

Feral Camel Distribution and Abundance of the Warburton Central Ranges and Northern Great Victoria Desert

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Abstract

A broad scale aerial survey of the Warburton Central Ranges and the northern Great Victoria Desert was undertaken in May 2007 to determine the density and distribution of camels within the survey area. A population of 54,579 camels at a mean density of 0.84/km² was determined. Two methods were utilized, a double count method used routinely for camel assessments and a distance sampling method proposed by Lethbridge (2007b). Both methods returned a similar density result although the distance sampling method was considered more accurate. The camel density was almost three times that measured elsewhere in WA and suggests the Central Ranges may be an exceptional 'hotspot' of camel density. Camels were highly clustered in the landscape with 25% of the area containing over 70% of the camels.

Introduction

An estimated 10- 20,000 Arabian camels (*Camelus dromedaries*) were imported into Australia between 1840 and 1907 to assist with transport and exploration (Pest Animal Control CRC 2005). As motor transport developed there was a wholesale abandonment of camels into the wild during the 1920s and 1930s (Edwards et al 2004). Earlier surveys have shown dramatic growth trends in the Australian camel population with numbers set at about 100,000 in the mid 80s which had increased to 600,000 by 2005. Current estimates are placing camel numbers over 1 million for all of Australia (extrapolated from Lethbridge 2007b). These population values display an exponential growth rate which as yet has not shown any signs of slowing. Commensurate with this growth in the feral camel population has been documented and anecdotal evidence of damage to native vegetation in some ecosystems, damage to cultural sites, especially rock holes, and damage to pastoral infrastructure.

Understanding the density and distribution of feral camels is a prerequisite for assessing risk, formulating cost-effective control strategies and for assessing the effectiveness of control strategies.

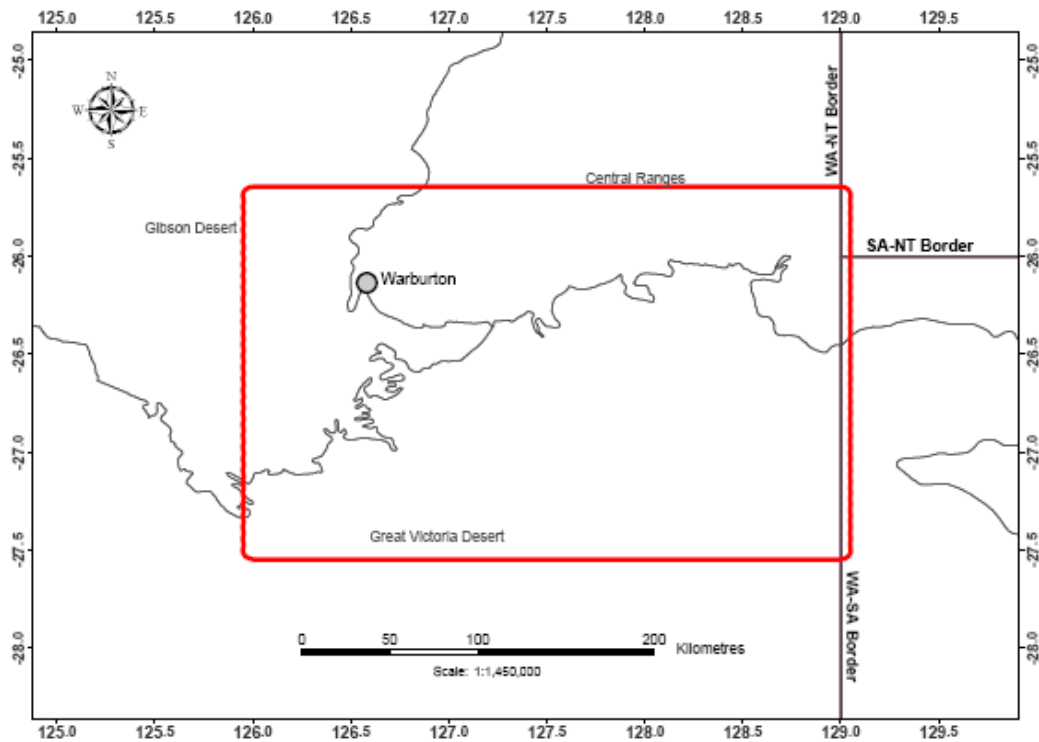
Broad scale aerial survey techniques which have been developed to monitor kangaroo and other wildlife populations remains the only practical method for large scale surveys in remote areas. The aerial survey method adopted from Edwards *et al* (2004), Axford *et al* (2002), Ward *et al* (2005) and others has become the established way to assess the abundance of feral camels and utilizes a double count method. The precision of density estimates have varied significantly between surveys and may be due to localised variation within the survey areas (Lethbridge 2007b). A distance sampling method was proposed (Lethbridge 2007a) to run in conjunction with the double count method and as an alternative to compare density estimates and survey precision. Computer simulation was used to test the relationship between camel density estimates, standard errors and survey intensity. These simulations used a range of survey intensities and camel group size to test the effect on survey precision measured against effort (cost) (Lethbridge 2007a).

