DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

Aerial Survey of Magpie Geese in the 'Top End', Northern Territory

Moyle River Floodplains to Murganella Creek Floodplains
April 24 – May 6, 2017

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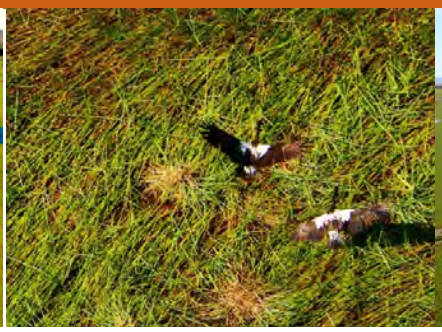


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NORTHERN TERRITORY GOVERNMENT

Contents

Acknowledgements

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Abstract

During the period of 26th April to 10th May 2017, an aerial survey of the floodplains/wetlands in the Moyle River floodplain to Murganella Creek floodplain area was conducted to determine the overall distribution and abundance of Magpie Geese in the 'Top End' of the Northern Territory. The total survey area of 15,640 km^2 was surveyed at a sampling intensity of 14.4%. Species counted were Magpie Goose, Magpie Goose nests, Brolga, and Jabiru. Counts for Magpie Goose and Magpie Goose nests are corrected for a combined perception and visibility bias based on correction factors derived from Bayliss & Yeomans (1990a & b).

The population estimate for Magpie Geese was 643,542 ± 70,068 at a precision of 10.9% within the survey area. The population estimate for Magpie Goose nests was 84,824 ± 13,336 at a precision of 15.7% within the survey area. These are considered to be minimum estimates due to the negative biases commonly associated with aerial surveys. The survey area covered all of the western 'Top End' of the Northern Territory which is considered to be the 'core' wet season nesting habitat representing 85 to 90% of the total Northern Territory population, giving an estimated 724,500 Magpie Geese and 94,500 nests is taken to be the overall population estimate for 2017. The 2017 Magpie Goose population estimate represents a 45% decline from the 2016 population estimate and continues a downward trend observed since 2014. The high precision of the estimate gives a high degree of confidence in the estimate. The 2017 nest estimate is an increase on 2016 though is still lower than 2014 and 2015. This is considered reduced total nesting compared with the last 'good' nesting season of 2011.

Introduction

The Magpie Goose, ***Anseranas semipalmata***, was once widely distributed throughout Australia, with a breeding range extending from the tropical wetlands of northern Australia to the temperate wetlands of the southern States. From the early 1900s until the early 2000s Magpie Goose populations outside the tropics declined precipitately, resulting in an almost exclusively tropical distribution. The factors leading to this decline are poorly understood but were most likely associated with the degradation of wetland habitats in the more developed southern regions.

From the early 2000s, the Australian Magpie Goose population has steadily expanded southwards, primarily along the eastern coastal area from the tropics into the temperate regions of eastern Australia (Delaney et al. 2009). This expansion back into their former range is attributed to the rehabilitation and recovery of some wetland habitats in the southern temperate regions.

The coastal and sub-coastal floodplains of the Northern Territory support Australia's largest populations of Magpie Geese, with the wetlands of Kakadu National Park supporting a significant percentage of the total magpie goose population of the Northern Territory.

The NT Department of Environment and Natural Resources, the Parks and Wildlife Commission of the Northern Territory and the Australian Department of Environment and Energy recognised the national significance of the Northern Territory's Magpie Goose populations, and the particular significance of the population(s) occurring within Kakadu National Park, and established (from 1983 to the early 2000's) a program to monitor the distribution and abundance of the populations on the major coastal and sub-coastal floodplains of the Top End of the Northern Territory (Bayliss & Yeomans 1990a, Saalfeld 1994, Saalfeld 1996).

During the period 1983 to 1993 the annual aerial survey of Magpie Geese on the Top End floodplains was conducted during the "Wet Season", so that additional data on nesting activity could be collected. Analysis of these data, while providing detailed information on instantaneous relative population distribution and abundance, was not of sufficient accuracy to develop a predictive model of Magpie Goose population distribution and abundance (Delaney et al. 2009). Between 1994 and 2001 surveys were undertaken during the "Dry Season" (see Bayliss & Yeomans 1990a for characterisation of "Dry Season" survey) however, as with the earlier "Wet Season" surveys, the results were not of sufficient accuracy to develop a predictive model of Magpie Goose population distribution and abundance (Delaney et al. 2009).

Between 2000 and 2010 only two major aerial surveys of Magpie Geese populations in the Top End of the Northern Territory were undertaken, in 2000 and 2006. Both surveys covered the floodplain areas from the Moyle River in the west to Murganella in the east, including Kakadu National Park (Delaney et al. 2009).

In 2009, the "Management Program for the Magpie Goose (***Anseranas semipalmata***) in the Northern Territory of Australia, 2009-2014" was implemented by the Department of Natural Resources, Environment, the Arts and Sport. This program has the aim to "Ensure the long-term conservation of the Magpie Goose and its habitats in the Northern Territory". One of the actions within this program was to review and redesign the monitoring program for Magpie Geese surveys in 2010 and to implement a survey monitoring program in 2011.

Review and redesign of the Magpie Geese surveys has been completed and the outcome reported in the "Biodiversity Monitoring Programs Reports - Monitoring program for Magpie Geese (***Anseranas semipalmata***) in the Northern Territory". The review identified broad-scale aerial survey as the most effective method of obtaining precise population distribution and abundance information for Magpie Geese in the Top End of the Northern Territory. Whilst an aerial survey annually covering the entire range of the Magpie Goose would provide the maximal combination of precision and accuracy, resource limitations do not allow for this. In recognition of resource limitations, initially the range of the Magpie Goose in the Top End was broken into three major distributions (Figure 1) with each to be surveyed tri-annually. Following survey in 2011 and 2012, it was decided that survey areas 1 and 3 (Figure 1) would be surveyed biannually. Survey area 2 (Arnhem Land) represented a much smaller area of Magpie Goose nesting habitat and population than either areas 1 or 3, with Bayliss & Yeomans (1990a) estimating that approximately 15% of the Magpie Goose population occupied the Arnhem Land floodplains.

The revised monitoring program was implemented in 2011, with a survey of the Adelaide River floodplain to Murganella Creek floodplain area (Saalfeld, 2011). The Moyle River floodplain to Finniss River floodplain area was surveyed in 2012 (Saalfeld, 2012) and the Adelaide River floodplain to Murganella Creek floodplain area again in 2013 (Saalfeld, 2013). In 2014 the Moyle River floodplain to Finniss River floodplain area was surveyed initially, and based on low numbers of geese and nests sighted the decision was taken to also survey the Adelaide River floodplain to Murganella Creek floodplain area as well, to give a more accurate population estimate. Since 2014, the Adelaide River – Murganella and Moyle – Finniss River Floodplain areas have been surveyed consecutively during the wet season. Overall population estimates from these surveys are presented in Table 1.

The greatly reduced population estimate for the 2014 survey (50% decline compared with previous few years) is ascribed to the failed nesting in 2013 and the 'poor' 2013-2014 wet season. In 2015 both the population estimate and estimate of nesting declined slightly compared with 2014. The continued decline is attributed to consecutive 'poor' wet seasons (Saalfeld, 2015) which have limited the Magpie Goose's capacity to recover.

Table 1: Details of population estimates from 2011 to 2016 aerial surveys.

	Magpie Goose population (million)	Magpie Goose nests
2011	2.4 ± 0.4	283,000 ± 82,000
2012	2.9 ± 0.5	184,000 ± 36,000
2013	2.5 ± 0.4	13,000 ± 4,000
2014	1.3 ± 0.1	134,000 ± 4,000
2015	1.1±0.2	105,000 ± 13,000
2016	1.3 ± 0.1	40,000 ± 6,000(15640

