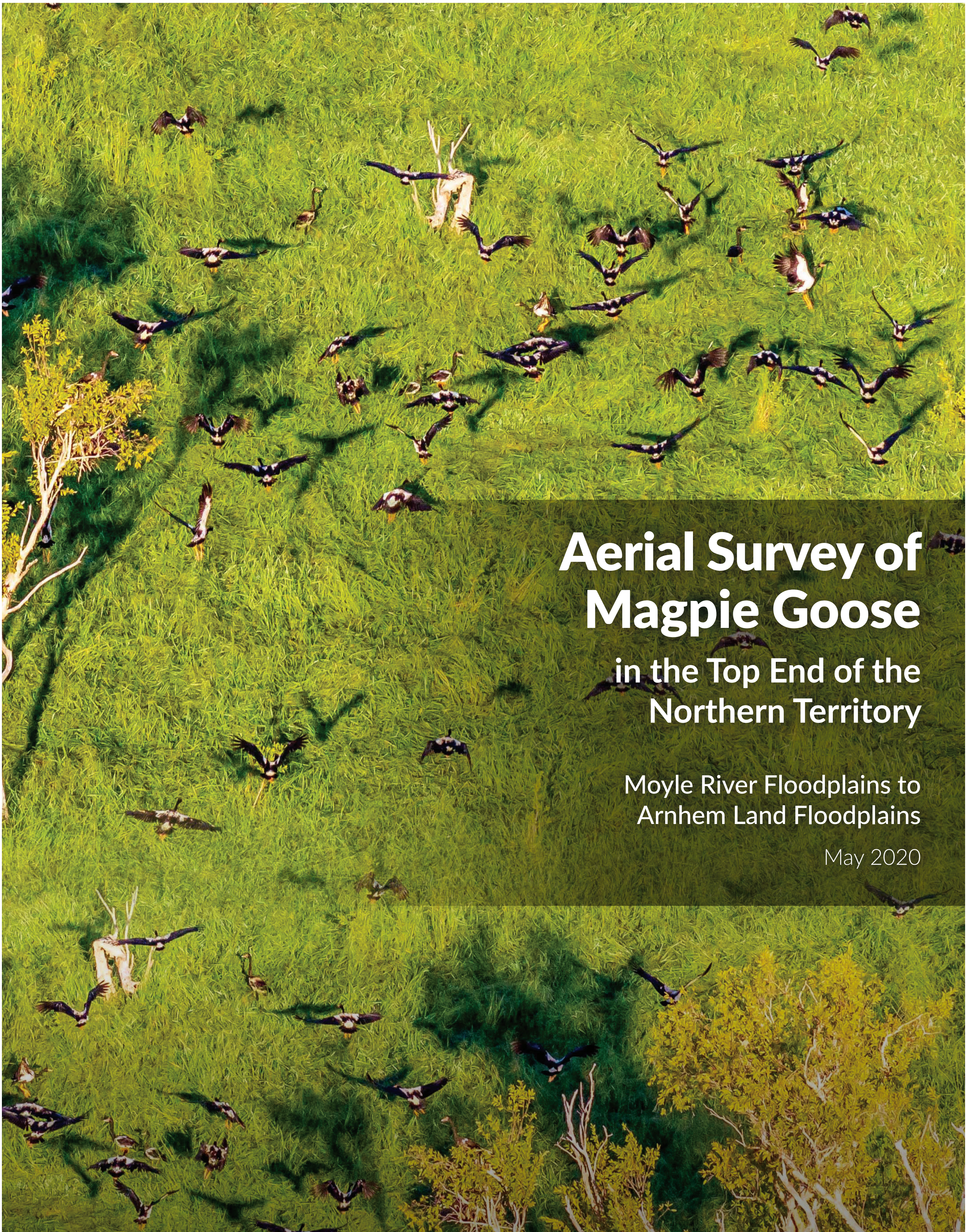

Aerial Survey of Magpie Goose

in the Top End of the Northern Territory

Moyle River Floodplains to Arnhem Land Floodplains

May 2020

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Department of
ENVIRONMENT, PARKS AND WATER SECURITY

NORTHERN TERRITORY GOVERNMENT

Aerial Survey of Magpie Goose in the Top End of the Northern Territory Moyle River floodplains to Arnhem Land floodplains, May 2020

Acknowledgments

This survey was funded by the Northern Territory Government and supported by the Department of Environment and Natural Resources, Department of Tourism, Sport & Culture and the Australian Government Department of Environment.

Thanks to Paul Sharp from Sharp Aviation for providing airframes for the surveys, logistical assistance and professional piloting services for the duration of the fixed-wing surveys under exacting conditions.

Skilled observing, data recording and support with survey logistics was provided by Tony Griffiths, Brydie Hill and Keith Saalfeld from Flora and Fauna Division, Department of Environment and Natural Resources.

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

Keith Saalfeld, and Glenn Edwards provided critical review that greatly improved this report.

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Summary

A fixed-wing aerial survey of Top End wetlands of the Northern Territory was undertaken from 10 May, 2020 to 16 June, 2020 to estimate population size and nesting activity of Magpie Goose. A total of 8,224 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 22,844 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 population estimate for Magpie Goose was 1,432,793 ± 211,784 (± standard error) with a coefficient of variation 14.78%; which is an average density of 62.7 geese per km^2 within the survey region. This is a decrease of -7.14 % on the 2019 estimate. This result signifies a population well below carrying capacity, coming off a poor breeding season in 2019 but with good adult survival. It is well above the historical low in 2017 of 724,500.

The number of Magpie Goose nests was estimated to be 39,723 ± 7,743 for the surveyed area with a coefficient of variation of 19.49 %. This was above 2019 nesting levels, but reasonable nesting was observed only in the Moyle River floodplains and below what would be considered a good nesting season. There was a lot of variation in the timing of nesting (e.g. fledglings and freshly laid eggs were observed in the same general areas), and it is difficult to predict the level of recruitment going into the 2021 breeding season.

Rainfall preceding the survey period was well below the long-term average for the wet season for the second year running and a third consecutive poor wet season may result in continued decline. However, an early wet, coupled with good survivorship of birds may return the population to a growth phase in 2021.

Introduction

The wildlife management program for 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. This includes the implementation of an annual aerial survey monitoring program across the key floodplain habitat at the early part of the dry. The survey program is scheduled to coincide with the period when birds are nesting (so information about likely future population size can be gathered) and when the population is at its most geographically concentrated (to improve sampling efficacy, see Clancy 2020).

