20. Progress towards a method of monitoring Malleefowl in the Maralinga Tjarutja Lands, South Australia

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Abstract

Monitoring Malleefowl in arid regions presents distinct challenges. These regions tend to be very remote, and the Malleefowl typically occur at very low densities making thorough searches of areas large enough to encompass several active mounds very difficult. Consequently, mound based forms of monitoring, as used in semi-arid regions, are not suitable in the arid zone. On the other hand, the sandy and open substrates typical of arid areas provide excellent opportunities for tracking which are not available in southern areas. Malleefowl footprints are distinctive and tend to accumulate over several days, thus providing a rich source of information on where Malleefowl have been.

Malleefowl occur over much of the western half of South Australia on Aboriginal lands. In this study in the Maralinga Tjarutja Lands, members of the local community at Oak Valley tried a variety of tracking methods to obtain data that may be useful for monitoring, including revisiting locations of past sightings and mounds, and various types of systematic tracking. We used CT Cybertracker to record data in the field, and photographs of prints to verify records. An important component of a sustainable monitoring program is the willingness and capacity of the people collecting the data. In this regard, and in terms of the efficiency and usefulness of the ensuing data, we conclude that a method of “leapfrog long-walks” was most suitable for monitoring Malleefowl at a landscape scale in the Maralinga Tjarutja context.

Introduction

Nga<u>n</u>amara, or Malleefowl (*Leipoa ocellata*), inhabit the mallee and acacia shrublands of arid and semi-arid Australia. Internationally renowned for its unique and extraordinary mound-building behaviour (Frith 1962), the species has been valued from time immemorial by A<u>n</u>angu, the traditional owners of the Maralinga Tjarutja Lands (MTL) in the eastern Great Victoria Desert, both as a food item and because Nga<u>n</u>amara are important Tjukurpa animals and totemic ancestors of A<u>n</u>angu.

For a bird with such atypical, laborious and complex nesting habits, Malleefowl were remarkably successful, occurring over much of the southern half of Australia from the west coast to the Great Dividing range in the east, and were widespread in every mainland state except Queensland. In arid Australia, the species occurred in the Great Victoria Desert (GVD), southern parts of the Great Sandy and Gibson Deserts, and as far north as the Tanami Desert in the Northern Territory (Kimber 1985). Since European settlement, Malleefowl have declined considerably in the arid zone and are now thought to be extinct in the Northern Territory. Although the species still occurs in the Anangu-Pitjantjatjara-Yankunytjatjara Lands (APYL) (Benshemesh 1997, Benshemesh 2007b) and MTL (Bellchambers 2007), its status in these remote Aboriginal lands is poorly known.

Bellchambers (2007) provided the first survey of Malleefowl in the MTL as part of a larger study site of the southern Great Victoria Desert in SA. He concluded that the species was widespread throughout the region but that it occurred at very low densities. Within the MTL, records were especially sparse and scattered and most were from the south of the MTL, possibly reflecting survey effort, higher rainfall, or habitats. Nonetheless, the distribution of Malleefowl in the MTL is poorly known and the scattered historical records suggest that Malleefowl may occur over much of the MTL with the exception of the Nullarbor Plain in the south west, and in the north east (Figure 1 and 2).

The importance of monitoring trends in Malleefowl has been emphasized in the National Recovery Plan for Malleefowl (Benshemesh 2007b) and also for the MTL in particular by Ward and Clarke (2007), Ward (2008) and Ward and Bellchambers (2008). While monitoring Malleefowl is well established in semi-arid areas in a national program involving over one hundred sites, the techniques used rely on relatively high breeding densities and are less suitable in arid areas where the species is scarce (Benshemesh 2004a).

Rather than basing monitoring on the activity at mounds, a more efficient approach in the arid zone is to search areas for the distinctive foot prints (or tracks) of Malleefowl. Loose, sandy substrates are typical of the areas inhabited by Malleefowl and provided the weather is dry and not too windy, their tracks are likely to accumulate over several days. The abundance of prints in an area provides a useful and efficient indicator of the birds' activity in an area: where birds are resident their prints are likely to consistently occur through their home range (1-4 km^2), whereas where birds have merely passed through an area their prints are likely be less prevalent in space and time.

