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

Moyle River to Arnhem Land Floodplains

April 2024

NORTHERN TERRITORY GOVERNMENT

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The Department thanks the Traditional Owners, pastoralists and park management agencies who allowed the surveys to be undertaken across their land.

Tony Griffiths and Tim Clancy provided critical review that greatly improved this report.

Contents

Summary

A fixed-wing aerial survey of Top End floodplains of the Northern Territory was undertaken from 2 April 2024 to 26 April 2024, to estimate population size and nesting activity of Magpie Goose. A total of 8,268 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 22,966 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 a combined perception and visibility bias using the correction factors derived from Bayliss and Yeomans (1990a & b).

The 2024 population estimate for Magpie Goose was 1,330,246 ± 138,163 (total ± standard error) with a precision of 10.4%; which is an average density of 57.9 geese per km^2 within the survey region. This is a slight increase of 5.2% compared to the 2023 estimate. The 2024 population estimate is below the most recent peak 2,900,000 recorded in 2012 (Clancy 2020) but above the historical low of 724,500 recorded in 2017. The population remains well below carrying capacity, despite there being relatively good rainfall for the 2022-23 and 2023-24 wet seasons.

The number of Magpie Goose nests was estimated to be 70,244 ± 8,077 for the surveyed area with a precision of 11.5%. This was above 2023 nesting levels and would be considered a moderate nesting season. However, similar to recent years there was substantial variation in the timing of nesting and it is difficult to predict the level of recruitment over the coming year. The rainfall preceding the survey period was variable across much of the survey region, with some areas being average and others above the long-term average for the wet season. In addition to rainfall, weeds and damage caused by introduced buffalo and feral pigs are known factors impacting nesting habitat and key food resources for Magpie Goose.

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 undertaking of an 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 are used to determine safe offtake levels for recreational hunting, pest mitigation and any commercial harvest. This report presents the results of the 2024 aerial survey of the Top End floodplains (Figure 1).

All three regions have been 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 details.

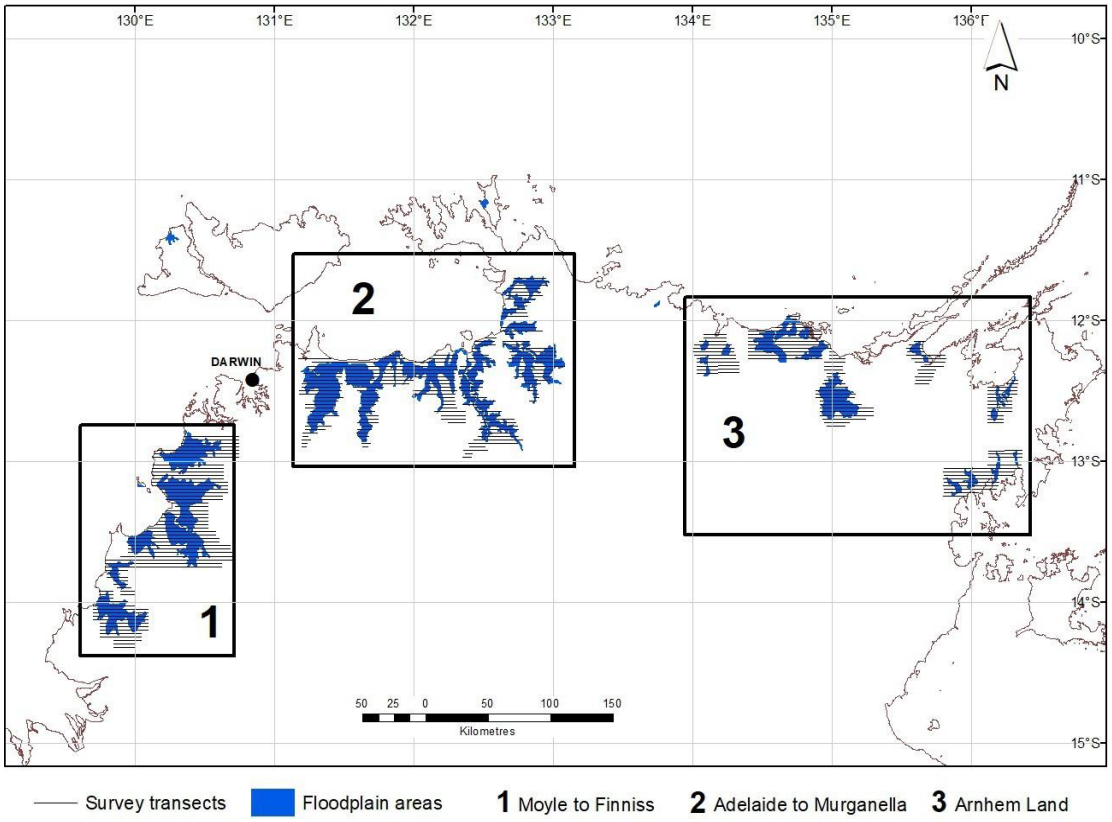

Figure 1. Map of the Top End of the Northern Territory showing the regions surveyed for Magpie Goose.

Overall population estimates from previous aerial surveys from 2015 to 2023 are detailed in Table 1. 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 2023 derived from wet season 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

2. Methods

2.1. Survey Area and Design

To assist in confirming optimal timing for the survey, current season to-date rainfall records were reviewed and stakeholder contacts were approached in early March, regarding observations of magpie geese (and any nesting) activity on the floodplains. Observations were reported of high levels of geese activity in the Adelaide River to Murganalla region, indicating that nesting should be well underway by early to mid-April. It was decided to schedule the surveys to commence from early April in the Moyle Finniss area and progress the survey from the western to eastern Top End, as in previous years.

