Aerial Survey of Magpie Geese in the Darwin to Kakadu region of the 'Top End', Northern Territory.

18st April, 2013 to 24th April, 2013

A report to the Department of Land Resource Management

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Abstract

During the period of 18th April to 24th April 2013, an aerial survey of the floodplains/wetlands in the Adelaide River floodplain to Murganella floodplain area, was conducted to determine the distribution and abundance of Magpie Geese within this area of the overall distribution of Magpie Geese in the Top End of the Northern Territory. The total survey area of 8,656 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 Baylis and Yeomans (1990a & b).

The resultant population estimate for Magpie Geese was 1,430,366 ± 247,807 a density of 165.2 ± 28.6 Magpie Geese per km^2 at a precision of 17.3% within the survey area. The population estimate for Magpie Goose nests was 12,730 ± 4,440 a density of 1.47 ± 0.51 nests per km^2 at a precision of 34.9% within the survey area. These estimates are considered to be minimum estimates due to the negative biases' commonly associated with aerial surveys. Extrapolating these estimates to the whole of the Top End based on the surveys of Bayliss and Yeomans (1990a), gave a Magpie Goose population range of 2.1 to 2.9 million geese. Given the poor precision of the Magpie Goose nest estimate for the survey area; estimates with precision greater than 21% are not considered reliable; no extrapolation of an overall nest estimate has been made. The very poor nesting is a consequence of the below average and highly variable 2012-2013 wet season and is interpreted as indicating a failed nesting season.

Introduction

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

From the early 2000's, Australia's 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 into their former ranger is attributed to the recovery/rehabilitation of 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 Department of Land Resource Management, the Parks and Wildlife Commission of the Northern Territory and the Department of Sustainability, Environment, Water, Populations and Community have 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 and Yeomans 1990a, Saalfeld, 1994 and Saalfeld 1996), including Kakadu National Park.

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 and Yeomans 1990 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, one in 2000 and a second in 2006. Both of these surveys covered the floodplain area 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 of "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 re-design the monitoring program for Magpie Geese surveys in 2010 and to implement a survey monitoring program in 2011.

Review and re-design on 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" (Appendix 1). 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 a full aerial survey covering the entire range of the Magpie Goose annually would provide the maximal combination of precision and accuracy, resource limitations do not allow for this. As a means of addressing the resource limitations, the range of the Magpie Goose in the Top End has been broken into three major distributions (Figure 1) and each will be surveyed tri-annually.