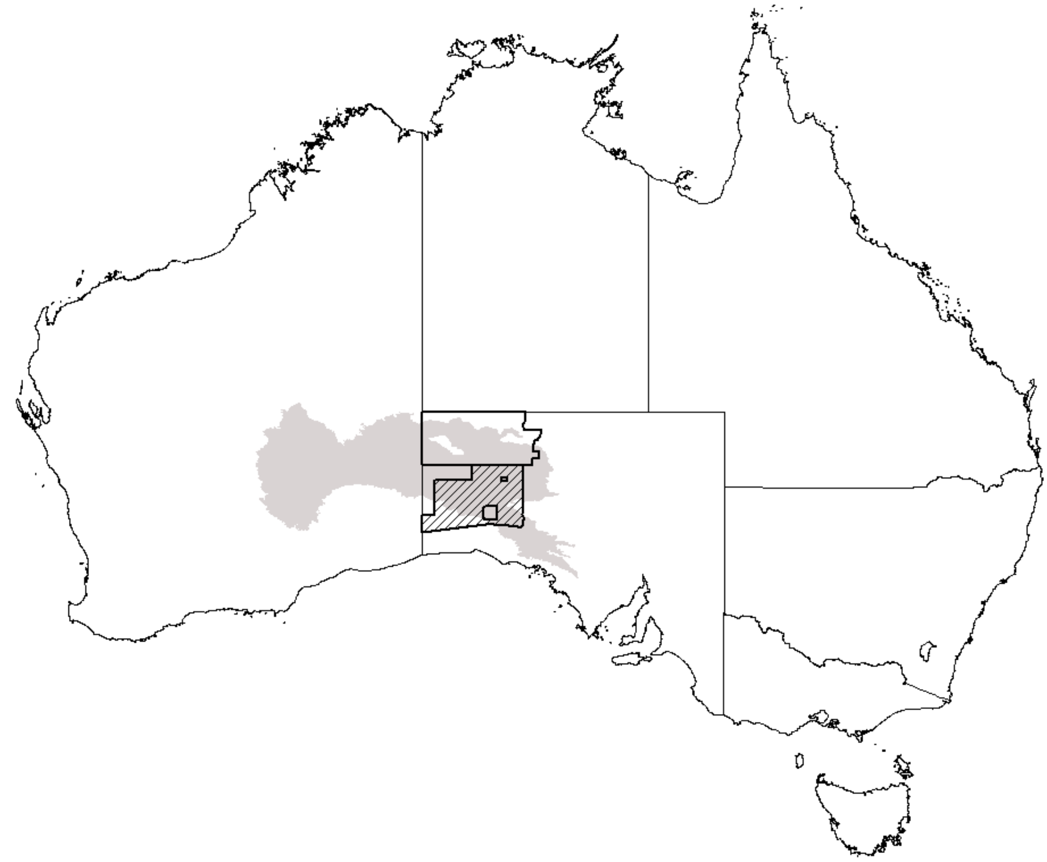

Figure 1. Map of Australia showing the location of the Maralinga Tjarutja Lands (MTL; outlined and hatched) in South Australia. Most of the MTL lies in the Great Victoria Desert (grey). The Anangu Pitjantjatjara Yankunytjatjara Lands (outlined) are also shown situated above and adjoining the MTL.

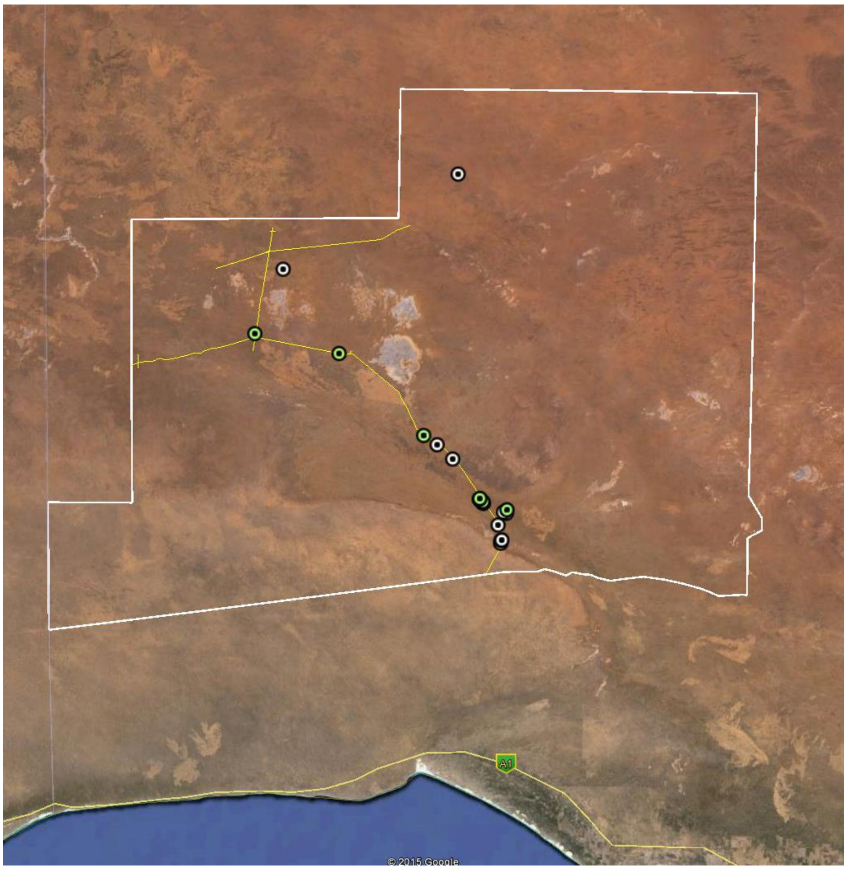

Figure 2. Map showing MTL boundary (white line) and records from Bellchambers' surveys and subsequent monitoring in 2008. For clarity, records outside the MTL are not shown. Colour key: Green= mounds; white= sightings of birds and prints.