Two surveys were proposed one in South Australia and the other in Western Australia with the same design and sample intensity applied. Both surveys aimed to determine the camel distribution and density within the survey areas. This document reports specifically on the Western Australian survey and on camel distribution in the Warburton survey area with associated effects on camel density estimates and survey precision.

Methods

Survey Area

A broad scale aerial survey was undertaken in the Warburton Central Ranges and northern Great Victoria Desert area during May 2007 (Figure 1). The survey employed 32 east-west transects each 300km long and 6km apart (4' latitude) providing a sample intensity of 6.6%.

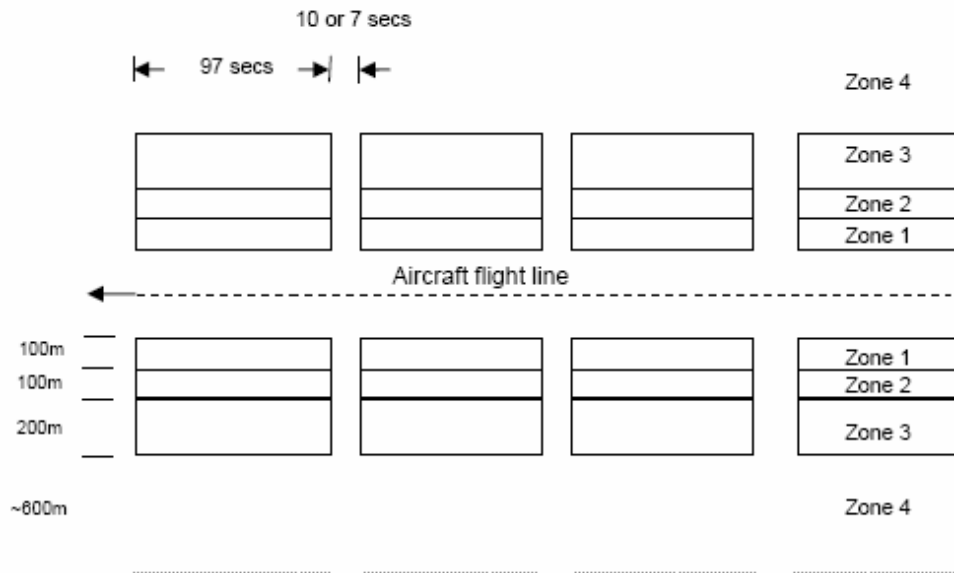


Source: Lethbridge (2007b)

Figure 1: Western Australia survey boundary 65,156 km² with IBRA regions

Survey Method

This survey utilised two assessment methods; a double count method (Edwards 2004) and distance sampling (Buckland *et al* 1993 and Lethbridge 2007b). A Cessna 210 aircraft fitted with radar altimeter and GPS (Global Positioning System) was used for the survey, which was conducted at a height of 250' (76m) and at a ground speed of 100kts (185 km/hr). Strips 200m on each side of the aircraft were used for the double count method and were delineated by cord attached to specially fitted wire struts. The 200m strip was a combination of zones 1 and 2 (figure 2 and plate 1). The distance sampling method used all 4 zones (figure 2).



Source Lethbridge (2007b)

Figure 2: Viewing zones utilized for camel density assessment with zones 1 & 2 used in the double count method and zones 1 to 4 in the distance sampling method.

