Auckland/Waikato Gamebird Harvest Assessment

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1 SUMMARY

The primary objective of this report is to estimate the mallard/grey harvest based on the Gamebird Harvest Survey (GBHS). As a secondary objective, the effect of season regulations on harvest and hunter activity is explored, along with other estimates, such as survival rates. Estimates of harvest for other species are also presented in the appendix.

In the Auckland/Waikato region, a decrease in hours hunting waterfowl and grallard harvest coincides with more restrictive regulations. This increases the difficultly in determining whether recent declines in harvest are due to the regulations or if there are other factors that have led to reductions in hunter effort.

Estimates of cumulative hours hunting waterfowl suggest trends are similar for short and long seasons when excluding the opening weekend. Trends in harvest were compared with Northland and Taranaki, the two neighbouring regions which have maintained consistently longer seasons. This allows exploration into whether the observed decline in harvest is unique to the Auckland/Waikato region (and therefore driven by season length), or is consistent across all three regions. Trends in hours hunting waterfowl were found to be similar across the three regions, and the decline in hours hunting waterfowl post-2009 was consistent. While regions are not directly comparable for several reasons, this provides strong evidence for the hypothesis that external factors (e.g., population size) are the primary drivers of the observed reduction in hours hunting (and consequently in harvest) in recent years. Furthermore, a similar pattern (i.e., a drop in harvest and more people shooting zero birds) is observed on opening weekend, which would not be expected to result from season length.

Bag limits have the most impact on opening weekend as they restrict harvest for only a small proportion of hunters during the rest of the season. Given that around 40% of harvest occurs on opening weekend, highly conservative bag limits, e.g. 2, could be very effective at reducing harvest; however, this is highly likely to impact hunter satisfaction and compliance.

Grallard harvest per hunter per hour appears to cycle up and down between 1993 and 2025, possibly linked to climatic conditions. However, the overall trend is downwards.

Survival estimates based on band return data show that survival is consistently lower for juvenile birds compared to adults, while sex differences are minimal. Further work is required to investigate whether environmental factors or regulations are impacting survival.

Harvest estimates for swan, pukeko, paradise shelduck, pheasant and quail indicate relatively stable patterns in harvest over the last two decades.

2 METHODS

2.1 GAMEBIRD HARVEST SURVEY DESIGN

The Gamebird Harvest Survey is designed to estimate how many waterfowl are harvested each year. Due to recall bias (i.e., people forgetting), the survey was designed to break the dabbling duck hunting season into survey periods based on the season length to improve accuracy (Barker, 1991). In each survey period, a random selection of at least 120 adult and junior full-season licence holders are phoned (i.e., the survey excludes children, day licence holders, landowner occupiers, and those who hunt without a licence). In period 1, randomly selected hunters are asked about the opening weekend harvest. In period 2 and onwards, randomly selected hunters are asked about their hunting in the preceding two weeks. Data is collected from hunters regarding the regions they hunt in, the number of hours they have hunted, and how many birds of each species they shoot during that survey period. From this data, key metrics such as total harvest (necessary for population estimates), average hours spent hunting waterfowl (to gauge hunter engagement) and harvest per hunter per hour (an index of hunter success) are collected. As a random selection of hunters are surveyed each period, estimates are first calculated at the period level (e.g., average opening weekend harvest) and then combined for whole season estimates. In some instances, daily estimates are calculated and aggregated. While this benefits accuracy (i.e., reduces recall bias), it limits the ability to test whole-season effects, as the data is aggregated[1].

The current report expands on the previous iteration by including data from all North Island Fish & Game regions. As a result, the total harvest in the Auckland/Waikato region now includes hunters from other "survey regions" who hunt in the Auckland/Waikato region. This is akin to what is presented on the Fish & Game harvest website and is how the data was designed to be used.

When mean values are presented, they are generated from Auckland/Waikato licence holders who hunt in the Auckland/Waikato region. This differs from the website/database, which estimates average harvest/hours as the total (i.e., sum of all regions) divided by the number of licence holders in that region. The updated approach ensures that mean estimates more accurately reflect the region's hunter population.

2.2 Estimating total harvest, hours hunted and days hunted

Methods for estimating total harvest/days/hours follow the 2024 South Island Hunter Harvest Report[2] (i.e., taken from the angler use study by Stoffels and Unwin, or based on how total harvest/hours were defined originally). However, calculations were made at the day level rather than by survey period. To generate day-level data, the survey region and hunting district were imputed per hunter using the last/next observation carried forward; remaining NAs were set to default codes to avoid dropping records.

For hunters licensed in region *p*, hunting in region *i* on day *d*, the total estimated quantity (E_{idp}) was calculated as the product of the number of active licence holders (N_p) and the mean value per respondent ($\bar{X}_{idp}$):

$$E_{idp} = N_p \times \bar{X}_{idp}$$

where $\bar{X}_{idp}$ represents:

- mean hours hunted ($\bar{H}_{idp}$) for total hours,
- mean birds harvested per active hunter multiplied by participation rate ($\bar{H}_{idp} \times \bar{P}_{idp}$) for total harvest, or
- participation rate alone ($\bar{P}_{idp}$) for total days hunted.

[1] Limitations include (1) loss of individual-level variation (e.g., modelling the effect on average harvest vs on harvest), (2) reduced statistical power (e.g., more challenging to detect differences with a smaller "aggregated" sample size), (3) limit on potential covariates (e.g., you could not include hunter age in a model with aggregated data), and (4) "Ecological fallacy" whereby relationships observed in aggregated data do not match those found at the individual level.

[2] By M.J. Garrick & H. Sanders Garrick

Participation rate was defined as:

$$\bar{P}_{idp} = \frac{a_{idp}}{n_p}$$

where a_{idp} is the number of surveyed hunters from licence region *p* who reported hunting in region *i* on day *d*, and n_p is the total number of surveyed hunters from that region.

Because hunting regions receive effort from hunters licensed in multiple regions, daily totals were obtained by summing across all licence regions:

$$\hat{E}_{id} = \sum_{p=1}^{m} E_{idp}$$

Where *m* is the number of licence regions.

Uncertainty around estimates was quantified using bootstrap resampling, similar to the 2024 South Island Hunter Harvest Report[2]. Bootstrapping repeatedly resamples the original data, with replacement, to create many new "pseudo-datasets." The variation in results across these resamples gives an estimate of uncertainty, such as standard errors and confidence intervals. Here, the survey period structure was kept fixed, reflecting the original sampling design. Within each licence region, year, and period, respondents were resampled with replacement to capture variability in hunter behaviour (200+ iterations). For each bootstrap sample, daily estimates were recalculated and aggregated to seasonal totals. The 95% confidence intervals were obtained from the empirical distribution of the bootstrap estimates.

2.3 INVESTIGATING POTENTIAL EFFECTS OF BAG LIMIT AND SEASON LENGTH

2.3.1 Season length

To investigate patterns in waterfowl hunter effort and grallard harvest, daily GBHS data from 1993–2025 were used to estimate the cumulative mean number of hours hunted, days hunted, and grallard harvested per licence holder. These estimates were used to identify hunting effort and harvest accumulation over the course of each season.

Regional comparisons focused on the Auckland/Waikato, Northland, and Taranaki Fish & Game regions. Auckland/Waikato has experienced shorter seasons since 2011, whereas Northland and Taranaki have maintained longer, more stable season lengths. To investigate whether declines in hunter effort and harvest were specific to Auckland/Waikato or reflected a broader inter-regional trend, linear models were fitted with mean annual hours hunting waterfowl as the response variable and region, period (pre-2009 vs post-2009), and using the interaction as predictors. A non-significant interaction term was interpreted as evidence of consistent temporal trends across regions.

2.3.2 Bag limit

Daily survey data from 1993–2025 were used to estimate the proportion of hunts in which more than five grallard were harvested. Estimates were calculated separately for the Saturday and Sunday of opening weekend and the rest of the season to assess how bag limits influence harvest behaviour over time.

For recent years (2022–2025), when the mallard bag limit was eight, the proportion of hunters reaching this limit was estimated, and expected proportions under hypothetical lower limits (e.g., six birds), assuming consistent hunter behaviour, were modelled.

2.4 Survival rates

To estimate annual survival rates for age and sex combinations, survival rates are modelled via R MARK as an interaction between the three variables using a Burnham Live-Dead model. Combinations of other parameters were tested, and the most weight was given to the model defined as S(sex*age*time) p(~1) r(sex*age) F(~1).

3 Results and Discussion

3.1 Estimating total harvest, hours hunted, and days hunted

3.1.1 Grallard harvest

Trends from 1993-2025 indicate that grallard harvest in the Auckland/Waikato region is decreasing, which could be due to several factors, namely the number of hunters, hours hunted (hunter interest/season length), environmental conditions, population size and bag limits.

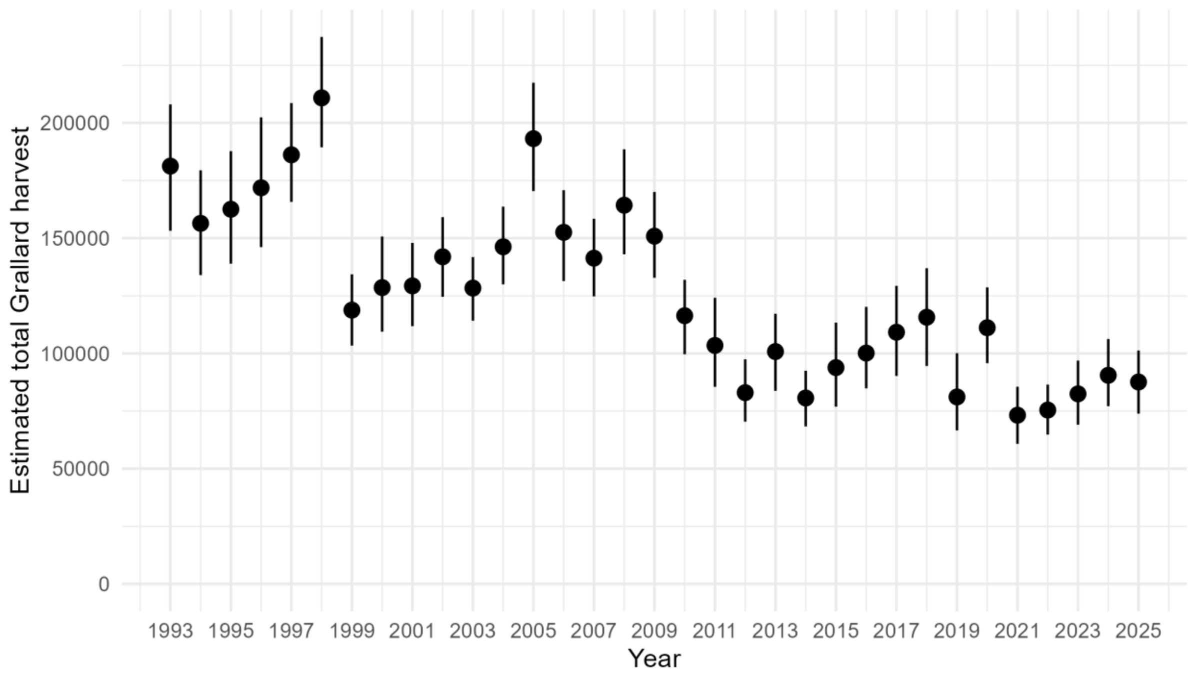

Figure 1: Total estimated grallard harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.

Figure 2: Estimated mean whole season grallard harvest per licence holder hunting from 1993-2025. Annual averages are calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

A decrease in average and total harvest (Figures 1 and 2) was observed around 2009. Around the same time, hunting regulations were made more conservative, going from an 8-week season to 4 weeks, and a 10 bird limit to 6 (see Appendix, Figures 22 and 23). The cause of the lower harvest may be influenced by either, or a combination of the more restrictive regulations or other factors that reduced effort such as lower population levels.

Average harvest on opening weekend shows a similar pattern which would not be expected to be impacted by season length (Figure 3).

