# Aerial Survey of Magpie Goose in the Top End of the Northern Territory 2026

## Moyle River to Arnhem Land Floodplains

NORTHERN TERRITORY GOVERNMENT

| | |
|---|---|
| **Document title** | Aerial Survey of Magpie Goose in the Top End of the Northern Territory 2026 |
| **Contact details** | Flora and Fauna Division<br>Department of Lands, Planning and Environment<br>Po Box 496, Palmerston NT 0831<br>Telephone 08 8995 500<br>Email: wildlife.use@nt.gov.au |
| **Approved by** | Alaric Fisher, Executive Director, Flora and Fauna Division |
| **Date approved** | 21/08/2026 |
| **Document review** | N/A |
| **TRM number** | BD2023/0012 |

| Version | Date | Author | Changes made |
|---|---|---|---|
| 0.1 | 17/08/2026 | Mike Welch | Draft report |
| 0.2 | 18/08/2026 | Tony Griffiths | Technical review |
| 1.0 | 21/08/2026 | Alaric Fisher | Approved for publication |


## Acknowledgements

Skilled observing and data recording was provided by Tony Griffiths and Anna Belford from Flora and Fauna Division within the Department of Lands, Planning and Environment. The Department thanks the Traditional Owners, pastoralists and park management agencies who supported the surveys being undertaken across their land. Tony Griffiths assisted with data analyses and provided technical review of the report.

# Contents

# Summary

A fixed-wing aerial survey of Top End floodplains of the Northern Territory was undertaken from 14 April to 7 May 2026, to estimate population size and nesting activity of Magpie Goose. A total of 7,343 km of fixed-width survey transects were flown using the standard methodology applied since 2011. The survey incorporated key floodplain habitats from Moyle River in the west to the Blue Mud Bay region of Arnhem Land in the east and covered 20,398 square kilometres (over 2 million ha) of potential habitat at a sampling intensity of 14.4%. All Magpie Goose and Magpie Goose nests sighted were recorded and corrected for visibility bias using the correction factors.

The 2026 population estimate for Magpie Goose was 1,692,389 ± 169,227 (total ± standard error) with a precision of 10%. This population estimate represents a substantial increase of 27.2% compared to the 2025 estimate. The observed population increase in 2026 follows a positive trend over recent years and is at a moderate level compared to historical results.

The number of Magpie Goose nests was estimated to be 121,998 ± 17,243 for the surveyed area with a precision of 14.1%. This represents a substantial increase of 71.3% compared to the 2025 estimate and is a moderate nesting season compared to historical results. The rainfall preceding the survey period was above or well above average across much of the survey region, likely resulting in an increased proportion of the population breeding as well as improved survival of birds over the preceding late dry season.

The increase in the Magpie Goose population and nesting estimates observed in the 2026 annual survey is encouraging and indicates that the population continues to recover from the historical lows observed in 2017-2019. However, a key threat to the Magpie Goose population is the imminent arrival of Highly Parthenogenic Avian Influenza (HPAI). It is likely that high levels of mortality will be observed in Magpie Geese and other NT waterbird populations when HPAI arrives. Ongoing annual monitoring will assist in determining the degree to which HPAI impacts Magpie Geese at a population level.

# 1. Introduction

The Wildlife Management Program for the Magpie Goose (*Anseranas semipalmata*) in the Northern Territory of Australia 2020-2030 (WMP MG) (Clancy 2020) sets out the management protocols to ensure the long-term conservation of wild populations of the Magpie Goose and its habitats in the Northern Territory, in the context of continuing sustainable harvest. A key management activity is the annual aerial survey monitoring program across the key floodplain habitat in the Top End (Northern Territory north of 15°S latitude), immediately following the end of the annual Wet Season. Surveys are timed to coincide with the period when birds are nesting and when the population is at its most geographically concentrated, in order to optimise sampling efficacy.

The survey methods have been standardised to ensure continuity with previous surveys, as set out in the WMP MG. The WMP MG also establishes population size thresholds that have been used to determine safe offtake levels for recreational hunting, pest mitigation and any commercial harvest. This report presents the results of the 2026 aerial survey of the Top End floodplains (Figure 1).

Three regions have been surveyed since population monitoring commenced in 1983, with all regions surveyed annually since 2017. From 2011 to 2016, Area 2 was surveyed annually and Area 1 on a biannual or more frequent basis. Area 3 was surveyed less regularly. See Clancy (2020) for further details.

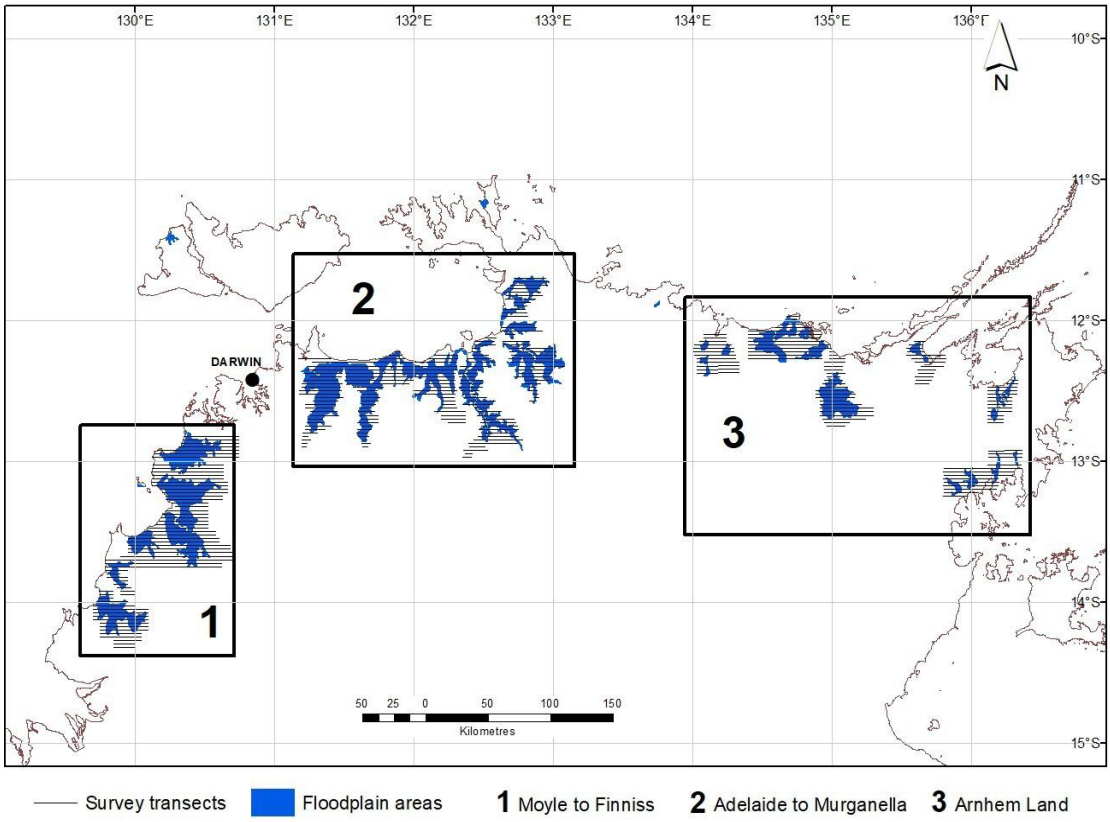



**Figure 1. Map of the Top End of the Northern Territory showing the regions surveyed for Magpie Goose.**

Overall population estimates from previous aerial surveys from 2015 to 2024 are detailed in Table 1. Note that in 2015 and 2016, when some survey regions were not surveyed, the figures have been adjusted to give an estimated total in a pro rata manner, relative to their contribution to the total counts (e.g. Arnhem Land is estimated to comprise 10% of total population in years when it was not surveyed).

It is assumed that the surveyed area encompasses 90-95% of the total area of the Northern Territory occupied by the Magpie Goose population at the time of the survey, due to their use of the floodplains as breeding habitat and the reliance of birds on the lower floodplains for food during this time of year.