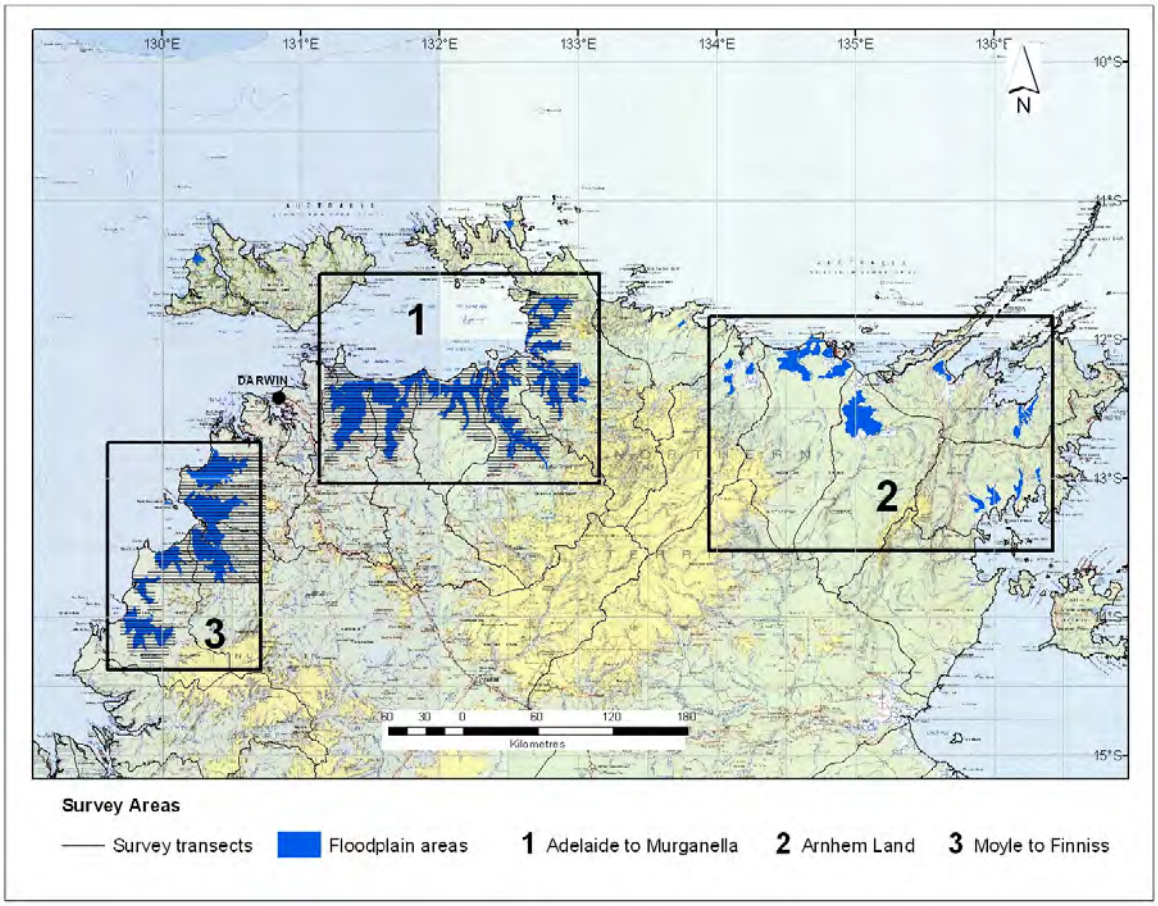

Figure 1: Survey areas for Magpie Goose aerial surveys. Areas 1 and 3 are surveyed annually.

This report describes the results of the 2017 aerial survey of Magpie Geese in the Moyle River floodplain to Finniss River floodplain and the Adelaide River floodplain to Murganella Creek floodplain areas (see areas 1 and 3 in Figure 1). It was considered prudent to obtain current information for the both areas 1 and 3 to ensure any major changes in distribution and abundance from the 2014 results would be detected. Area 2 (Arnhem Land) was not included in either the 2014 survey or this survey as Bayliss & Yeomans (1990a) have shown that Arnhem Land and the remaining areas of the Top End within the Northern Territory Magpie Goose distribution represents 15% or less of the total Top End population.

Methods

Survey Area and Design

The Moyle River floodplains to Finniss River floodplains survey area (latitude $11^0$50'S to $14^0$20'S, longitude $129^0$40'E to $130^0$45'E) includes all major floodplains and wetland habitat within the region (Figure 2a) and was surveyed between 26 April, 2015 and 3 May, 2017. This area was divided into nine major survey blocks (Fig. 2a).

The Adelaide River floodplains to Murganella Creek floodplains survey area (latitude 11040'S to 13000'S, longitude 131010E to 133000E) includes all major floodplains and wetland habitat within that region (Fig. 2b) and was surveyed between 4 May and 10 May, 2017. This area was divided into nine major survey blocks.

The survey was conducted using a Cessna 206 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 radar altimeter. Transect width on each side of the aircraft was demarcated by marker rods attached to the aircraft wing struts and calibrated (Marsh & Sinclair 1989a) to give a transect width of 200 m on each side of the aircraft at survey altitude.

Transect lines flown on the survey are shown in Figs 2a and 2b. All lines were aligned east-west to traverse perpendicularly the general north-south orientation of the major river systems, ridges and escarpments of the area. 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.

Counting Procedure

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

Sightings were recorded as groups of individuals ranging from 1 to 10,000. Observers recorded their observations of Magpie Goose, Magpie Goose nests, Buffalo (***Bos tarus***), Horses (***Equus ferus caballus***), Donkeys (***Equus asinus***) and Pigs (***Sus scrofa***) in a standard format using individual Hewlett Packard HP iPAQ RX5910 Palmtop Computers programmed as GPS data loggers. Data entry for each observer is as outlined in the DENR Magpie Goose Aerial Survey Standard Operating Procedure.

Post Survey Data Editing

Data was downloaded daily from each observer's Palmtop computer to a laptop computer. Data was immediately checked for gross errors (e.g. transects missed or errors reported by the observers), which were corrected, and the daily files from all observers merged. The resultant file was then appended to the survey master file for analysis.

Analysis

Because transects were variable in length/area, the Ratio Method (Jolly 1969, Caughley & 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 estimated numbers of each species for the port mid-seat and starboard mid-seat observers. The resultant standard error was adjusted to incorporate the error associated with the appropriate estimates of mean group size following the method of Jolly & Watson (1979) and Marsh & Sinclair (1989). Estimates were corrected for perception and visibility bias using the wet season correction factors of Bayliss & Yeomans (1990a & b) - correction factors were 3.28 for Magpie Geese and 2.23 for Magpie Goose nests.

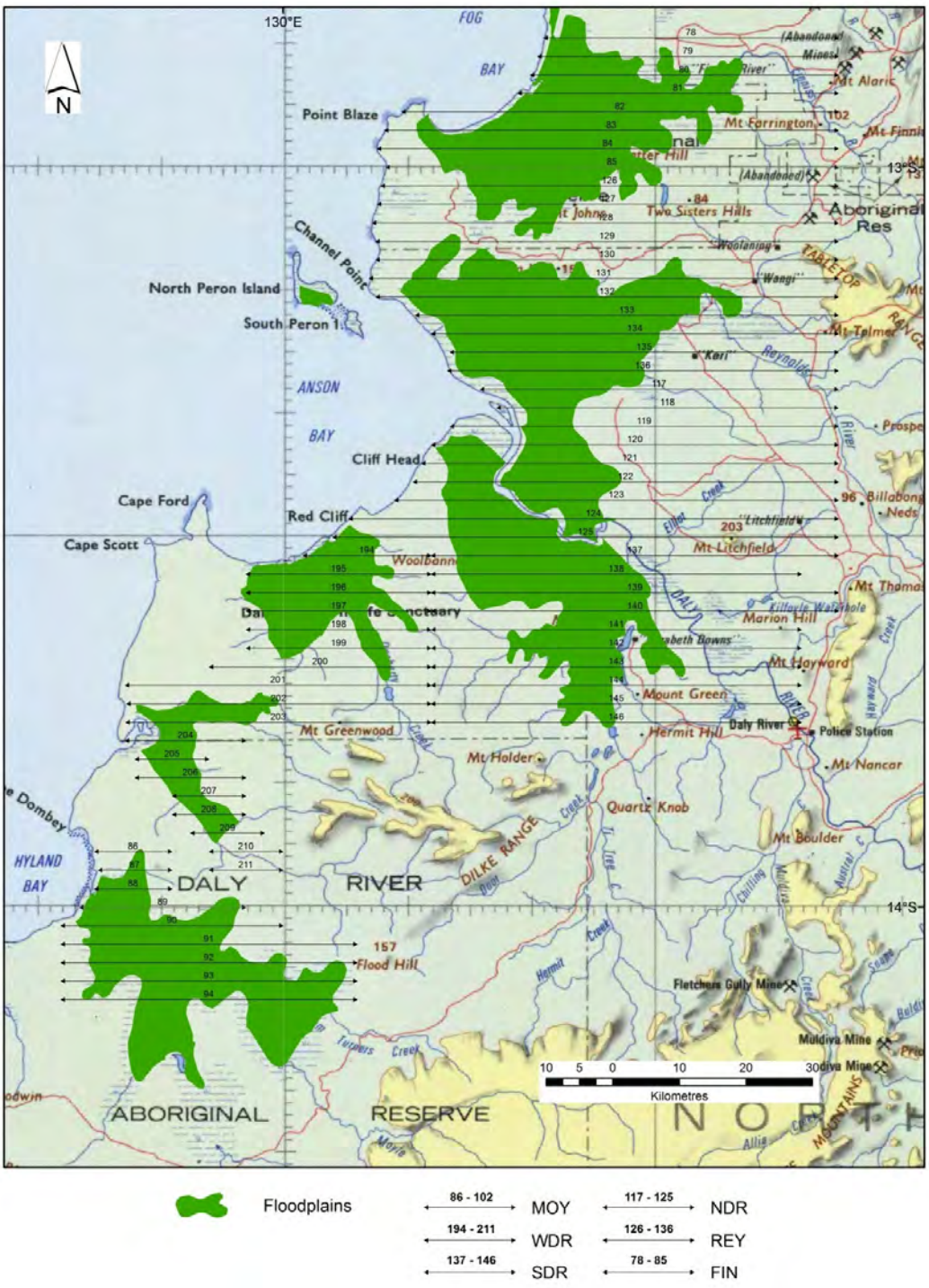

Figure 2a: **Survey blocks and survey transects flown in the Moyle River floodplain to Finniss River floodplain survey area**

