

A broad scale aerial survey of feral camel populations in the Great Victoria Desert May 2008

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Summary

The Department of Environment and Conservation in partnership with Anglo-Gold Ashanti undertook a broad scale aerial survey to determine the density and distribution of feral camels in the Great Victoria Desert and Nullabor regions of Western Australia. The survey, carried out 5-15 May 2008, covered an area of 60,000km² which was sampled using a series of 300 km long east-west flight transects spaced 10 km apart. Camel densities were extremely low with an average density of just 0.05 camels per km² determined for the survey area. Drought conditions were prevalent throughout the survey area and camels were mostly located close to lakes and water points with few camels observed away from these locations. An additional 10,000km² of survey area was sampled to the west of the main survey area extending lines 5-10 westward by 200 km taking in Lakes Minigwal, Carey and Reaside. This additional area gave a similar low camel density as the main survey area.



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Introduction

There has been a dramatic increase in feral camel numbers in recent years prompting various state and federal government agencies, NRM, pastoral and aboriginal groups to come together to find a ways of managing this emerging environmental issue. The major concern with increasing numbers is that high densities of feral camels can cause detrimental impacts on native vegetation and biodiversity values. Damage to infrastructure is a further issue which has been reported by mining companies, pastoralists and Aboriginal communities alike. Understanding patterns of density and distribution is necessary to quantify the magnitude of the problem, to assist with developing control measures and to assess the effectiveness of control measures. Past surveys in central Australia have demonstrated a rapid increase in camel numbers which continue to increase at an exponential rate such that the population is estimated to be doubling every 8-10 years, or increasing by about 12% per annum (Edwards et al 2008). Current estimates place the Australian camel population at over 1 million (Lethbridge 2007, Edwards *et al* 2008).

Commencing in 2005 the Department of Environment and Conservation, assisted by the Department of Agriculture and Food (DAFWA), Newcrest Mining (Telfer operation) and AngloGold Ashanti, have conducted a series of strategic broad area aerial surveys of feral camels across the major bioregions of central Western Australia (Burrows 2008). These surveys targeted the area beyond the pastoral zone where a gap in knowledge was apparent, and were designed to build an understanding of patterns in camel density, distribution and habitat utilization. Survey results showed that camels are clumped in the landscape and is an important finding that will help in designing control programs and identifying ecosystems most at risk. This current survey is the fifth in the series to cover the arid interior and specifically aimed to determine camel density and distribution for the Great Victoria Desert and Nullabor regions.

Method

The Great Victoria Desert bioregion is an area of 418,800 sq. kms of land within Western Australia and South Australia. Approximately 50% of the bioregion lies within Western Australia. The Great Victoria Desert is characterised by dunefields located between the Musgrave Ranges in the north and the Nullarbor Plain in the south. The population of the area is extremely low, with no major towns in the bioregion. The climate is arid, being warm to hot in summer and cool in winter. Rainfall generally occurs in winter with the passage of cold fronts as well as in summer from thunderstorms and cyclone remnants (Department of the Environment, Water, Heritage and the Arts 2008).

The mean summer temperature at Warburton (north of the bioregion) ranges from 20°C - 37°C. The mean temperature for winter is from 5.6°C - 20.3°C. The mean annual rainfall ranges from 100mm to 250mm (Bureau of Meteorology 2009).

The bioregion consists of active sand-ridge desert of deep Quaternary (less than 65 million years ago) aeolian sands overlying Permian (251-298 million years ago) and Mesozoic (65-251 million years ago) units of the Officer Basin. The northeast extent of the bioregion lies within the Great Artesian Basin. It is characterised by trees of marble gum (*Eucalyptus gongylocarpa*), mulga (*Acacia* spp.) and yarldarlba (*E. yougiana*) over hummock grassland dominated by spinifex (*Triodia basedowii*) (Morton, *et. al.*, 1995). For detailed vegetation description of the Western Australian portion of the bioregion refer to Beard (1990).

The Nullarbor bioregion lies within the flat treeless Nullarbor Plain. The bioregion includes land within South Australia and Western Australia, totalling 197,200 sq. kms. The majority of the bioregion (70%) lies within Western Australia. The south-eastern margin of the bioregion forms part of the Great Australian Bight coastline. The human population in the bioregion is extremely low. The bioregion has hot dry summers and cold winters. It is the world's largest single piece of limestone, and occupies an area of about 200,000 km². One theory is that the whole area was uplifted by crustal movements, and since then, erosion by wind and rain has smoothed out most topographic features, resulting in the extremely flat terrain across the plain today. The plain is a series of tiers. Each tier is flat and was formed when the sea level was much higher than it is today.