**Table 1. Population and nest estimates (total ± standard error) for Magpie Geese from 2015 to 2025 derived from aerial surveys.**

| Year | Number of geese | Standard error | Number of nests | Standard error |
|---|---|---|---|---|
| 2015* | 1,200,000 | 200,000 | 105,000 | 13,000 |
| 2016* | 1,350,000 | 136,000 | 40,000 | 6,000 |
| 2017 | 724,500 | 78,750 | 84,840 | 14,625 |
| 2018 | 918,200 | 117,000 | 77,840 | 14,250 |
| 2019 | 1,542,943 | 215,317 | 10,484 | 3,185 |
| 2020 | 1,432,793 | 211,784 | 39,723 | 7,743 |
| 2021 | 982,156 | 283,717 | 44,010 | 9,086 |
| 2022 | 1,856,935 | 250,620 | 62,674 | 17,895 |
| 2023 | 1,260,454 | 148,626 | 45,900 | 5,932 |
| 2024 | 1,330,246 | 138,163 | 70,244 | 8,077 |
| 2025 | 1,222,984 | 134,674 | 71,235 | 7,703 |

*adjusted

# 2. Methods

## 2.1. Survey Area and Design

The cumulative amount of rainfall during a given wet season is a key determinant of Magpie Goose commencing to congregate for their annual nesting (Whitehead and Saalfeld 2000). Confirmation of optimal timing for commencement of the survey was based on:

- Review of current season to-date rainfall records
- Stakeholder consultation (e.g. Aboriginal ranger groups, crocodile egg harvesters), regarding observations of Magpie Goose (and any nesting) activity on the floodplains
- Confirmation that Magpie Geese were no longer present in Darwin urban areas, via routine monthly surveys of the northern suburbs
- A reconnaissance flight undertaken a week prior to the planned survey start date, to determine whether heavy rainfall and flooding in the western Top End during February/March 2026 may have resulted in a delay to geese commencing their usual aggregation on floodplains in the mid to late wet season

The reconnaissance flight included key nesting areas in the Daly, Finniss, Adelaide and Mary River survey blocks. Observations of large aggregations of birds and nesting confirmed that the planned mid-April timing of survey commencement was appropriate.

As per previous years, surveys were scheduled to commence from early April in the Moyle Finniss area and progress from the western to eastern Top End:

- The Moyle River to Finniss River floodplains survey region (Area 1 in Figure 1) includes all major floodplain habitat within that region and was surveyed during the period 14-21 April 2026. This area comprises six major survey blocks (Figure 2).
- The Adelaide and Mary River floodplains (western section of Area 2 in Figure 1) were surveyed during the period 22-23 April 2026. This area comprises four major survey blocks (Figure 3).
- The Arnhem Land floodplains survey region (Area 3 in Figure 1) includes all major floodplain habitat within that region and was surveyed during the period 27-30 April 2026. This area was divided into six major survey blocks (Figure 4). Survey blocks were completed from east (based from Nhulunbuy) to west (based from Maningrida).
- The Kakadu to Murgenella floodplains (eastern section of Area 2 in Figure 1) were surveyed during the period 5-7 May 2026. This area comprises five major survey blocks (Figure 3).

The survey was conducted using a Cessna 206H high-wing aircraft flown at a ground speed of 185 km/h (100 knots) and an altitude of 61 m (200 ft) above ground level. Where the transect had to traverse open water, aircraft height was adjusted to maintain safe gliding range but in practice this did not impact on survey areas, as such occasions were rare and did not occur in areas of significant Magpie Goose habitat. Transect width was demarcated by marker rods attached to the aircraft wing struts and calibrated (Marsh & Sinclair 1989) to give a transect width of 200 m on each side of the aircraft at survey altitude.

Transect lines flown on the survey were aligned east-west, perpendicular to the general north-south orientation of the major river systems, ridges and escarpments of the area (Figures 2-4). Transects were spaced at an interval of 1.5’ of latitude (2.778 km) to give a survey intensity of 14.4% from the combined port and starboard transect width of 400 m. Navigation of transects was by Global Positioning System pre-programmed with all transect waypoints on Samsung Galaxy Tab 2 (7.0) using the OziExplorer Android GPS mapping software.

For all surveys, two observers (Mike Welch and either Anna Belford or Tony Griffiths) were used. All surveys included at least one observer with over 200 hours experience in aerial surveying for Magpie Goose and checks were done to ensure adequacy of less experienced observers via dual-observations with more experienced observers. On some survey flights, an additional observer was present (generally a local Aboriginal Ranger group representative) but data from these observers were not used in the population estimate. In many cases (i.e. 50% of survey blocks), the difference in counts of Magpie Geese among observers was <10% of the survey block total, and the difference among observers was <1% of the total count in four of the survey blocks.

During the 2026 survey, an informal survey flight was undertaken on 24 April over the Legune floodplain, to enable a preliminary assessment on whether there are geese aggregating and nesting in this area (Figure 5). Approximately 1200 birds and five nests were observed. There were some areas of suitable habitat (Figure 6), but these were very limited in extent. Most areas within the floodplain were relatively dry and fringing an extensive network of estuary systems (Figure 7). It was concluded that although there are suitable areas of habitat in the area, these are unlikely to support significant numbers of Magpie Geese or nesting by them.

## 2.2. Counting Procedure

The survey crew comprised a pilot/navigator, a starboard front seat observer and a port mid-seat observer. The pilot and observers could communicate via aircraft intercom, and the pilot indicated the start and finish of each transect by calling either 'start transect' or 'finish transect'.

All data entry was via an iPhone run in "flight" mode (to prevent mobile data connection during surveys and also to reduce power use and extend battery life) using the device's internal GPS receiver, which is considered adequate for the purposes of the survey.

Data were entered by observers using a purpose-built program developed in-house (Zeng et al. 2022) and based on the previously used Basic program written by K. Saalfeld. Species recorded in 2026 were: Magpie Goose, Magpie Goose Nest, Black-necked Stork (*Ephippiorhynchus asiaticus*), Brolga (*Grus rubicunda*), Feral Pig (*Sus scrofa*), Horse (*Equus caballus*, generally only feral animals counted), Buffalo (*Bubalus bubalis*) and Saltwater Crocodile (*Crocodylus porosus*)], with the additional inclusion of wild cattle and Banteng in the Arnhem Land survey areas where they are likely not managed stock. Number sighted and species code were entered by the observer upon sighting with each record automatically geocoded on entry. This report only covers the Magpie Goose and Magpie Goose nests observations and data collected for other species can be accessed via the NT Government's NR Maps online platform.

## 2.3. Post Survey Data Handling and Analysis

Data were downloaded daily from each observer's mobile device to a laptop computer and opened in Excel. Data were immediately checked for logged errors (signified by code 999 entered by the observer) as well as any apparent major errors in recording (e.g. transects wrongly coded by the observers). Files for each observer were merged on a survey block basis and converted from .csv format and uploaded to the RStudio desktop application (RStudio Team 2020) for analyses in R (R Core team 2020). Data files were run through a simple validation process via package "pointblank" (Iannone and Vargas 2020) to check for duplicated observations, missing values, non-conforming variable types and other anomalies.

Because transects were variable in length and therefore area, the Ratio Method (Jolly 1969, Caughley and Grigg 1981, Marsh and Sinclair 1989, Caughley and Sinclair 1994) was used to estimate density, population size and their associated standard errors for the survey area. Input data were the observed numbers of each species for the port mid- seat and starboard front-seat observers. Estimates were corrected for visibility bias using the wet season correction factors of Bayliss and Yeomans (1990a, b); 3.28 for Magpie Geese and 2.23 for Magpie Goose nests. All analyses were performed using R version 4.5.3 (R Core team 2020) and attached packages.

Population estimates are accompanied by a 'standard error' statistic, which provides an indication of how accurately the sample data represents the whole population. The higher the standard error, the lower the confidence that can be placed in the estimated population. The 'precision' of the population estimates, also known as the 'co-efficient of variation', is the standard error as a proportion of the population estimate. This is expressed as a percentage with lower values indicating a more precise population estimate. Wildlife management often centres on identifying trends in abundance over time, which requires a reasonable level of precision, and most wildlife surveys aim for a precision of less than 20% (Harris et al. 2013).