There are several potential theories as to what may have caused this. One may be that the drop aligns with the hypothesis that the population decreased due to back-to-back drought events around 2009. It has also been suggested that this drop in harvest may be a result of a decline in hunter effort. Additionally, it has been suggested that the survey implementation changed around this time (e.g., before 2009, the selection of surveyed hunters may not have been perfectly random, and some group totals were entered (D. Klee, personal communication)[3]. While randomisation cannot be determined from the data, outliers were checked for (e.g., group counts), with only a few being identified.

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[3] The structure of the survey also changed around this time (i.e., the format of the database). However, considerable time has been dedicated to investigating whether this may have resulted in some inconsistency with nothing found. It is reassuring to note that other regions also experienced this change but did not observe a change in their estimates (e.g., Southland).

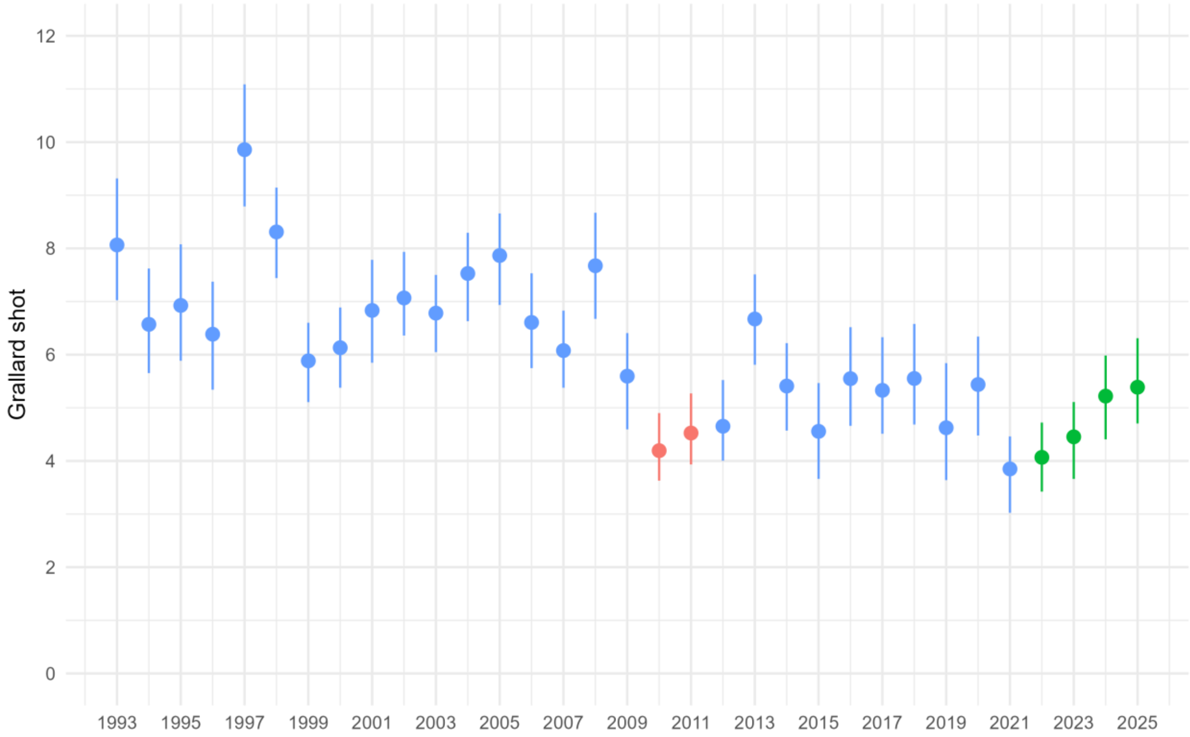

Figure 3: Estimated mean Auckland/Waikato opening weekend grallard harvest per licence holder from 1993-2025. Estimates are based on only AW surveys. Years are coloured by mallard limit. Blue = 10, Green = 8, Orange = 6. Opening weekend averages are calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

3.1.2 Hours spent hunting waterfowl

How long people spend hunting provides a good indication of social trends in waterfowl hunting and the potential effect of regulations. By reducing the season length, the aim is to reduce the time spent hunting (and, in turn, harvest). Total hours hunting waterfowl in the Auckland/Waikato region shows a drop around 2009, with a decreasing trend since then (Figure 4). The average amount of hours spent hunting waterfowl follows a similar trend (Figure 5).

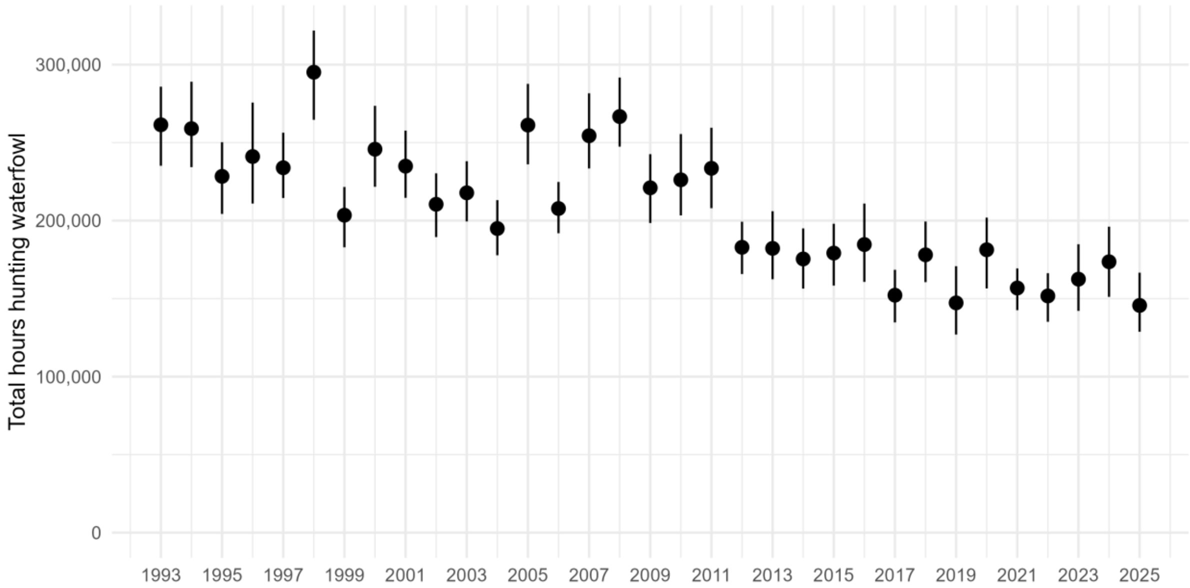

Figure 4: Total estimated hours hunting waterfowl in the Auckland Waikato region from 1993 to 2025. The estimate is based on hunters from all North Island regions.

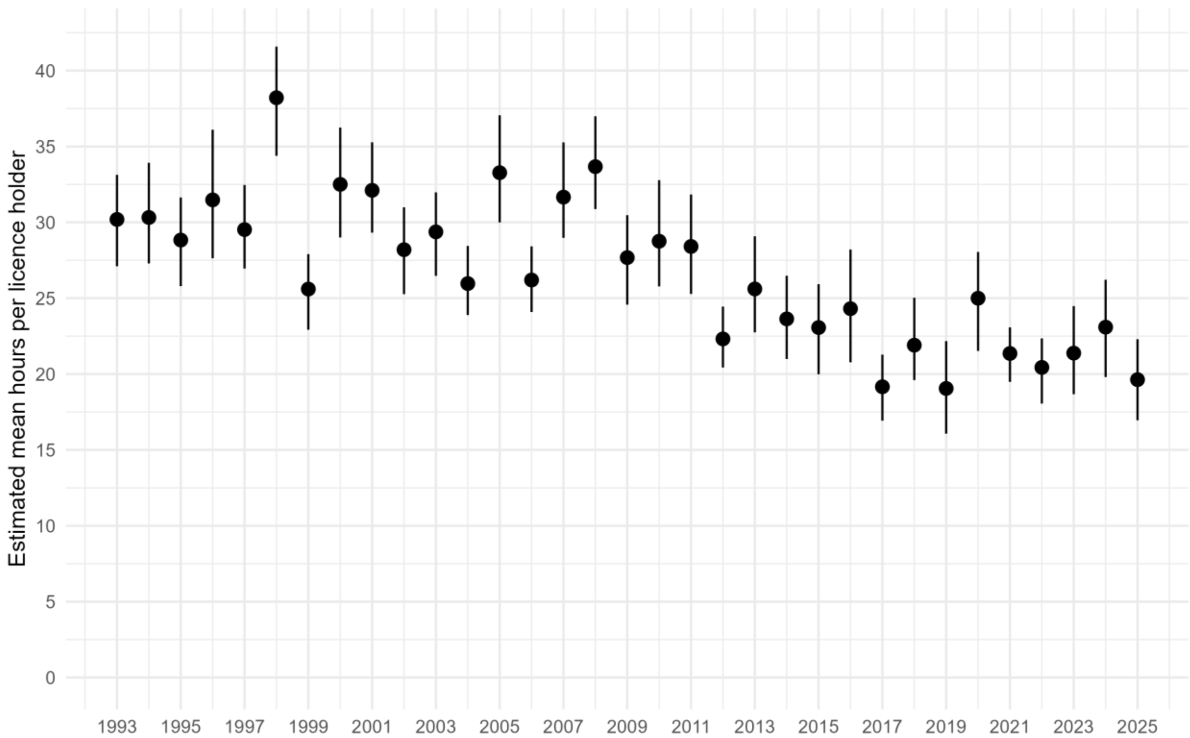

Figure 5: Average estimated hours hunting waterfowl per licence holder in the Auckland/Waikato region from 1993-2025. The estimate is based on Auckland/Waikato survey data only. Annual averages are

calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

3.1.3 Days spent hunting waterfowl

The number of days spent hunting waterfowl allows a different perspective into how hunter effort has changed over time, and the potential effects of season length. It has been hypothesised that a reduction in season length would mean that hunters would hunt for a similar number of total days, just in a more condensed period.

Figure 6 shows the estimated total days of waterfowl hunting in the Auckland Waikato region follows a similar drop post 2009, and has been trending downwards since.

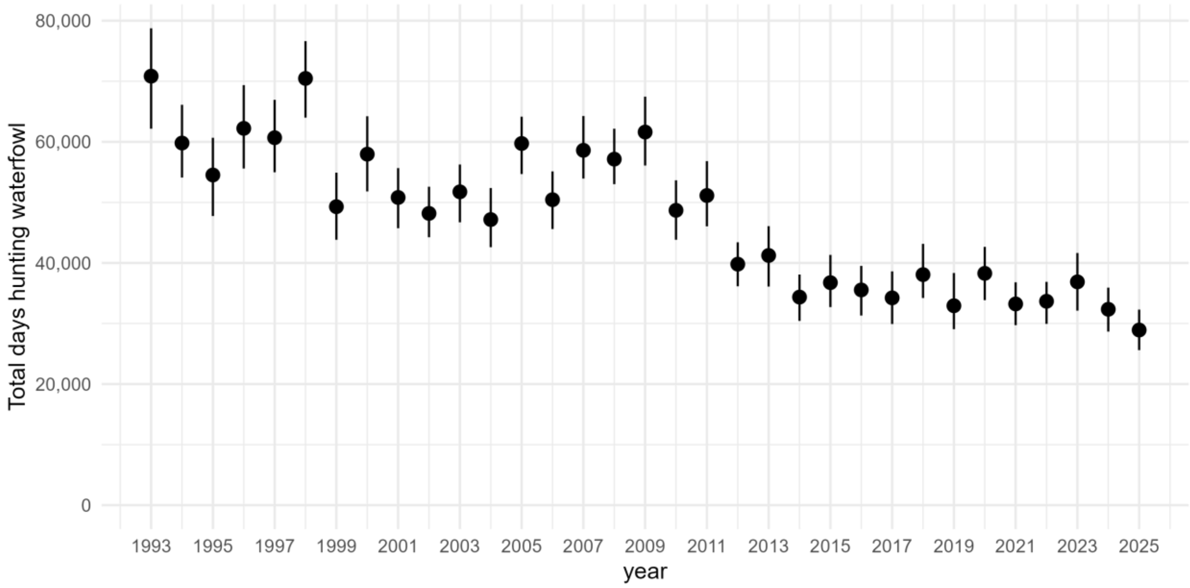

Figure 6: Total estimated days hunting waterfowl in the Auckland Waikato region from 1993 to 2025. The estimate is based on hunters from all North Island regions, and 95% quantile confidence intervals are generated from bootstrapping.