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 between the 3rd and 9th of April, 2024. This area comprises six major survey blocks (Figure 2).

The Adelaide River to Murganalla Creek floodplains survey region (Area 2 in Figure 1) includes all major floodplain habitat within that region and was surveyed between the 10th and 18th April, 2024. This area comprises nine 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 between the 23rd and 26th April, 2024. 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 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 Tim Clancy, Anna Belford, Brydie Hill or Tony Griffiths) were used unless indicated. 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).

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 2024 were the same as for 2023 [i.e. Magpie Goose, Magpie Goose Nest, Black-necked Stork (*Ephippiorhynchus asiaticus*), Brolga (*Grus rubicunda*), Feral Pig (*Sus scrofa*), Horse (*Equus caballus*, generally only feral counted), Buffalo (*Bubalus bubalis*) and Saltwater Crocodile (*Crocodylus porosus*)], with the additional inclusion of wild cattle in the Arnhem Land survey areas where they may not be considered as managed stock. Number sighted and species code were entered by the observer upon sighting, or in the case of high densities as soon as practicable afterwards, with each record auto geo-coded on entry. This report only covers the Magpie Goose and Magpie Goose nests observations and data collected for other species can be provided on request.

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. For part of one survey block only one observer was available (TG) and the data from these lines was in-filled assuming the observer would have counted the same numbers (with the observer position recorded as null). As this

was only a small fraction of the overall surveyed areas, it was assumed that this procedure did not introduce any bias into the overall estimate.

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 perception and 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 in RStudio (RStudio 2022.07.1+554 "Spotted Wakerobin" Release for Windows; RStudio Team 2020) using R version 4.2.2 (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 estimate, also known as the 'co-efficient of variation', is the proportion of the standard error compared to the population estimate. This is expressed as a percentage and the lower it is, the more precise the population estimate is. 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).

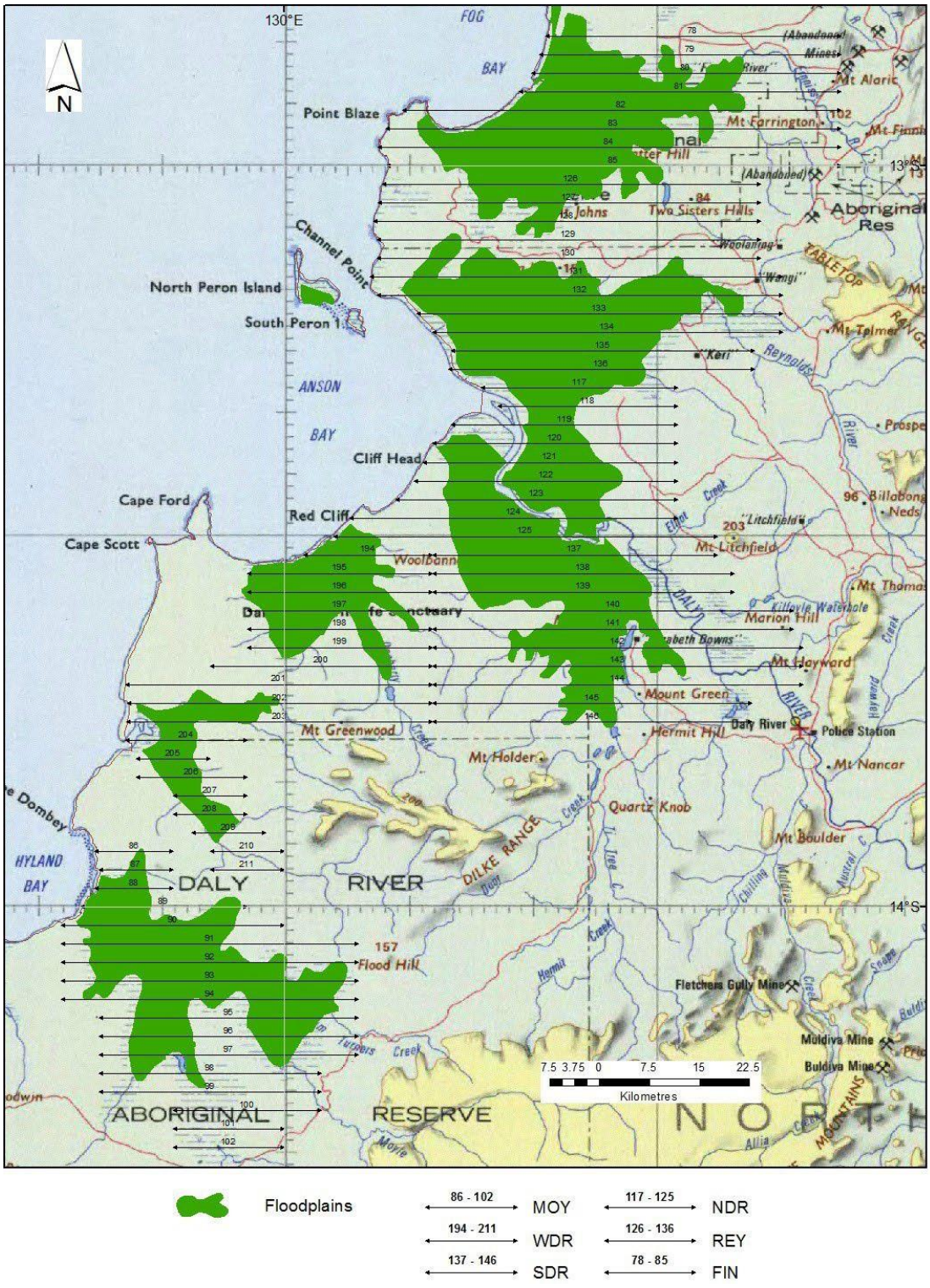

Figure 2. Survey blocks and survey transects flown in the Moyle River floodplain to Finniss River floodplain survey region