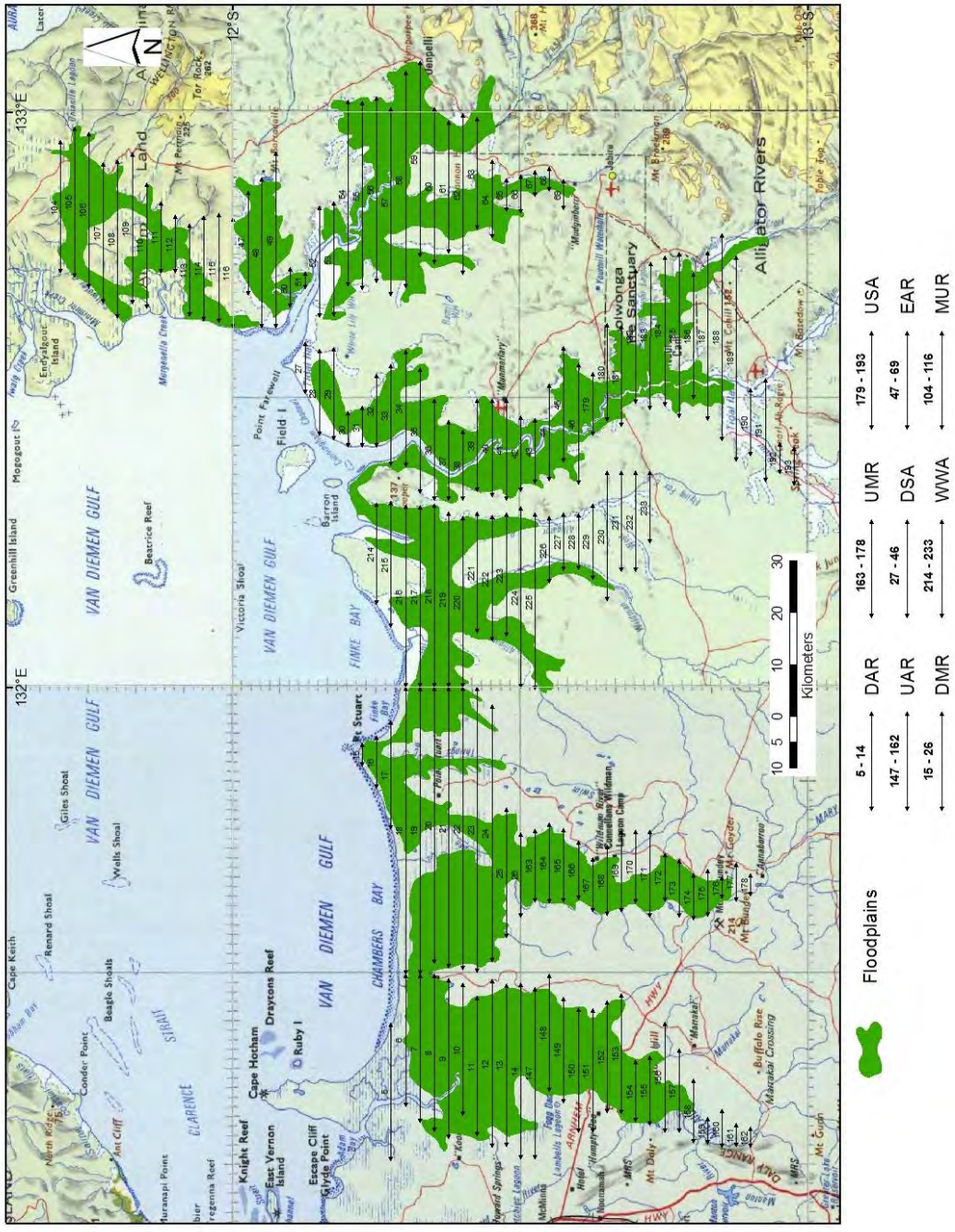

Figure 2b: **Survey blocks and survey transects flown in the Adelaide River floodplain to Murganella Creek floodplain survey area.**

Results

Minimum Population and Density Estimates

The population estimates, density and precision figures for the survey area are presented in Tables 2a and 2b. These results show that the precision for population estimates within survey blocks is variable and in most cases is quite high (greater than 20%, the level considered acceptable in providing a reasonable compromise between survey cost and ability to detect moderate to substantial change in population abundance). For the Magpie Goose population estimate for each of the survey areas the overall precision was 17.3% and 14.0% respectively. For the Magpie Goose nest population estimate for each of the entire survey areas the overall precision was 17.5% and 20.0% respectively.

The overall (combined areas) Magpie Goose population estimate was 643,542 $\pm$ 70,068 which gave an overall density of 41.15 $\pm$ 4.48 geese.km^{-2} at a precision of 10.9%. For Magpie Goose nests the population estimate was 84,824 ± 13,336 which gave an overall density of 5.42 $\pm$ 0.85 nests.km^{-2} at a precision of 15.7%. For both the goose population estimate and the nest estimate the precision value was small, indicating that the overall population estimates are robust. With the recognised biases of aerial survey and the application of correction factors, these can be considered as reliable minimum population estimates.

Distribution of Magpie Goose and Magpie Goose nests

Figures 3a & 3b and 4a & 4b show distribution maps for Magpie Geese and Magpie Goose nests within the survey areas. Figures 5a & 5b and 6a & 6b show kernel density distribution maps for Magpie Geese and Magpie Goose nests within the survey areas.

The distribution of Magpie Geese within the survey area is very patchy, with a number of areas of very high density surrounded by large areas of much lower density. There is a general pattern of Magpie Goose and Magpie Goose nest numbers being higher toward the downstream areas of each of the major river/floodplain systems.

Table 2a: Estimated population, density (in brackets), and precision for Magpie Geese and Magpie Goose nests in the Moyle River floodplain to Finniss River floodplain survey area. Values are ± standard error (incorporating errors from sampling and estimating mean group size).

Block (area in km^2)	Magpie Goose	Magpie Goose nests
Moyle River (731)	40,023 ± 8,046 (54.8 ± 11.0) 20.1	4,662 ± 687 (6.4± 0.9) 14.7
Daly River west (1,164)	37,723 ± 15,708 (32.4 ± 13.5) 41.6	4,615 ± 2,066 (4 ± 1.8) 44.8
Daly River south (1,362)	19,750 ± 9,511 (14.5 ± 7) 48.2	883 ± 271 (0.6± 0.2) 30.7
Daly River north (958)	41,277 ± 22,073 (43.1 ± 23) 53.5	2,695 ± 1,496 (2.8 ± 1.6) 55.5
Reynolds River (1,648)	43,327 ± 18,030 (26.3 ± 10.9) 41.6	3,593 ± 1,352 (2.2 ± 0.8) 37.6
Finniss River (1,233)	49,455 ± 19,792 (40.1 ± 16) 40	4,398 ± 2114 (3.6 ± 1.7) 48.1
Total survey area (8,186)	231,555 ± 40,074 (32.6 ± 5.6) 17.3	20,846 ± 3,653 (2.9 ± 0.5) 17.5

Table 2b: Estimated population, density (in brackets), and precision for Magpie Geese and nests in the Adelaide River floodplain to Murganella Creek floodplain survey area. Values are ± standard error (incorporating errors from sampling and estimating mean group size).

Block (area in km^2)	Magpie Goose	Magpie Goose nests
Downstream Adelaide River (798)	78,635 ± 40,308 (98.6± 50.5) 51.3	20,227 ± 11,149 (25.4 ± 14.0) 55.1
Upstream Adelaide River (719)	22,529 ± 8,907 (31.4 ± 12.4) 39.5	1,409 ± 984 (2 ± 1.4) 69.8
Downstream Mary River (1,240)	76,744 ± 16,026 (61.6 ± 12.9) 20.9	8,069 ± 1,886 (6.5 ± 1.5) 23.4
Upstream Mary River (490)	8,588 ± 3,953 (17.5 ± 8.1) 46	123.9 ± 53.3 (0.3 ± 0.1) 43
Wildman/West Alligator River (1,205)	24,940 ± 9,628 (20.7 ± 8) 38.6	898 ± 541 (0.7 ± 0.4) 60.2
Downstream South Alligator River (915)	35,832 ± 6,906 (39.2 ± 7.6) 19.3	9,680 ± 2,340 (10.6 ± 2.6) 24.2
Upstream South Alligator River (950)	25,194 ± 7,115 (26.5 ± 7.5) 28.2	8,069 ± 3,873 (8.5 ± 4.1) 48.0
East Alligator River (1,404)	79,956 ± 27,211 (56.9 ± 19.4) 34	8,642 ± 2,848 (6.2 ± 2) 33
Murganella (822)	59,569 ± 19,890 (72.4 ± 24.2) 33.4	6,861 ± 2,605 (8.3 ± 3.2) 38

Block (area in km^2)	Magpie Goose	Magpie Goose nests
Total survey area (8,543)	411,988 ± 57,477 (48.2 ± 6.7) 14.0	63,978 ± 12,826 (7.5 ± 1.5) 20.0

The value of mean group size and associated coefficient of variation used in obtaining the population abundance and density for Magpie Goose and Magpie Goose nests are summarised in Table 3.