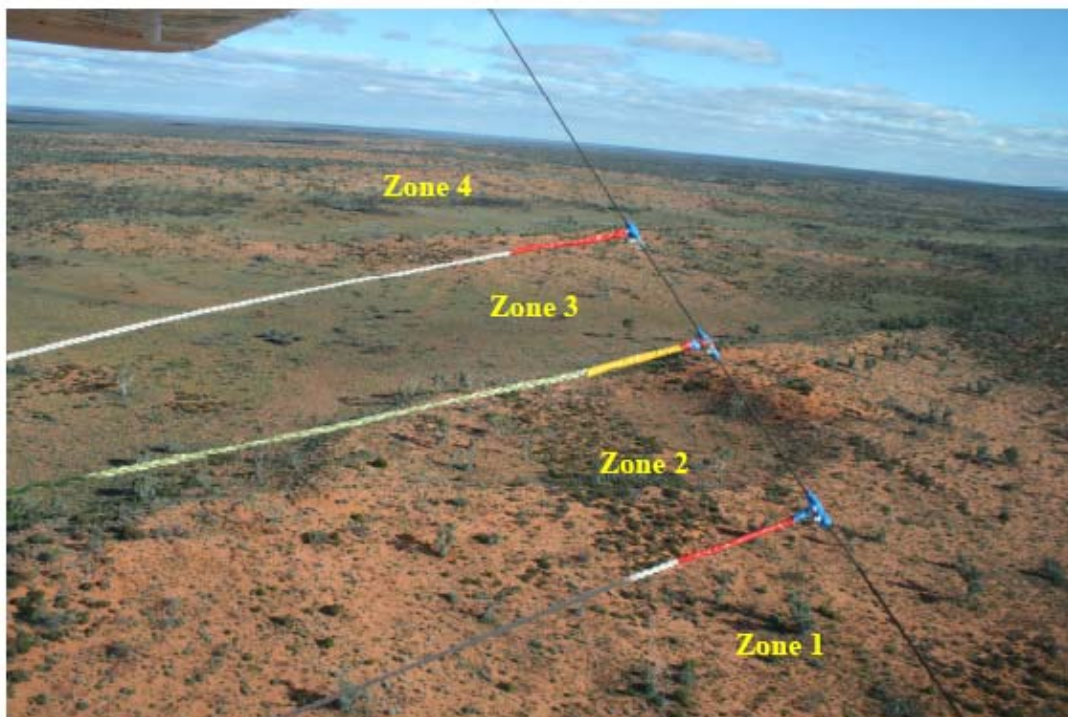


Plate 1 Strut marking on the WA aircraft (*N. Burrows*)

The position of the cords were calibrated on the ground from functions determined by Lethbridge (2007c) and were checked for accuracy once airborne against markers set at 100m, 100m and 200m along the airstrip.

The flight crew consisted of a pilot and three observers seated in the front right, rear right and rear left positions. The observers were rotated each flight and the tandem right observers counted the same transect independently. Species counted included camels (*Camelus dromedarius*), goats (*Capra hircus*), horses (*Equus caballus*), donkeys (*Equus asinus*), dingo (*Canis lupis dingo*) and cats (*Felis catus*), which were recorded onto data sheets designed for the purpose and camel data was captured using GPS linked electronic keypads. Notes on flight path direction, temperature (°C) and visibility were taken at the time of measurement. The protocol for this technique requires counters to count for 97.5 seconds followed by a 7 second gap where backup data were recorded onto prepared data forms. Each counting period is equivalent to 1 km² sampling area for the double count method. A timer was used so that an audible buzz signalled the end of the count period and was continuous for the 7 seconds gap. The 7 seconds recording time gave a 360m gap between sample cells where no counting was done. For camels, individual numbers and group size was recorded.

The computer program 'Aerial' (Lethbridge 2007) was used for the double count method by Mark Lethbridge at Flinders University to analyse the camel data where camel group size, density estimate, correction factors for perception bias and precision of the population estimate were automated. The distance sampling method was also automated using a program called 'Distance' (Thomas *et al* 2006) and this approach explicitly models detectability with distance, which was categorized into the various viewing zones for this study. A mark recapture distance sampling (MRDS) method and the multiple covariate distance sampling method were combined to determine density estimates and survey precision. For detailed explanations of analysis methods see Lethbridge (2007b).

Results

The two survey methods returned a similar result in terms of camel density (Table 1) however the precision of density estimates is quite different and is due to the high variability of camel density across the survey area.