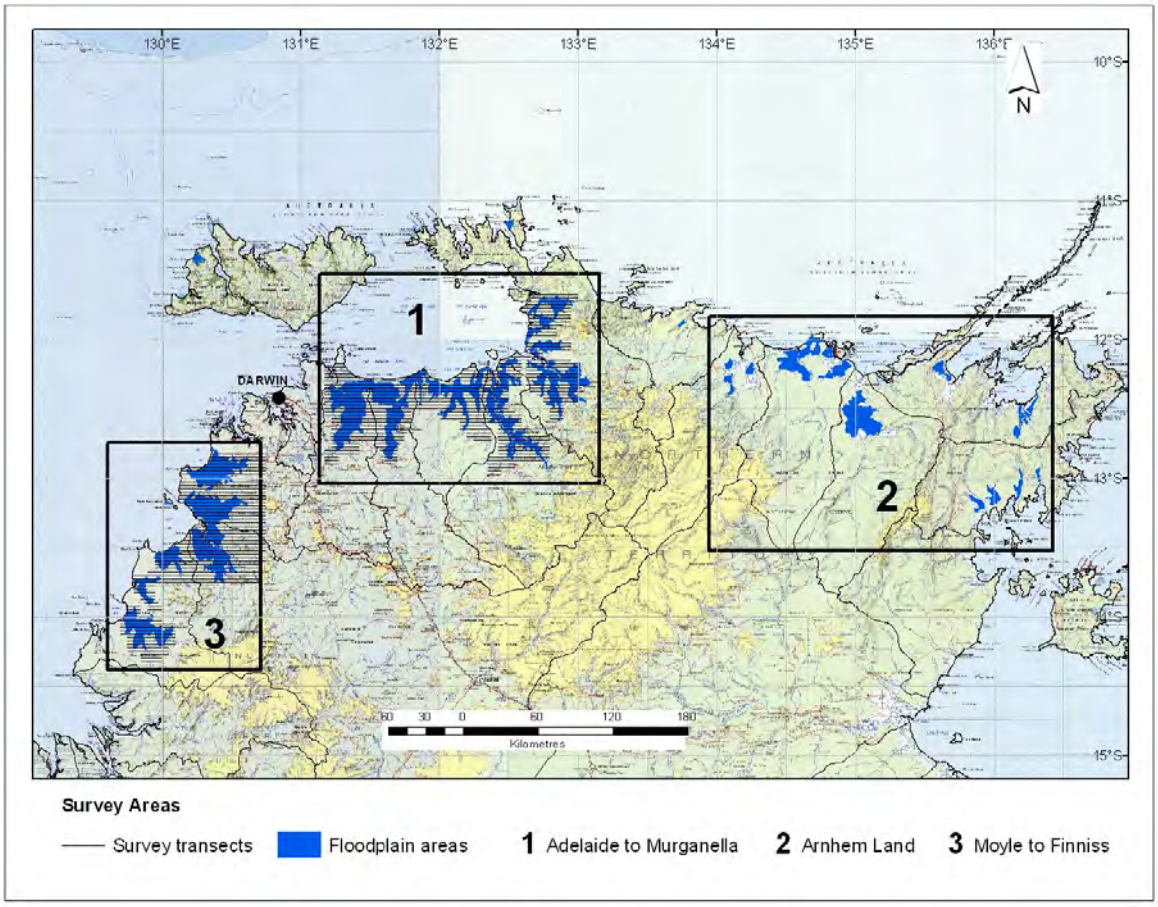

Figure 1: Survey areas for Magpie Goose aerial surveys. Each area will be surveyed tri-annually.

The first of the three major distribution areas to be surveyed is the Adelaide River floodplain

to Murganella floodplain (see Figure 1). This will be followed by the Arnhem Land floodplain area in the second year and the Moyle floodplain to Finniss floodplain area in the third year (see Figure 1).

The revised monitoring program was implemented in 2011, with the survey of the Adelaide River floodplain to Murganella floodplain area (see Saalfeld, 2011). Due to poor wet season conditions in 2011-2012, the decision was made to survey the Moyle floodplain to Finniss floodplain area in 2012, rather than Arnhem Land (see Saalfeld, 2012). Overall population estimates from these two surveys are presented in Table 1.

Table 1: Details of population estimates from 2011 and 2012 aerial surveys.

	Magpie Goose	Magpie Goose nests
2011	2.02 to 2.82 million	201,000 to 366,000
2012	2.4 to 3.4 million	148,000 to 220,000

This report details briefly the results of the 2013 aerial survey of Magpie Geese in the Adelaide River floodplain to Murganella floodplain area. The decision was taken to survey this distribution area in preference to the Arnhem Land distribution area due to the extremely poor wet season (below average rainfall and highly variable monthly distribution of rainfall). This is a consequence of the Adelaide River floodplain to Murganella floodplain area survey covering a significant proportion (approximately one half to two thirds) of the total distribution of Magpie Geese in the Top End.

Methods

Survey Area and Design

The Adelaide River floodplains to Murganella floodplains survey area (latitude $11^0$40'S to $13^0$00'S, longitude $131^0$10E to $133^0$00E) covered all major floodplains and wetland habitat within the area (Figure 2) and was surveyed between 18th April to 24th April, 2013. This area was divided into nine major survey blocks.

The survey was conducted using a Cessna 182 high-wing aircraft flown at a ground speed of 185 km^{-1} (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 and 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 Figure 2. All lines were aligned east-west to traverse perpendicularly the 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% with a 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) and a port rear seat observer.

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, Brolga (***Grus rubicundus***), and Jabiru (***Ephippiorhynchus asiaticus***) 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 Magpie Goose Aerial Survey Standard Operating Procedure.