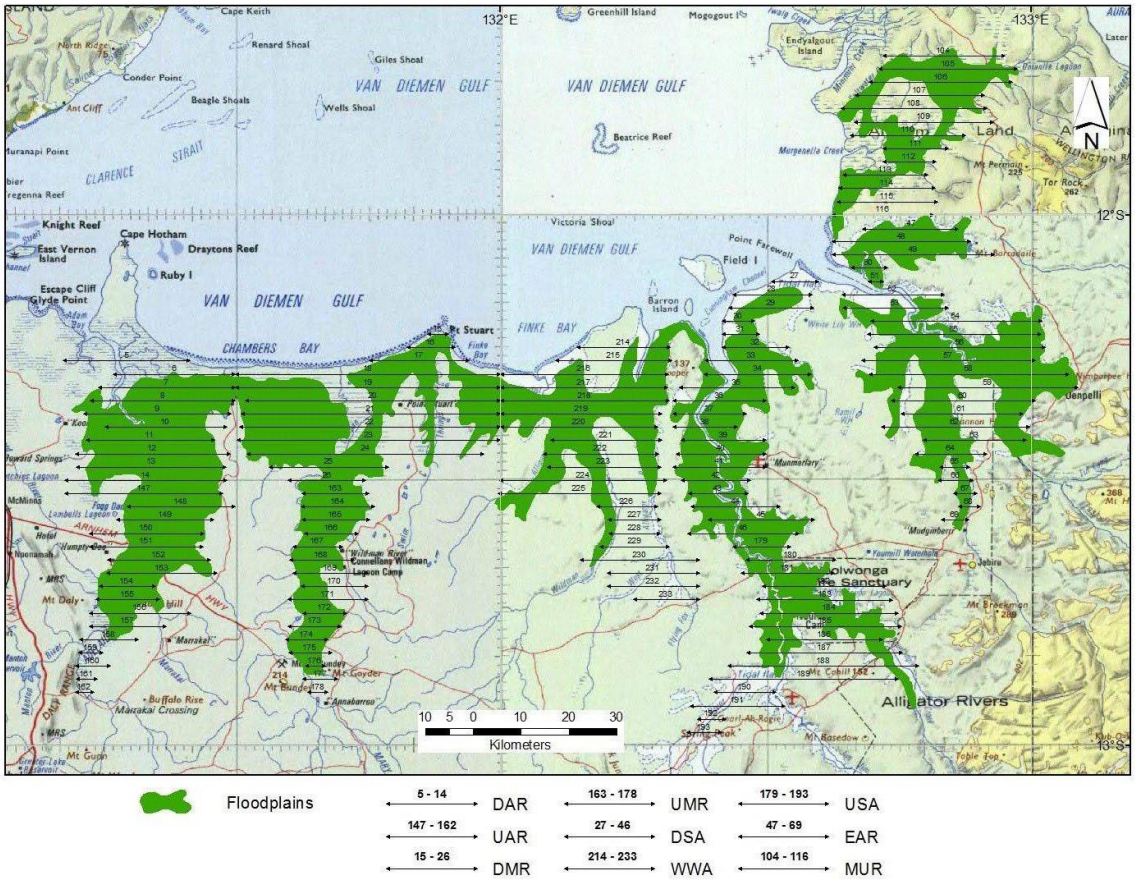

Figure 3. Survey blocks and survey transects flown in the Adelaide River floodplain to Murganalla Creek floodplain survey region.