The summer is extremely variable. Hot days with daytime temperatures exceeding 40°C can be followed by mild cloudy days in the low 20s. Summer rainfall is unreliable, usually comprising localised heavy showers or coastal drizzle. The mean summer temperature ranges from 18.2°C - 32.9°C. Winter climate is affected by northerly moving low-pressure systems off the Southern Ocean and winter mean temperatures range from 4.4°C - 13.8°C. The Nullarbor coastal area receives winter rainfalls. By the time the system reaches the Nullarbor interior it is usually devoid of rain, rarely do low-pressure systems provide significant winter rainfall. The annual mean rainfall is generally between 100mm and 200mm across the bioregion (Bureau of Meteorology 2009).

Vegetation in the area is dominated by bluebush (*Maireana* spp.) and saltbush (*Atriplex* spp.) and a vegetation map of Western Australia by Beard (1975) provides a vegetation classification for the region. For detailed vegetation descriptions of the Western Australian portion of the bioregion refer to Beard (1990) and Mitchell, *et al* (1988).



Figure 1: Survey flight lines showing main survey area with additional 6 lines extended to the west across Lake Carey.

A standard aerial survey technique has been developed to assess camel density and distribution and was utilised on this and all previous surveys. This survey used two assessment methods a double count method (Edwards *et al* 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 altitude of 250' (76m) above ground and at a ground speed of 100kts (185 km/hr).

Although two methods were used the results reported here are from the double count method and the distance sample analysis will be used to compare both procedures at a later date. 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 also zone 1 in the distance sample method. Distance sampling used 4 zones (figure 2) and were zone 1 (200m), zone 2 (250m), zone 3 (300m) and zone 4 (~400m). The width of the zones was adjusted following a previous survey and analysis of results which

suggested that zone 1 should be further out from the aircraft and all zones should be wider (Ward 2007).

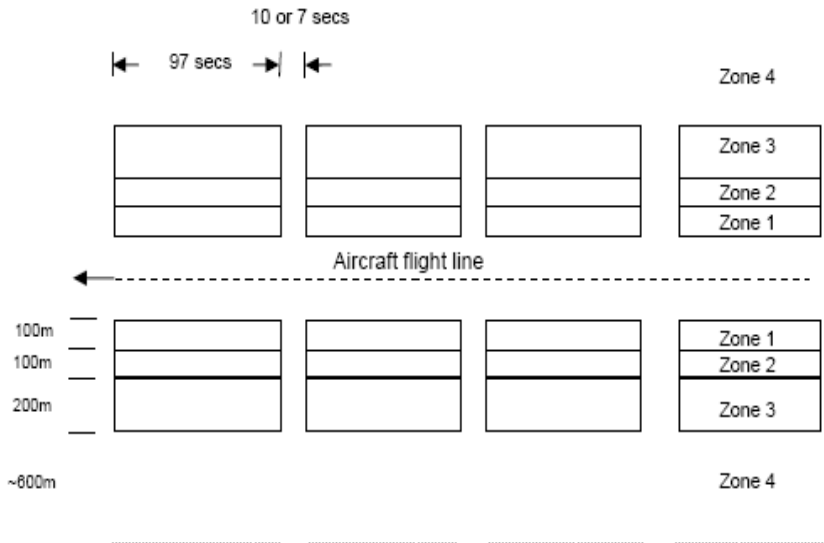


Figure 2: Viewing zones utilized for camel density assessment with zones 1 & 2 used in the double count method and zones 1 to 4 in the distance sampling method. Source Lethbridge (2007)