Post Survey Data Editing

Data was downloaded daily from each observer's Palmtop computer to a Laptop Personal 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 the observers merged. The resultant file was then appended to the survey master file for analysis

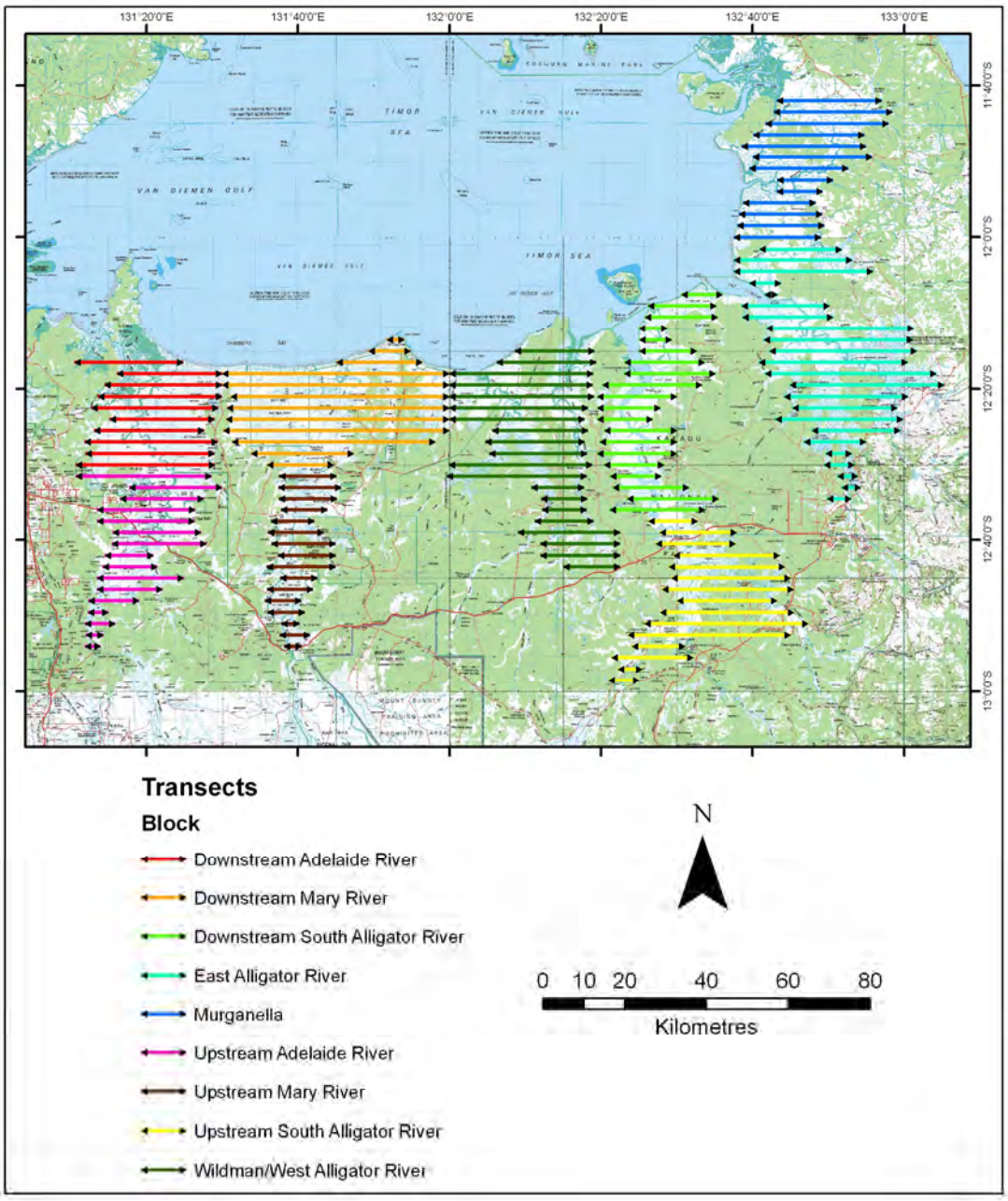

Figure 2: Survey blocks and survey transects flown.

Analysis

Because transects were variable in 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 estimated numbers of each species for each observer. The resultant standard error was adjusted to incorporate the error associated with the appropriate estimates of mean group size following the method of Jolly

and Watson (1979) and Marsh and Sinclair (1989). Estimates were corrected for perception and visibility bias using the wet season correction factors of Bayliss and Yeomans (1990a & b). Correction factors were 3.28 for Magpie Geese and 2.23 for Magpie Goose nests.