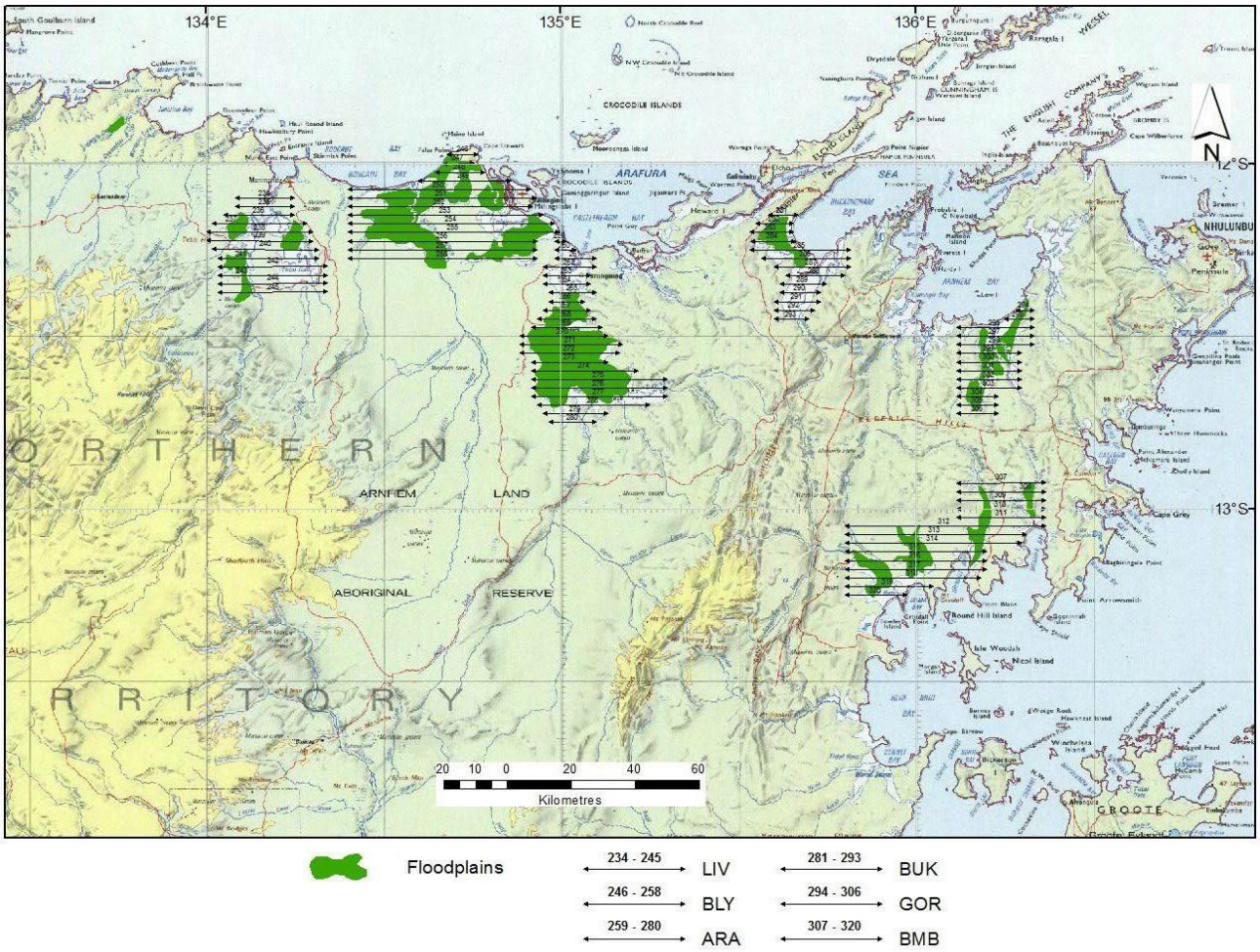

Figure 4. Survey blocks and survey transects flown in the Arnhem Land floodplains survey region.

3. Results and Discussion

3.1. Environmental conditions

Rainfall recorded across the Top End in the 2023/24 wet season was generally average for most of the floodplain areas and their catchments with some areas of above average rainfall in the far west, centre and far east (Figure 5).