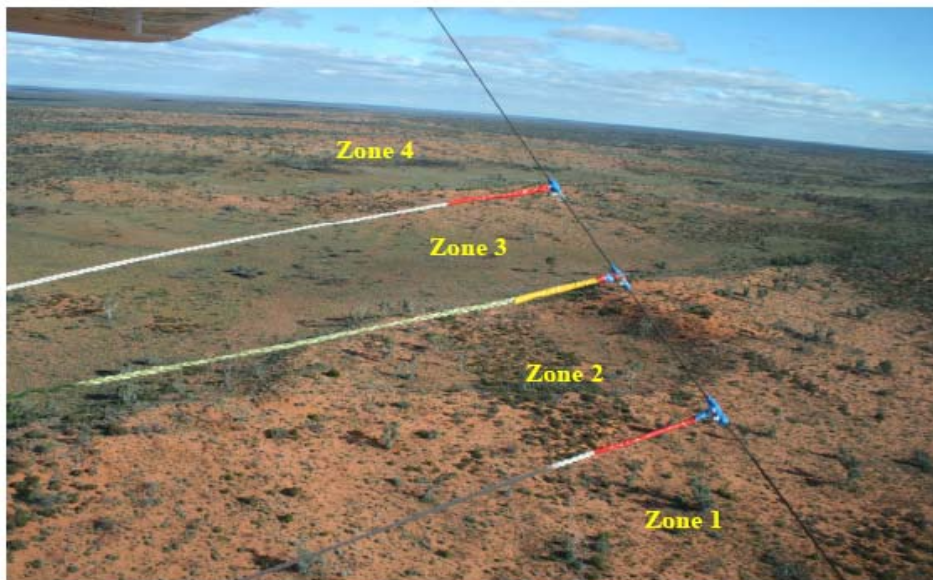


Plate 1 Strut marking on the WA aircraft (N. Burrows)

The position of the cords were calibrated on the ground from functions determined by Lethbridge (2007) and were checked for accuracy once airborne against markers set at 200m, 250m and 300m 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 were captured using GPS linked electronic keypads. Notes on flight path direction, temperature ($^{\circ}\text{C}$) 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 seconds gap when backup data were recorded onto prepared data forms. Each counting period is equivalent to 1 km^2 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 sizes were recorded.

Photographic Method

The standard camel survey method used to assess camel densities requires that the aircraft is operated at a low altitude (76m) and from a risk management point of view carries a relatively high risk. To reduce the risk, a large format digital photography technique that enabled the aircraft to fly at much higher altitude was trialed. The camera used was a 39 mega pixel large format Hassel-Blad digital camera with a 50mm lens connected to a GPS navigation system that could provide direction for the pilot and automatically trigger the camera on a preset grid pattern. The lens size (50mm) and the aircraft flying altitude (3000') determined the ground coverage of the image which for this combination was 0.54 km^2 per image. Images were butted together with no forward overlap and a continuous line of images was taken. Two images together was equivalent to the same area as the survey cell size (1 km^2) and 56 pairs of images per survey line were needed for direct comparison of the two methods. Another advantage of this technique, if it proved successful, was that fewer aircrew would be needed to undertake the surveys, further reducing costs.

Data Analysis

The data analysis follows that of Edwards (2004) and uses data from groups of camels recorded from the front and rear right hand observations to develop correction factors for perception bias. The tandem counts of groups of camels were classified as;

S_f = seen by the front observer and missed by the rear.

S_r = seen by the rear observer, missed by the front.

b = seen by both observers

The steps to determine population estimates and their precision were;

1. Calculate the mean group size with its precision ($V_g = \text{standard error}/\text{mean}$)
2. In each transect calculate the total number of camel groups sighted by both the left and the combined right hand team.
3. From (1) and (2) above calculate the camel numbers for left and right sides for each line.
- 4 Calculate the correction factors for perception bias for combined right observations pooled across transects for the entire survey and its approximate precision.
5. Calculate the correction factor for left observations.
6. Apply correction factors to (3) above to obtain number of animals.
7. Sum the corrected number of animals from each transect
8. Apply the ratio method to obtain an estimate of population.
9. Calculate the precision of the population estimate

See Edwards *et al* (2004) for a detailed description of the analysis procedure

Results

The mean camel density estimate for the survey area was 0.053 camels per km² corrected for perception bias and produced a population estimate of 3,216 for the survey area. This population estimate had a precision of 10.8%. The mean group size was 5.0 (\pm se 0.44) and the correction factors to account for perception bias were 1.12 for the right and 1.58 for the left. The correction factors had a CV of 4.5%. Camel density estimates for this survey are very low with most camels observed to be close to lake systems or in the pastoral areas where permanent water was available. An outlier in the middle of the survey area was from a green patch of vegetation that has most likely responded to thunderstorm activity in the area or was regeneration from a recent fire.