Table 1: Combined port and starboard results in SA and WA all models

MRDS and MCDS				Double Count Method		
State	Density	Abundance	Precision	Density	Abundance	Precision
SA	0.646	40,626	16%	0.619	38,920	12%
WA	0.838	54,579	25%	0.800	52,158	15%

(Source Lethbridge 2007b)

The Western Australia survey of 65,156 km² contained an estimated 54,579 camels at a mean density of 0.84/km² (combined MRDS and MCDS methods). This density value is almost three times the camel density recorded from any other survey in Western Australia and suggests that this area may be a ‘hot spot’ for camel congregations. Even within the survey area there is a large variation in density with the Central Ranges having the highest (Figure 3) and reflects the productive capacity of this landform system.

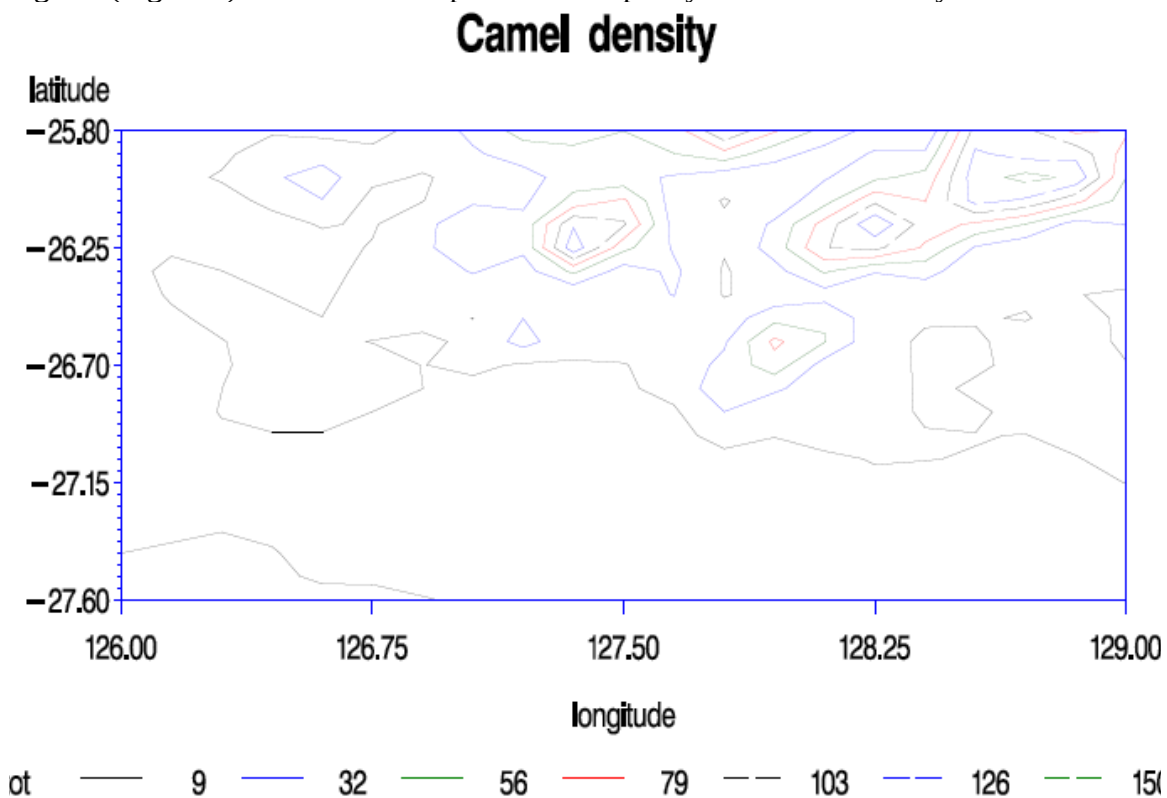


Figure 3: showing camel density concentrations within the survey area with the highest density in the Central Ranges.

Camel densities have increased at an exponential rate and show no signs of slowing (figure 4).