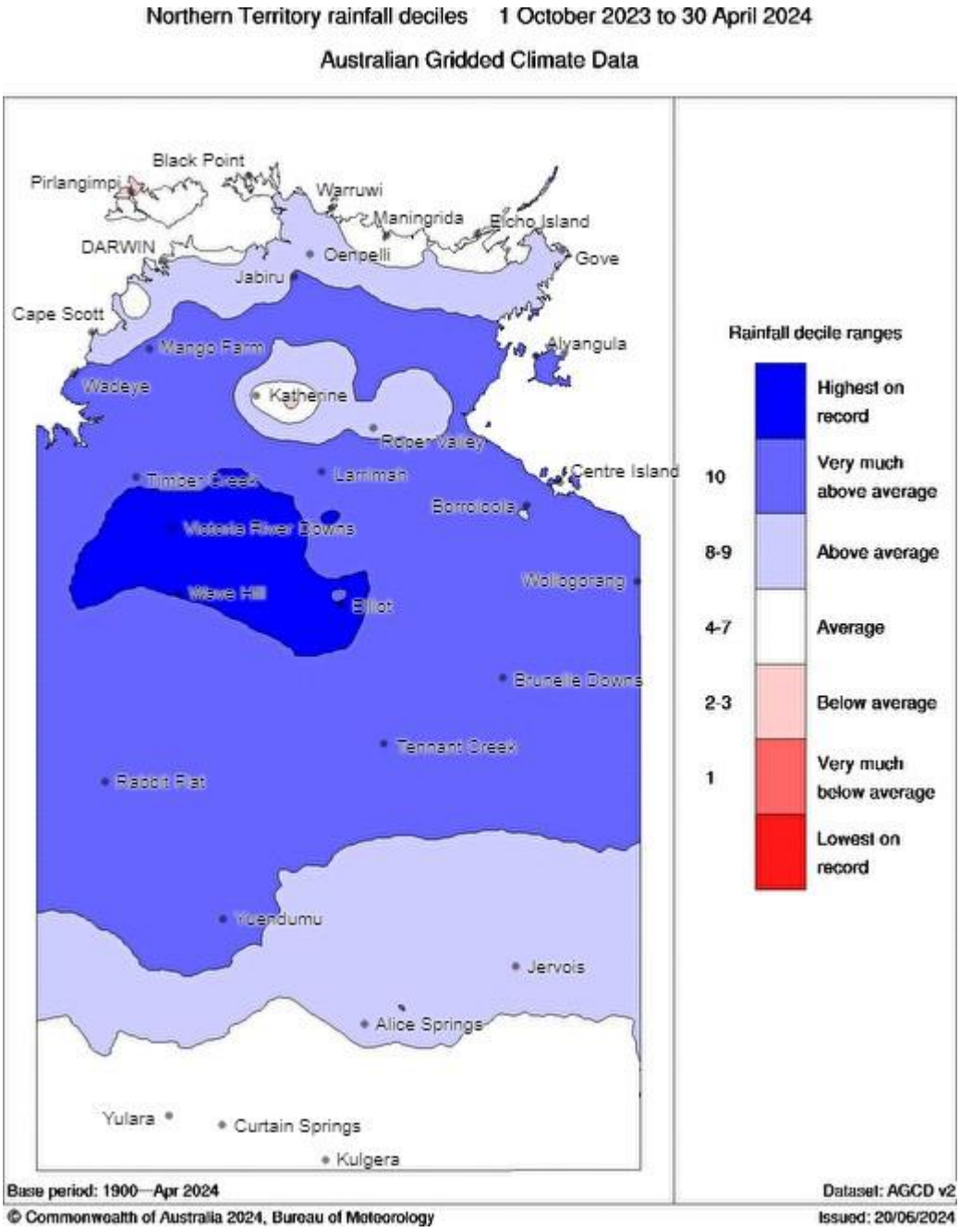

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Figure 5. Map of the NT showing rainfall deciles for the 2023/24 wet season.

3.2. Total Population Estimate and Nesting Rate

The total population of Magpie Goose in the Top End in 2024 was estimated to be 1,330,246 ± 138,163 (total ± standard error) geese with a density of 57.9 ± 6.02 per km² (mean ± standard error) and reflecting a small increase from that estimated in 2023 (1,260,454 ± 148,626). The precision of the overall population estimate was considered to be very good (10.4%) and in line with typical values from previous surveys, which have been in the range of 8-18%.

The total estimated Magpie Goose nests was 70,244 ± 8.08, with an overall density of 3.06 ± 0.35 nests per km², at a precision of 11.5%. The ratio of nests to total population of Magpie Goose gives an indication of the nesting rate for the season. For 2024, the value was 5.2% which signifies a moderate nesting season. Only moderate levels of nesting have been observed since 2021, despite there being two average and two above-average wet seasons over the past four years. High levels of nesting have not been observed since 2018. Similar to 2022 and 2023, it is possible that the overall level of nesting was underestimated due to a general lack of nesting synchrony compared to historical observations, meaning in some areas nesting may have occurred later than the survey. Field observations during the 2024 survey indicated that in many areas surveyed (particularly in the Adelaide River to Murganalla region), geese were starting to aggregate into small breeding groups of 2-3 birds that had were only just commencing nest-building.

3.3. Population Dispersion

As in previous years, the total population estimate may represent a conservative estimate of the species population in the NT, recognising that some birds may occur outside the surveyed area at the time of survey. Despite the modest population increase after two consecutive average two above average rainfall years, it is not considered likely that there had been large scale migration outside the survey region during the survey period. There is no evidence of unusual movements of birds from within to outside the survey area from other data sources (e.g. comparing frequency of Magpie Goose sightings reported in eBird (www.ebird.org). The results are also consistent with the prevailing rainfall conditions and there is no need to assume any emigration to explain the year to year trend.

The average size of observed groups of Magpie Goose for each of the three survey regions compared with those recorded in previous years is presented in Figure 6. The mean group size was similar to the past several years, with the exception of the Arnhem Land region, where average group sizes were substantially higher and more variable than the other regions. The larger group sizes were mainly observed in the ARA (Arafura Swamp), LIV (Liverpool River) and BLY (Blyth River) survey blocks, with several flocks having 500 to 1000 birds in each. It appears that in very dry years (e.g. 2016 and 2019), birds tend to become much less aggregated and occur in very large flocks, rather than spread out across the nesting areas (Figure 6).

The population estimates for each survey block within the three survey regions are presented in Table 2, along with the density and precision values for all estimates. The precision of individual block estimates ranged from around 23% to as high as 82% (Table 2). However, as with previous years the high sampling intensity means that at a whole of survey region scale, the estimate is generally satisfactory (precisions of 14.5, 25.7 and 15.5 % respectively). The overall population estimate has a precision value of 10.4%. For both the goose population estimate and the nest estimate, the precision values are at acceptable levels, indicating that the overall population estimates are robust.