In the past, most Malleefowl records in the MTL have been obtained opportunistically. Where targeted searches have been undertaken in the past, details of search effort have not been recorded; it is difficult to detect trends in data without knowing the search effort involved. Techniques have been proposed to obtain information more systematically on Malleefowl abundance by tracking along square transects (Benshemesh 2007a, Ward and Clarke 2007 and Ward) but these methods are not often employed.

Whatever technique is considered, a critical component in its successful application will be how the technique is received by Anangu at Oak Valley, the community in the MTL. Anangu have expressed an interest in land management jobs and are geographically well placed to undertake regular monitoring. Moreover, their traditional skills and aptitude for reading their country makes them ideal candidates in an ongoing Malleefowl monitoring project.

The current project had three basic aims: 1) to train Anangu in monitoring techniques, 2) to trial different techniques with Anangu, and 3) to collect data on the distribution and abundance of Malleefowl.

Methods

We undertook systematic searches for Malleefowl prints and other signs in areas in which the birds had been detected in the past decade. In total, 18 discreet sites (eight mounds and six point localities representing prints or sightings) were revisited from historical records, the Alinytjara Wilurara NRM database and from Bellchambers' report.

Monitoring

Monitoring involved searching for Malleefowl signs at and around each previous record in a nested square pattern: the location of the record was searched for prints, and 200m and 500m sided squares centred on the record were also searched (Figure 3). This provided an efficient means of searching the vicinity of each record in a systematic and repeatable way. Navigation was performed by GPS: site locations, and the eight points defining the corners of square transects at 18 sites were entered into the Cybertracker sequence (see below) and the GoTo function (Benshemesh 2009) was used to navigate from corner to corner within the Cybertracker application.

Survey

Survey at a landscape scale was accomplished by Long Walks along established tracks and roads. A method was trialed in which pairs of observers were dropped off by vehicle every 2km along tracks. Each pair then walked the 2km stretch to the next drop-off, searching for Malleefowl prints parallel to and about 50-150m from the road. The number of pairs of observers varied with their availability, but the technique enabled large distances to be covered quickly: five pairs of observers could search 10km in about one hour. We also searched for Malleefowl prints from vehicles along one 14km stretch of disused vehicle track by driving at about 10km/hr while observers attempted to spot Malleefowl tracks from the windows.

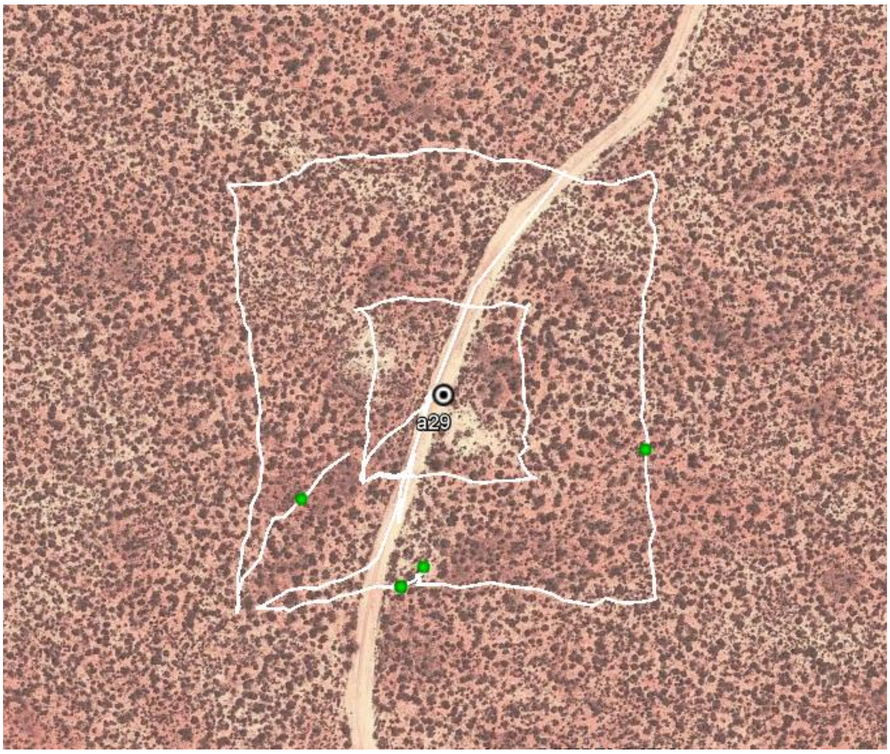

Figure 3. Concentric square transects centred on record AWMF29. The white lines show the paths searched by observers along 200m and 500m sided square transects. Green dots indicate fresh Malleefowl prints (other species not shown).

Verification

Observers were instructed to take a photo of Malleefowl tracks to provide verification of their identification, but not of other animals which were regarded as of secondary importance. Nonetheless, the recording of other animal's tracks was of some interest, and was also beneficial in that it provided many opportunities to practice recording data. Photos were taken within Cybertracker (below) and were linked to the record. A scale-card or other scale was included in each photo. Malleefowl tracks were often clumped and in practice, not every track was photographed, but the aim was to obtain some photos for verification in each new area. Observers were instructed to always take a photograph of prints that they were uncertain about, particularly if they thought they might be of Malleefowl.