Results

Minimum Population and Density Estimates

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 2.

Table 2: Details of mean group size and associated standard error used in the population estimates.

Species	Mean Group Size	Standard Error
Magpie Goose	50.3	5.32
Magpie Goose nests	10.7	2.20

The population estimates, density and precision figures for the survey area are presented in Table 3.

From Table 3 it is apparent that the precision for individual species within survey blocks is variable and in a number of cases 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 the entire survey area the overall precision was 17.3%, while for the Magpie Goose nest population estimate for the entire survey area the overall precision was 34.9%. The overall precision of the Magpie Goose population estimate is considered acceptable for accurate estimation of the population abundance and distribution, but the precision of the Magpie Goose nest population estimate is too great for accurate estimation of the population abundance and distribution and the nest data is not analysed further.

Distribution of Magpie Goose and Magpie Goose nests

Figures 3 and 4 shown sighting distribution maps for Magpie Goose and Magpie Goose nests within the survey area. Figures 5 shows kernel density distribution map Magpie Goose within the survey area.

From Figures 3 and 5 it can be seen that 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. Also apparent is that the pattern of Magpie Goose distribution is toward the downstream areas of each of the major river/floodplain systems within the survey area.

Table 3: Estimated population, density figures (in brackets), and precision (as a percentage), for Magpie Goose and Magpie Goose nests. Values are ± standard error incorporating the errors resulting from sampling and in estimating mean group size.

Block (area in km^2)	Magpie Goose	Magpie Goose nests
Downstream Adelaide River (798)	132,986 ± 53,380 (166.8 ± 66.9) 40.1	6,944 ± 3,766 (8.7 ± 4.7) 54.2
Upstream Adelaide River (719)	40,125 ± 15,242 (55.8 ± 21.2) 38.0	1,323 ± 963 (1.8 ± 1.3) 72.8
Downstream Mary River (1,240)	182,282 ± 62,342 (147.0 ± 50.3) 34.2	3,307 ± 1,887 (2.7 ± 1.5) 57.1
Upstream Mary River (490)	20,636 ± 14,228 (42.1 ± 29.0) 68.9	
Wildman/West Alligator River (1,319)	126,876 ± 55,205 (96.2 ± 41.9) 43.5	
Downstream South Alligator River (915)	168,525 ± 63,846 (184.2 ± 69.8) 37.9	165 ± 169 (0.2 ± 0.2) 102.4
Upstream South Alligator River (950)	33,246 ± 14,092 (35.0 ± 14.8) 42.4	
East Alligator River (1,404)	488,379 ± 185,697 (347.7 ± 131.9) 37.9	
Murganella (822)	237,311 ± 112,161 (288.6 ± 136.4) 47.3	992 ± 1,007 (1.2 ± 1.2) 101.5
Total survey area (8,657)	1,430,366 ± 247,807 (165.2 ± 28.6) 17.3	12,730 ± 4,440 (1.5 ± 0.5) 34.9