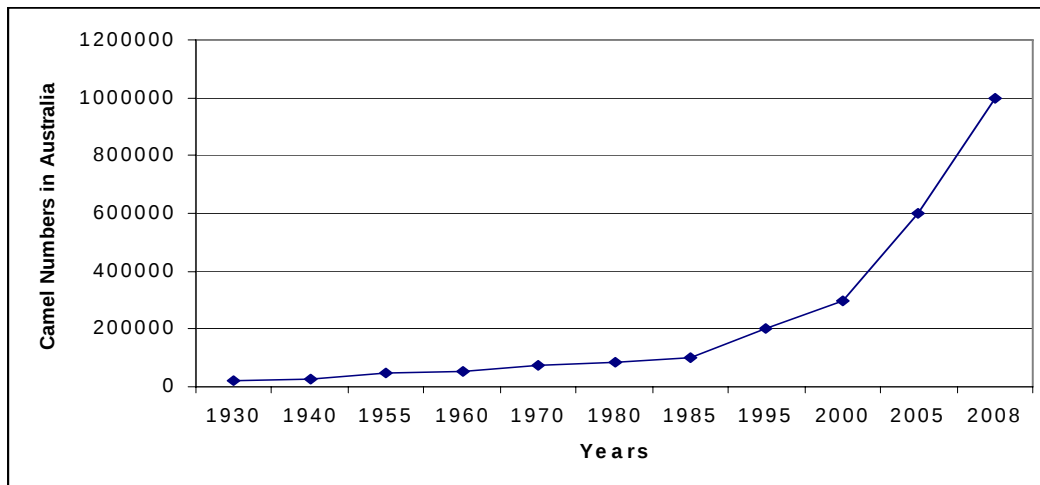


Figure 4: Exponential growth of camel populations in Australia determined from aerial surveys with numbers extrapolated for the known camel distribution area.

There was a large rainfall event in the months leading up to the survey (Figure 5) however this also corresponds with high evaporation rates which are double the rainfall. Pools of water are likely to be short lived and areas such as the central ranges where runoff may concentrate water, the larger collections may persist for longer. These areas are also likely to be more productive providing higher levels of herbage for grazing.

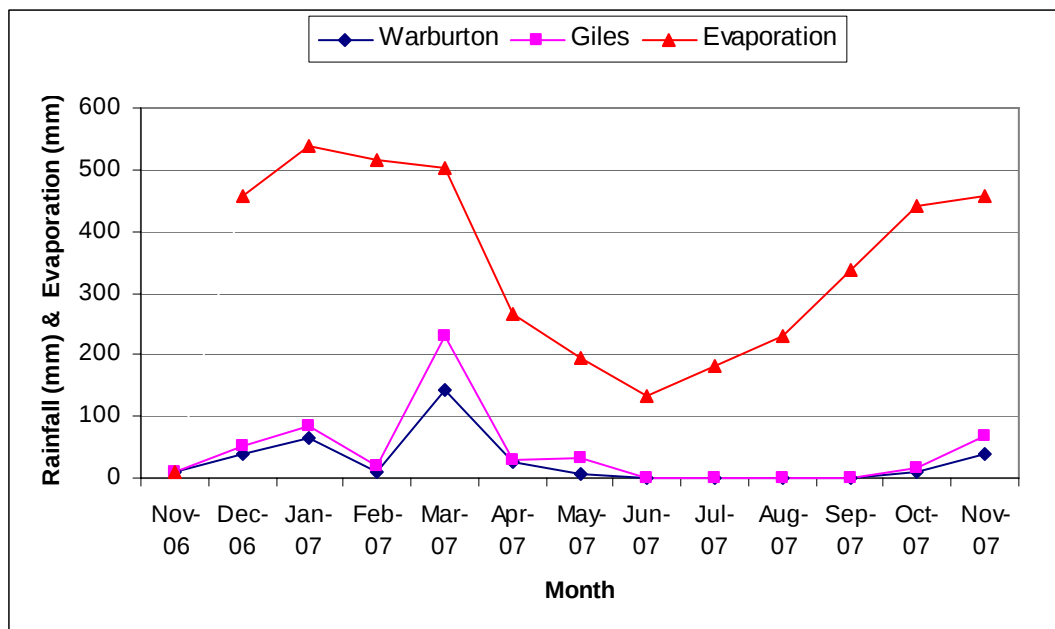


Figure 5: Rainfall and evaporation across the survey areas measured at Warburton and Giles weather stations.