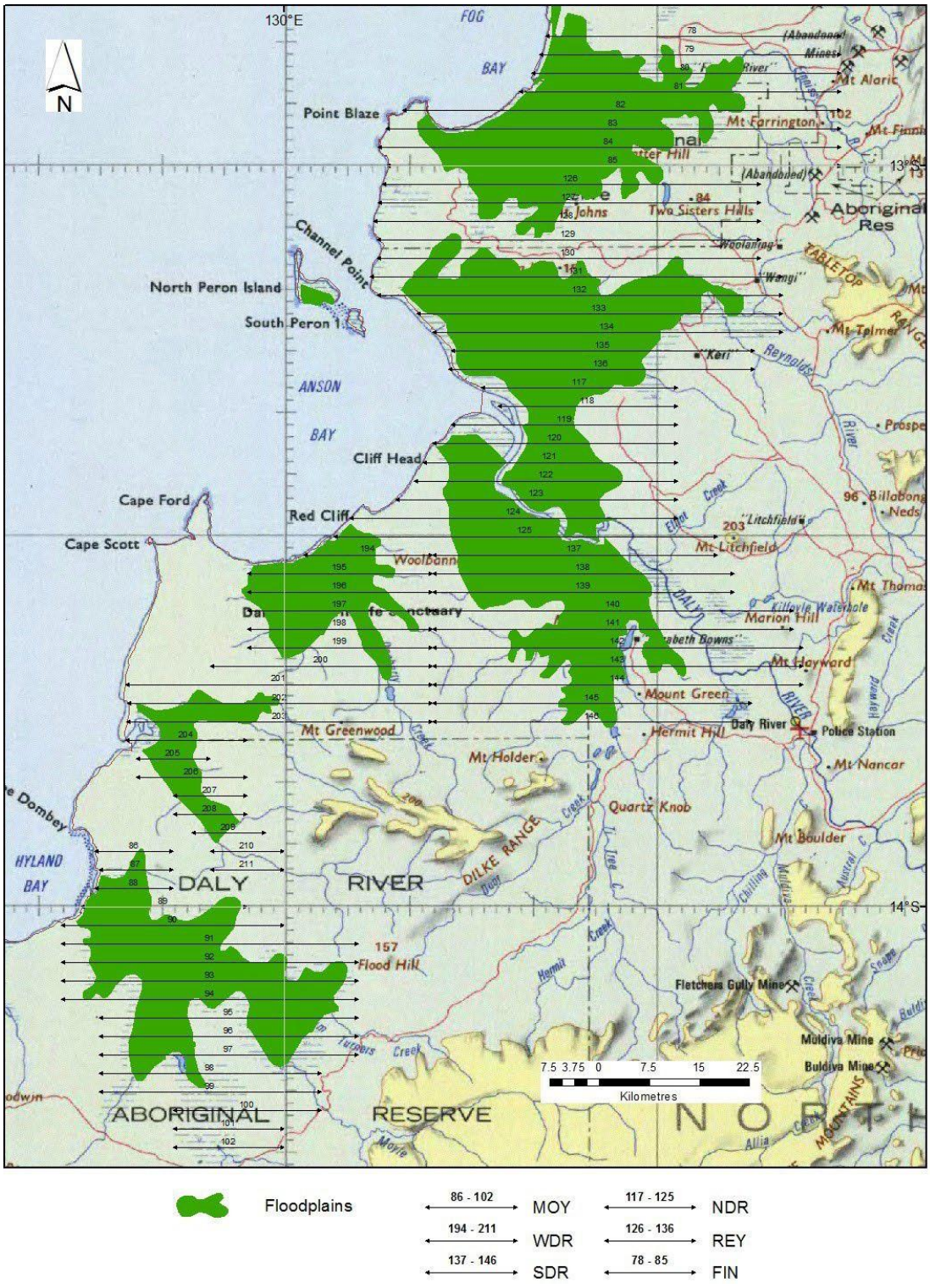
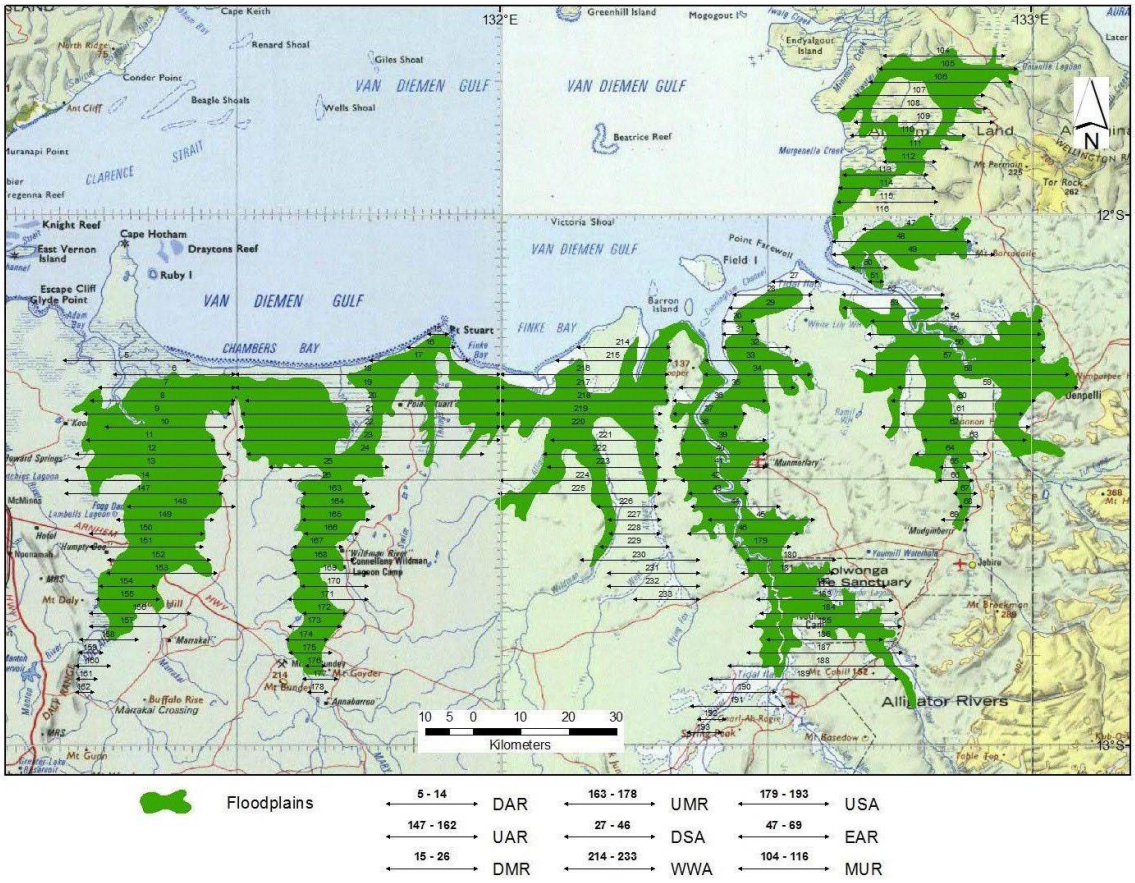



**Figure 2. Survey blocks and survey transects flown in the Moyle River floodplain to Finniss River floodplain survey region**




Floodplains

| | | | | | |
|---|---|---|---|---|---|
| 5 - 14 | DAR | 163 - 178 | UMR | 179 - 193 | USA |
| 147 - 162 | UAR | 27 - 46 | DSA | 47 - 69 | EAR |
| 15 - 26 | DMR | 214 - 233 | WWA | 104 - 116 | MUR |

**Figure 3. Survey blocks and survey transects flown in the Adelaide River floodplain to Murgenella Creek floodplain survey region.**