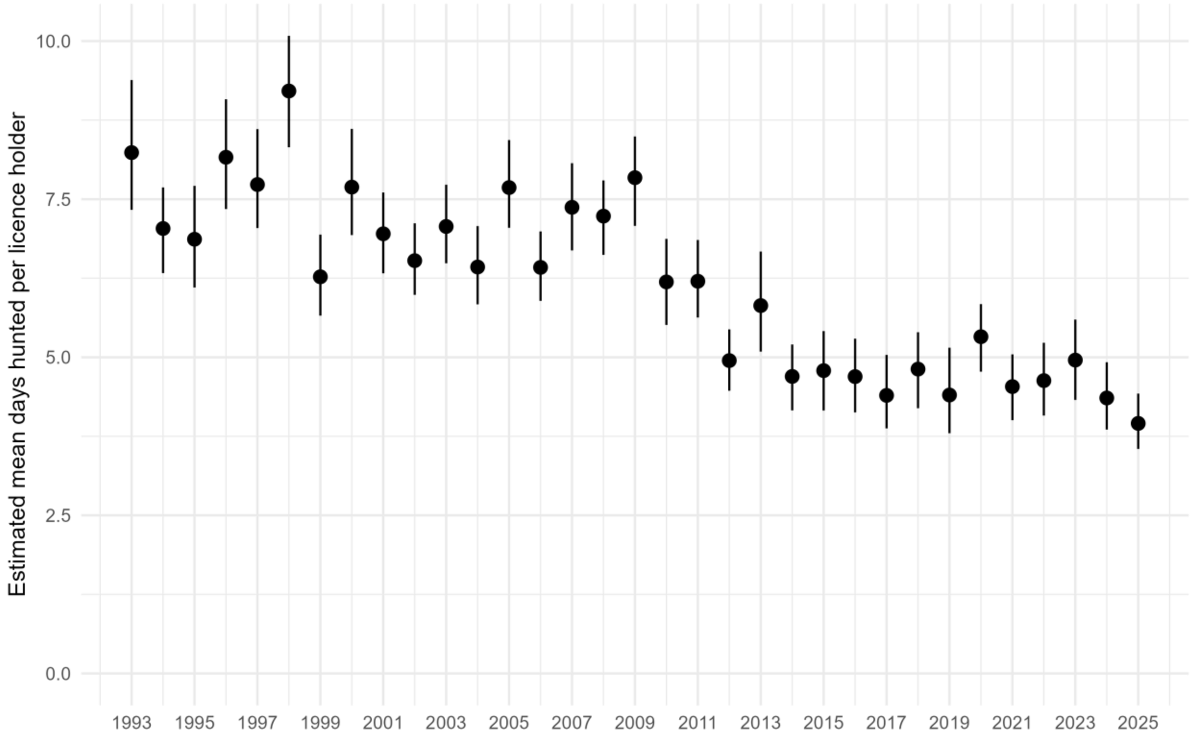

Figure 7: Average estimated days hunting waterfowl per licence holder in the Auckland/Waikato region from 1993-2025. The estimate is based on Auckland/Waikato survey data only. Annual averages are calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

3.1.4 Grallard per hour

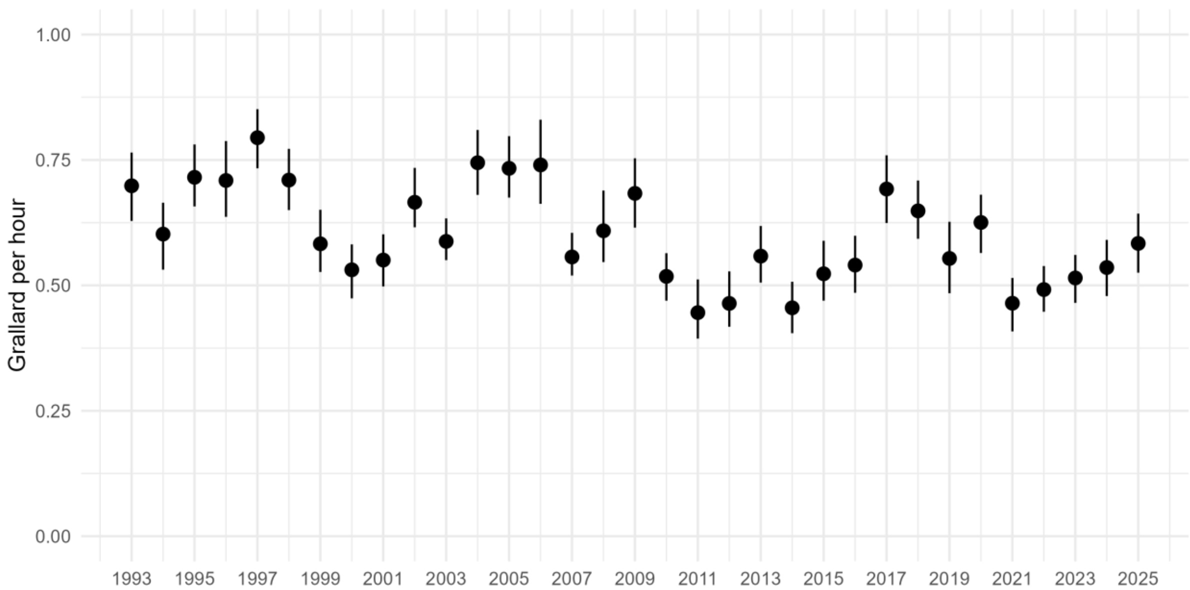

Figure 8: Estimates of average grallard harvest per hunter per hour in the Auckland/Waikato region from 1993-2025. The estimate is based on Auckland/Waikato survey data only. Annual averages are calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

Grallards per hunter per hour seems to fluctuate between 1993 and 2025. On the whole, this cycle is trending slightly downwards over time (p=0.0013). Grallard per hour has been shown to correlate with estimates of population size; however, this should be interpreted with caution, given that it is derived from the same harvest data.

3.2 INVESTIGATING POTENTIAL EFFECTS OF BAG LIMIT AND SEASON LENGTH

3.2.1 Season length

3.2.1.1 Most hunter effort and harvest occur on the opening weekend, and subsequent weekends and patterns in harvest and effort are similar in long and short seasons.

Patterns in the average number of hours spent hunting waterfowl in the Auckland/Waikato region indicate that much of hunter effort (Figure 9), and consequently harvest (Figure 10) occurs on opening weekend, and in subsequent weekends. This can be observed in the jump in the first two days and the step-like pattern in cumulative harvest/effort for the rest of the season (i.e., harvest and effort jump up on weekends but remain flatter during the weekdays). In this respect, it may be better to consider season length in terms of the number of weekends (e.g. a four-week season is actually a five-weekend season).

When opening weekend is included (the left plot in Figures 9, 10 and 11), it is apparent that in more recent years (i.e., in years with shorter seasons and lower estimates of population size) patterns in cumulative harvest are generally lower compared to more historic years with longer seasons and higher estimates of population.

However, when opening weekend is excluded (the right plot in Figures 9, 10 and 11), patterns in hunter effort and harvest are much more comparable, indicating the rate of harvest or effort does not differ between long and short seasons. In the previous report, it was hypothesised that this could be a result of two scenarios;

1. Season-length-driven reduction:

Shorter seasons directly reduce cumulative hunter effort (hours/days) and harvest simply by ending earlier. Hunters maintain similar behaviour regardless of season length, so the cumulative harvest and effort curves for short and long seasons follow similar trajectories; shorter seasons are just truncated versions of longer ones.

2. Behavioural-and-population-driven:

Declines in hunting effort and harvest reflect broader, longer-term changes such as a reduction in waterfowl population size, rather than the direct effect of season length. Hunters may respond to shorter seasons by concentrating their activity, hunting more intensely within the available days, making total harvest appear similar even though overall effort has declined.

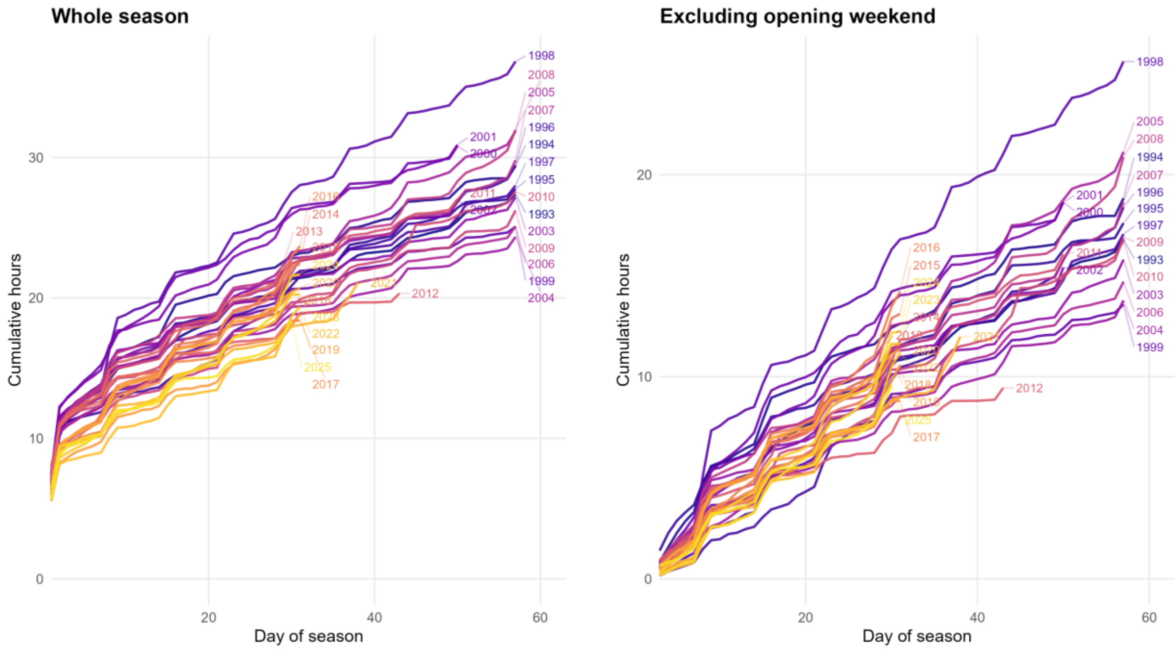

Figure 9: Cumulative daily mean hours spent hunting waterfowl per licence holder from 1993-2025 for the whole season (left) and excluding opening weekend (right). Where each year's line ends corresponds to the average hours per person in a season.