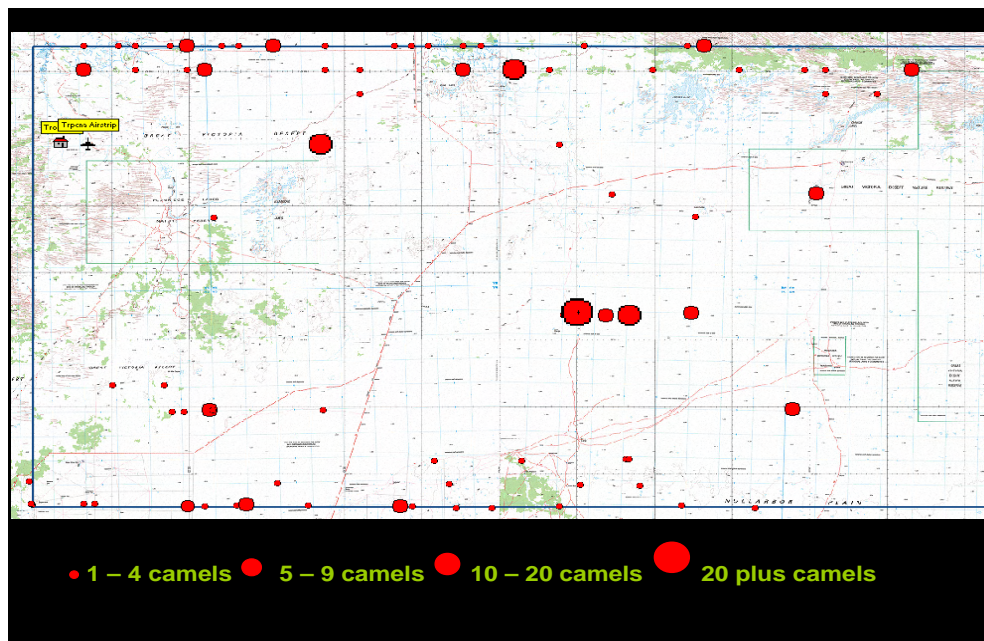


Figure 3: Showing camel numbers and distribution across the survey area determined from aerial count surveys and includes camels observed in all zones (Figure 2 above).

The six additional lines to the west of the main survey area picked up three camel groups and when numbers were corrected for perception bias, this survey area had an estimated density of 0.08 camels per km² which is slightly higher than the mean density for the main survey area. This is perhaps biased given that we targeted major lake systems, but even so the result is still a very low density value compared with results from previous surveys in other areas.

The photography system failed after a couple of lines and a direct comparison of camel densities could not be made. However sufficient images were obtained to test this method and its suitability as a replacement for traditional aerial count surveys. High resolution photography showed promise but the lens size and height combination chosen produced images that were too small even at 500 times magnification to readily identify camels amongst the vegetation. It is likely that further development of this method will be needed before it can be considered as a replacement to the survey method currently used. New digital camera backs in the 60 mega-pixel range are now available which would greatly improve the image quality and with different lens and height combinations could probably make this a viable method. A full description of the photographic method and results will be available once data analysis is complete.

Discussion

The total survey area of ~70,000 km² had a mean camel density of 0.05 camels per km² which is equivalent to 3500 camels for the survey area. Once plotted the camel groups were shown to be clustered in close proximity to water, which is consistent with observations from previous surveys in dry conditions. The survey area appeared very dry with very little surface water observed which most likely explains the low density of camels. Much of the area flown was spinifex covered sand dunes and sand plains, which has very little capacity to hold surface water and provides relatively poor food resources. Camel group size was generally quite small with greater than 70% of the groups in the 1-4 camels category (Figure 3). There was considerable evidence of previous camel activity with many camel pads and lay marks and the amount of visible activity appeared to be greater than the number of camels observed. It seemed probable that the bulk of the camel population had moved on to where permanent water and food could be obtained.

These less productive environments probably only attract significant camel numbers immediately following good rainfall. Because of the poor moisture holding and storage capacity of these sandy substrates, it is likely that camels use these landscapes for relatively short periods, then move on to more productive landscapes, or follow storms. Green plant regeneration on recently burnt patches may also provide a food resource in these otherwise harsh environments. Satellite tracking currently underway will shed more light on camel movements in relation to spatial and temporal resource availability in these environments.

When the camera system failed there was an opportunity to test the theory that camels had moved on by extending additional survey lines to the west of the main survey area. Six lines 10km apart were flown extending lines 5 to 10, 200km to the west through a large lake system. These additional lines although returning a slightly higher density than the main survey numbers were still very low suggesting that camels had not moved in that direction. It is more likely that they would have followed some general migration pattern for harsh conditions developed over many generations of camel habitation. As mentioned above, a study using satellite tracking collars on 18 camels across WA and SA will provide information about whether migration patterns exist and where and why camels congregate (Lethbridge 2008). This knowledge is vital if control programs are to be efficient and cost effective and for identifying parts of the landscape most at risk from degradation by camels.

The survey techniques currently employed to census feral camel numbers still carry a high degree of error and carries a relatively high risk to observers flying at low altitude. A photographic system offers a way of both improving the accuracy and reducing the risk. However such a system does not come without its problems and the storage, handling and processing of images are perhaps the critical aspect of this method.

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