Table 3a: Details of mean group size and associated standard error used in the population estimates.

Survey Area	Species	Mean Group Size	Standard Error
Moyle River floodplain to Finniss River floodplain	Magpie Goose	7.95	0.92
	Magpie Goose nests	2.98	0.18
Adelaide River floodplain to Murganella Creek floodplain	Magpie Goose	13.96	0.83
	Magpie Goose nests	8.76	1.31

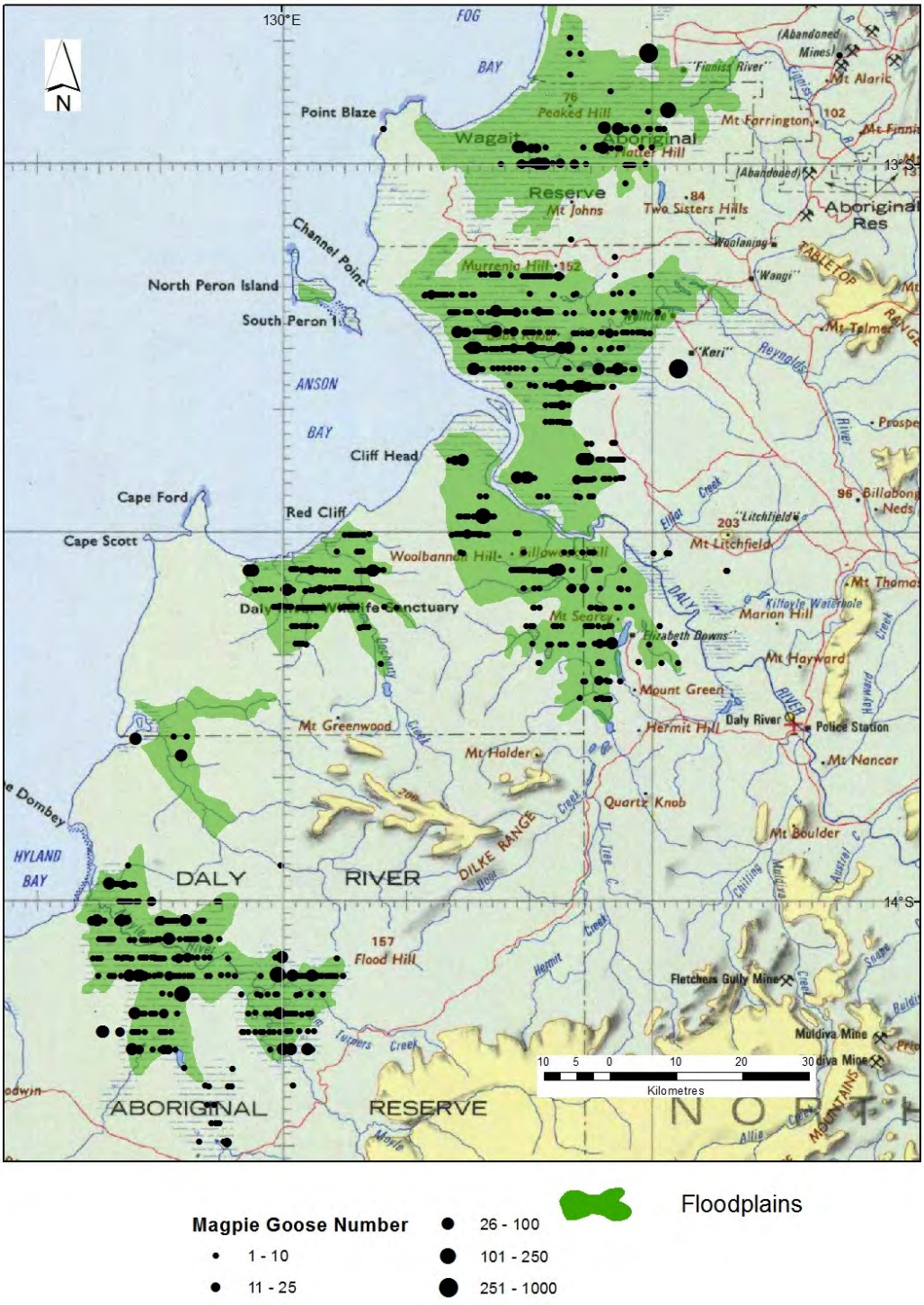

Figure 3a: Distribution of Magpie Goose sightings across the Moyle River floodplain to Finniss River floodplain survey area.

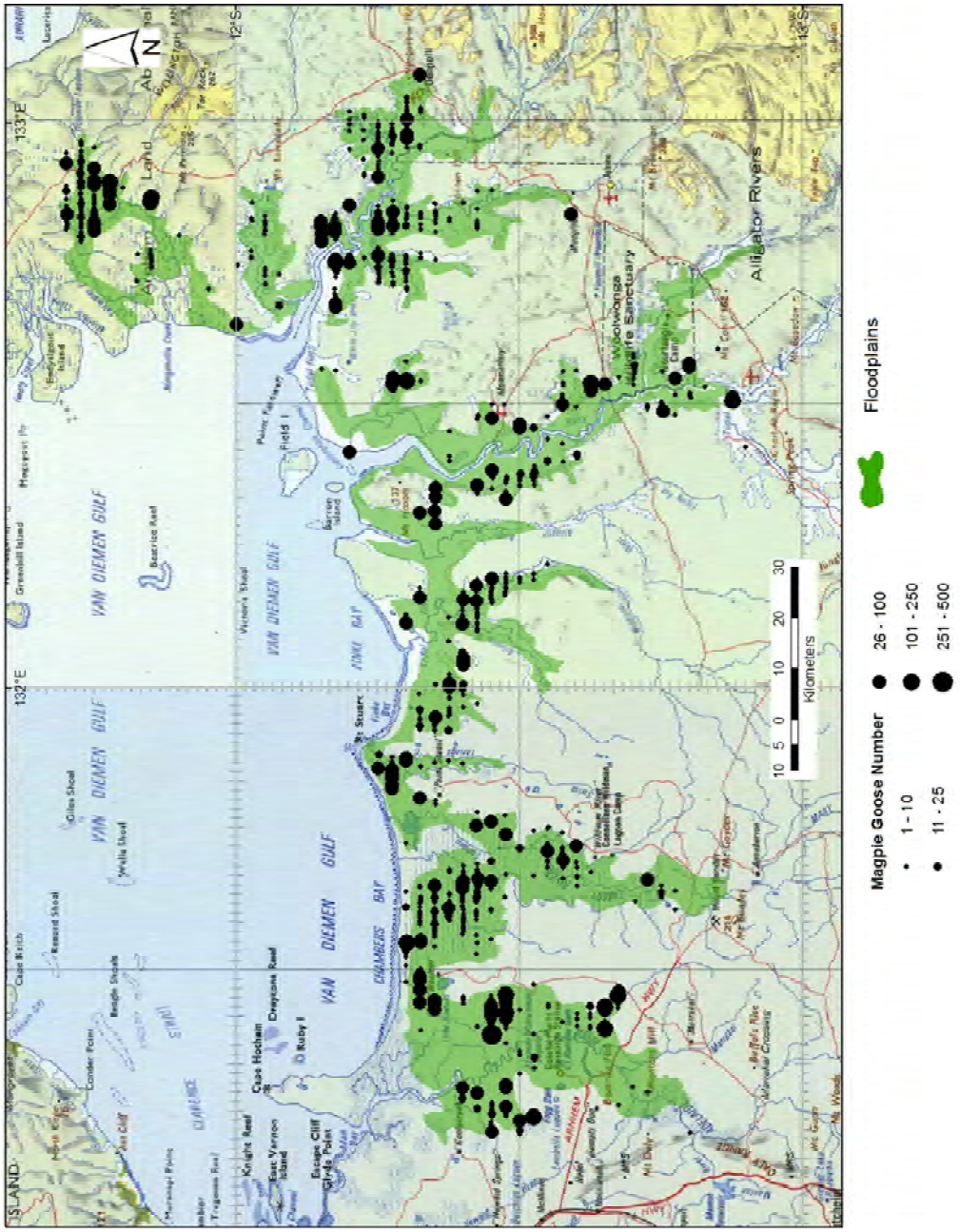

Figure 3b: **Distribution of Magpie Goose sightings across the Adelaide River floodplain to Murganella Creek floodplain survey area.**