Discussion

An overall camel population of 54,579 at a mean density of 0.8-0.84 camels/km² was determined by Lethbridge (2007b) for the Western Australian survey area using the two survey methods. The distance sampling method consistently produced a slightly higher density estimate and is likely to be due to using a mark recapture distance sampling (MRDS) method combined with the multiple covariate distance sampling (MCDS) method. Together this approach models detectability with distance and incorporates other covariates of group size and sun direction, whereas, the double count method without these other variables tended to contain un-modelled heterogeneity. Lethbridge (2007b) considers for these reasons that the distance sampling approach returns a more accurate estimate of camel density and should be considered for all future surveys.

The poor precision levels (15% and 25%) returned in this survey is well above the levels predicted from sample intensity simulation and is most likely due to the large variation of camel numbers across the survey area. Simulation modeling (Lethbridge 2007a) from data accessed in previous surveys compared simulated standard errors against various sample intensity rates and estimated survey cost. This showed an increase in precision as sample intensity increased and with a corresponding increase in costs. A balance between acceptable precision and the cost needs careful consideration during the survey design and for this survey a sample intensity of 6.6% was selected with the view to achieving good precision. In this case the actual precision was less than the predicted and we attribute this to a high density of camels and their extreme clustering in the landscape. When animals are highly grouped the standard error rises for the same sample intensity because more groups are missed (Axford *et al* 2002, Lethbridge 2007a). For this survey about 25% of the area contained almost 73% of the camels (Figure 1). It is likely that as camel populations increase large scale clusters may become more prevalent requiring higher sample intensities to provide an acceptable sample precision. Lethbridge (2007a) suggests that a sample intensity of 6.6% (lines 6 Km apart) is about the limit to avoid the possibility of double counts from camels moving to the next survey line. An alternative is to use other technologies such as large format digital photography or infrared imagery to remove these sampling errors.

The extreme clustering of camels in the north eastern portion of the survey area (Figure 3) is most likely due to run off from the central ranges concentrating water into semi-permanent pools and proving increased growth in gullies and areas surrounding water points attracting camels from surrounding areas as the country dried out. During the survey little surface water was observed and was mostly in clay pans close to the ranges where camels were observed in large groups of 25-50 grazing in broad gullies or near water points.

Camel populations observed in previous surveys within Australia have shown camel populations to be increasing at an exponential rate (Figure 4) and as yet are showing no

signs of leveling off. This suggests that there will be progressively more pressure from grazing over time if no control is done. Camel numbers have been shown to be increasing at about 10% per year (Edwards *et al* 2004) and with the Australian population approaching 1 million means over

100,000 camels will need to be removed annually to keep the population at its current level. Indications are that most camel congregations are in areas of high productivity associated with drainage patterns and certain landform units. This has important implications for designing surveys in that the use of GIS can describe the likely broad scale distribution allowing a better placement of survey lines. Knowing where camels are and where they are likely to congregate will have important consequences to management of sensitive areas or control programs.

Rainfall patterns in the central and northern arid zone are under a summer influence which also corresponds to high evaporation rates (Figure 5). Surface water unless quite deep will be short lived as a result. Good falls of rain at this time of year is needed to be effective in providing sources of water allowing camels to disperse. The survey area received large falls of rain during March (89 - 142 mm) with 142 mm received in the Warburton area and 89 mm at Giles indicating that the rainfall across the survey area was patchy and variable. The weather records show that much of the rain was received over consecutive days associated with cloud cover, lower temperatures and lower evaporation rates. These conditions allow water time to infiltrate the ground before being lost to evaporation.

Conclusions and Management Implications

1. Both aerial survey methods demonstrated that they were reliable techniques for assessing feral camel populations and both methods returned similar camel density estimates. The distance sampling method was thought to provide a more accurate result by incorporating additional attributes in the analysis.
2. The overall mean camel density was high (0.8 camels per Km²) and almost 3 times the mean density of camels measured elsewhere. The camels were highly clustered in the landscape with greater than 70% of the camels in 25% of the survey area. These groups were utilizing the most highly productive areas. Congregations of camels of this magnitude are likely to have serious impacts on the vegetation and monitoring of grazing effects must be given high priority.
3. There may be close to 1 million feral camels in Australia with an expected doubling of the population within 8 years if the current population trend continues. This signals an urgent need to design an effective control program at a national scale capable of taking over 100,000 camels per year.

4. Investigate the use of other technologies such as aerial digital photography or infrared imagery to increase the precision of animal counts.

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1

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