The WMP MG sets out survey methods to be used to allow continuity with previous monitoring effort. It 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 2020 aerial survey. In 2020 there were challenges with the implementation of the survey program caused by the COVID-19 pandemic which impacted on survey timing (see below); however, the required variation to the survey protocol are not believed to have made any substantive difference to the overall population estimate.

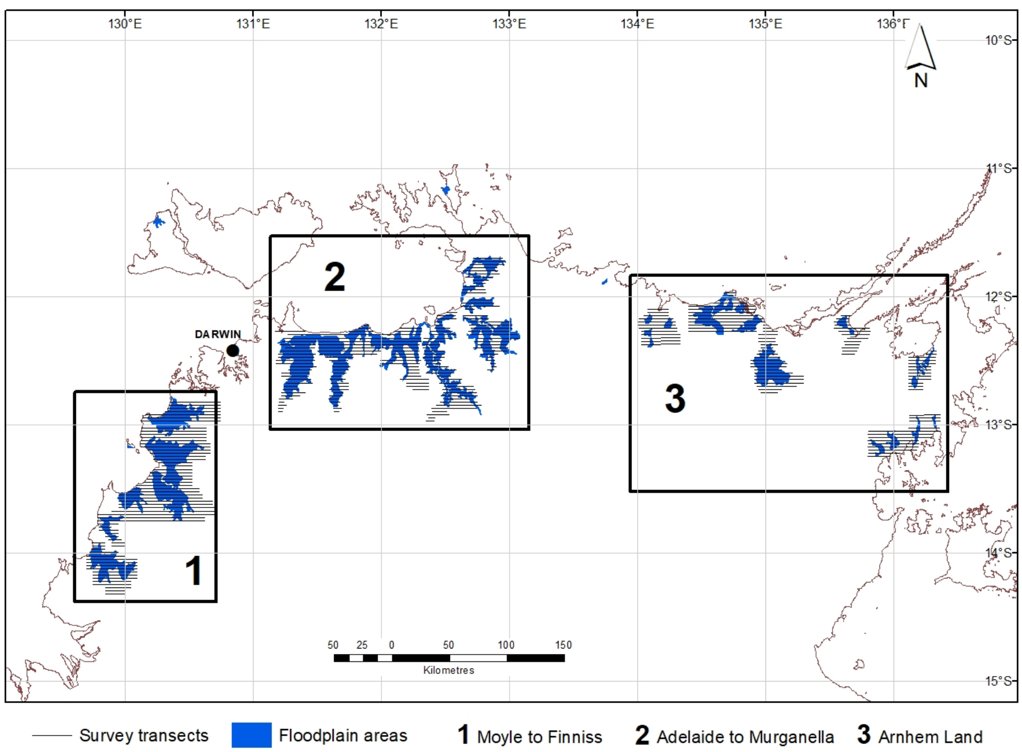


Figure 1: Survey regions for Magpie Goose aerial surveys. Since 2011, Area 2 has been surveyed annually and Area 1 on a biannual basis or more frequent basis. Area 3 has been surveyed less regularly. All areas have been surveyed annually since 2017.

Overall population estimates from aerial surveys from 2011 to 2019 are given in Table 1. In years when only one or two areas were 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).

This report deals with the 2020 aerial survey of the Top End wetlands as per the WTM MG (Clancy 2020).

It is believed that this surveyed area encompasses 90-95% of the current magpie goose population due to the use of the floodplains as breeding habitat and the reliance of birds on the lower floodplains for food during this period.

Table 1: Population and nest estimates (± standard error) for Magpie Geese from 2011 to 2018 derived from wet season aerial surveys. Estimates are adjusted to be comparable among years, independent of areas surveyed (Saalfeld 2011-2016, Groom and Saalfeld 2017, Clancy 2019).

Population Estimate

2011 to 2019

Year	Number of animals	Standard error	Number of nests	Standard error
2011	2,400,000	400,000	283,000	82,000
2012	2,900,000	500,000	184,000	36,000
2013	2,500,000	400,000	13,000	4,000
2014	1,300,000	100,000	134,000	4,000
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

Source: See *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*

Methods

Survey Area and Design

Due to the COVID-19 restrictions on field work, no reconnaissance flight was possible in the lead up to the 2020 surveys. Instead the survey timing was based on previous years' timing window (relative to the end of the wet) and the practicalities of developing an appropriate COVID-19 safe protocol. For example, the Arnhem Land segment of the survey was not feasible to be carried out until June due to restrictions on entering remote communities. The low rainfall in the 2019/20 wet followed on from a poor 2018/19 wet season resulted in poor nesting (Clancy 2019) and similar with last year, a relatively late survey period was deemed appropriate.

The Moyle River floodplains to Finniss River floodplains survey region (latitude 11° 50'S to 14° 20'S, longitude 129° 40'E to 130° 45'E) includes all major floodplains and wetland habitat within that region and was surveyed between 10 May, 2020 to 21 May, 2020. This area comprises six major survey blocks (Figure 2a).

The Adelaide River floodplains to Murgenella Creek floodplains survey region (latitude 11° 40'S to 13° 0'S, longitude 131° 10'E to 133° 0'E) includes all major floodplains and wetland habitat within that region (Figure 2b) and was surveyed between 26 May, 2020 to 02 June, 2020. This area was divided into nine major survey blocks.

The Arnhem Land floodplains survey region (latitude 12° 0'S to 13° 18'S, longitude 134° 10'E to 136° 21'E) includes all major floodplains and wetland habitat within that region (Figure 2c) and was surveyed between 13 June, 2020 to 16 June, 2020. This area was divided into six major survey blocks. Survey blocks were completed from east (based from Nhulunbuy) to west (based from Maningrida).

The survey was conducted using a Cessna 185F 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. Altitude was maintained using a laser altimeter and the aircraft was fitted with Spidertracks Tracking, 406 GPS ELT. Where the transect had to traverse open water aircraft height was adjusted to maintain safe gliding range; in practice this did not impact on survey areas as such occasions were very 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, i.e. perpendicular to the general north-south orientation of the major river systems, ridges and escarpments of the area (Figure 2). 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.

To meet COVID-19 protocols for all surveys only two experienced observers (Tim Clancy and either Keith Saalfeld, Brydie Hill or Tony Griffiths) were used, as opposed to previous years when a third observer was generally present.