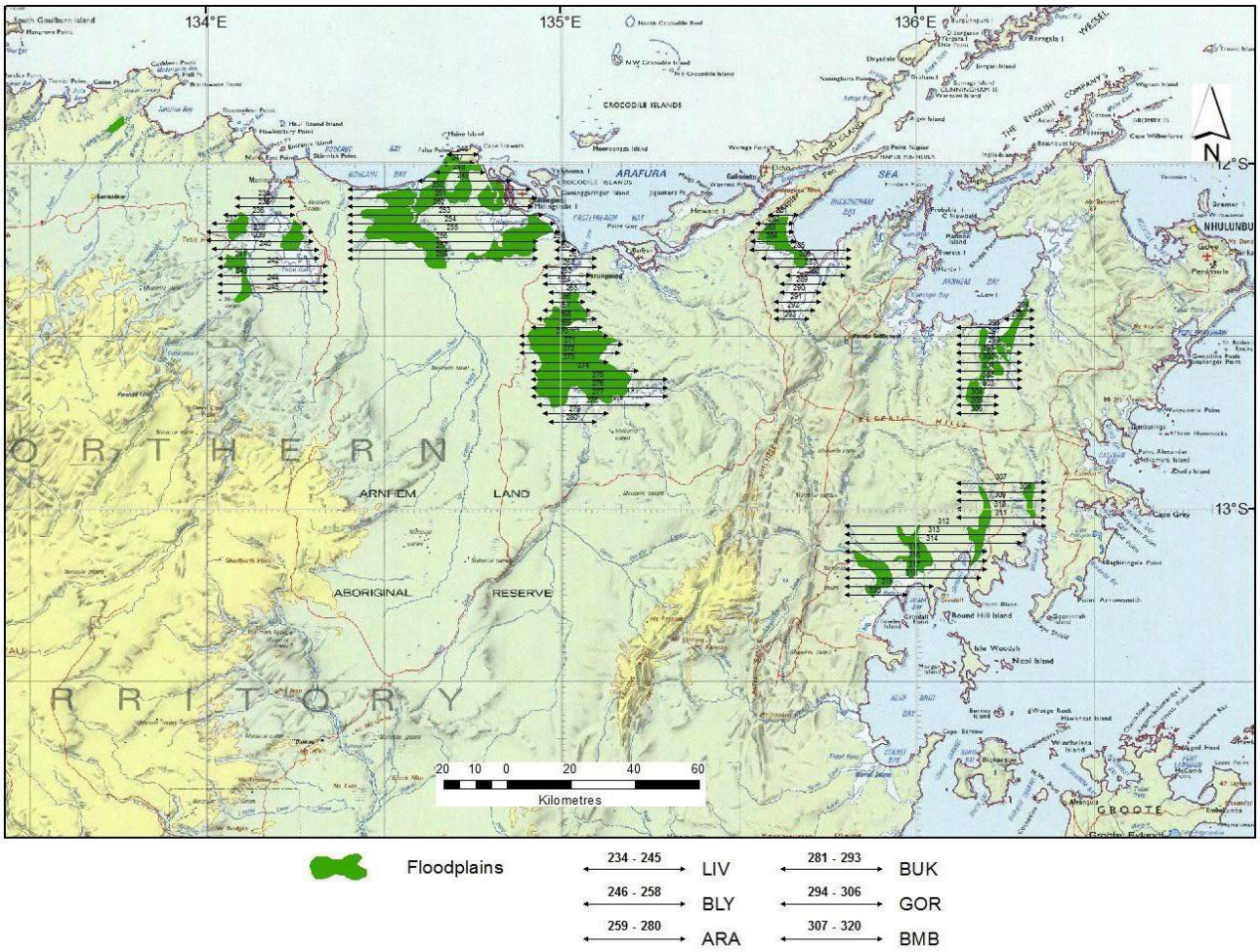



**Figure 4. Survey blocks and survey transects flown in the Arnhem Land floodplains survey region.**

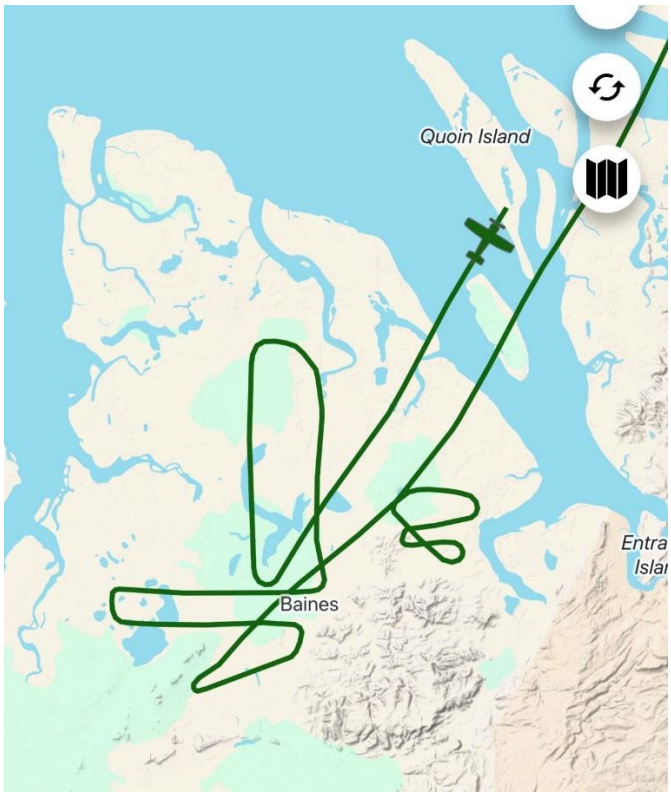



**Figure 5. Flight path taken during informal survey flight over Legune floodplain**

**Figure 6. Photograph showing example of potentially suitable Magpie Goose habitat on Legune floodplain**

**Figure 7. Photograph showing example of low-suitability Magpie Goose habitat on Legune Station**

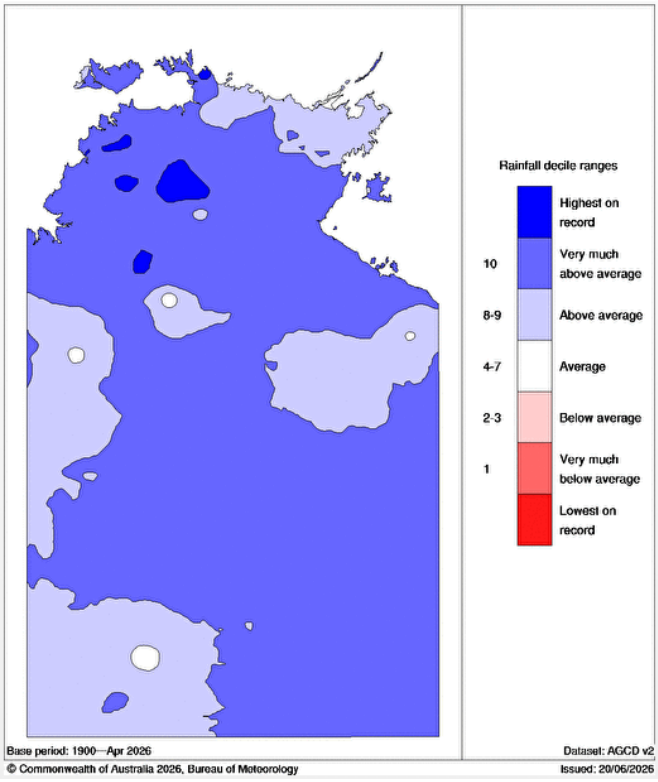
# 3. Results and Discussion

## 3.1. Environmental conditions

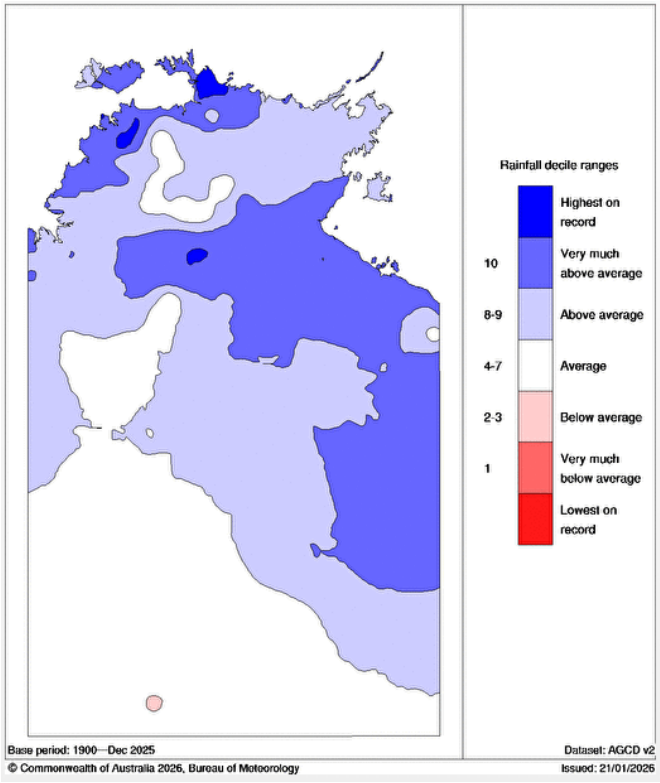
Rainfall recorded across the Top End over the 2025/26 wet season was above average for all of the floodplain areas and their catchments, with the western Top End receiving 'very much above average' rainfall (Figure 8a). This same pattern of above or well-above average rainfall was also seen for the early wet season (i.e. October to December) (Figure 8b).