Data recording in field with Cybertracker

Data recording was accomplished with a custom Cybertracker sequence on ruggedized handheld computers (Magellan/Ashtech Mobilemapper6) with built-in camera and GPS. Ten of these units were borrowed from the Victorian Malleefowl Recovery Group for the current study. The Cybertracker sequence enabled observers to enter their names, select whether they were undertaking monitoring or survey, and record the prints of a variety of animals they encountered, including Malleefowl (single or paired prints, mound), dog/dingo, fox, cat, camel, red and grey kangaroo, emu, bustard, rabbit, echidna, and Itjaritjari (southern marsupial mole). When Malleefowl was selected, a screen requesting a photo automatically appeared. Whenever an animal's tracks were recorded, the GPS location was automatically recorded along with the observers name, date and time, and photos. At the end of each square transect side (i.e. when a corner was reached) or long-walk section, observers were instructed to estimate the tracking conditions by choosing one of five categories from 'all ok' to 'none-ok'. These categories were described in terms of the likelihood of detecting Malleefowl if they walked through the area and reflected a combination of many factors that may affect the clarity of tracks such as substrate, recent weather, and lighting. The sequence was designed to be simple and quick in order to keep people interested and moving while recording the most essential information.

Training

A<u>n</u>angu and other participants were trained in the use of Cybertracker to both record data and to navigate from point to point. Most A<u>n</u>angu were familiar with the prints of different animals, including Malleefowl, but special attention was paid to the identification of Malleefowl prints. A<u>n</u>angu also tended to discuss print identification amongst themselves and learn from each other. The reasons for doing monitoring and survey, and the techniques used, were also discussed at length and the Cybertracker sequence was improved following feedback from A<u>n</u>angu. The results of searches was usually downloaded from Cybertracker at the end of each day and displayed on maps on a laptop. This provided an opportunity to discuss issues with navigation and recording and the concepts involved in the work.

Results

Between the 19th to 30th July 2012 the team spent eight days undertaking survey and monitoring, two days travelling and setting up remote camps, and one day each was spent in training and resting. During this time the team searched more than 131 kilometres and recorded 2,288 animal tracks on Cybertracker, including 282 tracks of Malleefowl which were the primary target of the surveys.

Print confirmations

Of the Malleefowl tracks recorded during surveys and monitoring, 93 (33%) were associated with digital photos for validation. Of these, 81 (87%) were confirmed as Malleefowl, and two (2%) were too indistinct to identify. Ten photos (11%) were considered to be other bird species: one was the track of a corvid, and nine were the tracks of small birds. All of the misidentified track photos were taken by white people assisting A<u>n</u>angu and most were taken in the spirit of demonstrating to A<u>n</u>angu that uncertain cases should always be photographed. While 67% of Malleefowl tracks recorded were not photographed, these all occurred in the vicinity of records confirmed by photos, providing no reason to doubt the accuracy of identifications.

1. Searches at previously known sites

Searches for Malleefowl prints at known sites usually involved nested square transects involving a localised search at the previous record, and 200m and 500m sided square transects centred on the record. Previous records included mounds and locations at which Malleefowl or their prints had been sighted.

Searches at mounds

The team attempted to find all seven of the previously listed mounds. In 2012 we were only able to locate four of the known mounds: one mound was clearly being renovated for use by Malleefowl and being filled with leaf litter, while the other three were old and disused. Of the mounds we were unable to re-find, one may have been destroyed during road widening works over the past few years; the scarcity of prints in this vicinity suggests that if the mound does still exist, it was not being prepared for use in the 2012-13 breeding season. Of the two other mounds we were unable to find, one had been recorded as active in 2007 but was unlikely to have been active in 2012 as there were no Malleefowl footprints recorded within 250m of the mound location. The other mound had not previously been recorded as active but might have been active in 2012 as there was an exceptionally high density of Malleefowl prints in this area (18 prints per km), many of them paired, it was thus likely that an active mound was nearby.

Searches at sites where prints or birds were previously recorded

Apart from mounds, Malleefowl signs or sightings were recorded at eleven sites between 2006 and 2008, and all but one of these was visited in 2012. At each of the ten sites revisited, we walked nested transect. Malleefowl signs were detected at six of the ten sites. However, at none of these sites were Malleefowl recorded in the vicinity of the original record: at two of the sites Malleefowl prints were only recorded along the 200m transects, at another three sites they were only recorded along the 500m transects, and at one site prints were recorded along both the 200m and 500m transects. The density of prints at the six sites where prints were recorded was generally low (0.6 - 2.0 prints per km of transect).

Comparison of success at mounds and sightings

The detection of Malleefowl prints at previously known mounds and previous sightings were similar: Malleefowl prints were detected at five of the seven previously known mounds (71%) compared with at six of the ten (60%) of previous sightings. Nonetheless, there were major differences between mounds and sightings where at least some prints were detected in 2012. Print densities tended to be much higher around mounds (average=8.5 prints/km, n=5) compared to past sightings (average=1.0 prints/km, n=6).