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 a HP iPaq rx5900 Travel Companion linked to an external antenna mounted internal to the plane to improve GPS signal reception. Data were entered by observers using a purpose-built Basic program written by K. Saalfeld which allowed for Species [Magpie Goose, Magpie Goose Nest, Jabiru (*Ephippiorhynchus asiaticus*), Brolga (*Grus rubicunda*), Feral Pig (*Sus scrofa*), Horse (*Equus caballus*, generally only feral counted) and Buffalo (*Bubalus bubalis*)] and number to be recorded. This survey was also used to trial the ultility of counting Burdekin Duck (*Tadorna radjah*) and whistle ducks (either Wandering Whistling-Duck *Dendrocygna arcuata* or Plumed Whistling-Duck *Dendrocygna eytoni* which could not be reliably discriminated from each other from the air). 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.

Post Survey Data Handling and Editing

Data were downloaded daily from each observer's iPaq 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 RStudio (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 etc. Full code used in the analysis is available from the author.

Analysis

Because transects were variable in length/area, the Ratio Method (Jolly 1969, Caughley and Grigg 1981, Marsh and Sinclair 1989) 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 & Yeomans (1990a, b) - 3.28 for Magpie Geese and 2.23 for Magpie Goose nests.

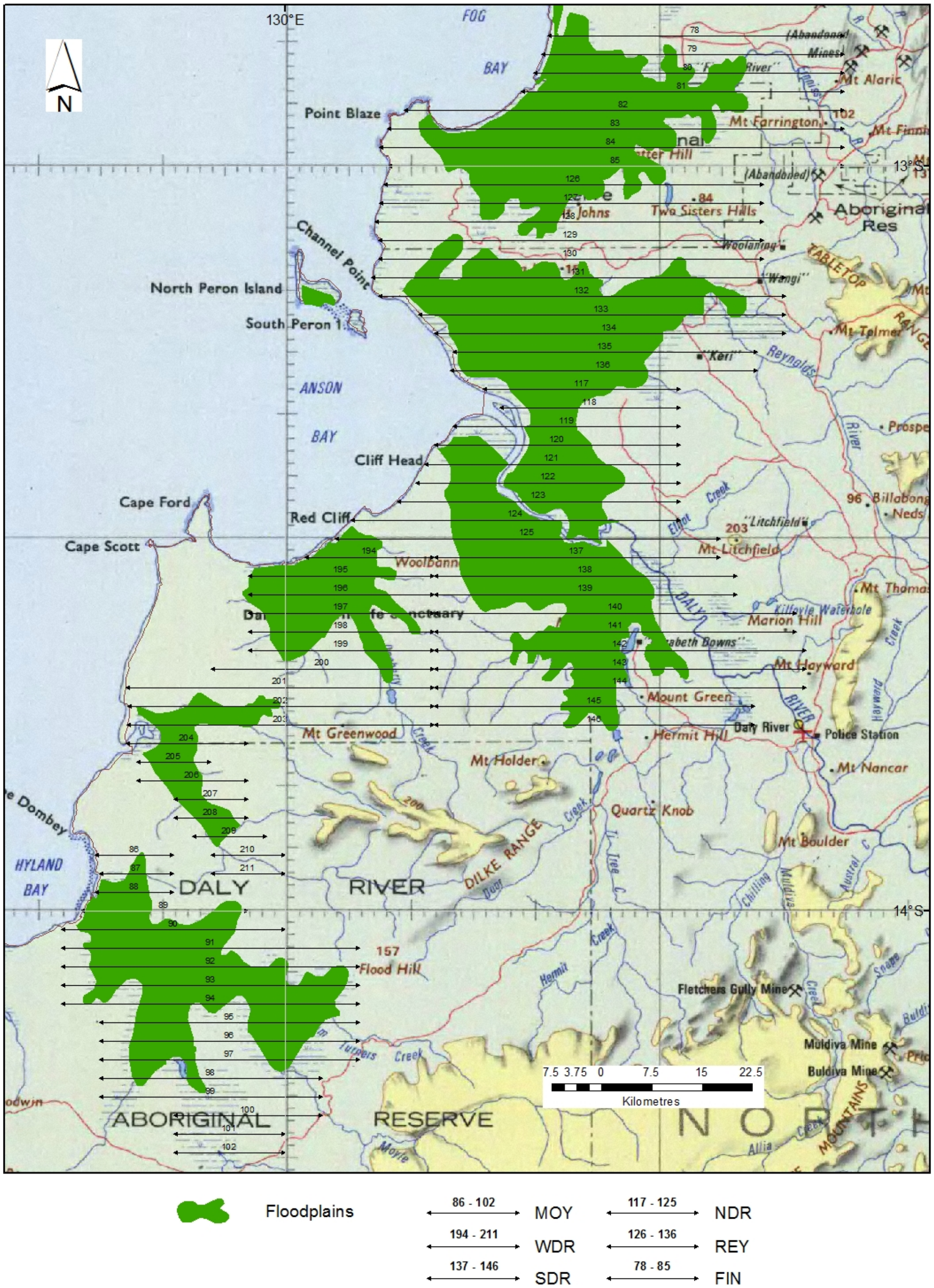


Figure 2a: Survey blocks and survey transects flown in the Moyle River floodplain to Finniss River floodplain survey region