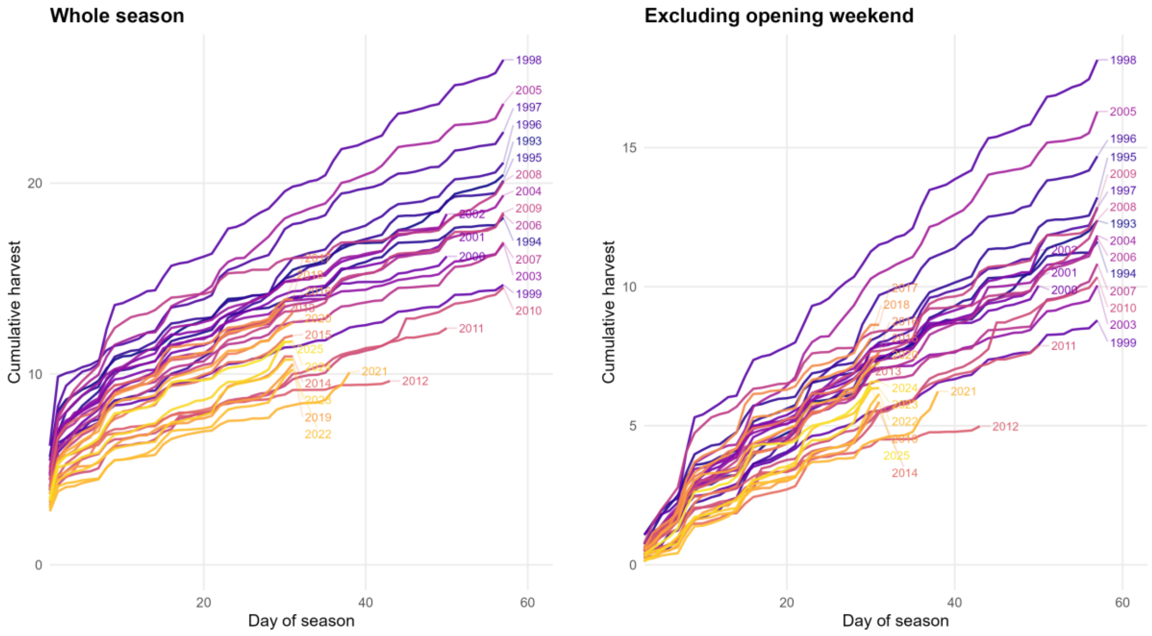

Figure 10: Cumulative daily mean grallard shot per licence holder from 1993-2025 for the whole season (left) and excluding opening weekend (right). Where each year's line ends corresponds to the estimated average grallard shot per person in a season.

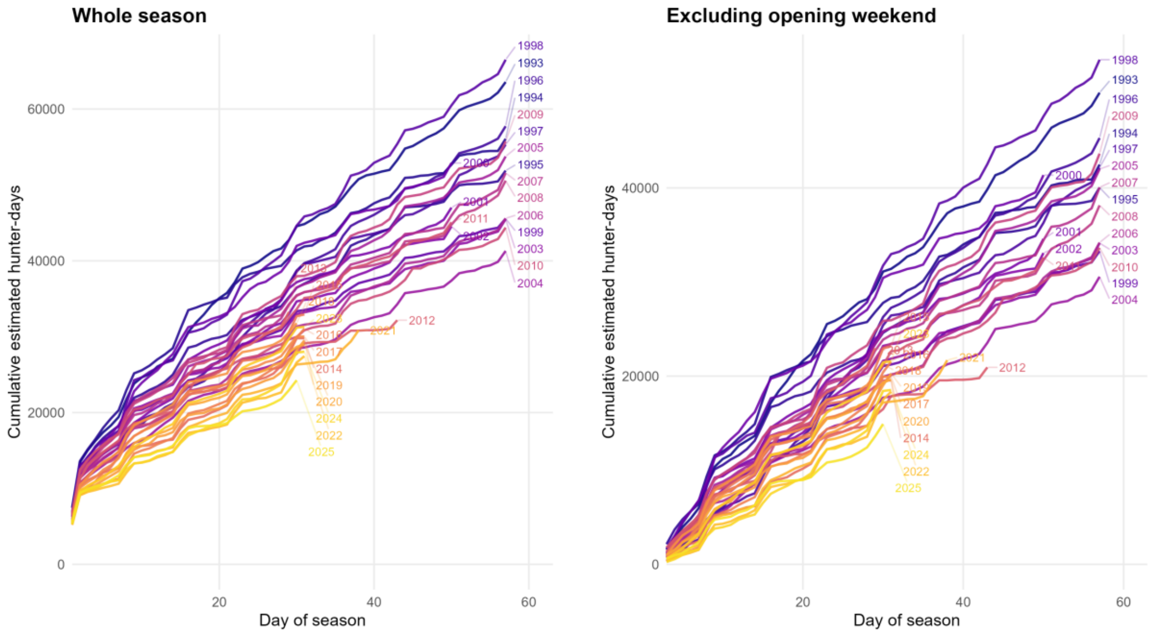

Figure 11: Cumulative mean days hunted per licence holder from 1993-2025 for the whole season (left) and excluding opening weekend (right). Where each year's line ends corresponds to the estimated average days hunted per person in a season.

3.2.1.2 Patterns of effort in neighbouring regions indicate that recent declines in hunter effort (post 2009) may not be driven by changing regulations and may instead reflect more general societal or population trends.

By comparing patterns in hunter effort (hours/days) and harvest between Auckland/Waikato (which have had reduced season lengths since 2011) and neighbouring regions, Northland and Taranaki (which have had more consistently long seasons), these two hypotheses are further investigated. The analysis focuses on hours hunted, as this is what is expected to be primarily influenced by season length. Naturally, each region differs in external factors (e.g. climatic, economic), so it cannot fully infer causation. To isolate the effect of season length, the opening weekend is excluded (which may be more impacted by factors such as bag limits).

Hours hunted in Northland and Taranaki show remarkably similar patterns post-opening weekend. Despite consistently longer seasons, both regions have observed a decline in hunter effort starting around 2010. Figure 12 clearly shows that for Northland and Taranaki, the cumulative hours hunting after the opening weekend are higher in earlier years (shown in purple) compared to more recent years (shown in yellow). This pattern is similarly observed in harvest (Figure 13).

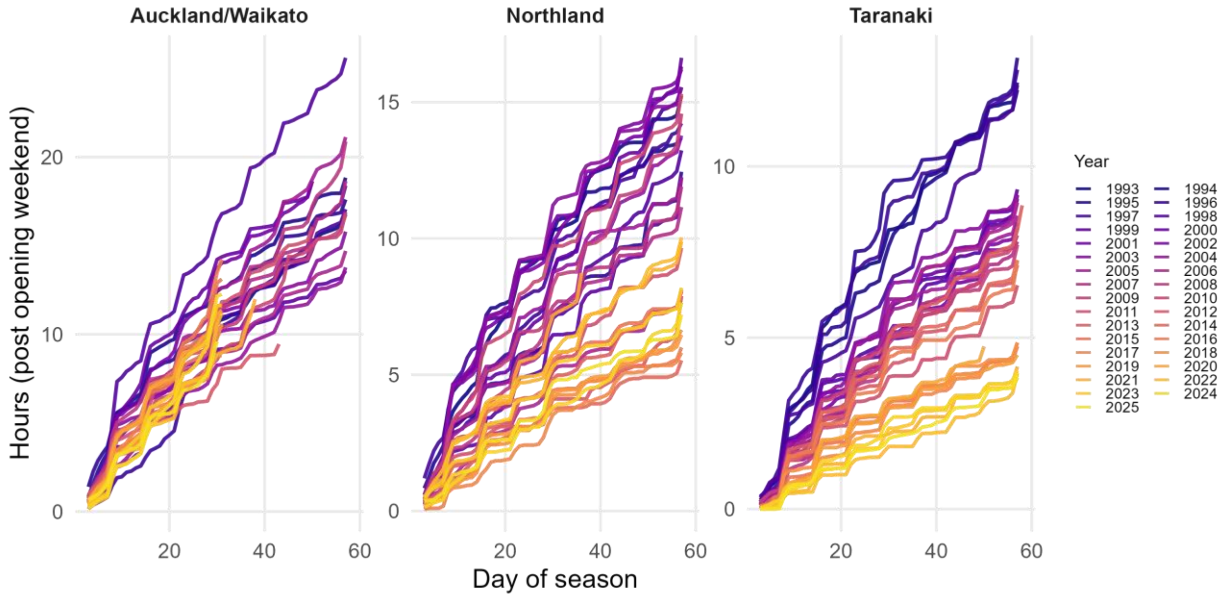

Figure 12: Cumulative daily mean hours spent hunting waterfowl per licence holder from 1993-2025, excluding opening weekend in the Auckland, Waikato, Northland and Taranaki regions.

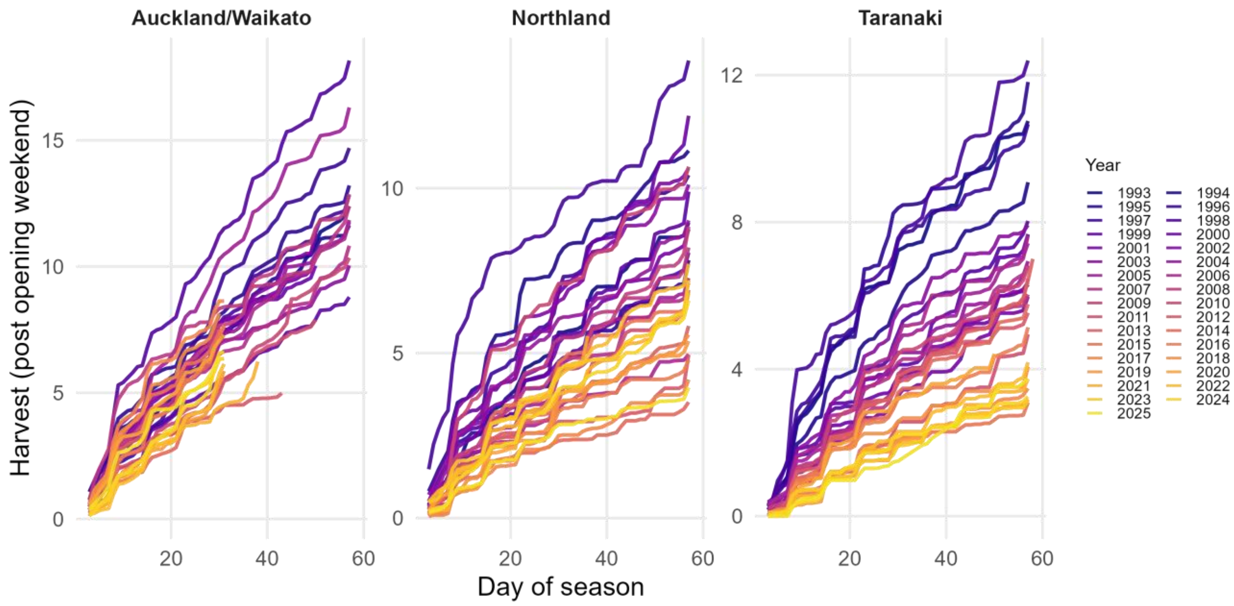

Figure 13: Cumulative daily mean grallard harvest per licence holder from 1993-2025, excluding opening weekend in the Auckland, Waikato, Northland and Taranaki regions.

From 1993 to 2025, all three regions followed a similar trend in the mean number of hours hunted after the opening weekend, with the mean hours hunted dropping around 2010 (Figure 14). This drop in hunting hours is not significantly different between the three regions. Specifically, a linear model testing the change in mean harvest between years 1993-2009 and 2010-2025 found no significant interaction between region and pre/post 2009 mean harvest (p =0.277). I.e. the drop in harvest observed between 1993-2009 and 2010-2025 is consistent between the three regions, despite Auckland/Waikato having shorter season lengths (most of which were four weeks) in the latter period. This is further illustrated in the interaction plot (Figure 15), where the parallel lines indicate no interaction between region and period. This implies all regions experienced a similar decline in mean annual harvest over time, suggesting the post-2009 reduction was not region-specific. This lends considerable weight to the hypothesis that declines in hunting effort reflect broader, longer-term changes, rather than the direct effect of season length.

Several specific factors could be driving a recent decline in hours hunted. It has been hypothesised that competing hobbies and interests may contribute to a decline in hunter effort. A reduced grallard population (and therefore potentially lower grallard per hour) may also contribute to a reduction in hunter effort, as hunting is now more challenging or less rewarding. Environmental factors are also worth considering, with drier conditions in May, hunters may increasingly experience less available "hunting habitat" than historically.