The difference between the detectability of Malleefowl prints around mounds and sightings was also evident at sites where at least some Malleefowl prints were detected in the square transects. There were seven mounds at which searches revealed prints somewhere within the surrounding 25 hectares (ha), and six sites that were based on previous sightings where searches revealed prints somewhere within the surrounding 25ha. Malleefowl prints were detected on or near 71% of mounds where prints were eventually detected somewhere in the 25ha search (Figure 4), and prints were similarly detected in six of the seven 200m square transects. Checking the vicinity of the mound, and undertaking a 200m square transect around it would have identified Malleefowl prints at all seven mounds. The 500m square transect also detected Malleefowl at all sites.

In contrast, Malleefowl prints were not found in the local vicinity of any of the six sites based on sightings, and on only 50% of the 200m transects and 67% of the 500m transects (Figure 4). A combination of both 200m and 500m transects was required to detect Malleefowl at these sites, and local searches of the point locality were completely ineffective.

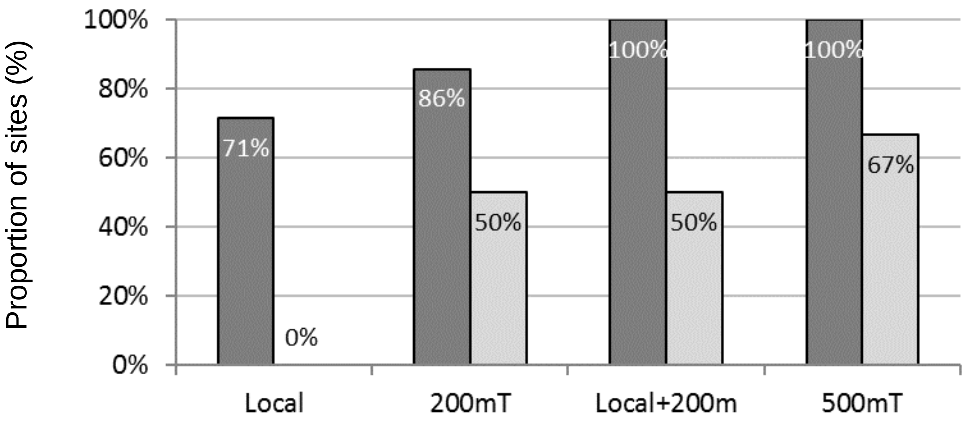

Figure 4. Comparison of search type in detecting Malleefowl prints. The proportion of sites at which Malleefowl would have been detected is shown for different components of searches for mounds (dark bars) and sightings of prints or birds (light bars). Only sites where at least some prints were detected in 2012 are included in the graph.

2. Survey: new sites

Newly recorded mounds

In addition to the previously known mounds, the team recorded three mounds that had not previously been represented in the database. One of these was a well-known and active mound within the Prohibited Area, whereas the other two mounds were found by the team in the south east of the study area and were long disused. Nonetheless, Malleefowl print densities were high (>10 prints/km) around both mounds which were separated by about 650m. An active mound was known about one kilometre from each of these old mounds, and it is possible that the birds from the active mound ranged this far.

Long walks

Linear transect walks of 16-28km length alongside existing tracks provided a useful means of broadscale survey. Four walks were undertaken (Figure 5), two of which occurred in areas where Malleefowl had previously been recorded south of Oak Valley along the main road (southwest and southeast), and two along a relatively new track that ran east-west about 40-50km south of the Anne Beadell Highway (northwest and northeast) in areas that are more remote and where there were no previous records of Malleefowl. Malleefowl were most frequently recorded in the southern transects where they were recorded in 45 - 50% of one kilometre stretches of transect (Table 1), compared to 0 - 7% in the northern transects. The number of Malleefowl prints recorded also showed relatively low values in the northern transects (0 - 3 prints per 10km) compared with southern transects. The southeast transect showed the highest number of prints averaging 48 Malleefowl prints per 10km, compared with six prints per 10km in the southwest transect. Thus, while Malleefowl prints were widely distributed across both the southwest and southeast transects, they were much more abundant in the southeast.

Table 1. Search length and Malleefowl signs along the four long-walks.

	Km	*%Km with prints*	*No. prints*	*Prints/10km*
Northwest	28	7%	9	3.2
Northeast	24	0%	0	0
Southwest	20	45%	12	6.0
Southeast	16	50%	77	48.1
	88	22%	98	11.1