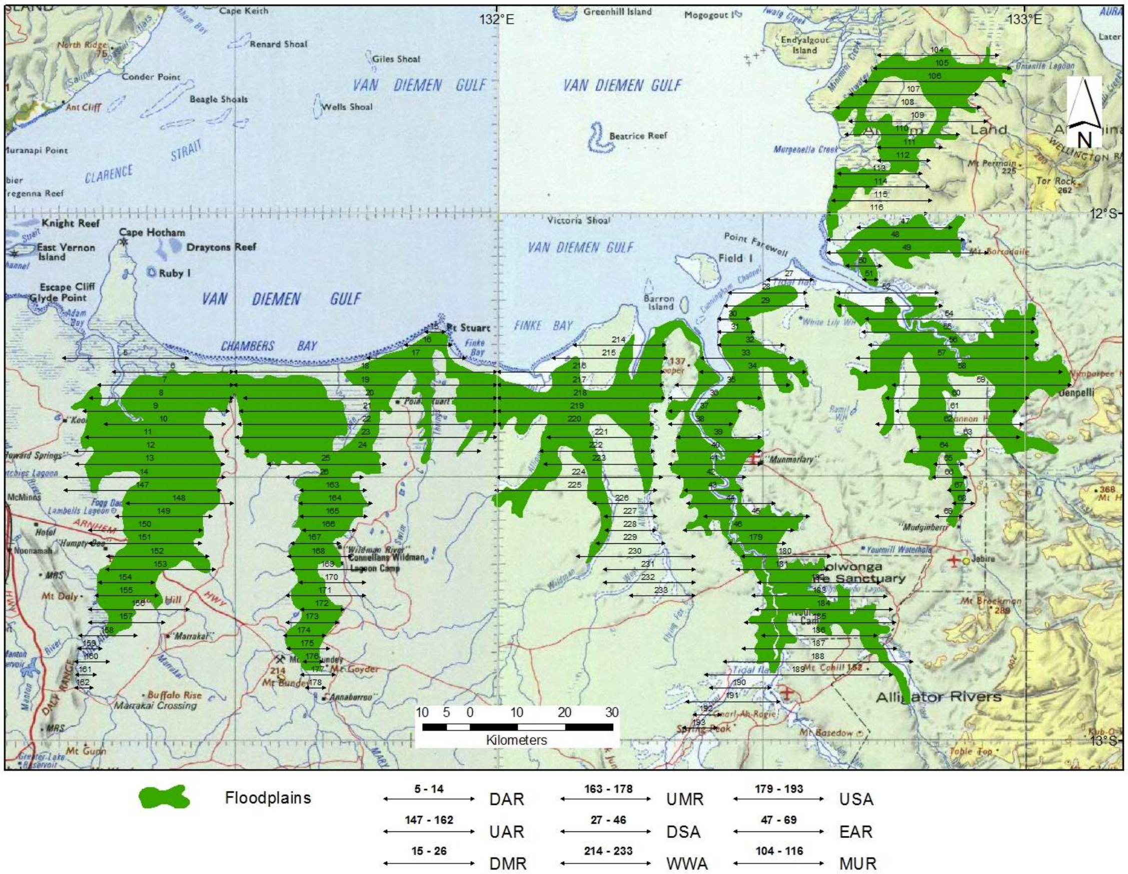


Figure 2b: Survey blocks and survey transects flown in the Adelaide River floodplain to Murgenella Creek floodplain survey region.

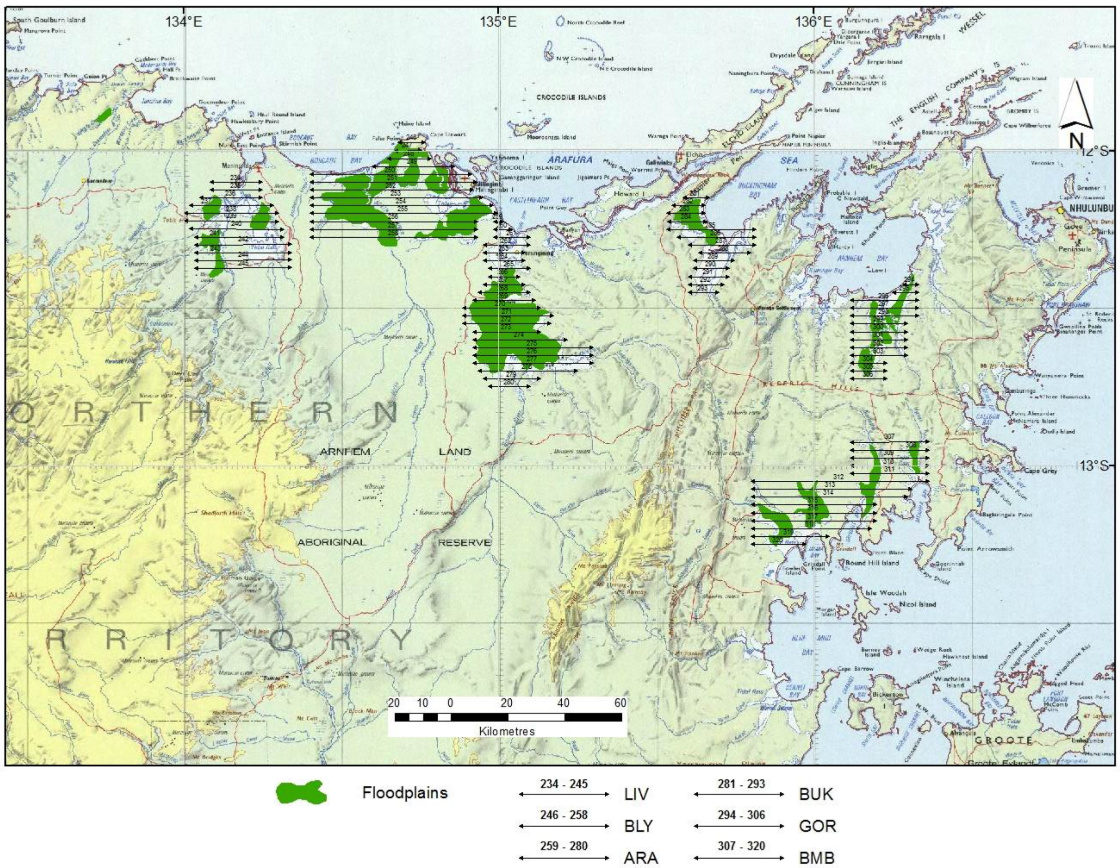


Figure 2c: Survey blocks and survey transects flown in the Arnhem Land floodplains survey region.

Results

Overall Population Estimate and Nesting level

The total population of Magpie Goose in the Top End in 2020 was estimated to be 1,432,793 ± 211,784 (± standard error) geese with a density of 62.72 ± 9.27 per km^2 (mean ± standard error), and a precision of 14.78 %. For Magpie Goose nests the estimate and standard error was 39,723 ± 7,743, an overall density of 1.74 ± 0.34 nests per km^2, at a precision of 19.49%.

Survey Block Population and Density Estimates

The population estimates for each survey block within the three survey regions are presented in Table 2 a-c, along with the density and calculated error (expressed as % coefficient of variation) for all estimates. The block densities ranged from less than 1 km^{-2} for a couple of blocks in Arnhem Land to 300.3 km^{-2} from the MOY survey block. 53.2% of the total population occurred in the survey region from west of Adelaide River to Murgenella Creek which was lower than in previous years when around two thirds of the total population generally are counted there. This was a result of quite a high proportion of the population concentrating in the Moyle region with over one quarter of the total (29 %) from this one block (MOY). Only 4.4% of the total population was recorded in the Arnhem Land region under half what is typically found there. Recent trends in population size for the three survey regions is given in Figure 3.