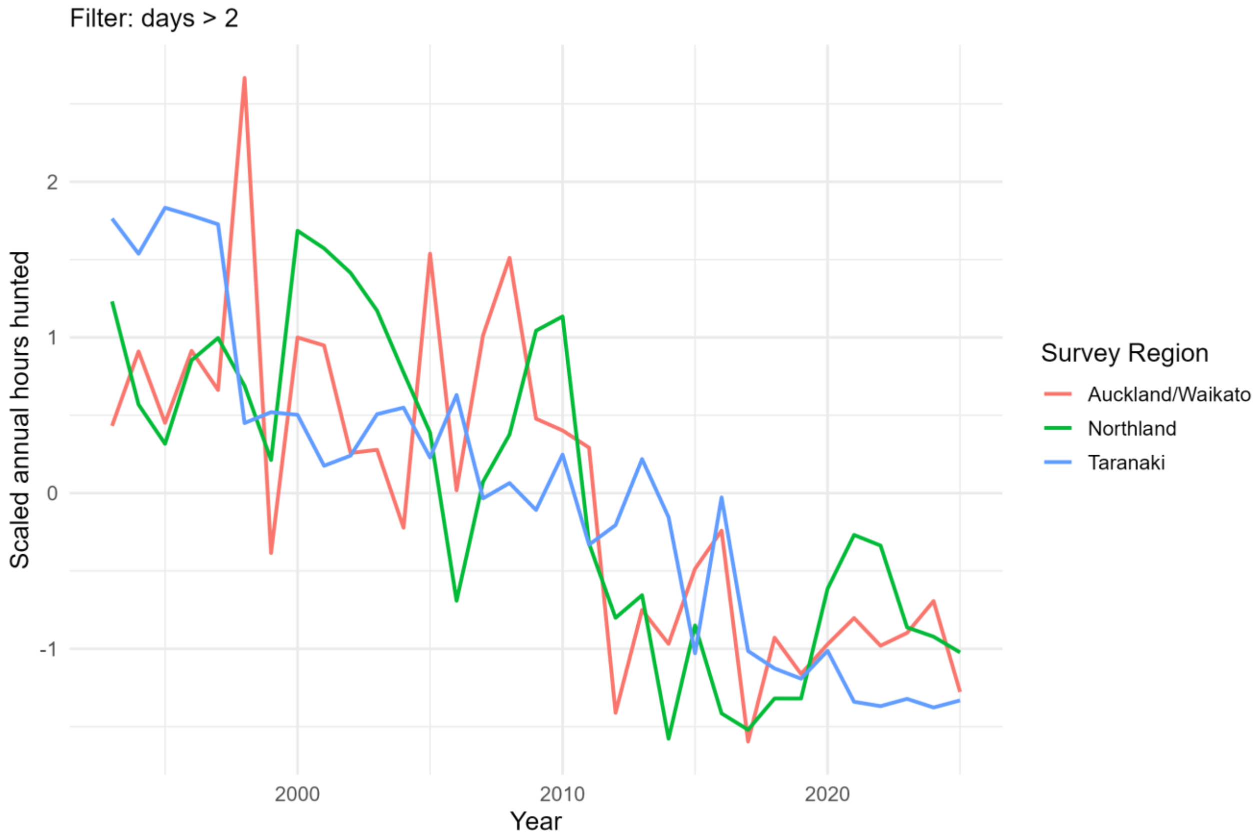

Figure 14: Trends in mean hours hunted per licence holder (excluding opening weekend) from 1993-2025 in the Auckland, Waikato, Northland and Taranaki regions. Here, the mean hours are scaled (subtracted from the regional mean and divided by the standard deviation) to allow for comparisons in trends between regions.

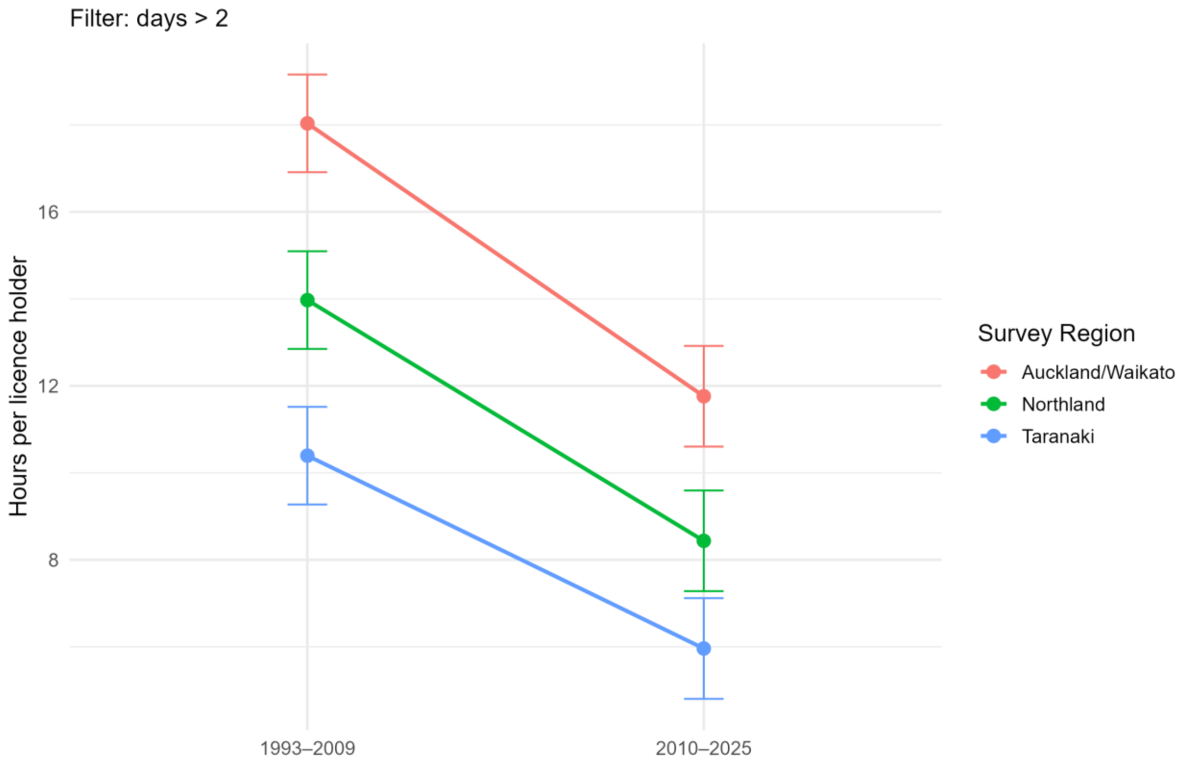

Figure 15: Change in the estimated mean annual hours hunting water (± SE) between 1993-2009 and 2010-2025 across Auckland/Waikato, Northland, and Taranaki post opening weekend. Parallel lines indicate no interaction between region and period, meaning the drop in mean harvest before and after 2009 is consistent across the three regions.

3.2.2 Bag limits

3.2.2.1 Bag limits are more effective when the population is higher.

The proportion of hunters shooting more than 5 birds a day provides an indication of how impactful bag limit reductions are. Figure 16 shows that, for the Saturday of opening weekend (and to a much lesser extent, Sunday as well), this proportion has decreased over time. This matches the pattern in population size, indicating that for the opening weekend, bag limits will impact more people when the population is higher (i.e., in the 2000s). In contrast, this proportion appears to be reasonably stable over time after opening weekend (i.e., "Rest of season"), at just over 10%.

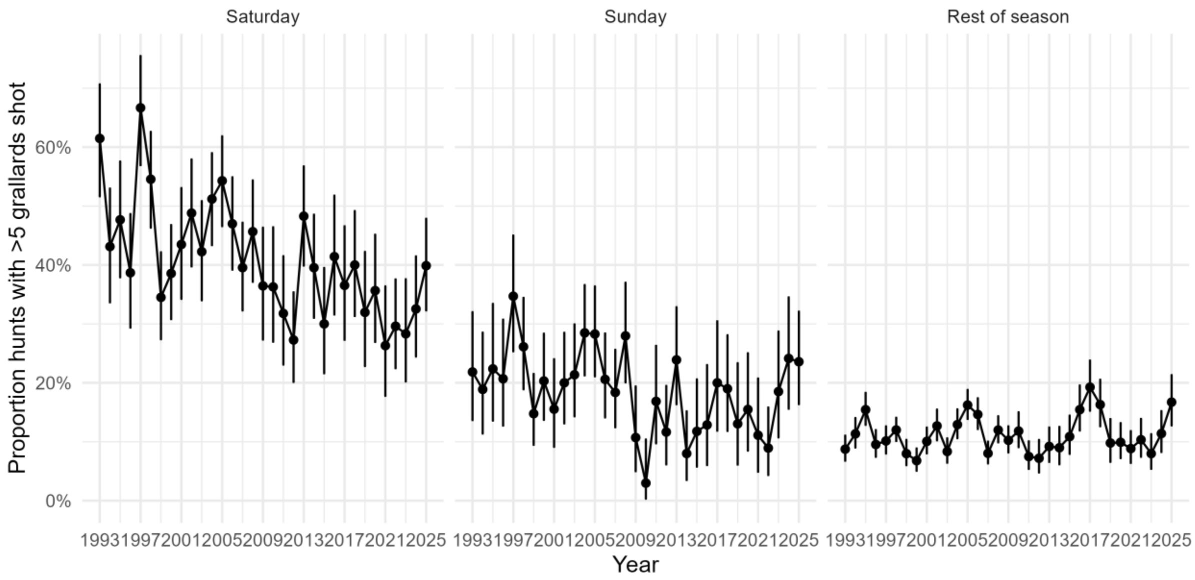

Figure 16: Estimated proportion of hunts in which more than five grallards are harvested from 1993 to 2025. Estimates are given for the Saturday (left) and Sunday (middle) of opening weekend, and the rest of the season (right).

3.2.2.2 Bag limits are most effective on opening weekend.

Given that the effect of bag limits varies depending on the population size (i.e., when there are lots of birds, it is more common to harvest more), data was limited to the most recent years (2022 to 2025), which have had a mallard limit of 8 and likely a more comparable population size than that of the early 2000s.

Figure 17 shows that in recent years, around 19% of hunters reached their limit of eight on the Saturday of opening weekend. On Sunday, this drops to 10%, and for the rest of the season, on average, 5.5% of hunts will result in the hunter getting their limit.

If this distribution were to hold (i.e., assuming hunter behaviour stays consistent), it is expected that a 6-bird limit would result in around 34% of hunters making their limit on the Saturday of opening weekend. On Sunday, this drops to 17% and for the rest of the season, on average, 10% of hunts will result in the hunter getting their limit (Figure 18).

However, it is expected the hunter behaviour would change with bag limits. Most likely, the distribution would be shifted to the right. For example, someone who might typically shoot five birds might hold out an extra hour for the satisfaction of getting their limit (if the bag limit is 6). Estimates of expected harvest under these hypothetical scenarios may therefore be better thought of as “at best” reduction.

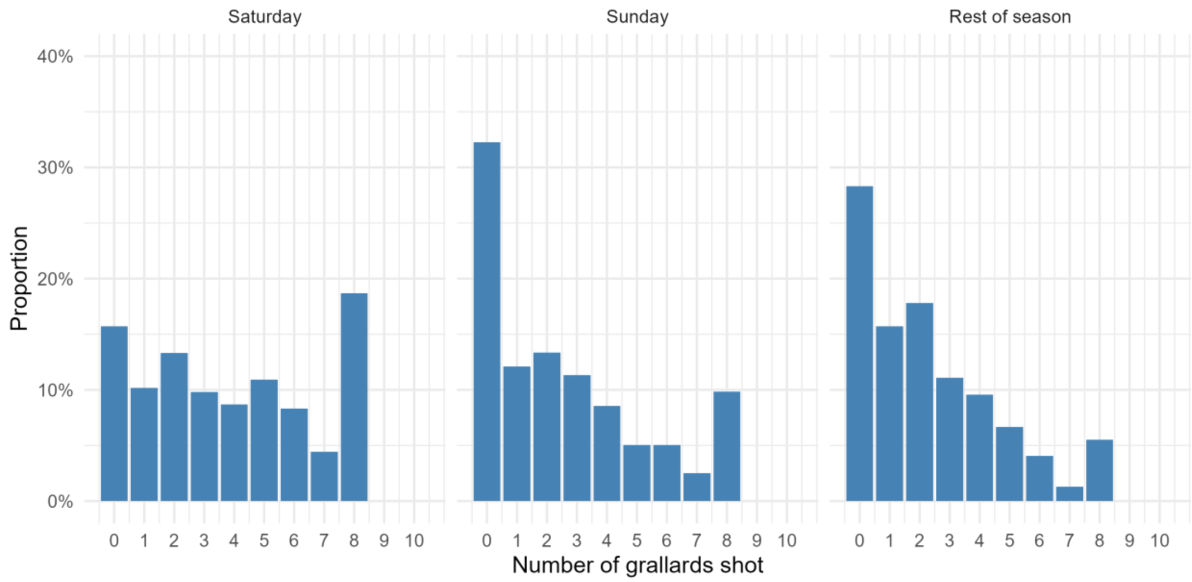

Figure 17: The distribution of grallard shot per day for years 2022 to 2025 (all with a bag limit of 8) for Saturday (left) and Sunday (middle) of opening weekend, and the rest of the season (right).