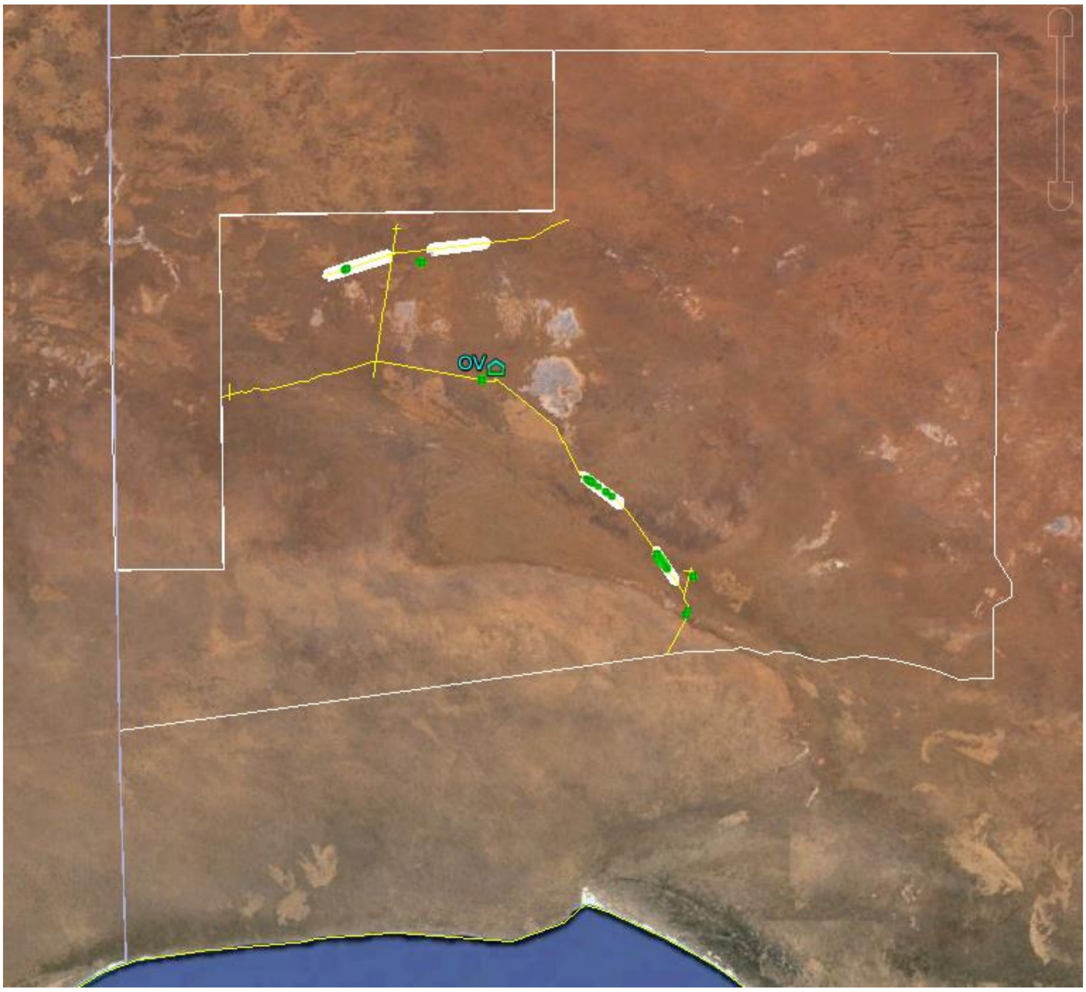

Figure 5. Location of the four long-walks (thick white bars) in the MTL. Green dots indicate where Malleefowl prints were found.

14km drive and searches north of AWMF45

We searched for Malleefowl prints from vehicles along a 14km stretch of the disused, old Vokes Hill Road vehicle track because our square transect search at AWMF45 found no Malleefowl signs, although the area was previously known to support Malleefowl. The occurrence of Malleefowl prints at AWMF45 was recorded in both 2007 when a 'recent track' was noted, and in 2008 when 2 'very old tracks' were noted. In addition, a 500m square transect around this point locality was undertaken in October 2007 when one of us (JB) was in the area on another project. In 2007, 13 print locations were recorded scattered through the south western half of the square transect, including paired prints that differed in size consistent with a male and female pair. A mound was not found, but given the pattern of prints it was strongly suspected that an active mound occurred close by. Print density along the 500m square transect in 2007 was about 6.1 prints/km.

Malleefowl prints were not recorded in the square transects around AWMF45 when they were returned to in 2012, however the team did detect Malleefowl prints about 7km along the 14km drive to the north at two locations separated by several hundred metres. A 500m square transect and local searching around the centre point between these records (named J03, see below) revealed a high density of Malleefowl prints in the area: 19 prints were recorded along about 4.5km of search path (500m transect plus local searches) in the area, suggesting a print density of 4.2 prints/km.

Aggregate Grid-cell metrics

The proportion of all grid cells visited in this study in which particular species were recorded provides an alternative metric of their abundance. In this study we recorded animal prints in a total of 127 one-kilometre square grid cells, of which 37 (30%) contained Malleefowl prints (Table 2). On average, Malleefowl prints represented 10% of prints in grid cells, with a coefficient of variation of 2.1 suggesting a patchy distribution. The most widespread animals were camels which were recorded in 84% of cells and on average represented more than a quarter of recorded prints, and fox and cat which were recorded in 78% and 73% of cells respectively. Low coefficients of variation for these abundant animals suggest a relatively even spread across the grid cells visited. Dingoes and kangaroos (both red and western grey combined) were also well represented and occurred in most grid cells, whereas rabbits occurred in about one third of cells. In contrast, emu, echidna and bustard (kipora) were relatively rarely recorded.