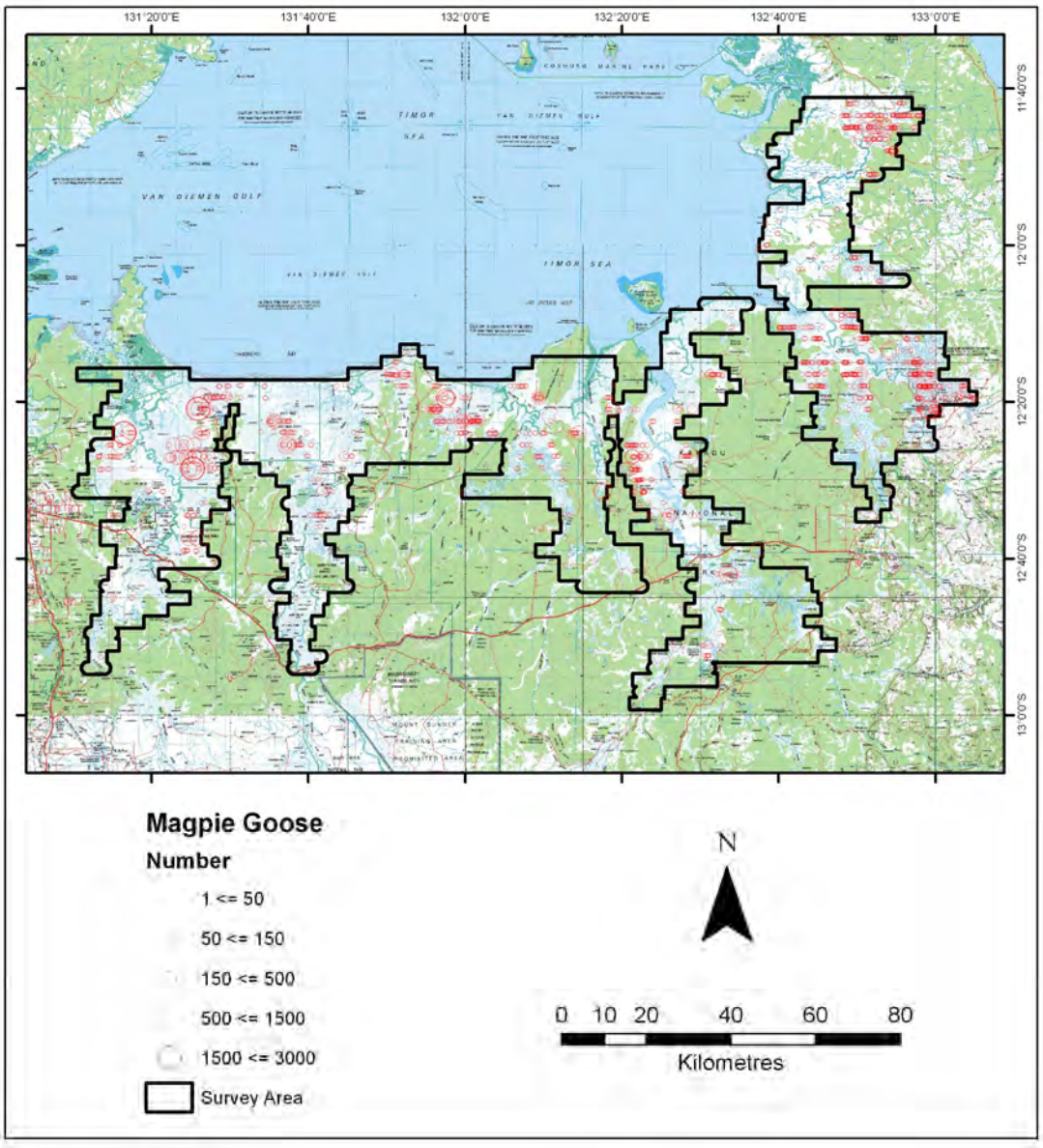

Figure 3: Distribution of Magpie Goose sightings across the survey area.