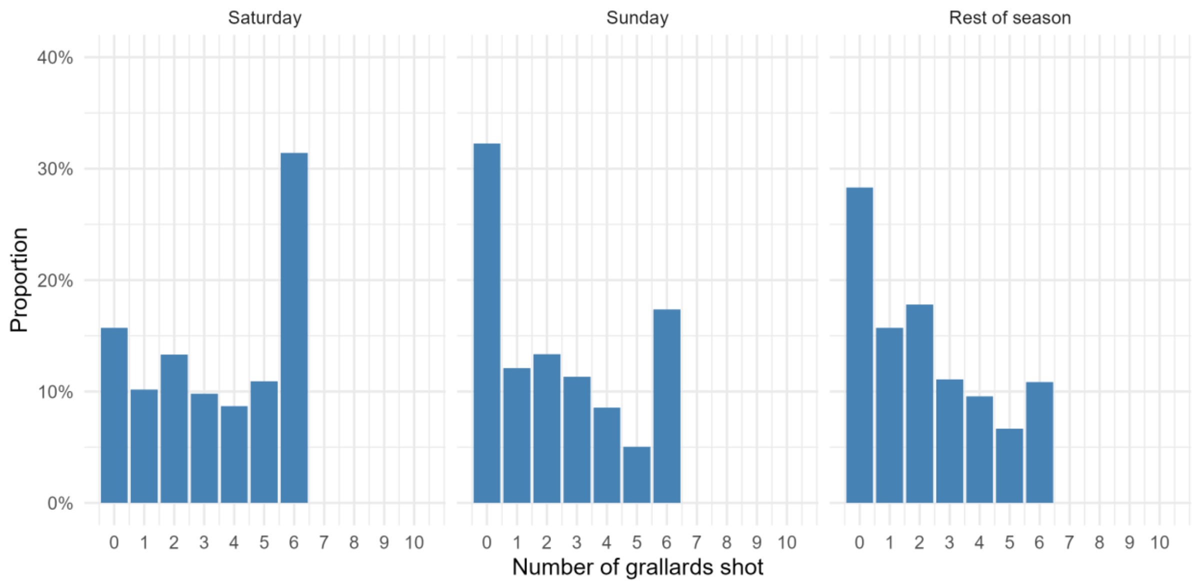

Figure 18: The distribution of grallard shot per day for years 2022 to 2025 (all with a bag limit of 8) by opening weekend (left) and the rest of the season (right) under a hypothesised six-bag limit (i.e., data is mutated so that those who shot more than six are assumed to get their limit of 6).

3.2.2.3 Expected reductions in harvest likely only occur when bag limits are highly restrictive.

Figures 17 and 18 illustrate how imposing a bag limit of six compresses the upper tail of the distribution of birds shot. However, because the distribution is truncated rather than shifted downward, the reduction in total harvest is likely smaller than it appears, as demonstrated below.

Table 1: Estimated percent reduction in harvest using data from 2022 to 2025.

Bag limit	0	1	2	3	4	5	6	7	8

Percent reduction in total harvest	100.0	72.2	49.7	33.6	21.5	12.8	7.0	3.1	0

Table 1 shows the estimated percent reduction in harvest under different bag limit scenarios, calculated using data from 2022 to 2025. For example, to achieve a 33% reduction in harvest, a 3-bird limit would be necessary. This reduction in harvest has a greater effect on opening weekend (Figure 19) and can be expected to differ by year (Figure 20). Figure 20 highlights the annual effects of bag limit on total harvest for years 2018 to 2025, where years 2018 to 2021 had a bag limit of 10.

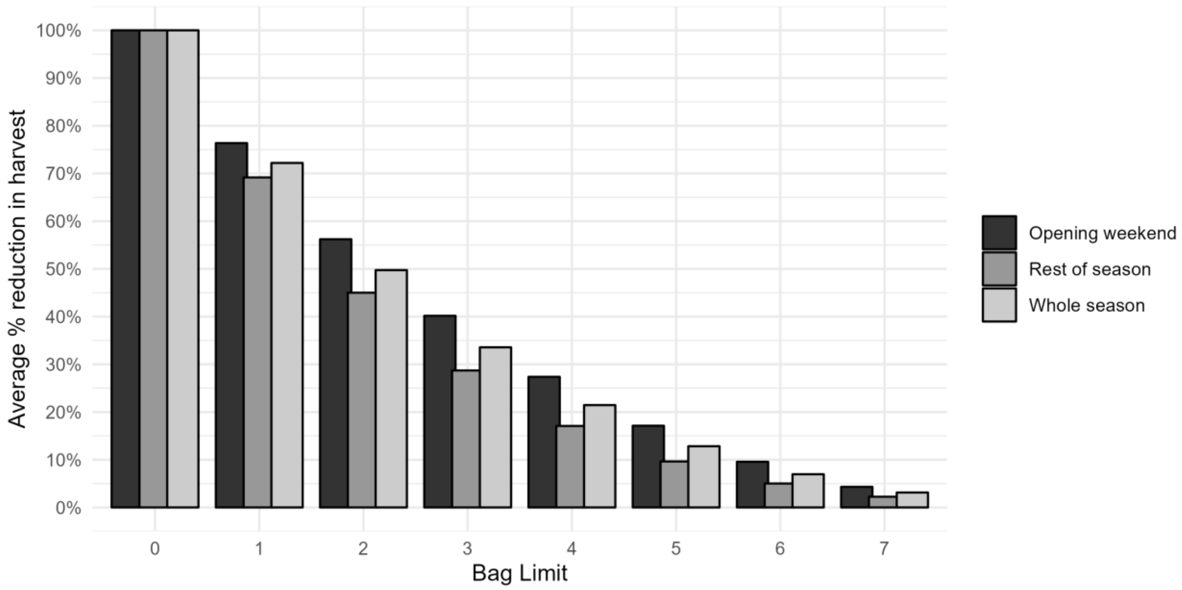

Figure 19: Estimated reduction in harvest under different bag limit scenarios (based on 2022 to 2025 data). Here, harvest data is mutated so that those who shot above the scenario bag limit now shoot that value.

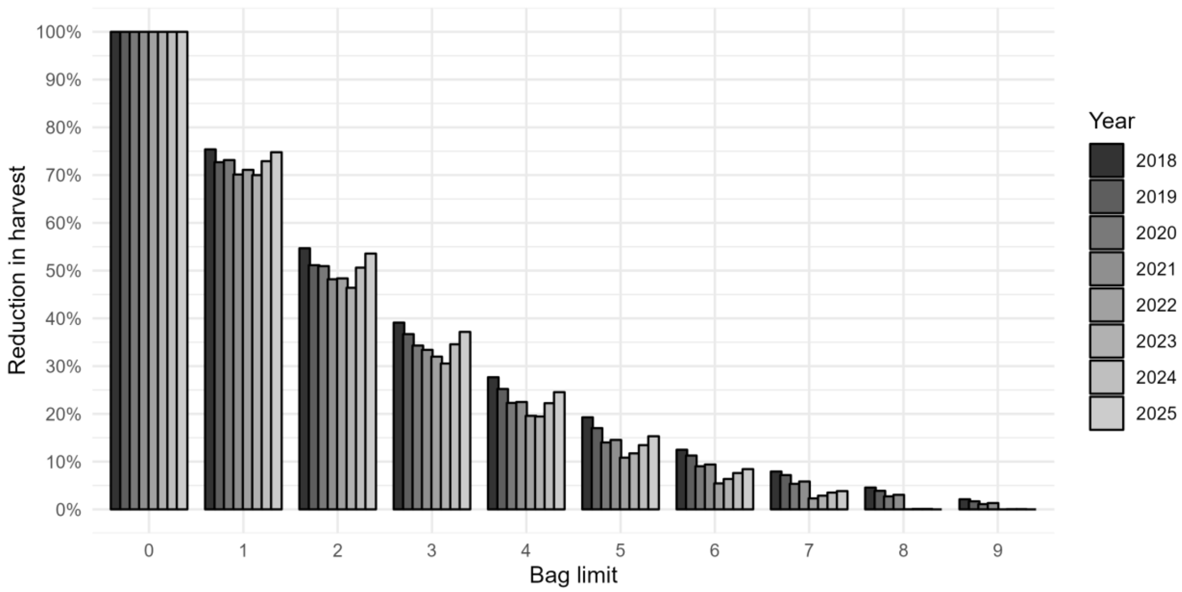

Figure 20: Estimated reduction in harvest under different bag limit scenarios for years 2018 to 2025. Highlighting the expected reduction in harvest for years with a limit of 10 (2018 to 2021) and 8 (2022 to 2025).

3.3 Survival rates

Annual survival rates are calculated from banding data and represent the proportion of the population that survives from one year to the next. In some contexts, annual survival is separated into breeding survival and non-breeding survival[4]. It is assumed that breeding survival is dependent on factors such as predation, food availability, etc, while non-breeding survival is dependent on these factors plus harvest.

From 2002 to 2025, the long-term average survival rates are estimated as:

- Juvenile females = 0.323 (95% CI: 0.302 – 0.344)
- Juvenile males = 0.425 (95% CI: 0.404 – 0.445)
- Adult males = 0.606 (95% CI: 0.595 – 0.617)
- Adult females = 0.49 (95% CI: 0.47 – 0.618)

Juvenile survival rates are here shown to be lower than those of adults, and that female survival rates are lower than those of males.

Figure 21 shows that while there are some annual fluctuations in survival rate, it is generally stable over time.

Estimates of survival rates may remain stable during a hypothetical population collapse because duckling survival is understood to be the single most important variable governing population growth[4] which is not captured in the survival estimates. Environmental effects and seasonal regulation can be included as predictors in the Burnham live-dead model, but further work is required to explore this fully.

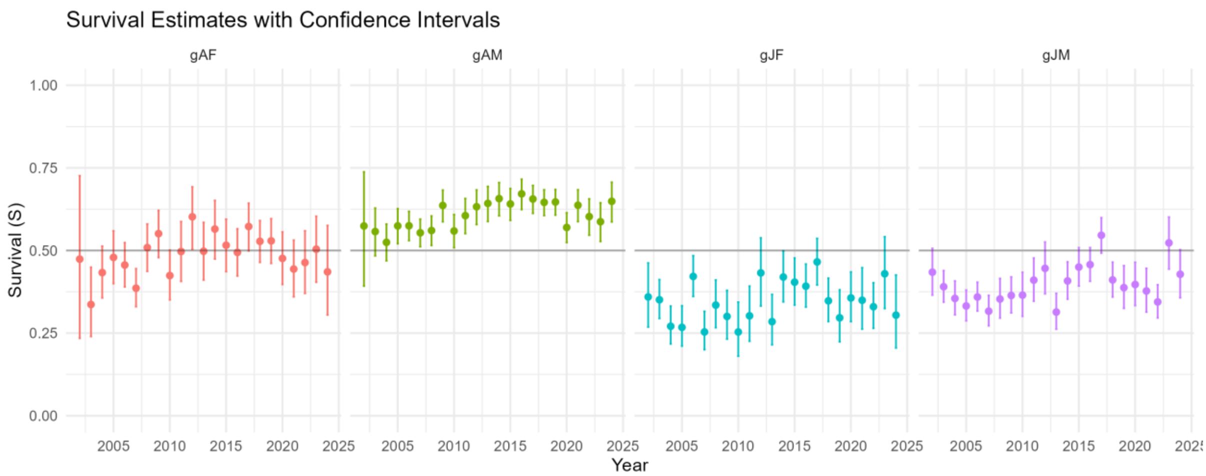

*Figure 21: Estimates of survival (S) from 2002 to 2024 based on a Burnham live-dead model. AF (orange) = Adult females, AM (Green) = adult males, JF (blue) = juvenile females, JM (purple) = juvenile males. Distinct estimates of survival for sex and age classes over time are generated from an S(sex*age*time) p(~1) r(sex*age) F(~1) model. The most recent year is excluded from the plots because it cannot be reliably estimated.*

[4] J. Sheppard (2017). Breeding Ecology and Productivity of Mallards and Mallard-grey Duck Hybrids in New Zealand.