Table 2. Aggregate statistics for animal signs in 1km^2 grid cells. K'roo represents both western grey and red kangaroos.

	Mf	Camel	Fox	Cat	Dog	Emu	Kipora	Rabbit	Echidna	K'roo
%cells	30%	84%	78%	73%	60%	2%	16%	35%	2%	55%
Mean %/cell	10%	27%	15%	14%	10%	0%	2%	8%	1%	13%
Stdev %/cell	20%	22%	15%	16%	16%	1%	9%	14%	9%	17%
Cov %/cell	2.1	0.8	1.0	1.2	1.6	7.9	3.5	1.8	10.0	1.3

Discussion

Anangu training and competence

Anangu were impressive in their tracking abilities and attitude to the work at hand, which often involved walking many kilometres while navigating and recording information on the handheld devices.

Anangu typically learnt to use Cybertracker competently. However, it was also clear that some members of the team were still having difficulty recording information even on the last day of surveys. This occurred despite a genuine enthusiasm for the work by the person in question. The lesson in this example is that it is easy to overestimate the proficiency (or perhaps comfort level) of people involved in data collection using equipment they are unfamiliar with. The situation reinforces the need to keep processes as simple and streamlined as possible in order to reduce the opportunities for confusion, especially if the goal is for participants to work unsupervised.

Overall, the Anangu participants in this study demonstrated an enthusiasm and aptitude for the Malleefowl survey and monitoring work, and the Cybertracker sequence developed for them served its purpose in providing a quick and simple means of recording information without slowing down the walking and searching through country. There is certainly a great deal to be gained environmentally and socially in developing the Malleefowl program further, and we have no doubt that continuing in-house training and practice would consolidate the skills learned and result in the collection of valuable information on Malleefowl conservation.

Malleefowl in the MTL

Malleefowl were noted as inhabiting the eastern Great Victoria Desert by the early explorers, such as Giles (1889) and Maurice (Cleland 1942, Gara 1989). Black and Badman (1986) reviewed the records and anecdotal accounts and concluded that the species was still sparsely distributed through the eastern GVD. Interestingly, the most recent records they reviewed were of two recently used mounds recorded in 1981 by the side of the newly created road from Maralinga to Lake Maurice, and the location of these mounds (approximately 18km and 60km north west of Maralinga) coincide roughly with the two main centres of Malleefowl activity recorded in the current survey.

After the early 1980s, there appear to have been no records of Malleefowl in the Maralinga lands until 2007 when dedicated surveys for Malleefowl were undertaken by Keith Bellchambers (Rick Southgate also recorded Malleefowl footprints in a few tracking plots at about this time). In the intervening 25 years, extant Malleefowl populations were 'rediscovered' in the Anangu-Pitjantjatjara-Yankunytjatjara Lands to the north where they were thought to have become extinct (Benshemesh 1997) and on the eastern edge of the Maralinga TL (Robinson, Casperson & Copley 1990). In the APYL, Anangu knew that Malleefowl still occurred at certain localities during the intervening period, and indeed occasionally raided the birds' mounds, but these sightings were rarely passed on to scientists or wildlife authorities. Likewise, the absence of Malleefowl records from the MTL between the early 1980s and 2007 most likely reflects low survey and reporting effort rather than changes in Malleefowl populations.

The Malleefowl surveys by Keith Bellchambers (2007) and his Anangu coworkers clearly showed that Malleefowl were still widely and sparsely distributed in the MTL, despite the previous paucity of records. Bellchambers recorded five Malleefowl mounds, and sighted the birds or their tracks at an additional 10 sites.

In the current study we revisited the locations of previously known mounds and sightings, and searched new areas for signs of Malleefowl. Revisiting previously known sites after a period of five years provided some idea of how Malleefowl have persisted in the landscape: we found Malleefowl prints at about 65% of sites where Malleefowl were previously recorded (ten mounds, seven sighting locations). In contrast, Bellchambers (2007) only recorded Malleefowl prints at 36% of the 11 locations he revisited (including Yellabina/Yumbarra), and Malleefowl prints were found at only 33% of nine previously known sites that were revisited the following year in the MTL (Matt Ward, AW database).

While the current study has reaffirmed the finding of Bellchambers (2007) that Malleefowl are still sparsely and widely distributed in the MTL, the data are insufficient to comment meaningfully on trends apart from stating that Malleefowl appear to be doing well in some areas, especially along the southern sections of the Oak Valley main road. The detection of population trends, which is the purpose of monitoring, requires a consistent and repeatable effort. This has been difficult to achieve but the past and current surveys provide a good basis from which to consider the monitoring options in light of the data collected, and this is discussed in the following section.

Survey and monitoring Malleefowl in the MTL

Understanding the distribution, abundance and trends of Malleefowl populations in the Maralinga Tjarutja Lands is essential for the conservation of the species, to identifying its vulnerabilities, and managing the populations. This study has clearly demonstrated that Anangu are capable and interested in being involved in this work and in providing data of a high standard. The question however remains as to the best approach to achieve a meaningful survey and monitoring program.