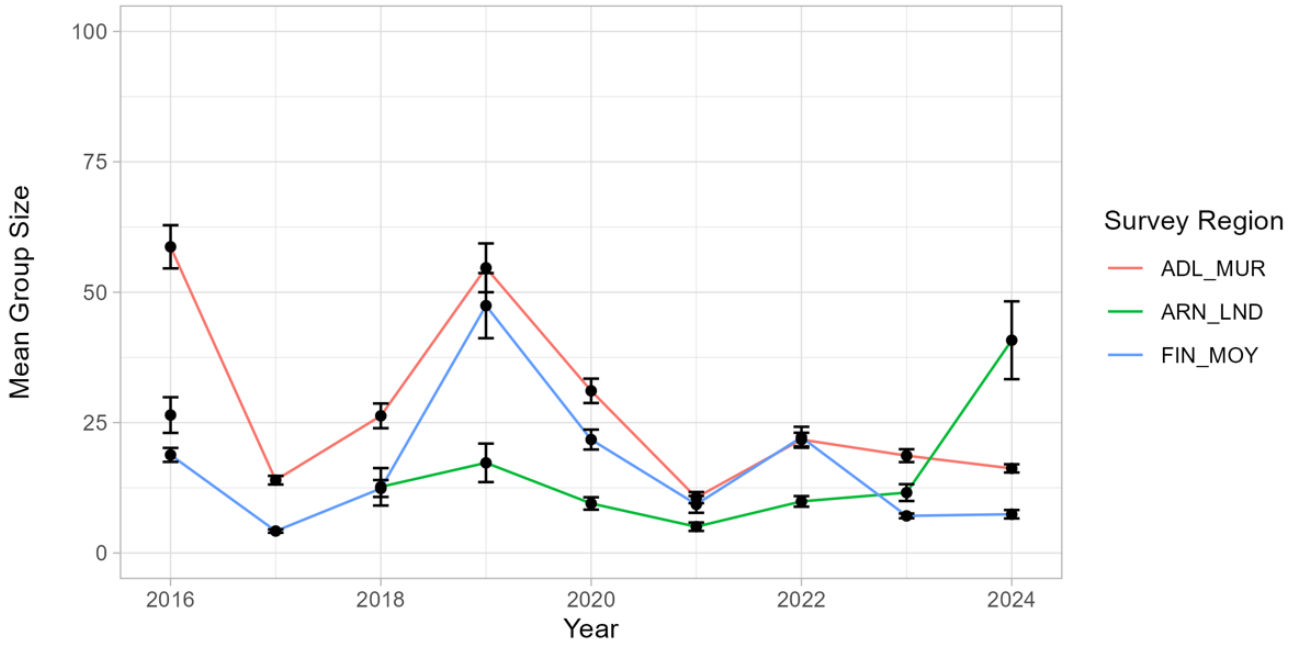

Figure 6. Mean (+/− standard error) recorded group size of Magpie Goose 2016 to 2024 (End of Wet Season Surveys)

ADL_MUR = Adelaide R to Murganalla Ck, ARN_LND = Arnhem Land, FIN_MOY = Finniss R to Moyle

The block densities ranged from 3.4 per km² within the Blue Mud Bay floodplain block (BMB) in the Arnhem Land region to 169.7 per km² within the Downstream Adelaide River flood plain survey block (DAR) in the Adelaide River to Murganalla Creek region. The majority of the total population (60.8%) occurred in the survey region from west of Adelaide River to Murganalla Creek which was slightly lower than the 2023 survey and still less than historical levels when around two thirds of the total population generally were counted there (Clancy 2018, Clancy 2019). Similar to the 2023 survey, in the Moyle River floodplain to Finniss River floodplain region the largest number of birds were counted in the North Daly flood plain (NDR) block with 141,101. Sixteen percent of the total population was recorded in the Arnhem Land region, which was substantially higher than any previous years that surveys have been undertaken in this region. Recent trends in population size for the three survey regions are presented in Figure 7.