4 APPENDIX A: SUPPLEMENTARY FIGURES

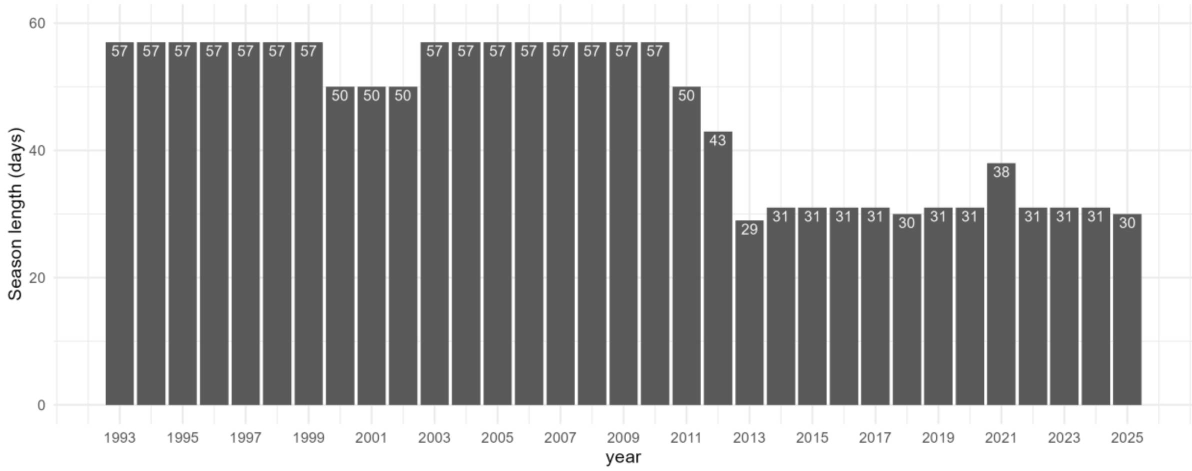

Figure 22: Auckland Waikato season length (days) 1993-2025.

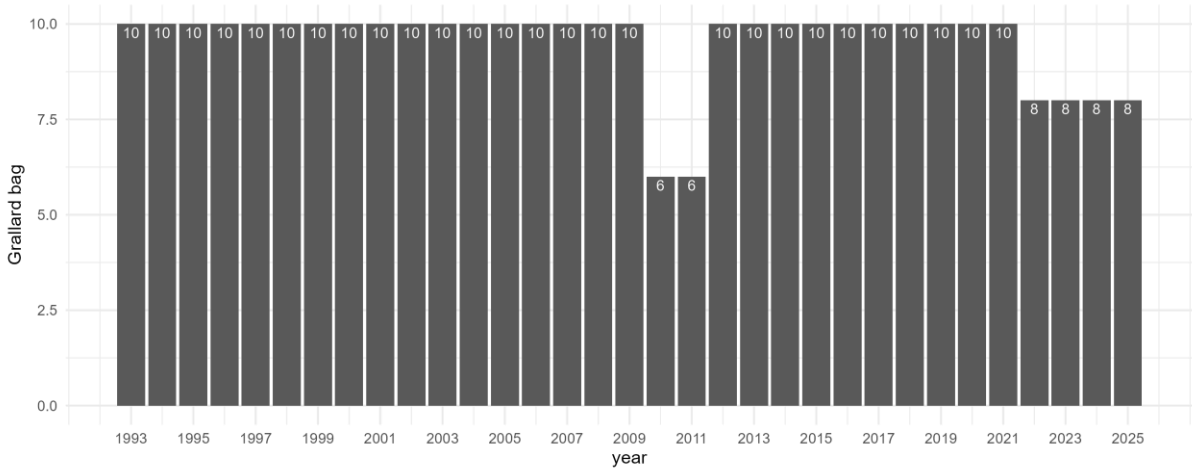

Figure 23: Auckland Waikato mallard bag limit 1993-2025.

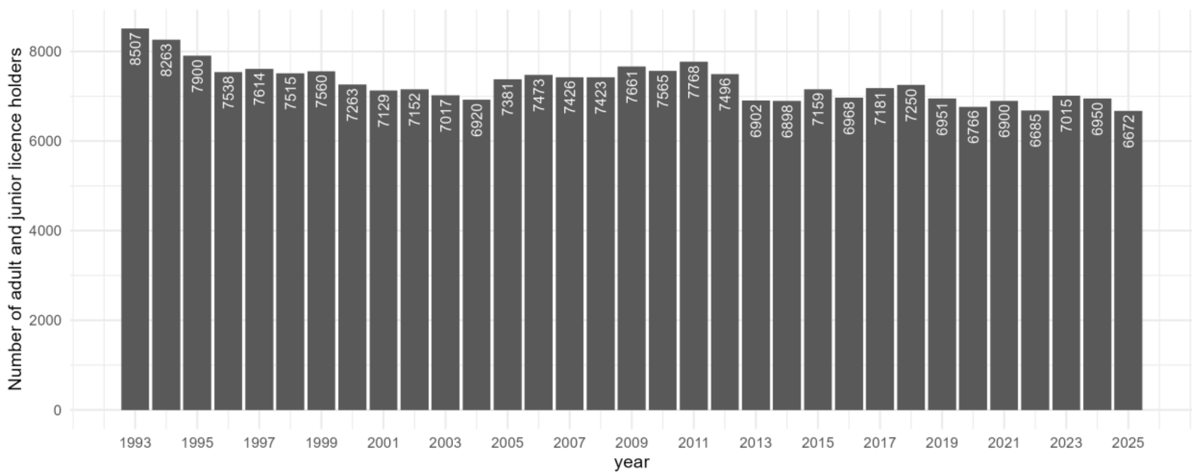

Figure 24: Auckland Waikato adult and junior full-season licence holders 1993-2025. Note that for 1995, the number of licence holders is unknown, and the average of the two surrounding years is imputed.

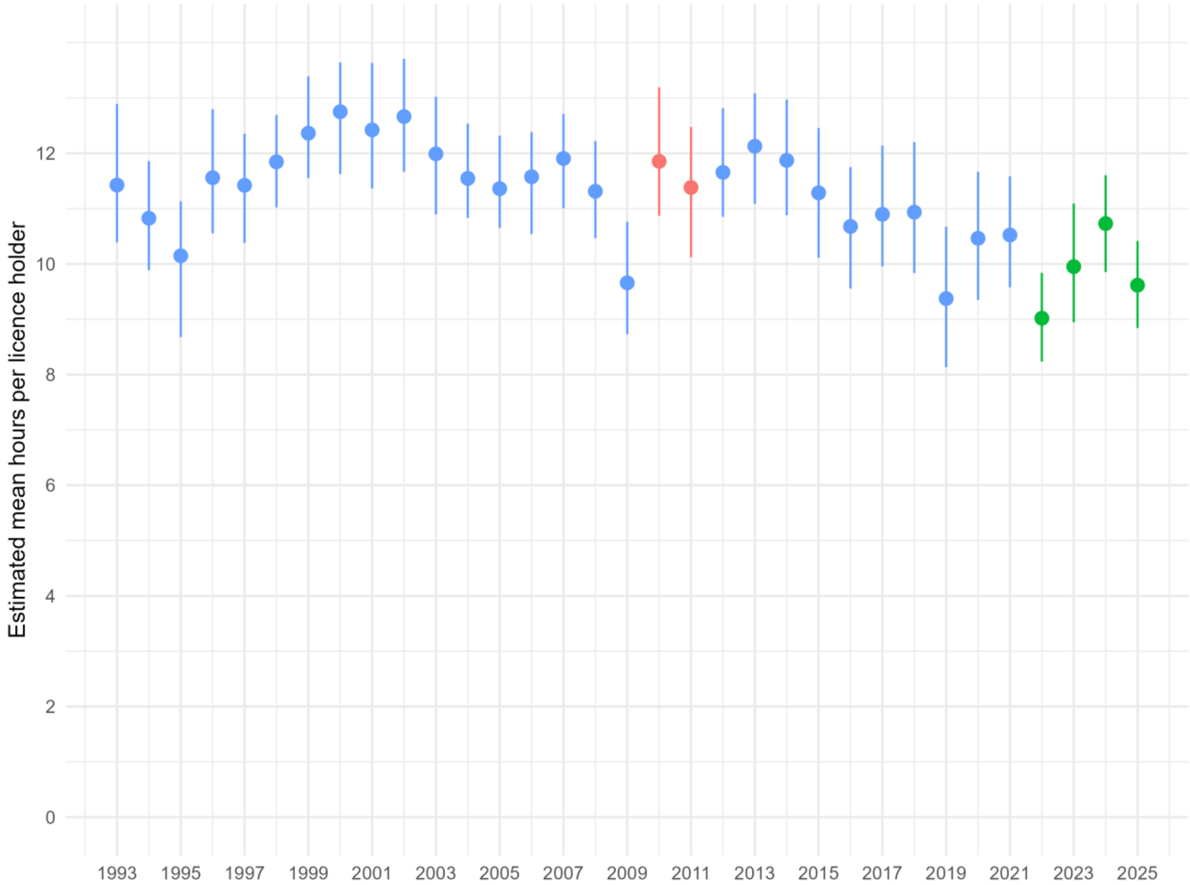

Figure 25: Estimated mean opening weekend grallard hours hunting waterfowl per licence holder from 1993-2024. Years are coloured by mallard limit. Blue = 10, Green = 8, Orange = 6. Opening weekend averages are calculated as the sum of daily averages, and 95% quantile confidence intervals are generated from bootstrapping.