Population dispersion

The average size of observed groups of magpie goose is given in Figure 4 along with those recorded in previous years. The sightings were less clumped than in 2019. The dispersion index (ratio of mean to variance where ~ 0 = uniform, ~ 1 = random and » 1 = clumped; Caughley and Sinclair 1994) of the component blocks all reflected significant clumping (Range 2.67 to 264).

The precision of individual block estimates (as measured by the coefficient of variation, CV) ranged from around 26% to as high as 83% (Table 2 a,b,c); However, as with previous years the high sampling intensity means that at a whole of survey block level the estimate is generally satisfactory (CVs of 18.7, 26.0 and 25.7 % respectively). The overall estimate has a coefficient of variation of 14.8%. 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.

Nesting rate and rainfall

The ratio of nests to total population of Magpie Goose gives an indication of the nesting rate for the season. For 2020, the value was 2.8% signifying a poor nesting season, which was expected given the poor wet season. Rainfall recorded across the Top End was below average to well below average (Fig. 5) with catchments feeding into potential breeding areas recording below average to average rainfall.

Table 2 Population size for Magpie Goose and nests in the three floodplain survey regions.

2a Estimated population, density and precision (coefficient of variation expressed as a %) for Magpie Goose and nests in the Moyle River floodplain to Finniss River floodplain survey region.

Values and Coefficient of variaiton (CV %)

Block	Region (Km2)	Number of Geese	Density (km-2)	CV% Geese	Number of Nests	CV% Nests
FIN	1,234	15,216	12.3	83.3	186.0	91.3
MOY	1,375	412,893	300.3	36.8	29,501.0	25.5
NDR	958	46,353	48.4	29.8	1,022.0	39.4
REY	1,648	57,104	34.7	31.7	1,905.0	46.3
SDR	1,362	52,047	38.2	39.5	1,146.0	37.9
WDR	1,164	24,167	20.8	54.1	1,580.0	71.2

2b Estimated population, density, and precision (coefficient of variation expressed as a %) for Magpie Goose and nests in the Adelaide River floodplain to Murgenella Creek floodplain survey region.

Values and Coefficient of variaiton (CV %).

Block	Region (Km2)	Number of Geese	Density (km-2)	CV% Geese	Number of Nests	CV% Nests
DAR	738	19,931	27.0	50.4	496.0	53.0
DMR	1,240	156,142	125.9	58.2	201.0	71.9
DSA	915	73,618	80.5	26.0	434.0	31.3
EAR	1,404	221,423	157.7	33.2	867.0	57.6
MUR	822	56,876	69.2	49.5	77.0	93.4
UAR	657	25,534	38.9	76.3	15.0	96.8
UMR	490	6,173	12.6	42.1	248.0	58.7
USA	950	38,791	40.8	58.5	279.0	38.5
WWA	1,205	163,567	135.7	40.5	1,332.0	55.5

2c Estimated population, density, and precision (coefficient of variation expressed as a %) for Magpie Goose and nests in the Arnhem Land floodplain survey region.

Values and Coefficient of variaiton (CV %).

Block	Region (Km2)	Number of Geese	Density (km-2)	CV% Geese	Number of Nests	CV% Nests
ARA	1,361	50,498	37.1	31.2	372.0	74.3
BMB	1,468	2,301	1.6	63.1	0.0	0.0
BUK	595	137	0.2	78.7	0.0	0.0
GOR	623	6,833	11.0	59.2	0.0	0.0
MAN	975	1,822	1.9	65.6	62.0	63.0
MIL	1,662	1,367	0.8	76.8	0.0	0.0

Figure 3. Population size (± standard error) of Magpie Goose
2016 to 2020 (End of Dry Season Surveys)