Higher and earlier wet season rainfall (i.e. October to December) is associated with increased Magpie Goose population growth and improved dry season survival, through increased wetland productivity and availability of food and breeding habitat (Baylis 1989; Whitehead and Saalfeld 2000).

(a) October 1 2025 to 30 April 2026




(b) 1 October 2025 to 30 December 2025




Source: bom.gov.au

**Figure 8. Map of the NT showing rainfall deciles for a) the entire 2025/26 wet season and b) early 2025/26 wet season.**

## 3.2. Total Population and Nesting Estimates

The population and nesting estimates for each survey block within the three survey regions are presented in Table 2, along with associated density and precision values. The total population of Magpie Goose in the Top End in 2026 was estimated to be 1,692,389 ± 169,227 geese (total ± standard error) with a density of 83 geese per km2.  This represents a substantial increase of 27.2% from the 2025 population estimate (1,222,984 ± 134,674), which is at the higher end of the plausible potential rate of population increase in Magpie Geese (Brooke and Whitehead 2005).

The precision of the overall population estimate was very good (10%) and in line with typical values from previous surveys, which have been in the range of 8-18%. The precision of individual survey block population estimates ranged from around 19% to as high as 89% (Table 2). However, as with previous years the high sampling intensity means that at the scale of the whole survey region and survey blocks, the estimate is generally satisfactory (precisions of 13.7, 14.8, 22.1 % for the Moyle-Finniss, Adelaide-Murgenella and Arnhem Land regions respectively).

The total estimated number of Magpie Goose nests was 121,998 ± 17,243, with an overall density of  5.98 nests per $km^2$, with a precision of 14.1%. This represents a substantial increase of 71.3% in nesting levels compared to the 2025 estimate. The ratio of nests to total population of Magpie Goose (expressed as a percentage) gives an indication of the nesting rate for the season, which has ranged from 3% to 13% from 2011 to 2025. For 2026, the nesting proportion was 7.2% which can be considered a moderate nesting season. Only moderate levels of nesting have been observed since 2021, despite there being two average and three above-average wet seasons over the past five years. High nesting rates (i.e. 10% or greater) have not been observed since 2018.

**Table 2. Estimated population, density and precision (expressed as %) for 2026 Magpie Goose and nests in each survey region.**

| Survey Region | Survey Block | Survey Area ($km^2$) | No. Geese | Density Geese per $km^2$ | Precision Geese (%) | No. Nests | Density Nests per $km^2$ | Precision Nests (%) |
|---|---|---|---|---|---|---|---|---|
| Moyle to Finniss | FIN | 1,025 | 32,003 | 31.2 | 41.8 | 1,982 | 1.93 | 46.7 |
| | MOY | 1,149 | 161,449 | 141 | 28.2 | 20,147 | 17.5 | 31.0 |
| | NDR | 958 | 171,312 | 179 | 22.1 | 2,617 | 2.73 | 32.3 |
| | REY | 1,385 | 44,189 | 31.9 | 28.4 | 2,447 | 1.77 | 36.6 |
| | SDR | 1,428 | 59,769 | 41.9 | 18.6 | 4,228 | 2.96 | 21.1 |
| | WDR | 821 | 73,253 | 89.2 | 53.9 | 13,132 | 16.0 | 54.0 |
| Adelaide to Murgenella | DAR | 756 | 195,821 | 259 | 43.8 | 11,506 | 15.2 | 30.2 |
| | DMR | 1,234 | 146,302 | 119 | 31.8 | 22,068 | 17.9 | 47.6 |
| | DSA | 850 | 228,097 | 268 | 28.8 | 11,026 | 13.0 | 33.6 |
| | EAR | 1,366 | 174,888 | 128 | 38.2 | 15,625 | 11.4 | 47.8 |
| | MUR | 786 | 75,918 | 96.5 | 32.1 | 4,181 | 5.32 | 54.5 |
| | UAR | 670 | 102,090 | 152 | 41.2 | 4,197 | 6.27 | 36.7 |
| | UMR | 446 | 17,334 | 38.9 | 62.8 | 1,440 | 3.23 | 72.3 |
| | USA | 949 | 12,095 | 12.7 | 25.8 | 1,843 | 1.94 | 53.1 |
| | WWA | 1,211 | 53,664 | 44.3 | 67.7 | 2,617 | 2.16 | 42.1 |
| Arnhem Land | ARA | 1,295 | 77239 | 59.6 | 31.7 | 2679 | 2.07 | 51.4 |
| | BMB | 1,281 | 2255 | 1.86 | 87.6 | 232 | 0.19 | 87.1 |
| | BUK | 562 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GOR | 584 | 8473 | 14.5 | 55.2 | 0 | 0 | 0 |
| | LIV | 707 | 11844 | 16.8 | 88.6 | 0 | 0 | 0 |
| | BLY | 1,281 | 44394 | 34.6 | 37.5 | 31 | 0.02 | 92.7 |

## 3.3. Spatial and Short-Term Trends

### 3.3.1. Goose Populations

Detailed information on 2026 Magpie Goose population estimates according to regions and individual floodplains (survey blocks) is provided in Table 2. Recent trends in population size for the three survey regions are presented in Figure 9 and the proportion of the population observed within individual catchments is presented in Figure 10.

#### 3.3.1.1. Survey regions

Consistent with previous surveys, most of the population (59%) occurred in the survey region from west of Adelaide River to Murgenella Creek. This was slightly higher than the 2025 survey and less than historical levels of around two thirds of the total population being counted in this region (Clancy 2018, Clancy 2019). A third of the total population occurred in the Moyle River to Finniss River survey region and only eight percent of the total population was recorded in the Arnhem Land region (Figure 9).

### 3.3.1.2. Catchments

There was substantial variation in population estimates among the surveyed catchments. No Magpie Geese were observed in the Buckingham Bay survey block (BUK) during the 2026 survey, consistent with low numbers observed in this survey block over most years (zero were also observed in 2021-2023) and associated with consistently very high densities of feral buffalo. For the remainder of survey blocks, densities ranged from 1.86 per km$^2$ within the Blue Mud Bay floodplain block (BMB) in the Arnhem Land region to 153 per km$^2$ within the Downstream Adelaide River flood plain survey block (DAR) in the Adelaide River to Murgenella Creek region. The Downstream South Alligator River (DSA) survey block had the largest number of Magpie Geese with 228,097 birds, followed by the Downstream Adelaide River (DAR) survey block with 195,821 birds. The annual proportion of Magpie Geese observed within individual catchments since 2015 is presented in Figure 10. Patterns of abundance have generally been similar between catchments over recent years, although there has been a notable increase observed in the Adelaide River since 2020 (Figure 10).

