on performance of the bag limit model in achieving the seasonal harvest quota

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Abstract

Earlier this year, Ramsey et al. (2025) developed a statistical model to link the total harvest achieved during an annual open season to the regulated bag limit, which they used to estimate the 2025 bag limit required to achieve at least a 10% proportional harvest of the total Victorian game duck population. Preliminary estimates of the scale of game duck harvesting in Victoria during the 2025 season are now available (Moloney 2025) and allow the performance of the bag limit model to be assessed. The model underestimated the true harvest offtake by 15%, thereby resulting in a small increase in the proportional harvest from the planned 10.4% to 12.2%. However, realised proportional harvests for individual species ranged from 3% to 38%. This report recommends that: (1) the bag limit model should be developed further with the aim of reducing uncertainty in the predicted harvest; (2) species-specific proportional harvest estimates and associated uncertainty should be routinely reported; (3) variation in the proportional contribution of different species to the total harvest should be considered when setting the daily bag limit; (4) the accuracy of the current method for estimating chestnut teal abundance should be evaluated; (5) species-specific abundances and proportional harvests could be monitored by spatial regions; and (6) the accuracy of self-reported harvest numbers should be evaluated.

1. Overview of 2025 bag limit settings based on the bag limit model

Population modelling for four representative game duck species indicated that species-specific proportional harvest quotas of 10–20% of estimated Victorian population sizes should be sustainable (Prowse 2023). In 2025, Victoria's recreational harvest arrangements for game ducks were designed to deliver a proportional harvest of at least 10% of the total game duck abundance estimated for spring 2024. To achieve this, Ramsey et al. (2025) developed a statistical model to link the total harvest achieved during an annual open season to the regulated bag limit, the season length and the number of licensed hunters, while allowing for reduced harvest during the years of COVID-19 restrictions. The model was used to estimate the 2025 bag limit required to achieve at least a 10% proportional harvest, assuming a season length of 83 days and 21,383 licensed hunters. Assuming a point estimate of 4,005,600 game ducks present in Victoria in spring 2024, a daily bag limit of 9 ducks was predicted to produce a total harvest of 416,582 ducks [90% CI: 255,900 – 631,300], equivalent to a proportional harvest of 10.4% [6.4% – 15.7%].

2. Performance of the bag limit model for the aggregated game duck population, based on 2025 harvest survey data

Preliminary estimates of the scale of game duck harvesting undertaken in Victoria during the 2025 season are now available (Moloney 2025). Based on surveys of licensed hunters, the total estimated duck harvest in 2025 was 487,806 [95% CI: 429,200 – 554,000]. This point estimate and confidence intervals fall easily within the 90% confidence intervals on the predicted harvest from the bag limit model [255,900 – 631,300].

Relative to the predicted 416,600 ducks harvested by the bag limit model, a total harvest of 487,806 ducks represents an additional 71,206 ducks harvested (i.e., the bag limit model underestimated the true value by 15%). Hence, relative to the planned 10.4% harvest, recreational harvesting in 2025 has implemented a higher proportional harvest of 12.2 % [10.7%, 13.8%].

However, while the uncertainty bounds on the proportional harvest reported above incorporate uncertainty in the estimated harvest offtake, they do not include uncertainty in the total game duck population size. Furthermore, the realised proportional harvest varied substantially between species, and this is considered in the next section.

3. Performance of the bag limit model for specific game duck species, based on 2025 harvest survey data

With the exception of hardhead, Moloney (2025) provides estimates of the total number of each game duck species harvested in 2025 in Victoria and these can be matched to species-specific abundance estimates from spring 2024 (Table 1). At a species level, estimated proportional harvests range from 3.3 % for chestnut teal to 37.6% for pink-eared duck. The estimated proportional harvest exceeds 20% for three species (grey teal, Pacific black duck and pink-eared duck). Again, uncertainty bounds on these species-specific proportional

harvest estimates (Table 1) include uncertainty in the harvest offtake only, but do not include uncertainty in the estimated population sizes for these species.

Table 1. Estimated abundance, harvest, and proportional harvest for different game duck species. Species for which the point proportional harvest estimate exceeds 20 % are shown in bold type.

Species	Estimated abundance [95%CI] in spring 2024[1]	Estimated harvest [95% CI] in the 2025 open season[2]	Proportional harvest [95% CI]
Australian Wood Duck	1,389,000 [1,205,900 – 1,581,200]	116,059 [69,648 – 193,397]	8.4 %
Chestnut Teal	805,100 [709,500 –905,100]	26,653 [15,068 – 47,145]	3.3 %
Grey Teal	**693,200 [630,000 –757,800]**	**143,408 [86,418 – 237,982]**	**20.1 %**
Hardhead	149,400 [109,500 – 200,600]	n/a	n/a
Mountain Duck	110,900 [87,500 – 139,400]	9,746 [5,045 – 18,829]	8.8 %
Pacific Black Duck	**815,300 [743,600 –892,400]**	**176,028 [106,429 – 291,142]**	**21.6 %**
Pink-eared Duck	**42,300 [35,300 – 51,000]**	**15,912 [8,648 – 29,278]**	**37.6 %**
Total	4,005,600 [not reported]	487,806 [429,200 – 554,000]	12.2 %

[1] Estimates of game duck abundance from aerial and ground surveys (Ramsey et al. 2025)

[2] Estimates of harvest offtake from surveys of licensed hunters for the 2025 open season (Moloney 2025)

4. Discussion and recommendations

The bag limit model of Ramsey et al. (2025) predicted the total number of ducks harvested in the 2025 open season reasonably accurately, but underestimated the total harvest by 71,206 ducks (or 15%). Hence, the proportional harvest of 12.2% implemented is approximately 2% higher than planned.