ADL_MUR = Adelaide R to Murgenella Ck, ARN_LND = Arnhem Land, FIN_MOY

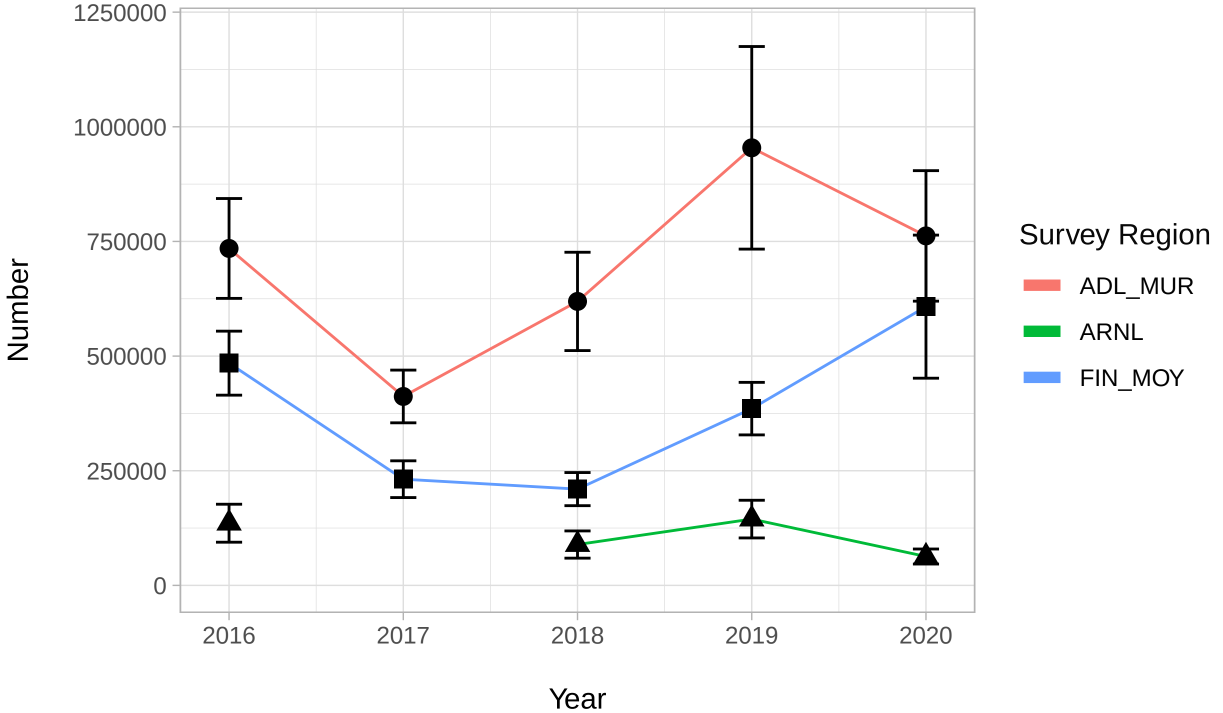
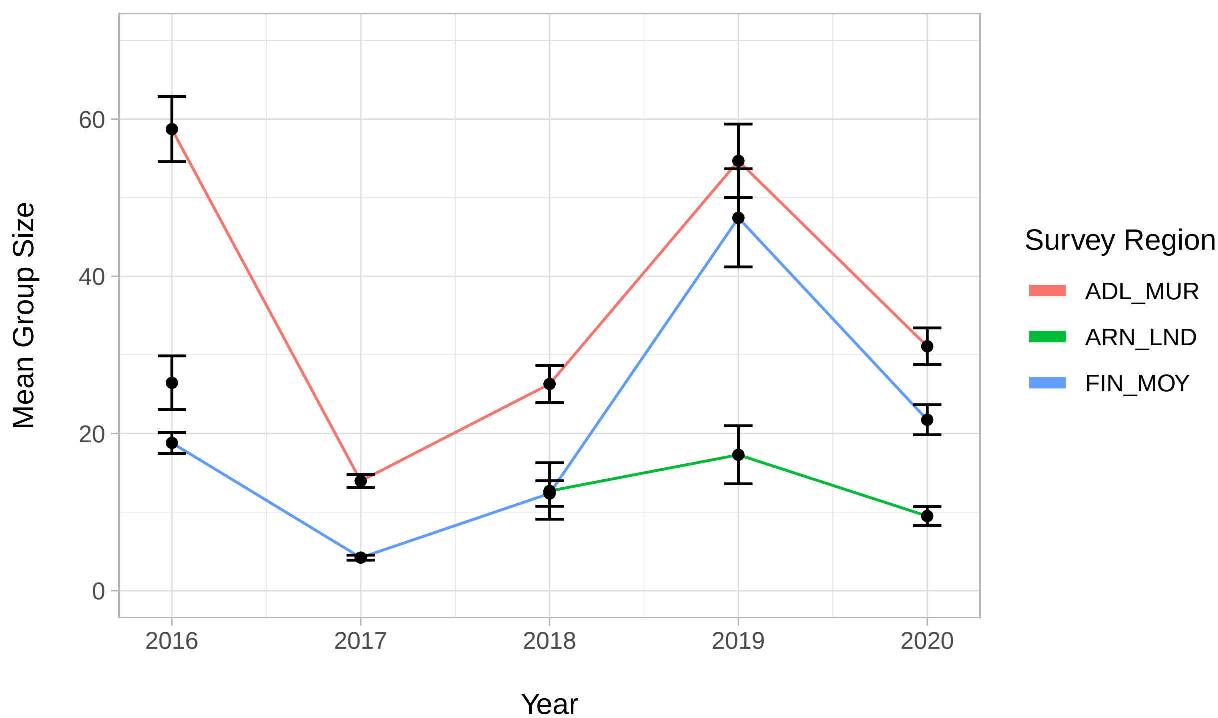


Figure 4. Mean (± standard error) recorded group size of Magpie Goose s
2016 to 2019 (End of Dry Season Surveys)

ADL_MUR = Adelaide R to Murgenella Ck, ARN_LND = Arnhem Land, FIN_MOY = Fin



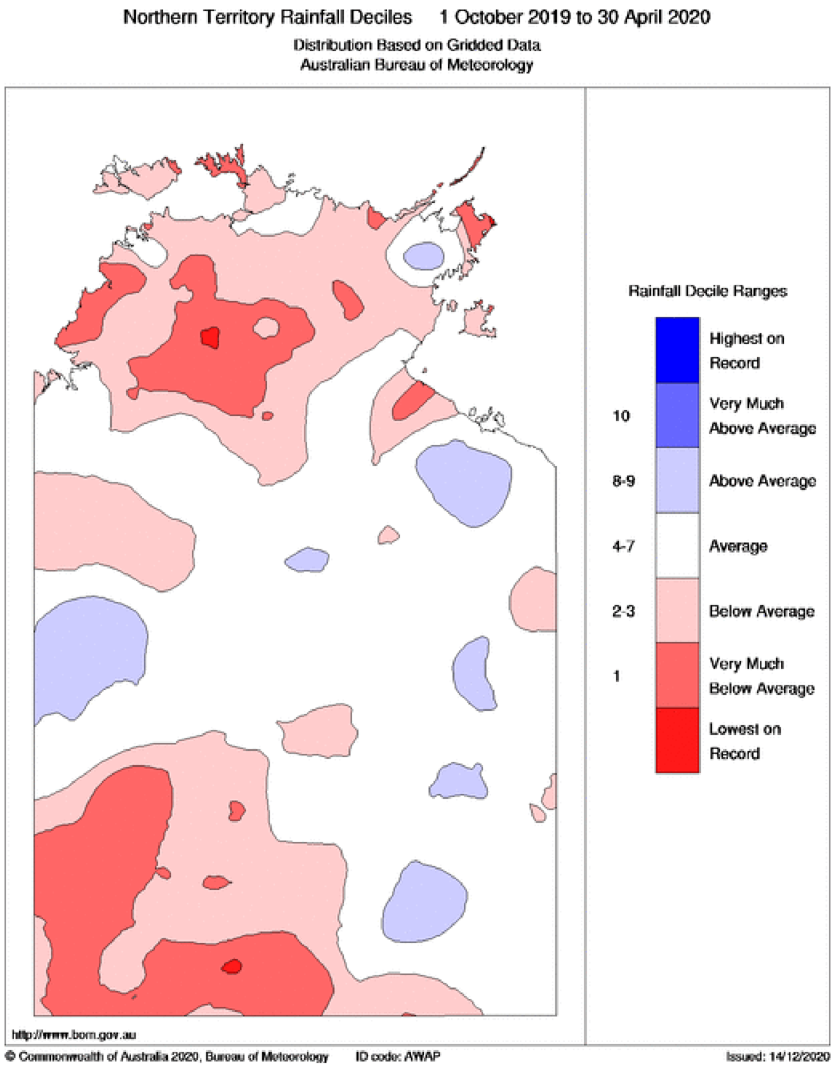


Figure 5 Map of the NT showing rainfall deciles for the 2019/20 wet season period. Figure from bom.gov.au.