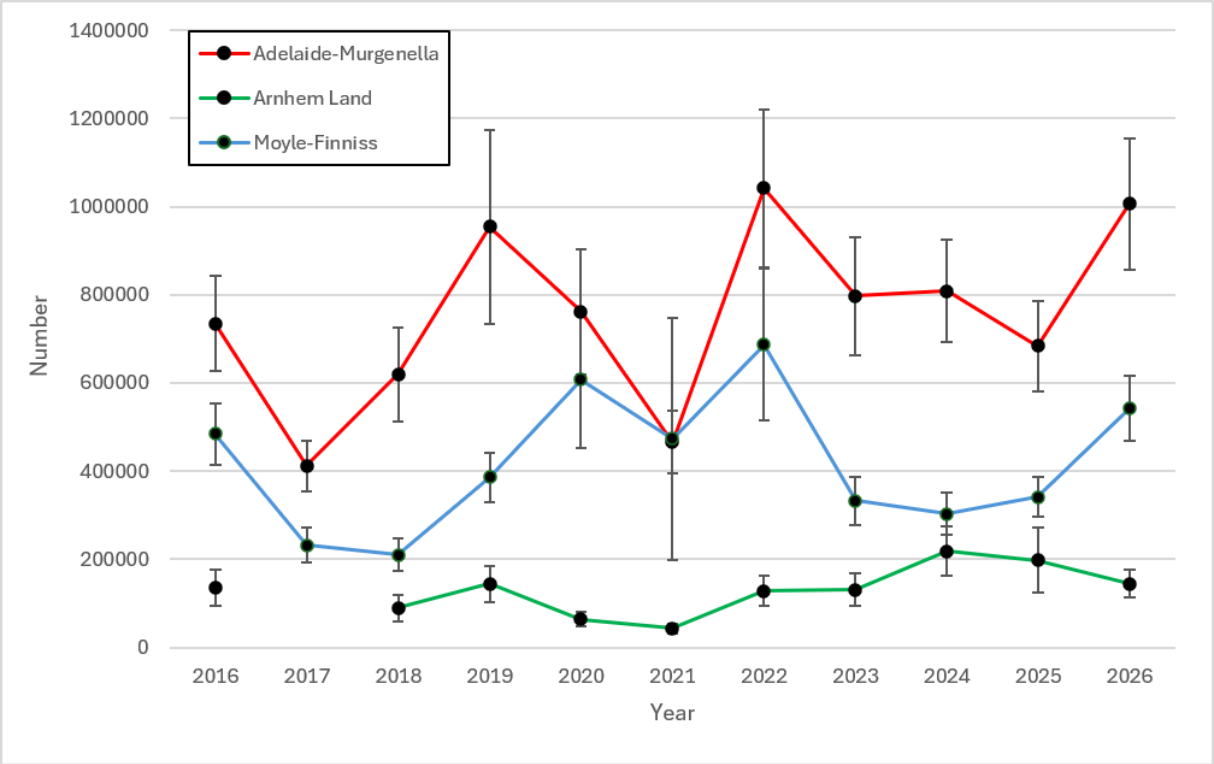



**Figure 9. Population size (+/- standard error) of Magpie Goose 2016 to 2026 in each survey region (End of Wet Season Surveys)**

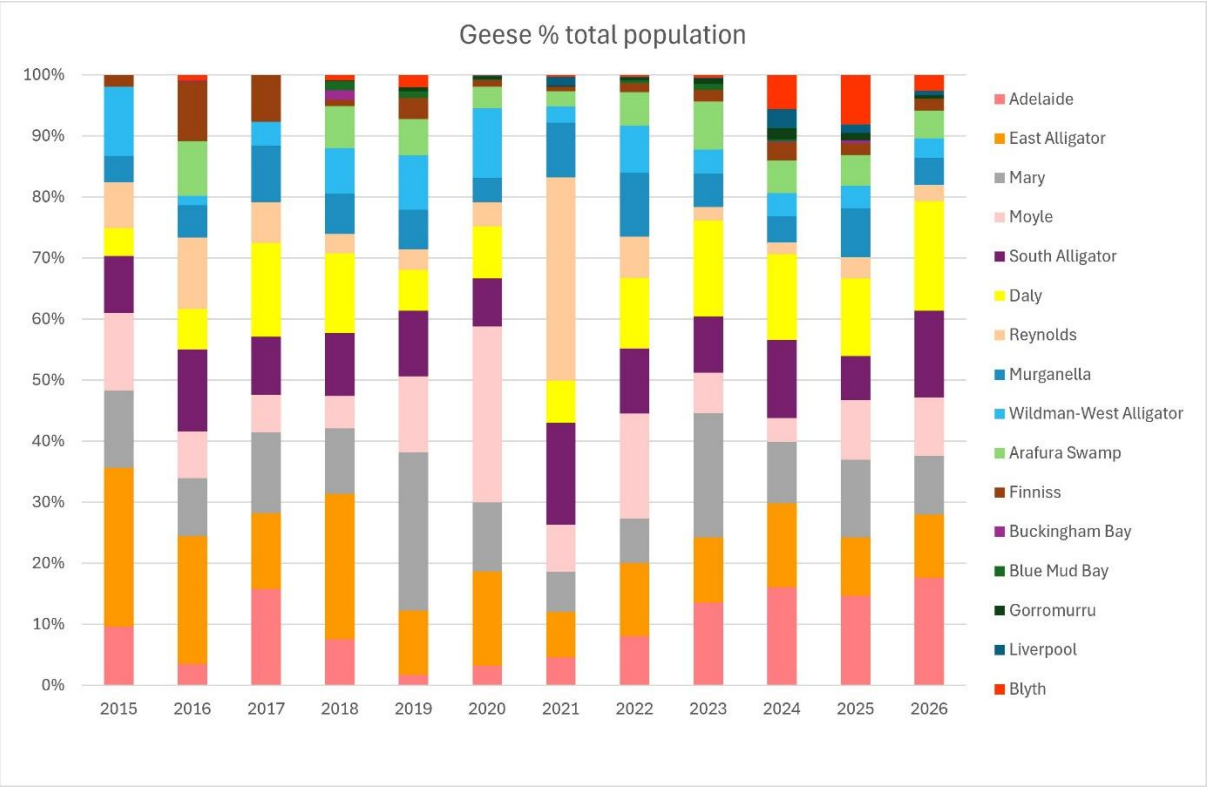



**Figure 10. Proportion of Magpie Goose population from 2015 to 2026 within individual catchments (End of Wet Season Surveys)**

## 3.3.2. Nesting Levels

In the 2026 survey, the highest nesting levels for Magpie Goose were observed in the Adelaide-Murgenella region (Table 2). Historically, the most important nesting areas have been in either the Adelaide-Murgenella or Moyle-Finniss regions, with the dominance between these two regions often alternating from year to year and the Arnhem Land region having relatively low nesting levels across all years (Figure 11).

There were differing levels of nesting activity across individual river catchments and this pattern has been observed over the past four years (Figure 12). In some years, the Moyle River has historically been the most important nesting area, such as in 2020 and 2022 when more than two thirds of all nesting were observed in this catchment (Figure 12).