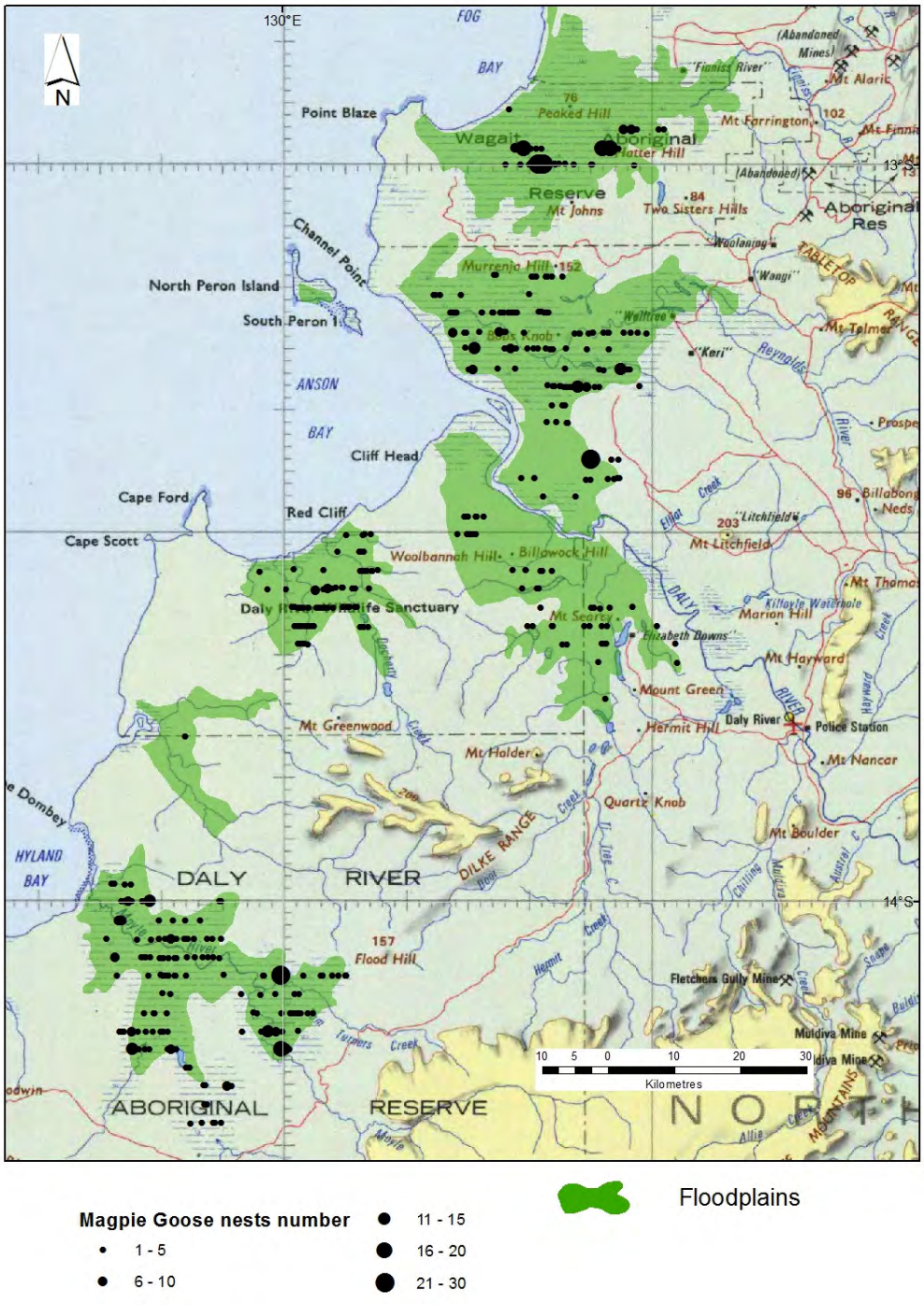

Figure 4a: Distribution of Magpie Goose nest sightings across the Moyle River floodplain to Finniss River floodplain survey area.

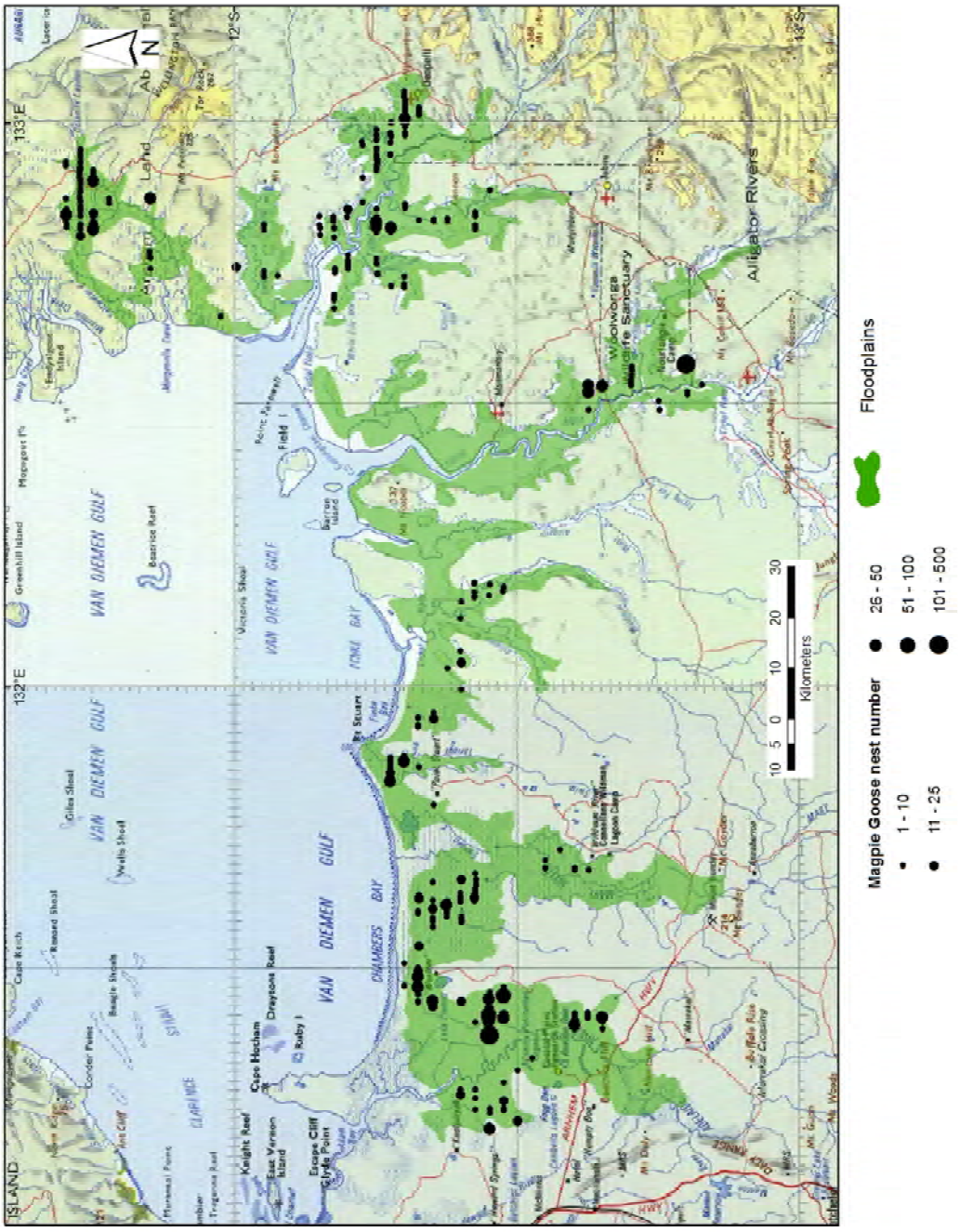

Figure 4b: **Distribution of Magpie Goose nest sightings across the Adelaide River floodplain to Murganella Creek floodplain survey area.**