Discussion

Population Size and Dispersion

The population estimate for Magpie Goose in the Top End of 1,432,793 ± 211,784 (mean ± standard error) reflected a small decrease from 1,542,943 ± 215,317 in 2019. As in previous years, this 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.

A comparison of the changes in magpie goose population from 2017 to 2020 is provided in Table 3. The 2020 result signifies a population well below carrying capacity, coming off a poor breeding season in 2019 but with good adult survival. It is well above the historical low in 2017 of 724,500. The population growth pause in 2020 was off the back of strong annual increase in numbers (25% and 62%) from 2017 to 2019 following on from a period of declines punctuated by period of relative stability from 2012 to 2017. The subsequent bounce back from the 2017 low was close to the upper limit of the biologically possible rate of increase postulated by Brook and Whitehead (2005), being dependent on almost complete survivorship of animals, all mature females reproducing and equivalent to 100% compensatory survivorship of birds removed from the population (Clancy 2019).

The precision of the overall population estimate was reasonably good (14.78%) and is comparable with previous years' surveys where the coefficients of variation have been in the range of 8-18 % (see Table 1).

Population trends and outlook

Significant rainfall-driven variability in both population size and nesting index are a feature of Magpie Goose population dynamics in the Top End (Bayliss & Yeomans 1990a, Whitehead & Saalfeld 2000, Delaney et al. 2009, Groom & Saalfeld 2017, Clancy 2020). The rainfall conditions experienced in 2018/2019 (as reflected in the low nesting; Table 3) were not conducive to continued population growth and this is reflected in this year's survey results. However, that the population only declined slightly in the face of two poor rainfall years suggests that adult survivorship was relatively high. This is to be expected with the overall population being well below long term carrying capacity as competition for food during the critical end of dry period is mitigated by the lower population size.

Magpie Goose nests were estimated to be only 39,723 ± 7,743 (coefficient of variation 19.49 %) for the Top End, which is whilst low compared with the recent good nesting of 2017 and 2018, was higher than in 2019 (Table 4). The relative low level of nesting observed in 2020 is also consistent with the very poor 2019/20 wet season across the Top End; however that is was higher than the previous years may reflect a reluctance of geese taking consecutive breeding seasons off. Whitehead and Saalfeld (2000) reported a bi-annual synchronicity to nesting (in the context of a period of declining nesting) in the Mary River floodplain region. It will be interesting to follow nesting synchronicity across periods of high and low rainfall at different scales. There is a clear trade of in investing resources in nesting behaviour and nesting habitat conditions, but also potential for birds to have a lower threshold for attempting nesting if they did not nest in the preceding season.

The monitoring results indicate that there has been a solid increase in the population since 2017 (Table 1; Figure 6a); however, with this year a slight decline, the population is still well below historical highs and likely to be around half the estimated long term carrying capacity (Clancy 2020). A key feature of any harvest offtake is the level of compensatory mortality (whether offtake is additive or there is increased survivorship; Caughley and Sinclair 1994). With the current population estimates at half the long-term carrying capacity, there is likely to be relatively less pressure on the population in its current phase than if it were significantly higher. However, the low nesting, on the back of two poor the wet seasons may trigger a further decline in the population going into 2021. Even with a good 2020/21 wet season, the uncertainty regarding the success of recent nesting makes it difficult to be confident of a return to increasing numbers.

Figure 6a. Population of Magpie Goose in Top End of NT
1983 to 2020 (End of Wet Season Surveys)

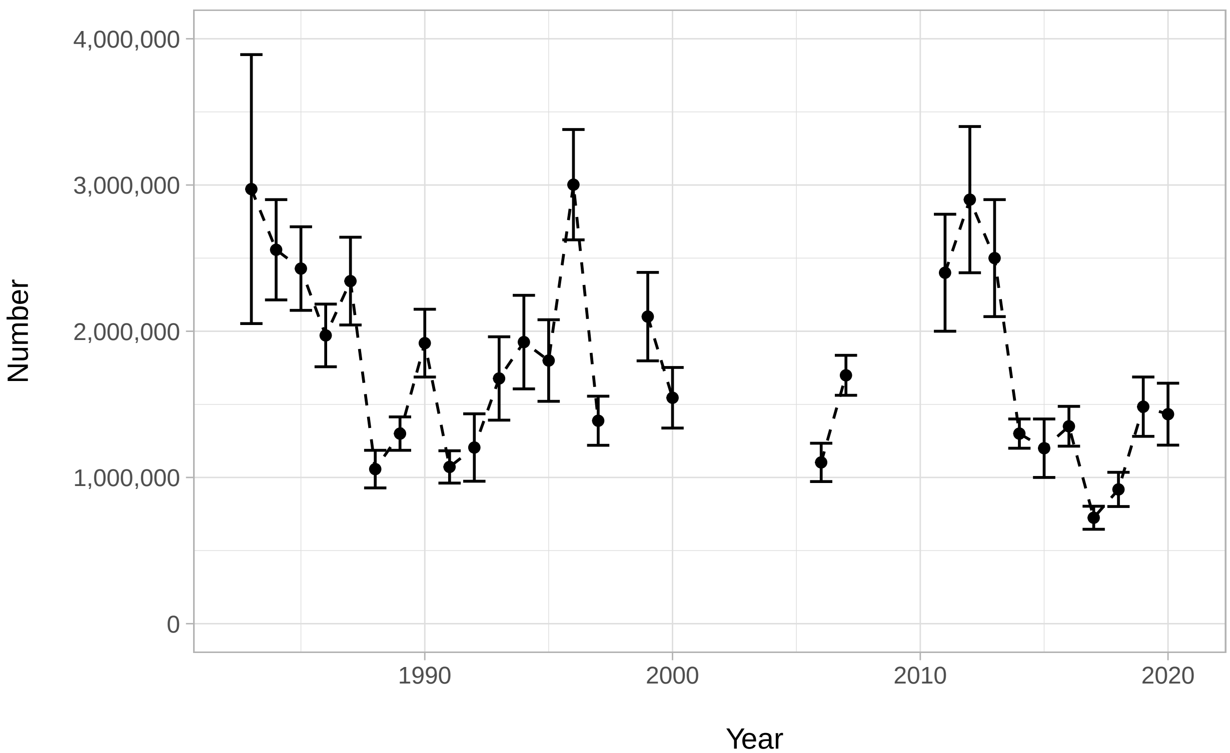


Figure 6b. Number of Nests in Top End of NT
1983 to 2020 (End of Wet Season Surveys)