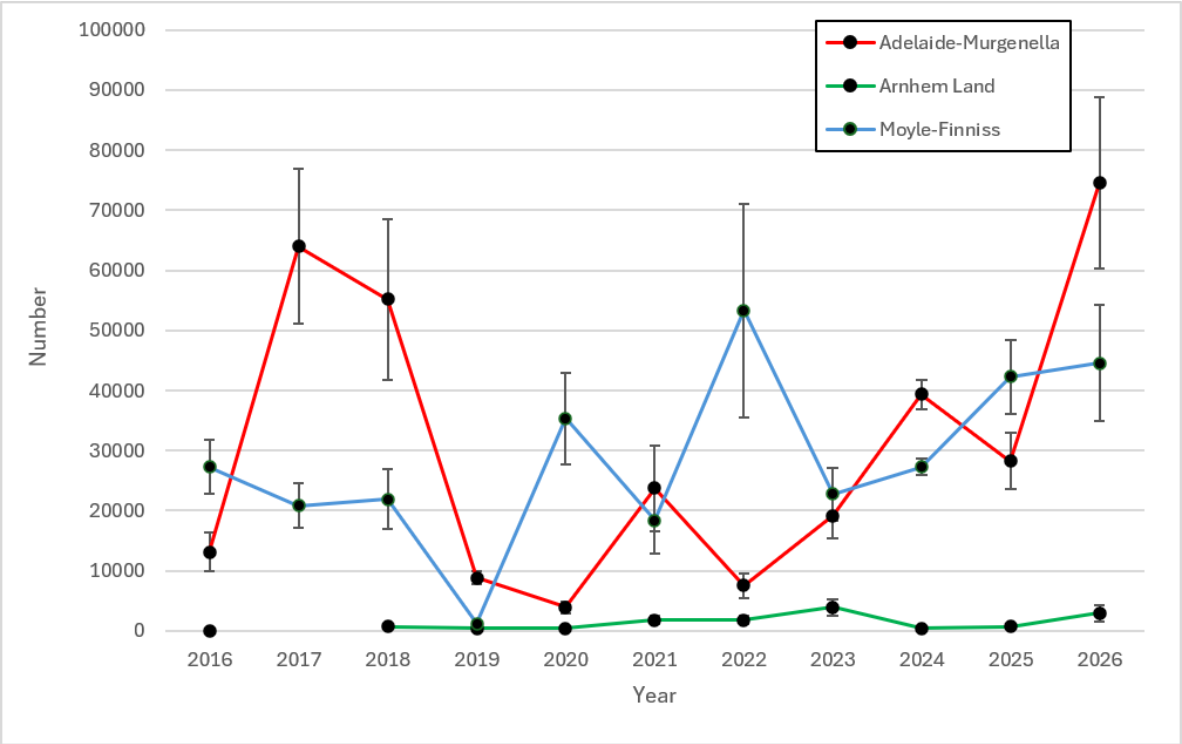



**Figure 11. Number of nests (+/- standard error) 2016 to 2026 in each survey region (End of Wet Season Surveys)**

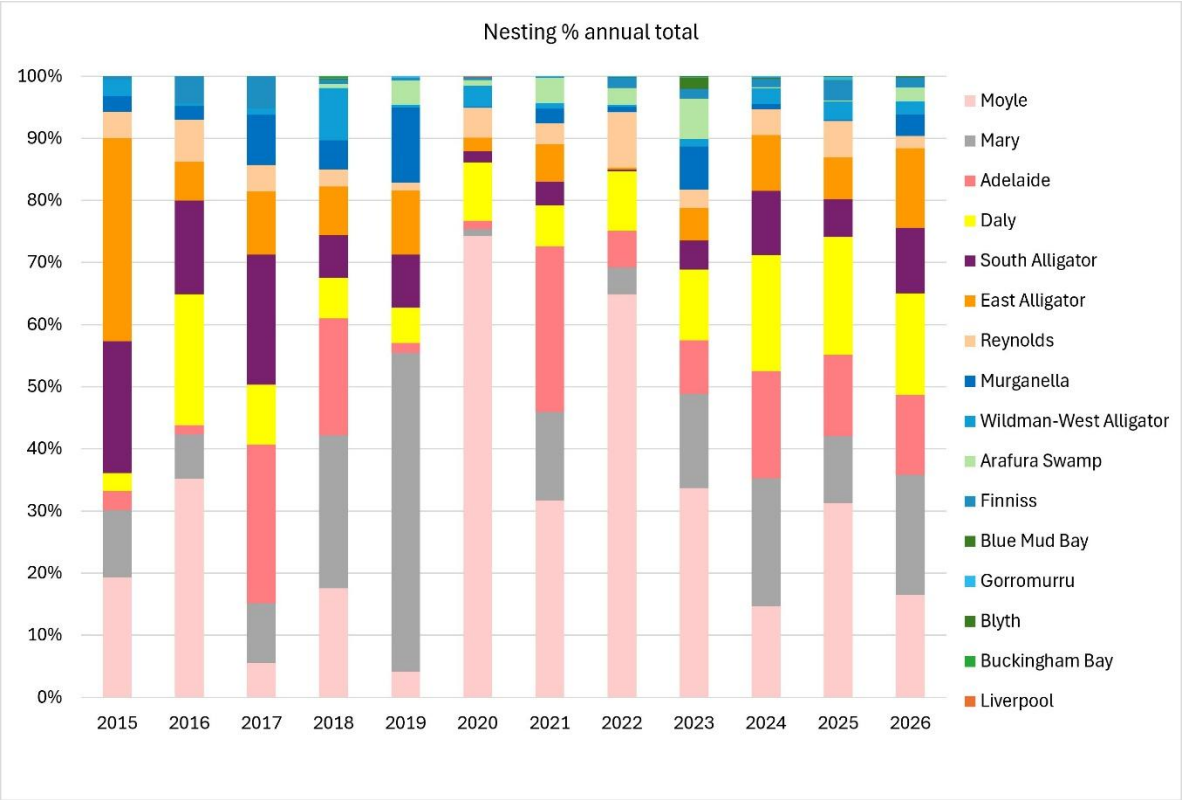



**Figure 12. Proportion of Magpie Goose nests from 2015 to 2026 within individual catchments (End of Wet Season Surveys)**

## 3.4. Long Term Trends

### 3.4.1. Magpie Geese

Long term trends in the Magpie Goose population and nesting activity from 1983 to 2026 are shown in Figure 13. Although substantially higher than the previous three years, the 2026 survey result is consistent with a population below carrying capacity. The population level (as shown by the 3 year moving average) has gradually increased following the recent historical low in 2017-2018 (Figure 13). The population can be considered to be in a "moderate" phase, being below the most recent peak 2,500,000 recorded in 2012 (Clancy 2020) but above the historical low population estimate recorded in 2017 (Table 1). Rainfall-driven variability in both population size and nesting index is a feature of Magpie Goose population dynamics in the Top End (Bayliss 1989, Bayliss & Yeomans 1990a, Whitehead & Saalfeld 2000, Delaney et al. 2009, Groom & Saalfeld 2017, Clancy 2020).

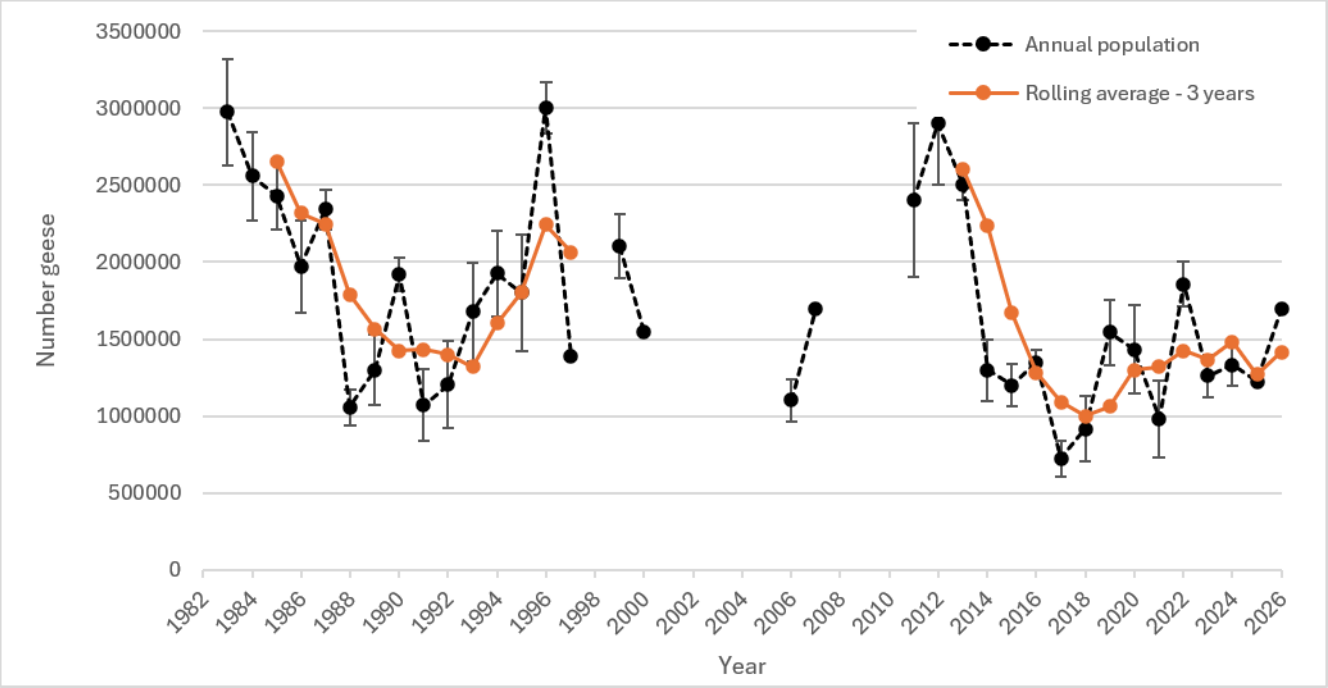



**Figure 13. Long term population trend of Magpie Goose 1983 – 2026 (end of Wet Season surveys)**

### 3.4.2. Nesting

Long term trends in the Magpie Goose nesting levels from 1983 to 2026 are shown in Figure 14. The nesting levels in 2026 are the highest observed since 2016 and this is likely to be the result of well-above average rainfall experienced across the western Top End during the early 2025-26 wet season (Figure 8).