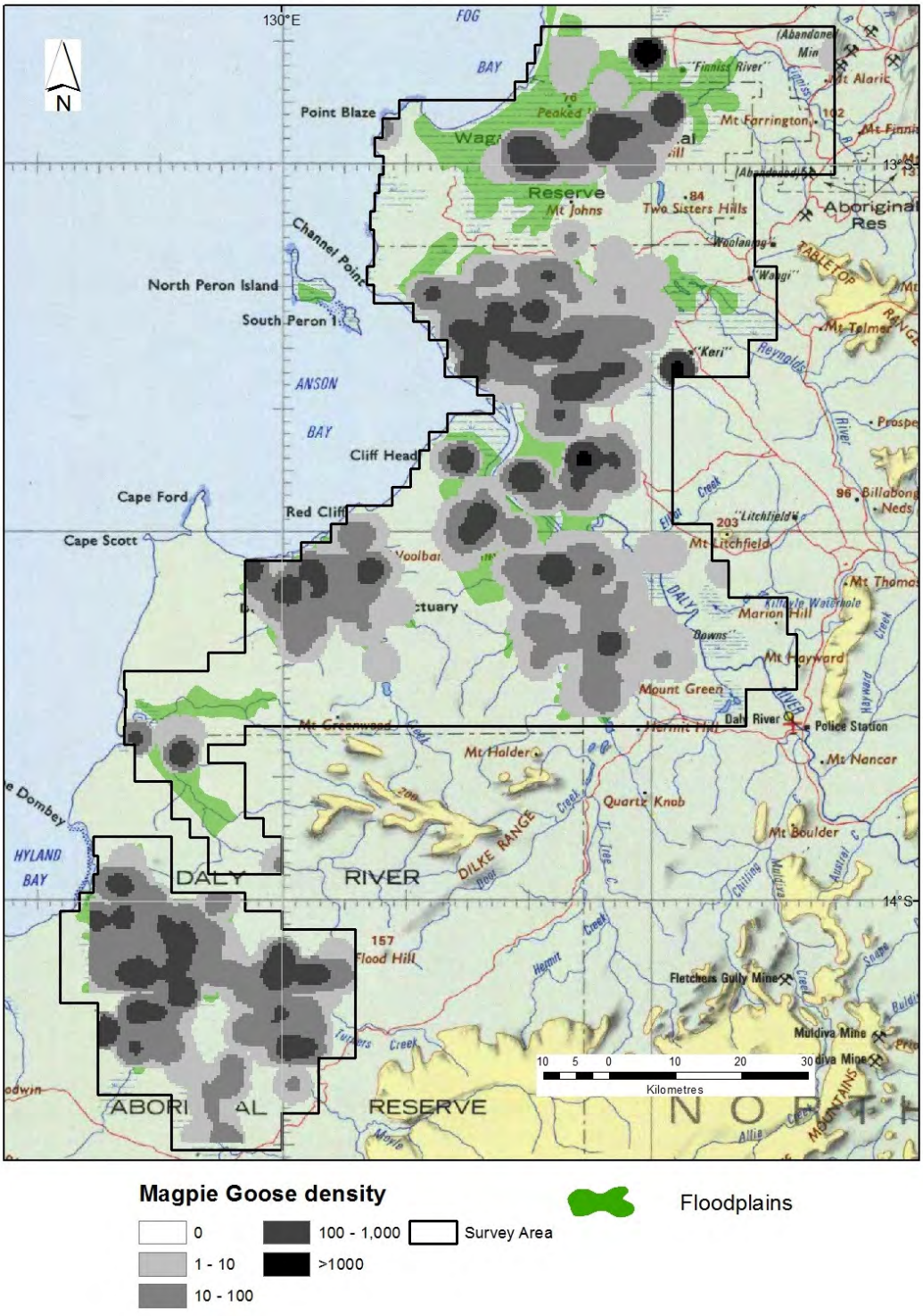

Figure 5a: **Magpie Goose density across the Moyle River floodplain to Finniss River floodplain survey area (number per sq. km).**

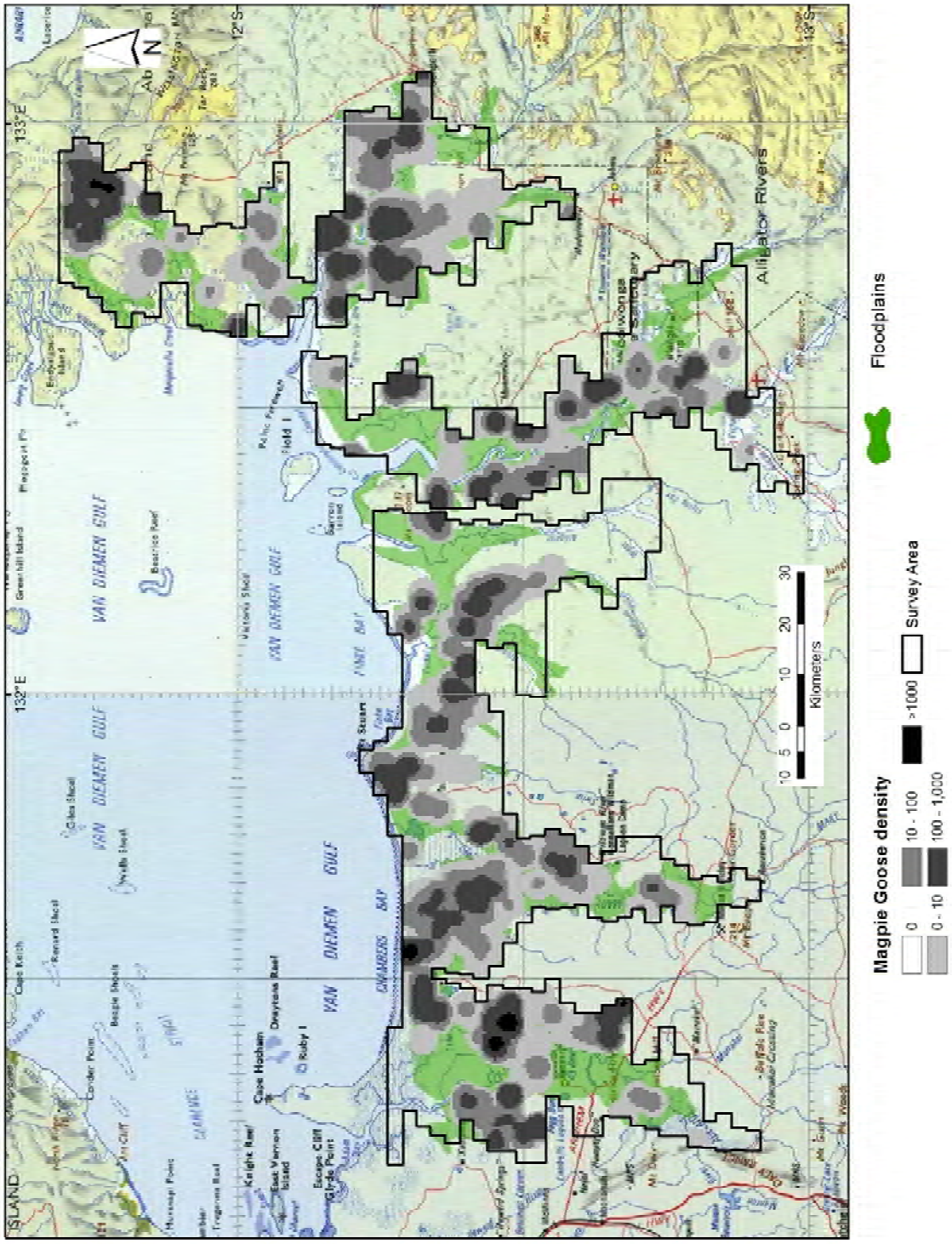

Figure 5b: **Magpie Goose density across the Adelaide River floodplain to Murganella Creek floodplain survey area (number per sq km).**

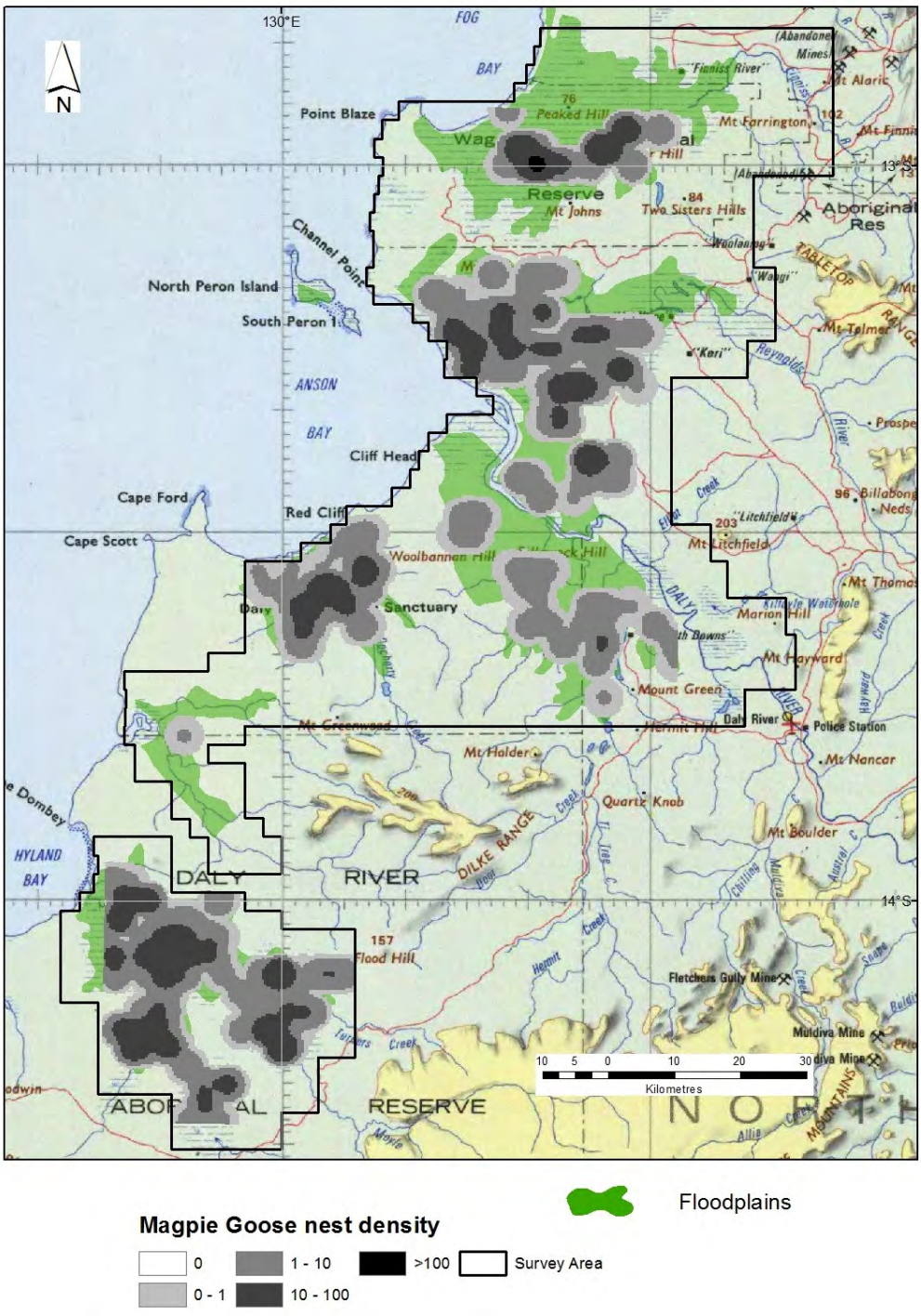

Figure 6a: **Magpie Goose nest density across the Moyle River floodplain to Finniss River floodplain survey area (Nests per sq km).**