5 APPENDIX B: HARVEST OF OTHER SPECIES

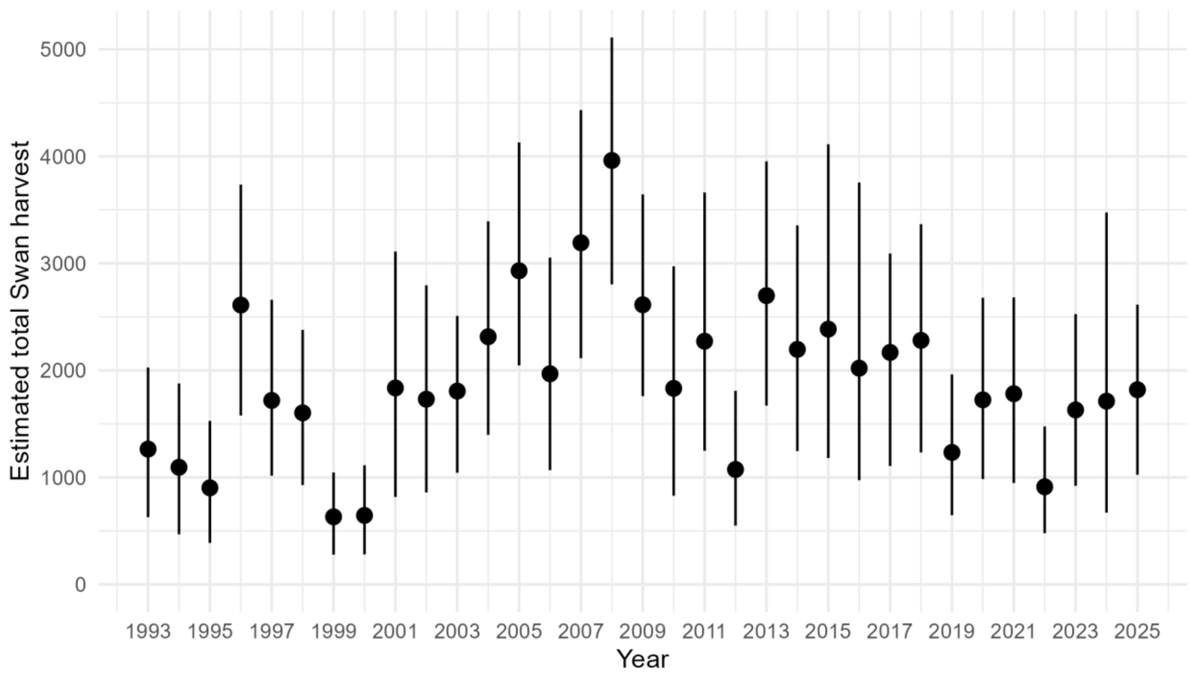

Figure 26: Total estimated black swan harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.

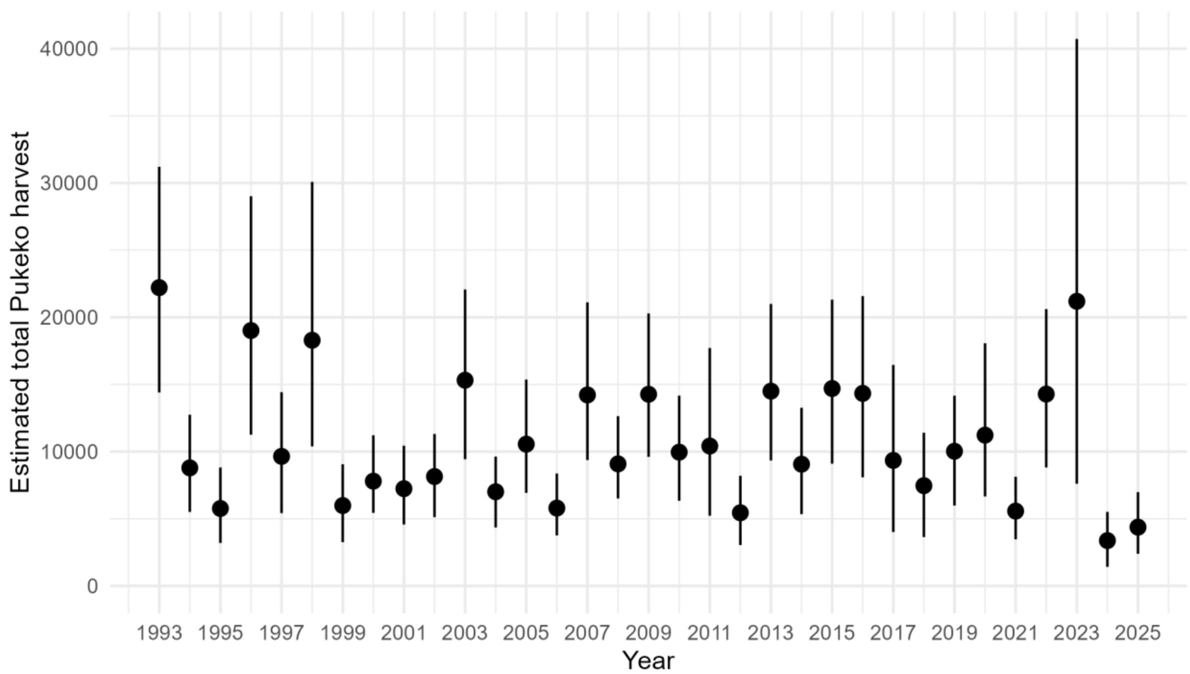

Figure 27: Total estimated pukeko harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.

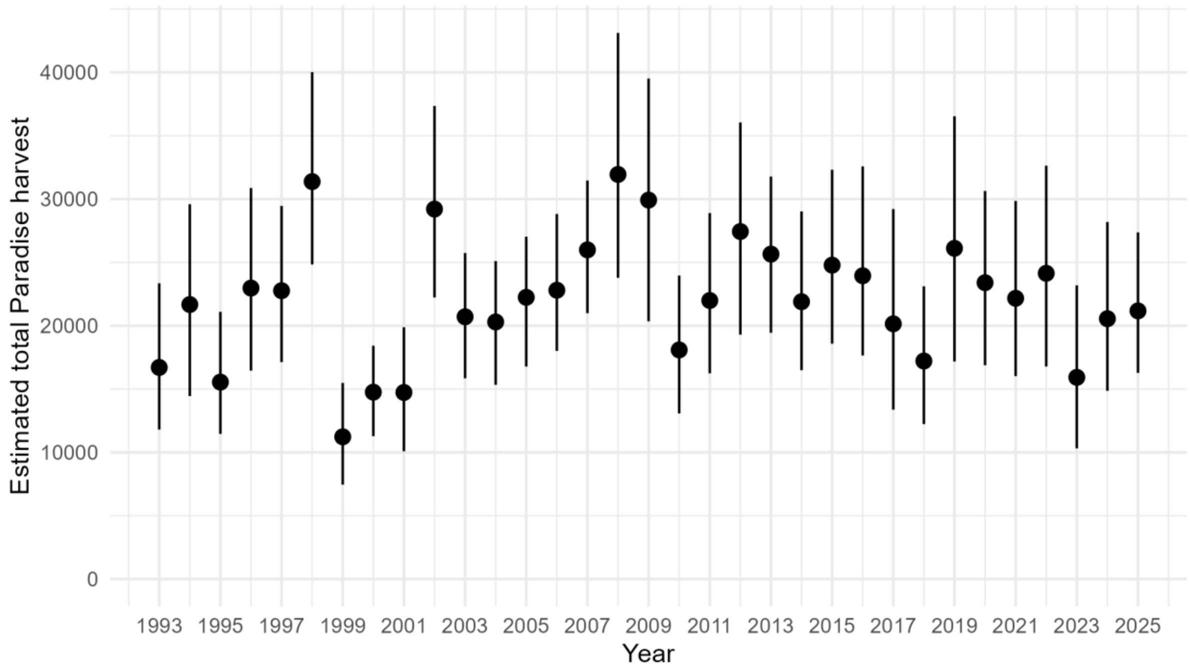

Figure 28: Total estimated paradise shelduck harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.

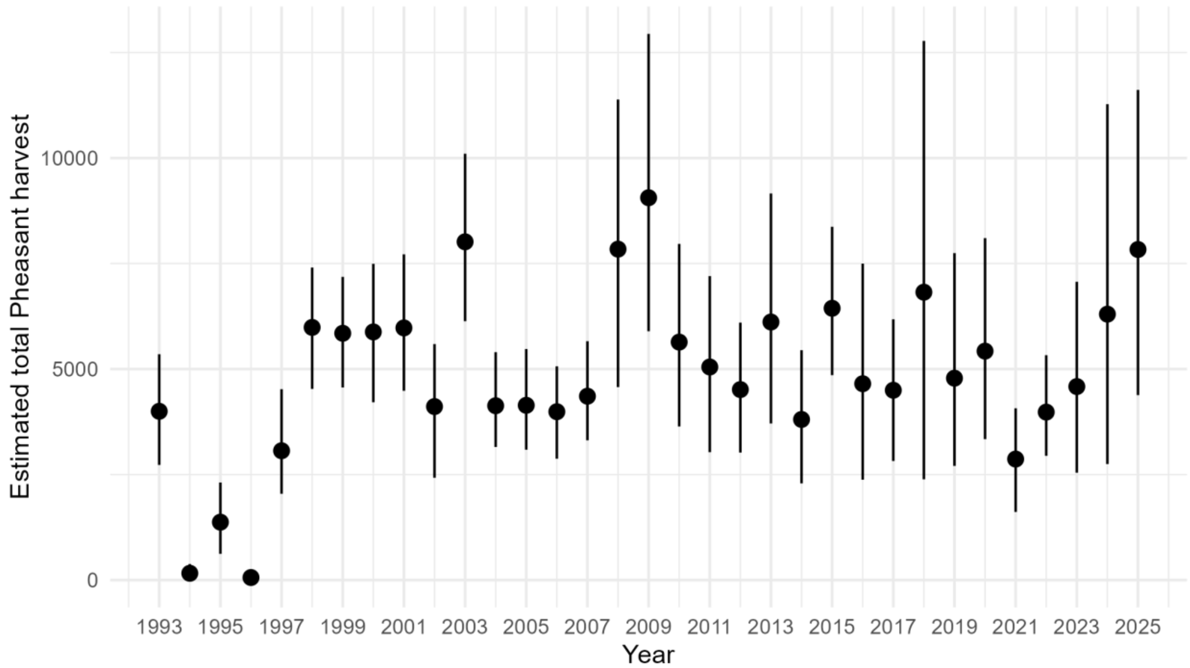

Figure 29: Total estimated pheasant harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.

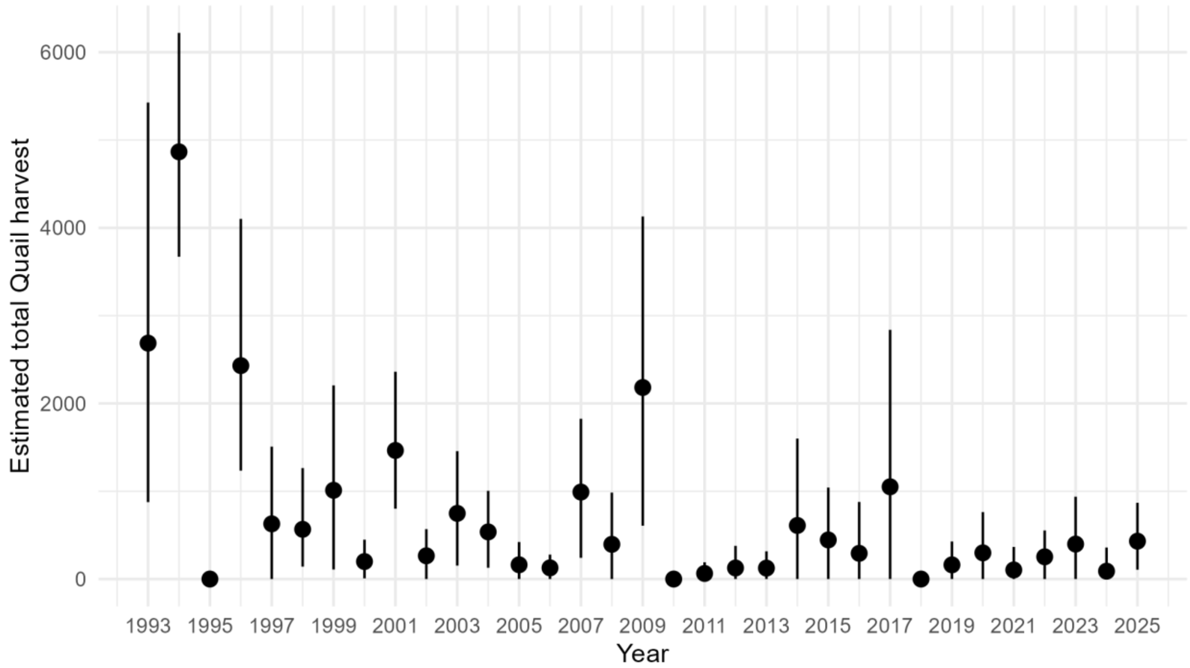

Figure 30: Total estimated quail harvest in the Auckland/Waikato region from 1993-2025. Annual averages are calculated as the sum of daily totals, and 95% quantile confidence intervals are generated from bootstrapping.