– **Recommendation 1: Test different formulations of the bag limit model to reduce uncertainty in the predicted harvest.** For the current bag limit model, uncertainty bounds on the predicted harvest for 2025 were wide (90% CI: 255,900 – 631,300 ducks). Further model development might reduce this uncertainty further, through the inclusion of additional predictors such as CMA region, climatic conditions in the year prior to the harvest season, and water availability in Victorian water bodies. On a related note, the predicted proportional harvest using the bag limit model is impacted by two primary sources of uncertainty – uncertainty in the population sizes (which are estimated from surveys for a sample of water bodies) and uncertainty in the bag limit model itself. Within the Bayesian modelling framework currently used for these analyses, it should be possible to estimate proportional harvest rates that account for both uncertainty sources.

As detailed in the Victorian Game Duck Harvest Strategy (Harvest Strategy) (DJSIR 2025), the bag limit model has not been developed for individual game duck species but for the Victorian duck population as a whole. The Harvest Strategy states that in future and with improved abundance monitoring and modelling capability, it may be possible to introduce species-specific controls. The current bag limit model has been developed for the Victorian duck population as a whole. Results from the 2025 surveys of licensed hunters indicate substantial

variation in species-specific proportional harvests which range from approximately 3 % to 38 %. Recent population modelling for four harvested species (Pacific black duck, grey teal, chestnut teal and wood duck) suggests that proportional harvest quotas of 10–20% of estimated Victorian population sizes should be sustainable (Prowse 2023). In 2025, the estimated proportional harvest for two of those modelled species exceeds the 20% target (Pacific black duck [21.6%] and grey teal [20.1%]). Pink-eared duck were not considered in the previous population modelling and the sustainability of the relatively high harvest of this species (38%) in 2025 has not been evaluated, although we note this species primarily occurs in the dry inland of New South Wales and Queensland so is likely robust to harvesting occurring in Victoria. Harvest data for hardhead have not yet been provided so the proportional harvest for this species could not be estimated.

– **Recommendation 2: Report species-specific proportional harvest estimates and associated uncertainty.** Moloney (2025) reported estimated harvest offtake for different game duck species but did not estimate the proportional harvests achieved for these species. Estimated proportional harvests, and associated uncertainty, should be reported routinely for each species each year.

– **Recommendation 3: Consider likely variation in species-specific harvests when setting the daily bag limit each year.** The sustainability of a proportional harvesting strategy relies on maintaining proportional harvests for individual species within a sustainable range. To account for variation in the harvesting rate between species: (a) species-specific bag limit models might be developed; or (b) historical harvest data might be examined to estimate the proportional contribution of different species to the total Victorian game duck harvest each year. These considerations might indicate lower bag limits are required to maintain harvests within the 10-20% target range for all species, and/or suggest species which should not be harvested under a planned bag limit.

– **Recommendation 4: Evaluate the accuracy of the current method for estimating chestnut teal abundance.** In spring 2024, the estimated Victorian abundance of chestnut teal (805,100) exceeded that of grey teal (693,200). This suggests some observer misidentification and/or a problem with the current method used to correct raw grey teal counts. Therefore, additional training/testing of observers may be warranted.

Game duck population abundance surveys and harvest surveys both provide spatial data (at least to the level of 10 CMA regions). Therefore, it should be possible to predict and then estimate proportional harvest rates spatially across Victoria.

– **Recommendation 5: Considering evaluating species-specific proportional harvests estimated by CMA or other spatial blocks.** Over time, monitoring species abundances and proportional harvests in space might help assess long-term impacts on game duck species within these spatial units, particularly if the proportional harvest varies substantially between regions.

In this report, the performance of the bag limit model has been assessed using harvest survey data for 2025. This comparison is appropriate since the bag limit model was developed using historical harvest survey data. However, proportional harvest estimates shown in Table 1 assume there is no illegal harvesting and that harvester surveys provide a true reflection of harvest offtake. These surveys are potentially affected by a non-response rate of around 30% (Moloney 2025). If this missingness is not randomly distributed (particularly in space) it could lead to biased estimates of species-specific offtake.

– **Recommendation 6: Validate the accuracy of self-reported harvest numbers.**

To ensure the reliability of harvest offtake data, it is essential that self-reported duck harvests, which are collected by telephone surveys, are independently validated. Although self-reporting is a practical and cost-effective method, its accuracy is affected by recall bias, non-compliance, and selective reporting. The current management strategy relies heavily on these data to assess total harvest and inform the effectiveness of annual bag limits in regulating harvest offtake, and any inaccuracies will reduce the effectiveness of the strategy. Independent validation of self-reporting, such as field audits or a real-time harvest reporting system, would provide a means of testing the accuracy of self-reporting and understanding the magnitude of biases. This is particularly important in a system where the total harvest is not capped, and self-reporting compliance serves as the primary regulating method. Including independent validation would strengthen confidence in the data, improve model calibration, and support more informed decision-making within the adaptive harvest management framework.

4. References

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