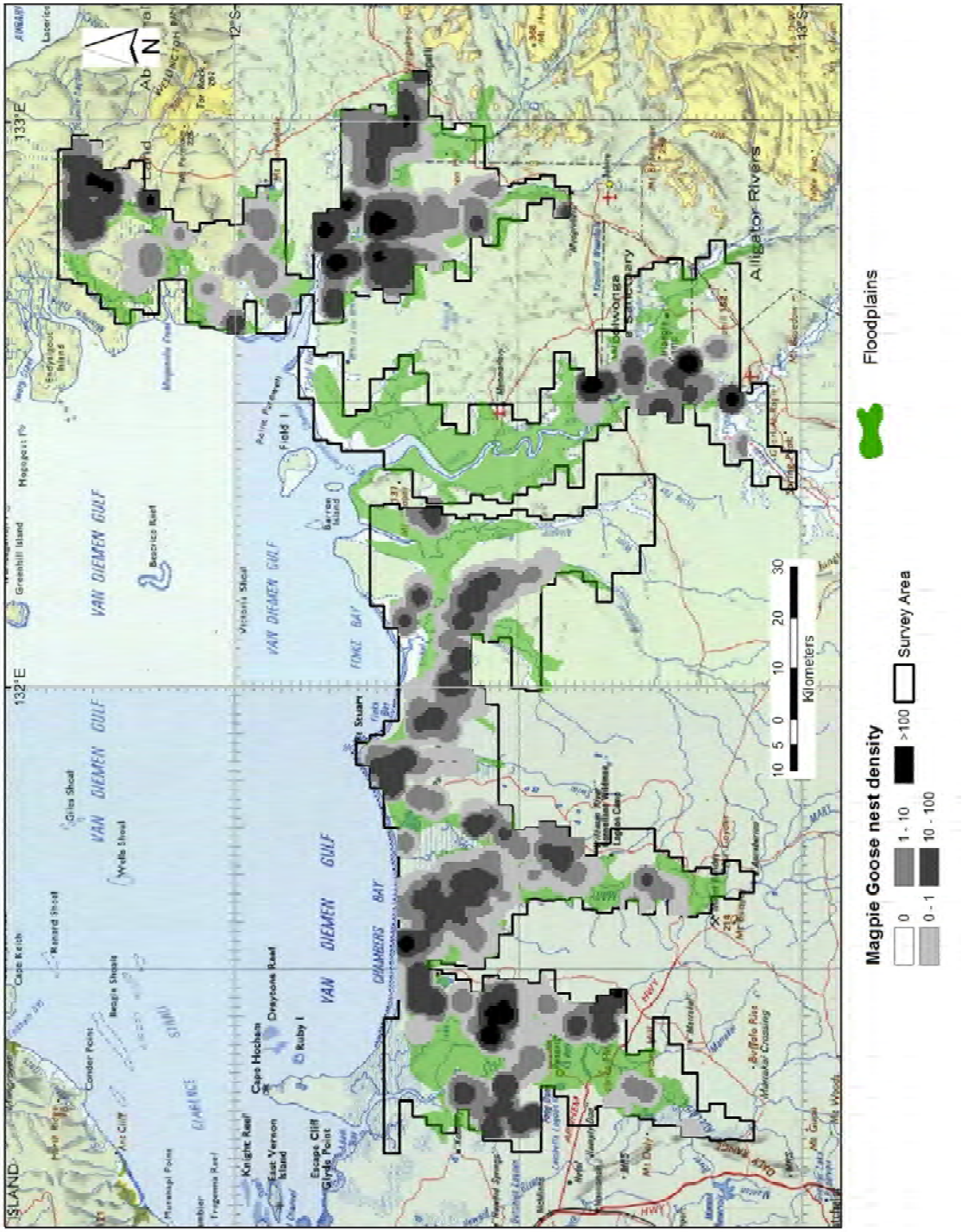

Figure 6b: **Magpie Goose nest density across the Adelaide River floodplain to Murganella Creek floodplain survey area (Nests per sq km).**

Discussion

Correction Factors

Population estimates are corrected for perception and visibility bias using the wet season correction factors of Bayliss & Yeomans (1990a, b). Use of these correction factors is considered to be the best approach in the absence of survey/observer specific corrections. Survey/observer specific corrections would require a replication of Bayliss & Yeomans (1990b) experiment for each survey, which is not considered to be a cost effective use of limited resources.

It should be noted that the Bayliss & Yeomans (1990a, b) correction factors were derived in ‘good’ wet season conditions. It is reasonable to assume that these corrections factors may result in some degree of overestimation of population estimates when applied to data collected in ‘poor’ wet seasons. In ‘poor’ wet season vegetation cover is reduced and animals and nests would be more visible and thus have a higher probability of detection. The degree of potential overestimation is considered to be small and not significant.

Population Size and Distribution

The distribution of Magpie Geese within the survey area was patchy with a number of major areas of goose distribution clearly visible in Figures 5a and 5b. Very low densities of Magpie Geese were seen on the inland (upstream) reaches of the major floodplains within the survey area.

The population estimate for Magpie Geese of 643,542 ± 70,068 for the combined survey areas potentially represents between 85 to 90% of the total 'Top End' Magpie Goose population, based on earlier 'wet' season surveys (Bayliss & Yeomans 1990a) which covered the entire Top End distribution. Extrapolation based on those proportions gives an estimated ‘Top End’ population of between 645,750 and 803,250 Magpie Geese.

The precision value of the overall Magpie Goose population abundance estimate was very low, 10.9%, which provides strong support for the robustness of the estimate and, subject to the appropriate correction factor being used, the accuracy of the estimate. This precision provides confidence that comparison of this with earlier surveys will give a good indication of population trend.

The estimate of nest abundance of 84,824 ± 13,336 for the combined survey areas can similarly be extrapolated to a total nest abundance of 79,895 to 109,125 for the Top End in 2017. The nest estimates from the 2014 survey to this year’s survey is low compared to 2011 and 2012 (Saalfeld 2011, 2012), although higher than 2013 when nesting was considered to have failed completely (Saalfeld 2013).

Population trends

Magpie Goose population estimates from the last five years of surveys indicate that the population was stable around the 2.6 million level for 2011 through 2013, and then suffered a substantial decline of about 50% in 2014 (Table 4 and Figure 6). Between 2014 and 2016 the population appeared stable around the 1 to 1.3 million level. In 2017 the population suffered a further 45% decline on the 2016 level and an overall 72% decline on the high of 2011-2013..

Table 4: Details of Top End Magpie Goose population and nest estimates from 2011 - 2017.

	Magpie Goose (million)	Magpie Goose nests
2011	2.4 ± 0.4	283,000 ± 82,000
2012	2.9 ± 0.5	184,000 ± 36,000
2013	2.5 ± 0.4	13,000 ± 4,000
2014	1.3 ± 0.1	134,000 ± 4,000
2015	1.2 ± 0.2	105,000 ± 13,000
2016	1.3 ± 0.1	40,000 ± 6,000
2017	0.72 ± 0.1	95,000 ± 15,000