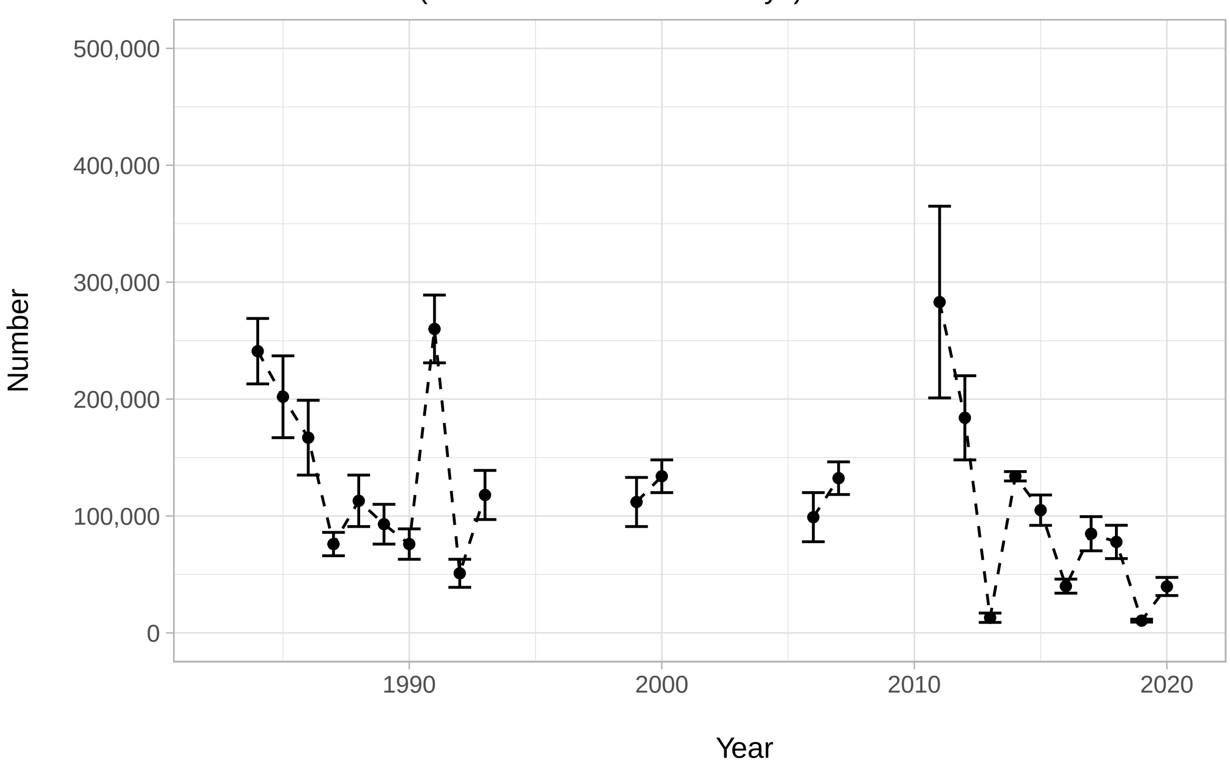


Table 3: Comparison of Top End Magpie Goose population trends and previous years nesting success from 2011 and 2019, and predicted trend in 2020.
[A] Nest count relative to overall goose population; [B] Change in estimated population size from previous year; [C] Index of nesting rate: < 5 % = Low (L), 5-10% = Moderate (M), 10-20%= High (H),$>$20% = Very high (VH); [D] Index of nesting success projected forward 1 year; [E] Observed and predicted population trend relative to nesting success index, $>$ 10 % population change = Increase (I), - 10%-+10% Stable (S); -10% - -40% = Decrease (D); $>$ -40% change = Big Decrease (BD).

Year	[A] Nesting %	[B] Popul Change	[C] Nesting Success	[D] Nest Success Previous Yr	[E] Popul Trend
2011	12%	NA	VH	NA	NA
2012	6%	21%	M	VH	I
2013	1%	-14%	L	M	D
2014	10%	-48%	H	L	BD
2015	9%	-8%	H	H	S
2016	3%	8%	L	H	S
2017	13%	-44%	VH	L	BD
2018	10%	25%	H	VH	I
2019	1%	62%	L	H	I
2020	3%	-7%	L-M	L	S

References

Bayliss, P (1989). Population Dynamics of Magpie Geese in Relation to Rainfall and Density: Implications for Harvest Models in a Fluctuating Environment. *Journal of Applied Ecology.* 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.

BoM (2020). Seasonal Climate Summary for Northern Territory. May 1, 2019. Bureau of Meteorology, Australian Government. - Product code IDCKGCC2R0 http://www.bom.gov.au/climate/current/season/nt/summary.shtml.

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 (in prep). 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.

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

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.

Saalfeld, W.K. (2011). Aerial Survey of Magpie Geese in the Darwin to Kakadu region of the 'Top End', Northern Territory. 31st May, 2011 to 5th June, 2011. A report to the Department of Natural Resources, Environment, the Arts and Sport.

Saalfeld, W.K. (2012). Aerial Survey of Magpie Geese in the Moyle River floodplain to Finniss River floodplain region of the 'Top End', Northern Territory. 8th May, 2012 to 14th May, 2012. A report to the Department of Natural Resources, Environment, the Arts and Sport.

Saalfeld, W.K. (2013). Aerial Survey of Magpie Geese in the Adelaide River floodplain to Murganella floodplain region of the 'Top End', Northern Territory. 18th April, 2013 to 24th April, 2013.

Saalfeld, W.K. (2014). Aerial Survey of Magpie Geese in the 'Top End', Northern Territory. Moyle River floodplains to Murgenella Creek floodplains. 31st March 2014 to 4th April 2014 and 13th May 2014 to 19th May 2014. A report to the Department of Land Resource Management, Darwin, Northern Territory.

Saalfeld, W.K. (2015). Aerial Survey of Magpie Geese in the 'Top End', Northern Territory. Moyle River floodplains to Murgenella Creek floodplains. 5st May 2015 to 16th May 2015. Flora and Fauna Division, Department of Land Resource Management, Palmerston, Northern Territory.

Saalfeld, W.K. (2016). Aerial Survey of Magpie Geese in the 'Top End', Northern Territory. Moyle River floodplains to Murgenella Creek floodplains. 3rd May 2016 to 22nd May 2016. A report to the Department of Land Resource Management, Darwin, Northern Territory.

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.

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.