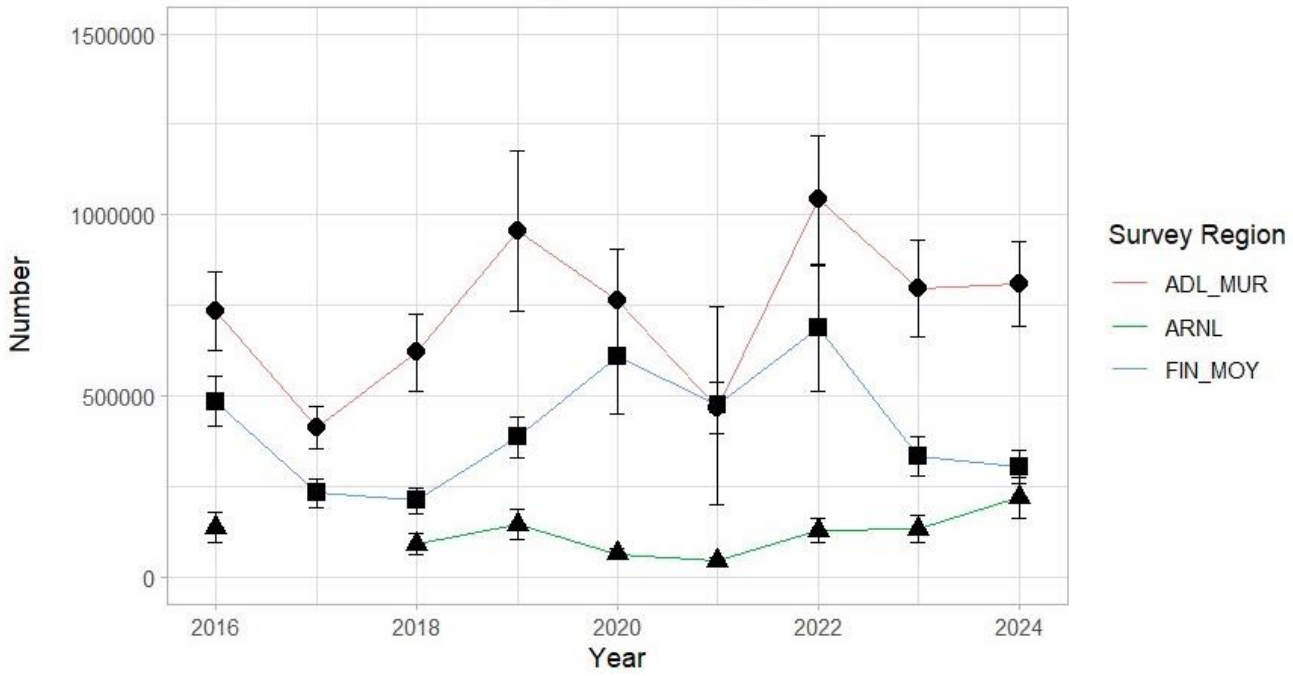

Figure 7. Population size (+/- standard error) of Magpie Goose 2016 to 2024 in each survey region (End of Wet Season Surveys)
ADL_MUR = Adelaide R to Murganalla Ck, ARNL = Arnhem Land, FIN_MOY = Finniss R to Moyle R

Table 2. Estimated population, density and precision (expressed as %) for 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	1,234	39,611	32.1	46.7	945	0.8	43.7
	MOY	1,375	51,091	37.2	23.2	10,267	7.5	29.1
	NDR	958	141,701	147.9	28.1	8,115	8.5	26.9
	REY	1,648	25,579	15.5	23.9	2,911	1.8	32.3
	SDR	1,362	28,859	21.2	23.5	3,020	2.2	26.6
	WDR	1,164	16,309	14.0	47.5	1,998	1.7	46.0
Adelaide to Murganalla	DAR	798	135,346	169.7	30.7	6,891	8.6	36.7
	DMR	1,240	127,328	102.7	33.1	13,968	11.3	35.5
	DSA	915	157,599	172.3	34.1	6,256	6.8	29.5
	EAR	1,483	183,019	123.4	39.2	6,334	4.3	39.7
	MUR	822	57,036	69.4	23.5	635	0.8	39.2
	UAR	719	77,604	108.0	52.3	5,250	7.3	51.0
	UMR	490	7,539	15.4	49.1	496	1.0	71.4
	USA	950	12,756	13.4	40.0	991	1.0	43.2
	WWA	1,205	50,544	41.9	35.3	1,734	1.4	49.1
Arnhem Land	ARA	1,361	71,181	52.3	56.3	124	0.1	55.5
	BMB	1,468	4,988	3.4	81.9	170	0.1	75.8
	BUK	595	2,232	3.7	76.5	0	0	0
	GOR	623	23,939	38.4	53.1	139	0.2	59.1
	LIV	975	41,638	42.7	52.1	0	0	0
	BLY	1,662	74,347	44.7	40.1	0	0	0

3.4. Population Trends and Outlook

Long term trends in the Magpie Goose population and nesting activity from 1983 to 2024 are provided in Figure 8, Figure 9 and Table 3, respectively. The 2024 result is consistent with a population below carrying capacity, following a reasonable 2023 breeding season with moderate survival across the 2023 dry season. The population level is in a “moderate” phase, being below the most recent peak 2,500,000 recorded in 2012 (Clancy 2020) but very much above the historical low population estimate recorded in 2017 (Table 1). Rainfall-driven variability in both population size and nesting index are 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).

As a result of the apparent pattern of lower synchrony of nesting across the survey area over recent years, it is difficult to predict what the population trend may be over the coming year. However, the monitoring results generally indicate a healthy population that whilst well below historical highs, is above recent population troughs. In addition to the influence of rainfall, factors such as weeds and introduced buffalo and feral pig damage are likely to impact nesting habitat and key food resources.