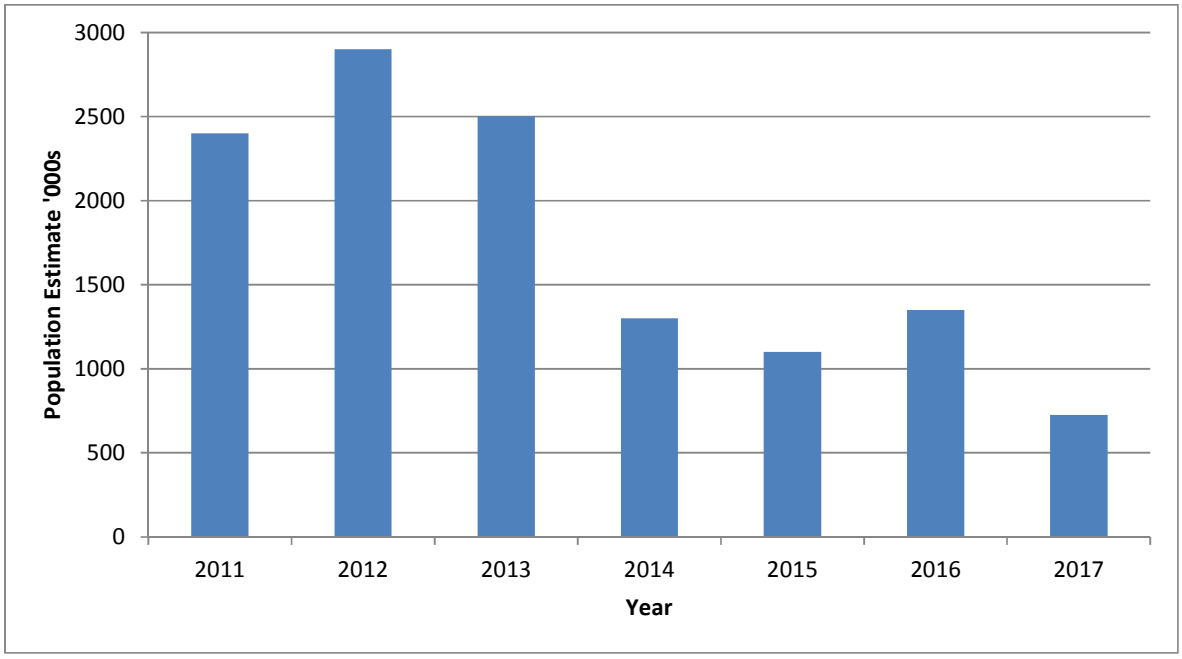

Figure 6: Top End Magpie Goose population estimates from 2011 – 2017

The decline in Magpie Goose abundance in 2014 followed a failed nesting year and was coupled with a reduced nesting season in 2014 (relative to nesting in 2011 and 2012). The reduced population was maintained in 2015 and 2016. The maintenance of the 2014 decline is interpreted as a response to a combination of events: negligible recruitment in 2014 and reduced recruitment in 2015 and 2016 following the failed and reduced nesting seasons between 2013 and 2016 (Figure 7), natural and hunting mortality during the 'dry season' at or exceeding sustainable harvest rates for the population size; and

possible dispersal of Magpie Geese out of the 'core' survey area during the 2014 to 2016 wet season due to below average and/or disjunct rainfall patterns. This interpretation is consistent with observed trends in the Magpie Goose population distribution and abundance over the last 30 years (Figure 8). In particular, there is a strong similarity to the substantial reduction of nesting in 1987 due to a cyclonic event, which was followed by a 50% population decline in 1988 and recovery over the next few years associated with good wet seasons in 1989 and 1990. The below average 2014-2015 wet season is considered the proximal factor in the continued low Magpie Goose and nest survey estimates.

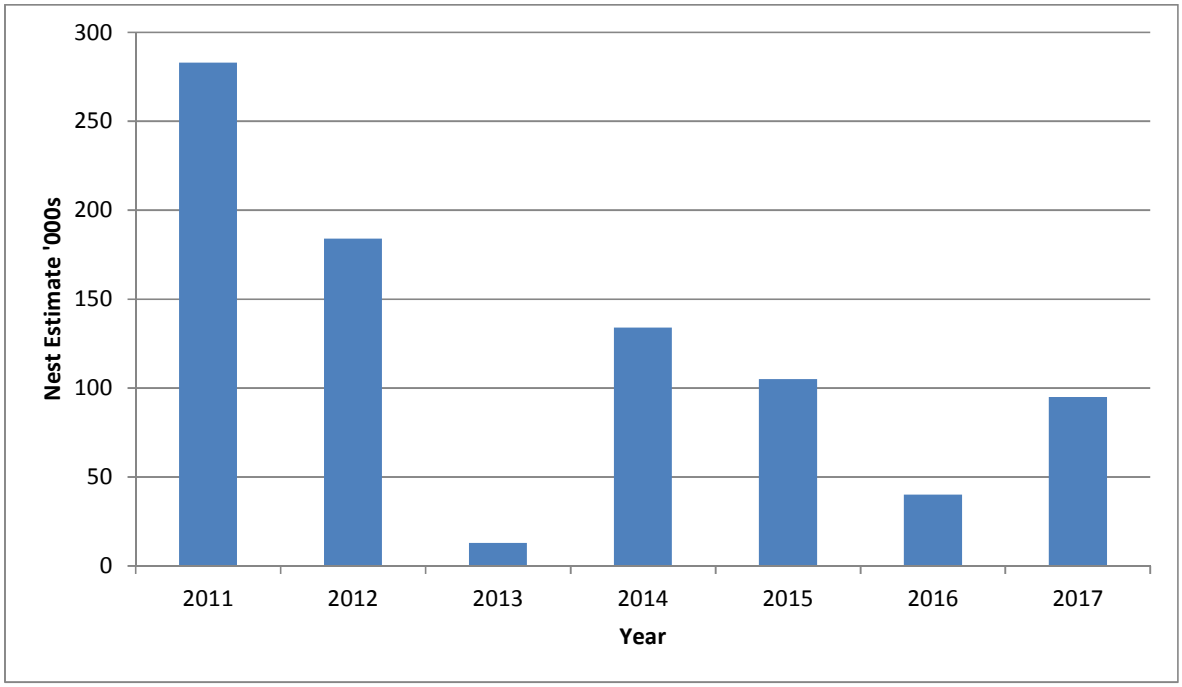

Figure 7: Top End Magpie Goose nest estimates from 2011 – 2017

The contribution of each of the possible factors to the observed population decline is uncertain, although there was limited evidence of large numbers of Magpie Geese occurring outside of the 'core' survey/nesting area during the course of the 2016-2017 wet season, as has been reported in previous years when the goose population has dispersed due to poor rainfall (Bayliss, 1989, Whitehead and Saalfeld, 2000). C. Manolis (***pers. comm.***) reported substantially increased numbers of magpie geese in the Townsville, Queensland, area during the 2016 dry season; estimating that numbers of geese present on a local mango farm had increased by at least an order-of-magnitude from hundreds to thousands and possibly tens of thousands.

Rainfall for the 2016-2017 wet season was 48% above average in total (Bureau of Meteorology). An observed proportionate increase in Magpie Goose nesting for the 2016-2017 wet season is attributed to this above average wet season; however, the nesting population was very low compared with years prior to 2014.

From a management perspective, the continued Magpie Goose population decline (Figure 6), coupled with reduced or failed nesting in 2 of the past 4 seasons up to 2017 (Figure 7), requires consideration be given to decisive management intervention to minimise and preferably reverse any continued population decline. This risk will become substantial if there are further reduced or failed nesting seasons in 2017-2018 and subsequent years. One management mechanism is to reduce human-induced mortality due to hunting, especially during periods where population levels and nesting success rates are relatively low (as described in the ***Management Program for the Magpie Goose (Anseranas semipalmata) in the Northern Territory of Australia, 2009-2014)***.

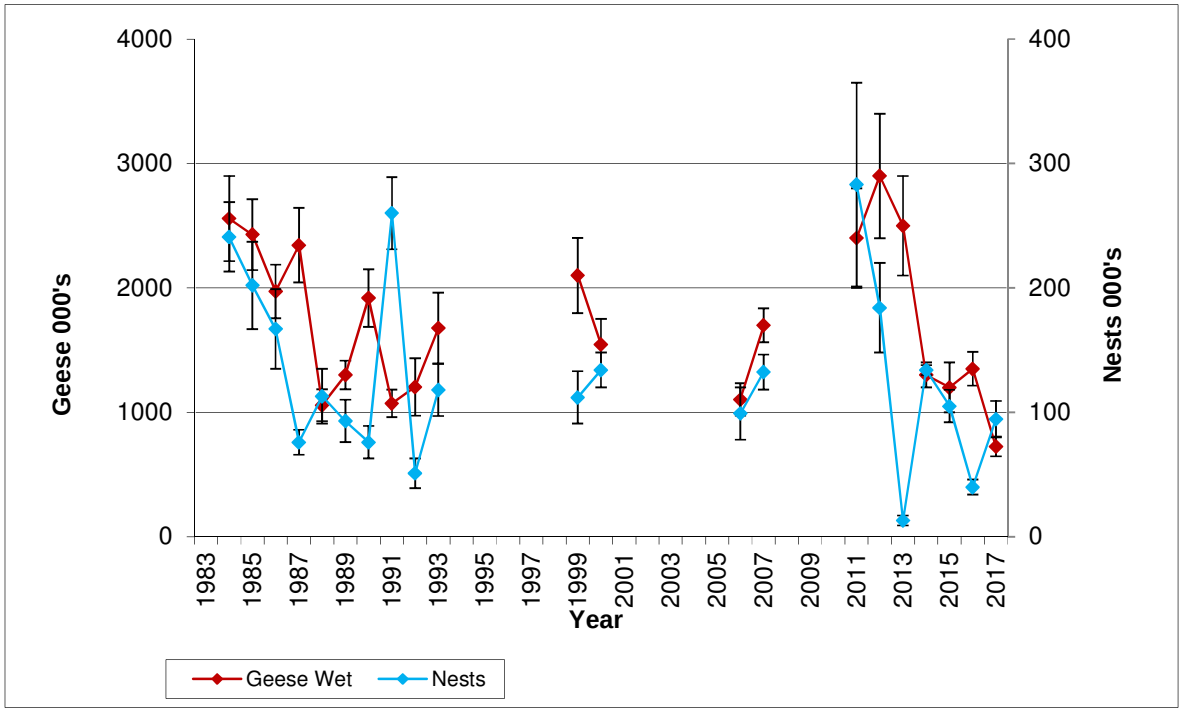

Figure 8: **Magpie Goose population and nests estimates for the period 1983 to 2017 derived from aerial survey data**

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