The Malleefowl monitoring program in southern areas provides excellent data that has been widely used to assess the population trends (e.g. Benshemesh, Barker & MacFarlane 2007, Walsh *et al.* 2012), but is not generally suitable in arid areas where mound densities are very low over vast areas (Benshemesh 2004b, Benshemesh 2007b, Benshemesh 2008). On the other hand, the sandy and open substrates typical of the Maralinga Lands provide excellent opportunities for tracking which are not available in southern areas. Malleefowl footprints are distinctive and tend to accumulate over several days, thus providing a rich source of information on where Malleefowl have been.

Conclusions and recommendations for future monitoring and survey

The number of sites at which Malleefowl have been recorded in the last few years has increased from 18 in 2007/2008, to 31 with the addition of the 13 new sites recorded in this study. This is a positive outcome, but has implications in planning monitoring in the future because it is becoming increasingly time consuming to visit all of these sites on a regular basis. Furthermore, it must also be asked whether regularly visiting all of these sites is likely to provide the information that is needed on trends in Malleefowl populations.

Monitoring a selection of sites where Malleefowl have been recorded in the past provides information on the persistence of the species at specific localities, but it does not provide information on the population trends across a landscape. For example, a population may be stable even though it does not persist at any particular site for very long. In a vast landscape where a species occurs only sporadically in pockets of suitable habitat, monitoring persistence may be the only feasible means of keeping tabs on a population, and would provide some insights. In the MTL the current project demonstrated that they were capable of walking and tracking over considerable distances, and Malleefowl appear to be sufficiently abundant in the MTL to allow a more broad scale approach than persistence monitoring.

Given that the interest in Malleefowl trends in the MTL is at the landscape scale, the long-walks trialed in this study would seem to provide the best balance between monitoring and survey. Long-walks were popular with Anangu too, especially as they were undertaken as a team effort. Long walks were also relatively simple to perform and repeat, and instilled a strong sense of achievement which was manifest when driving along roads with Anangu, knowing that long sections had been searched and that multiple animal tracks had been recorded. Another advantage of long-walks, as described in this study, is that they can be undertaken using any number of participants, but are especially suited to teams which, when split into pairs, can cover many kilometres rapidly and efficiently. Most importantly, long-walks are relatively easy to interpret because the sampling effort is spread out over large areas, matching the scale of the central question regarding Malleefowl trends across the landscape, rather than simply at small areas where they have previously been recorded.

We hope that regularly repeating the long-walks undertaken in this study will provide information on trends in Malleefowl populations at a landscape scale (comments in the previous section notwithstanding). However, only two of the four long-walks undertaken in this study showed more than occasional signs of Malleefowl; while there is some merit in monitoring these areas, more would be gained by surveying other areas for signs of Malleefowl. In particular, north and east of Maralinga village may be especially rewarding judging by the mallee type vegetation in that area, although there are many other areas that would also be suitable for survey, and if successful in finding concentrations of Malleefowl prints, for regular monitoring.

While a series of long-walk transects, regularly monitored, would seem the simplest and best means of tracking Malleefowl abundance and distribution in the MTL, regularly checking the vicinity of known mounds for prints and signs of breeding activity would also be useful both to learn about the frequency of reproduction in the MTL, and to provide information on the persistence of Malleefowl at points within the landscape. Nested square transects would be appropriate for this activity, although the results of the current study suggest that simply searching the mound, and a 200m square if no Malleefowl signs are found at the mound, would be adequate to provide information on activity and persistence.

Finding more mounds should also be regarded as a priority, second only to landscape scale monitoring, and may be an activity that could involve a range of people from the local community at Oak Valley once concentrations of Malleefowl prints have been located in survey/monitoring. Only a few mounds are currently known in the MTL, but the abundance of Malleefowl prints in some areas in this study was strongly suggestive that several active mounds would have been found if the time was available to search for them. With a little effort, the number of mounds known in the MTL is likely to accumulate, and the value of routinely checking them for signs of activity will increase and provide an additional means of monitoring the Malleefowl population. In this regard, recent developments in remote sensing Malleefowl mounds by photogrammetry and LiDAR show great promise in finding mounds to monitor in this vast landscape.

Given the level of enthusiasm and interest among Anangu in participating in this study, it would be beneficial for Anangu to be involved in further development of a Malleefowl survey/monitoring program in the MTL, along with scientists and other stakeholders. A medium term plan, detailing targets and processing and developed in conjunction with Anangu and state and NRM authorities, would also be beneficial and would provide clarity and a sense of purpose to the program.

Finally, if a systematic and regularly repeated monitoring program for Malleefowl is implemented in the MTL, the ensuing data should be made available to the National Malleefowl Recovery Team. Linkages to the National Malleefowl Monitoring Database (NMMD) should also be investigated. The NMMD is an online database that has been designed to manage the mound based monitoring in southern areas, and features a number of facilities such as data validation processes, preliminary analysis and automatic reporting. Apart from making the data available to the Malleefowl Recovery Team, links to the existing monitoring database will demonstrate to Anangu the importance of their work in a national context and foster a sense of shared purpose with the many community groups, land managers and researchers involved in Malleefowl monitoring across the continent.

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