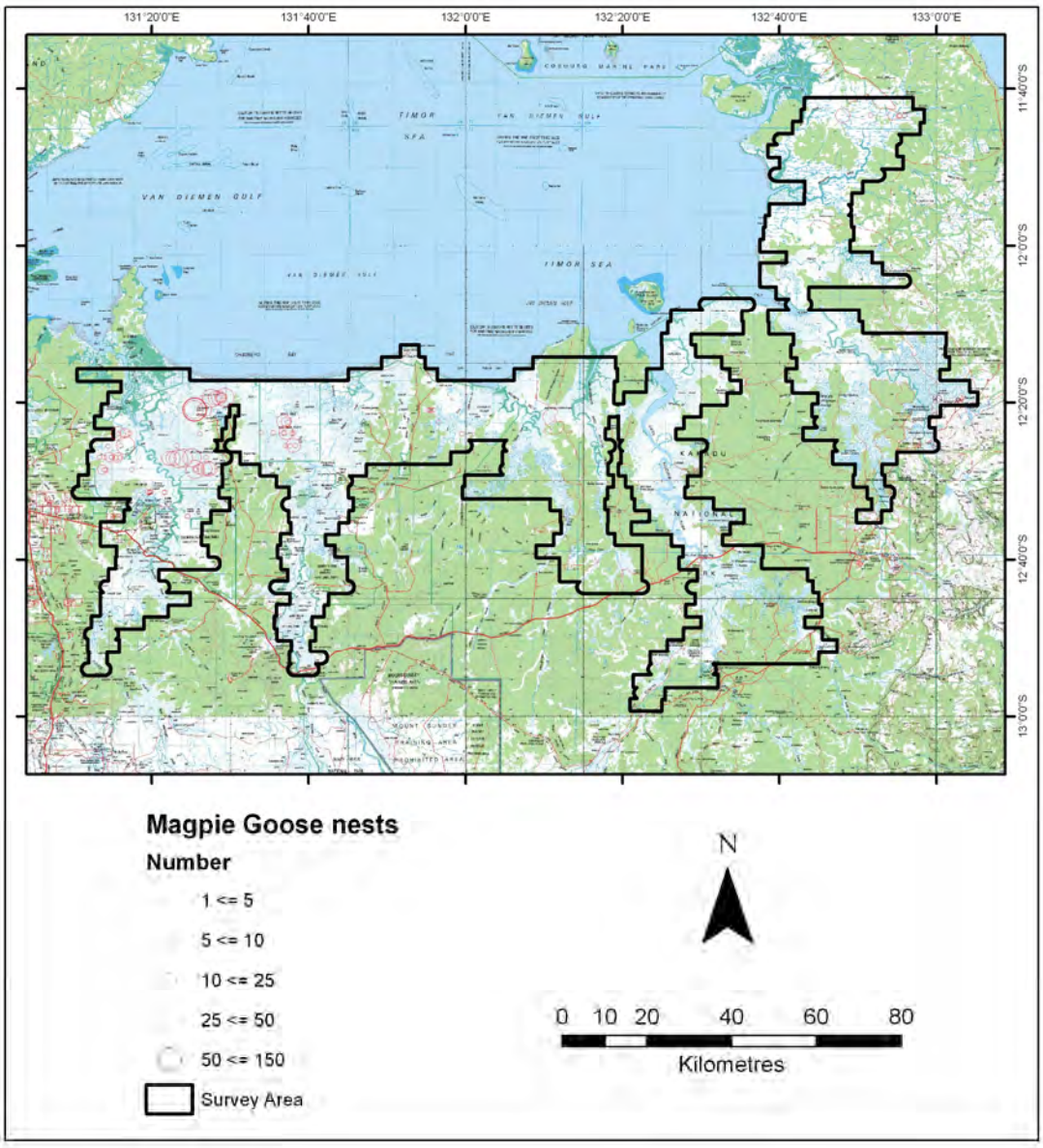

Figure 4: Distribution of Magpie Goose nest sightings across the survey area.