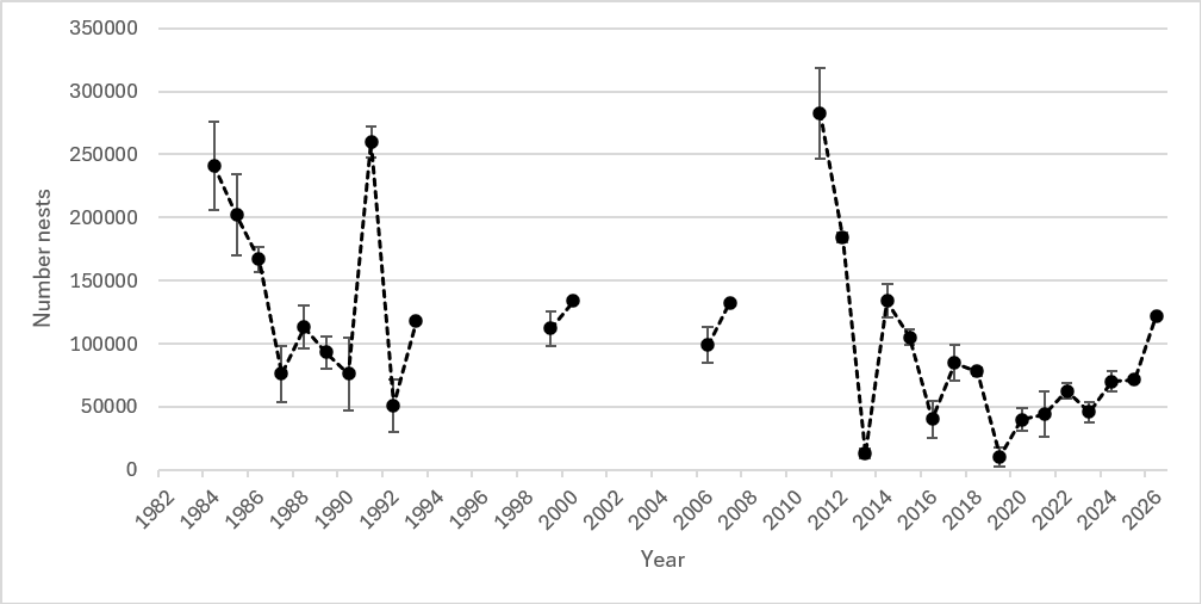



**Figure 14. Long term trend of Magpie Goose nesting 1983 – 2026 (end of Wet Season surveys)**

## 3.5. Future Outlook

The substantial increase in the Magpie Goose population and nesting levels observed in the 2026 annual survey compared to 2025 is encouraging and indicates that the population continues to recover from the historical lows observed in 2017-2018. It is likely that the population will continue to grow if there are favourable seasonal conditions, particularly if high rainfall is experienced in the early 2026-27 wet season that results in enhanced survivorship of young birds associated with the good 2026 nesting season.

In addition to habitat degradation associated with weeds and feral animals, a key threat to the Magpie Goose population is the imminent arrival of Highly Parthenogenic Avian Influenza (HPAI). At the time of compiling this report, HPAI had arrived in southern Australia and was affecting resident native bird populations. Based on international experience with waterfowl populations infected with HPAI, it is likely that high levels of mortality will be observed in Magpie Geese and other NT waterbird populations. Ongoing annual monitoring will assist in determining the degree to which HPAI impacts Magpie Geese at a population level, and tracking recovery.

# 4. References

Bayliss, P (1989). Population Dynamics of Magpie Geese in Relation to Rainfall and Density: Implications for Harvest Models in a Fluctuating Environment. J. App. Eco. 26(3), 913-924

Bayliss, P., and K.M. Yeomans (1990a). Seasonal distribution and abundance of magpie geese, *Anseranas semipalmata* Latham, in the Northern Territory, and their relation to habitat, 1983-86. Aust. Wildl. Res., 17, 15-38.

Bayliss, P., and K.M. Yeomans (1990b). Using Low-level Aerial Photography to Correct Bias in Aerial Survey Estimates of Magpie Goose and Whistling Duck Density in the Northern Territory. Aust. Wildl. Res., 17, 1-10.

Brook B.W. and Whitehead P.J. (2005). Plausible bounds for maximum rate of increase in magpie geese (*Anseranas semipalmata*): implications for harvest. Wildlife Research 32(5): 465–471.

Delaney R., Fukuda Y. and K. Saalfeld. (2009). Management Program for the Magpie Goose (*Anseranas semipalmata*) in the Northern Territory of Australia, 2009–2014. Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Darwin.

Caughley, G., and G.C. Grigg (1981). Surveys of the distribution and density of kangaroos in the pastoral zone in South Australia, and their bearing on the feasibility of aerial survey in large and remote areas. Aust. Wildl. Res., 8, 1-11.

Clancy, T.F (2018). Aerial Survey of Magpie Goose numbers in the Top End of the Northern Territory: Moyle River Floodplains to Arnhem Land Floodplains, April-May 2018. A report to the Department of Environment and Natural Resources. Northern Territory of Australia.

Clancy, T.F (2019). Aerial Survey of Magpie Goose numbers in the Top End of the Northern Territory: Moyle River Floodplains to Arnhem Land Floodplains, May 2019. A report to the Department of Environment and Natural Resources. Northern Territory of Australia.

Clancy, T.F (2020). Management Program for the Magpie Goose (*Anseranas semipalmata*) in the Northern Territory of Australia, 2020. Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Darwin.

Caughley, G., and Sinclair, A.R.E. (1994). Wildlife ecology and management. Blackwell Science Cambridge, MA. Jolly, G.M. (1969). Sampling methods for aerial census of wildlife populations. E. Afr. agric. For. J., 34, 46-49.

Groom, R. and Saalfeld, W.K. (2017). Aerial Survey of Magpie Geese in the 'Top End', Northern Territory. Moyle River floodplains to Murgenella Creek floodplains. April 24 – May 6 2017. A report to the Department of Environment and Natural Resources, Palmerston, Northern Territory.

Harris G, Farley S, Russell GJ, Butler MJ, Selinger J. (2013) Sampling designs matching species biology produce accurate and affordable abundance indices. PeerJ. 2013 Dec 17;1:e227. doi: 10.7717/peerj.227. PMID: 24392290; PMCID: PMC3869179.

Iannone, R. and Vargas, M. (2020). pointblank: Validation of Local and Remote Data Tables. R package version 0.6.0. https://CRAN.R-project.org/package=pointblank

Jolly, G.M. (1969). Sampling methods for aerial census of wildlife populations. E. Afr. agric. For. J., 34, 46-49.

Marsh, H., and D.F. Sinclair (1989). An experimental evaluation of dugong and sea turtle aerial survey techniques. Aust. Wildl. Res., 16, 639-50.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.

Saalfeld, W.K. (1990). Aerial survey of Magpie Goose populations and nesting in the Top end of the Northern Territory - Wet Season 1990. Technical Report Number 50, Conservation Commission of the Northern Territory.

Whitehead, P. J. and Saalfeld, K. (2000) Nesting phenology of magpie Geese (*Anseranas semipalmata*) in monsoonal northern Australia: responses to antecedent rainfall. J. Zoo. 251, 495-508.

Zeng, Q., Nugraeni, N. and Clancy, T.F. (2022). Aerial Survey Sighting Mobile Application. Version 1.1. Internal Flora and Fauna Division Standard Operating Procedure. Department of Environment, Parks and Water Security. Northern Territory of Australia.