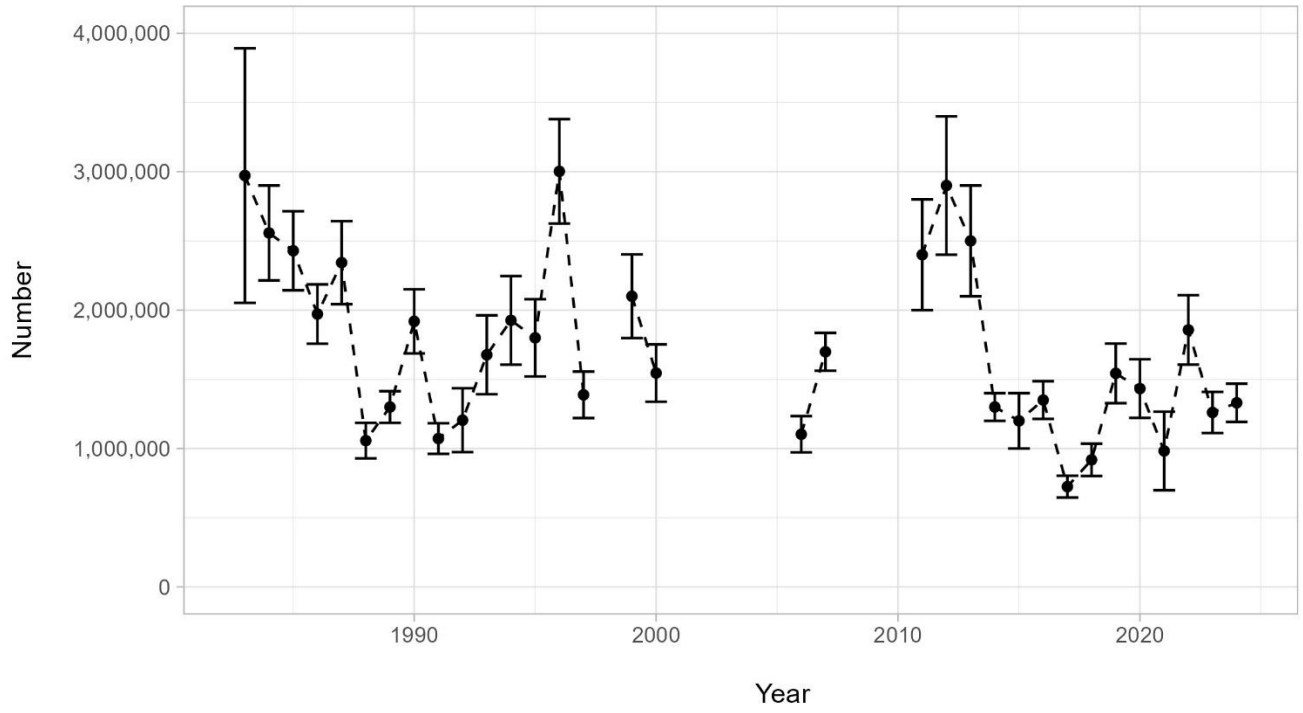

Figure 8. Long term population trend of Magpie Goose 1983 – 2024 (end of Wet Season surveys)

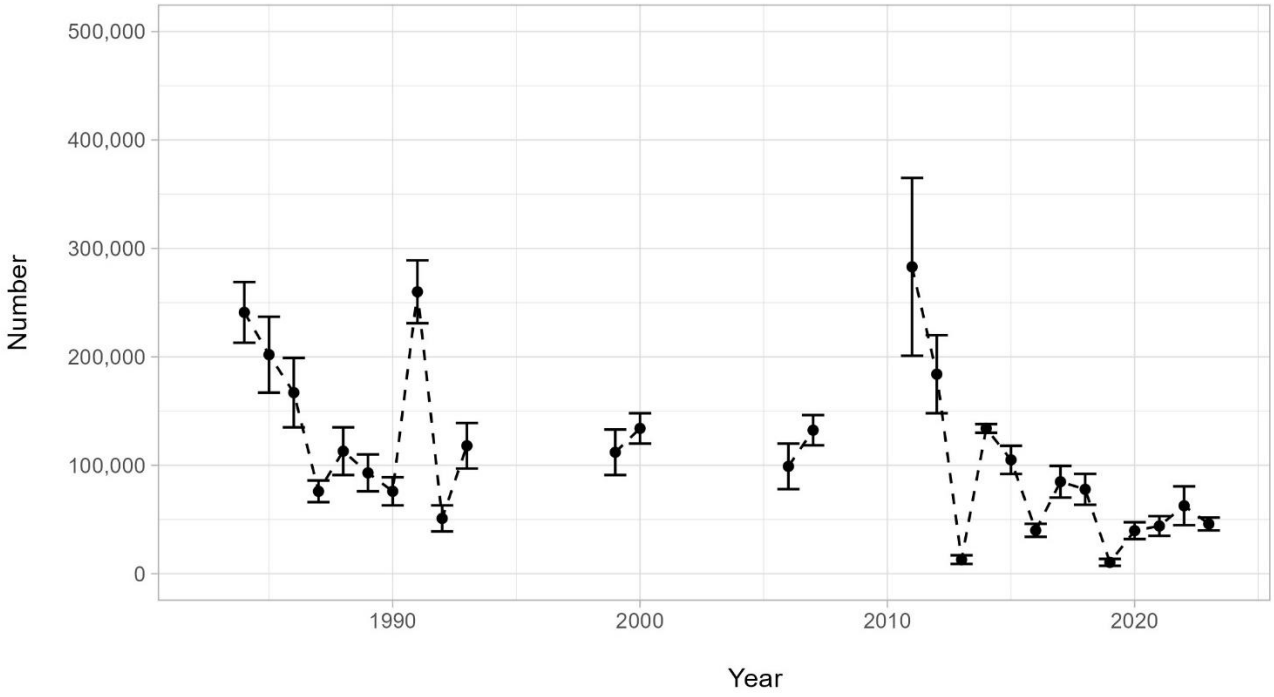

Figure 9. Long term trend of Magpie Goose nesting 1983 – 2024 (end of Wet Season surveys)

Table 3. Comparison of Magpie Goose population trends and previous years nesting success from 2011 to 2024

Year	Nesting Proportion % (A)	Population Change % (B)	Nesting Success (C)	Population Trend (D)
2011	12	n/a	VH	n/a
2012	6	+21	M	I
2013	1	-14	L	D
2014	10	-48	H	BD
2015	9	-8	H	S
2016	3	+8	L	S
2017	13	-44	VH	BD
2018	10	+25	H	I
2019	1	+62	L	I
2020	3	-7	L	D
2021	5	-31	M	BD
2022	4	+89	M	BI
2023	4	-32	M	BD
2024	5	+6	M	I

A Nest count relative to overall goose population
B Change in estimated population size from previous year
C Index of nesting rate: < 5 % = low (l), 5-10% = Moderate (M), 10-20%= High (H),> 20% = Very high (VH)
D Observed and predicted population trend relative to nesting success index, > 10 % population change = Increase (I), - 10%-+10% Stable (S); -10% - -30% = Decrease (D); > - 30% change = Big Decrease (BD}

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