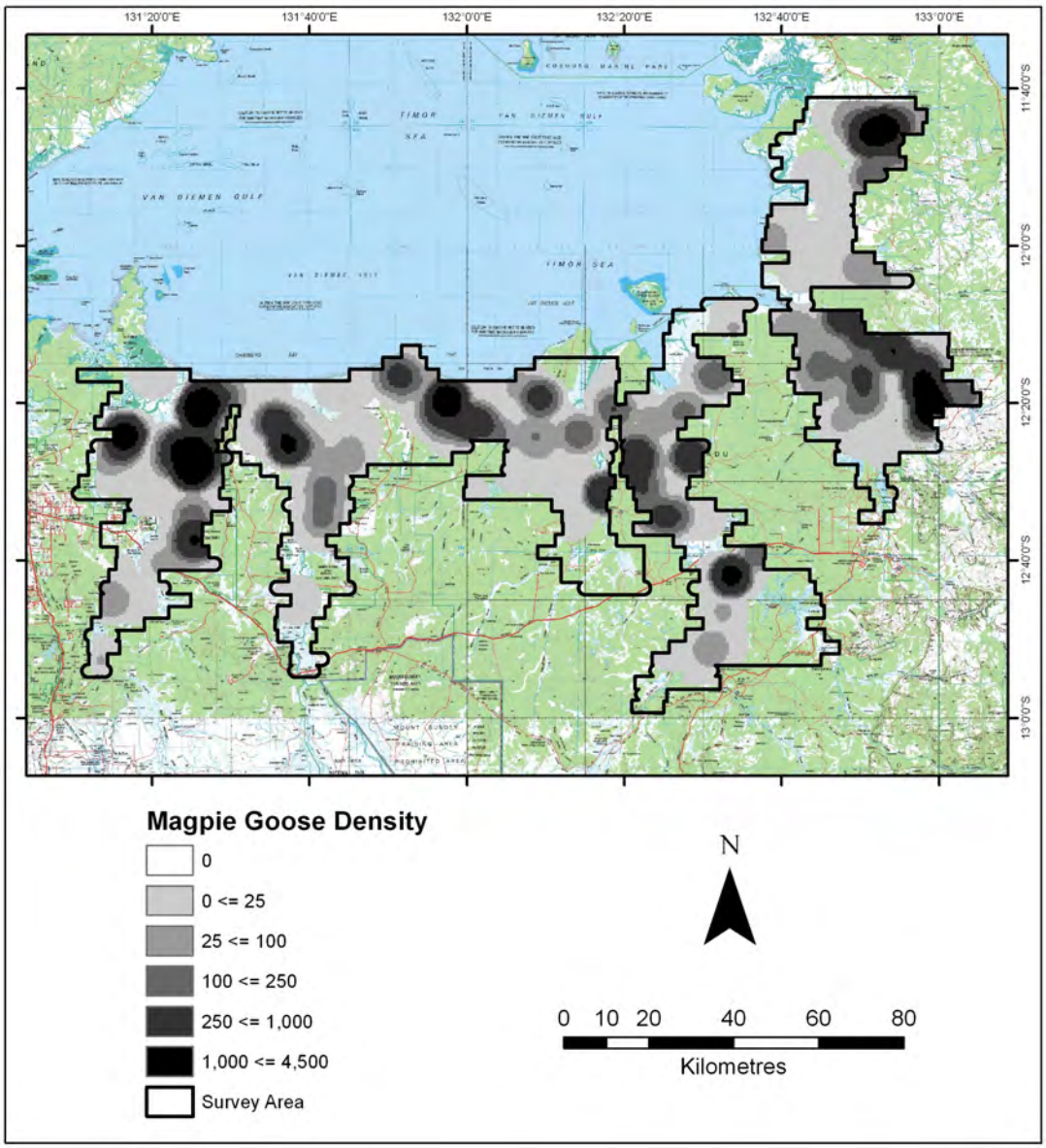

Figure 5: Magpie Goose density across the survey area (Geese.km^{-2})

Discussion

Correction Factors

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

It is proposed that for large scale surveys over seasonally variable habitat, survey specific correction factors are essential if accurate estimates are to be derived. The use of generalised correction factors based on past surveys is subject to a high degree of error due to variability in environmental bias in the same area depending on 'wet' and 'dry' season conditions. Weighing against obtaining survey specific corrections is the high cost associated with the necessary experimental models, particularly those involving index-manipulate-index designs or observer/photo contrast designs.

Using the correction factors of Bayliss and Yeomans (1990a & b) gives population estimates of 1.4 million Magpie Geese and 13,000 Magpie Goose nests within the survey area.

Population Size and Distribution

The distribution of Magpie Geese within the survey area was very patchy with a number of major areas of goose distribution clearly visible in Figures 3 and 5. Very low densities of Magpie Geese were seen on the inland (upstream) reaches of the major floodplains encompassed within the survey area.

The high population estimate for Magpie Geese of 1.43 $\pm$ 0.25 million, potentially represents anywhere from one half to two thirds of the total 'Top End' Magpie Goose population; based on earlier 'wet' season surveys (Bayliss and Yeomans 1990a) which covered the entire Top End distribution. This gives an estimated population abundance range using the mean of.2.1 to 2.9 million Magpie Geese and an absolute minimum to maximum Top End population estimate of 1.8 to 3.4 million Magpie Geese.

The precision of the overall Magpie Goose population abundance estimate, while less than the 20% limit considered acceptable for reliable estimates, is close to this limit. This high precision is a reflection of the extremely patchy distribution of Magpie Geese during the 2013 survey, with a few areas of very high abundance being observed across the survey area and large areas of low or zero abundance.

The extremely low estimate of nest abundance coupled with the very high estimate of precision is interpreted as indicating that almost no nesting occurred during the 2012-2013 wet season, and no further analysis of nest data was carried out.

Magpie Goose population distribution and abundance estimates from the last three years of surveys appear to indicate that the population is stable about the 2.6 million level (Table 4).

Table 4: Details of Magpie Goose population and nest estimates from 2011, 2012 & 2013 aerial surveys.

	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

These results are consistent with the trend observed in Magpie Goose population distribution and abundance over the last 30 years (Figure 6) and reinforce the importance of the floodplains of the Top End of the Northern Territory for the maintenance of the Magpie Goose in the Northern Territory and the need for management to continue to be directed towards to the maintenance of the area in a manner that avoids any loss or degradation of the floodplains, particularly the downstream reaches which appear to provide major nesting areas.

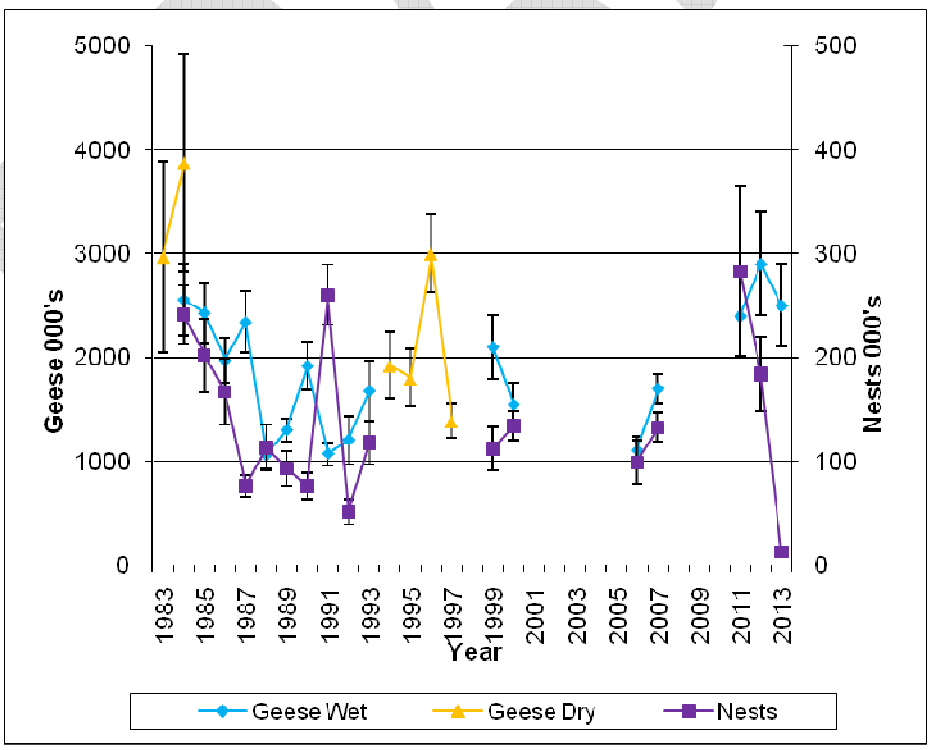

Figure 6: Magpie Goose population and nests estimates for the period 1983 to 2013 derived from aerial survey data

The failure of Magpie Goose nesting in the 2013-2013 wet season can be directly attributed to the pattern of rainfall distribution over the past wet season, rather than any anthropogenic mechanism. During the 2012-2013 wet season rainfall was average or slightly below average across the Top End of the Northern Territory, particularly on the coastal floodplains of the western op End, and had a very disjunct temporal (monthly) distribution. October, November and December 2012 all had slightly below average rainfall; January and February 2013 had substantially below average rainfall; and March, April and May 2013 had average to slightly above average rainfall. Magpie Goose population modelling (Bayliss 1989 and Whitehead and Saalfeld 2000) has indicated that early wet season rainfall October through February is crucial for Magpie Goose nesting to occur. The substantially below average January and February 2013 rainfall is considered to be the proximal cause for the failure of Magpie Geese to nest in the 2012-2013 wt season.

From a management perspective, failure of Magpie Goose nesting in the 2012-2013 wet season is not considered to be sufficient cause to recommend any changes to the 2013 waterfowl hunting season. This is based on the undiminished population estimate and the know resilience of the population (nesting has failed in the past with little or discernable impact on the population) [reference]. Consecutive years of nesting failure would be sufficient cause to review hunting season timing, duration and bag limits.

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