Aerial and ground baiting, Matuwa 2018

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Introduction

From the first operation in 2003 and until about 2012/13, aerial baiting of Matuwa with Eradicat© has mostly been effective, holding the feral cat and wild dog activity (population) to low levels throughout most of this period. However, since about 2012/13, the cat population has been trending upwards as baiting effectiveness has been 'variable'. Last year (2017), aerial baiting was ineffective, reducing cat activity by just 10.7%. When combined with ground baiting, the knockdown improved to 39.4%, which is still a poor result. As noted in the 2017 report (Burrows and Thoomes 2017), of concern is a) the trend of an increasing population of feral cats and b) the high post-bait residual cat population; the post-bait Track Activity Index (TAI) in 2017 was 21.5, about double the target level (<10). In 2017 the wild dog activity was also relatively high. While the 2017 baiting operation reduced dog activity by 41.7%, there was a relatively high residual population.

The decrease in baiting effectiveness and increase in cat activity is attributed to low bait uptake in response to either increased prey availability due to good seasons and reduced predation pressure, and / or the predators are becoming more wary of the baits – we may have selected for genetically 'risk averse' cats?

At a cost of about $100,000, annual aerial baiting of Matuwa is expensive and a significant waste if the introduced predator knockdown is poor. In 2017, a pilot trial of ground / track baiting in conjunction with aerial baiting showed some promise, increasing the knockdown of cats by about 30% compared with aerial baiting alone (Burrows and Thoomes 2017). Ground baiting is significantly cheaper than aerial baiting; if it proves to be at least as effective as aerial baiting, then it is a viable option in situations where there is adequate density of tracks, such as Matuwa. As recommended in the 2017 baiting report, this year (2018) a ground baiting trial was carried out on Matuwa west (west of Granite Peak Road) concurrent with routine aerial baiting, which was confined to Matuwa east (east of Granite Peak Road). The aim of the trial was to compare the cost effectiveness of the two techniques in reducing introduced predator density, especially feral cats.

Methods

Baiting

To compare ground and aerial baiting, two treatment cells were chosen - Matuwa east (~145,000 ha) and Matuwa west (~77,000 ha) - being east and west of Granite Peak Road, with a 5 km (~20,000 ha) wide buffer (no baiting) between the treatments east of Granite

Peak Road (Fig. 1). Ground baiting was carried out in the west cell because necessary track closures associated with the operation would have minimal impact on Matuwa access and other activities. As the cameras were deployed elsewhere, roadside camera traps were not used to assess the effectiveness of baiting. Cameras deployed off-track (in the bush) have a much lower detection rate (of introduced predators) than those deployed roadside (Wysong 2016). This can be compensated for somewhat by leaving the 'bush' cameras deployed for longer periods; however, this does not lend itself to timely assessment of the effectiveness of baiting operations, or other perturbations such as fire. Assessing the effectiveness of a baiting operation is best done within 2-4 weeks of the operation – allowing a longer time interval to elapse increases the potential for re-invasion of introduced predators from surrounding unbaited areas, confounding interpretation of the efficacy of baiting. With the unavailability of cameras for roadside survey, we reverted to the footprint / tracking transect technique to assess the level of activity of introduced predators before and after baiting. This methodology has been described in previous reports.

All track access points to the ground baited cell were closed and appropriate signage erected to reduce the risk of people entering and tampering with baits. The roads were closed until 8th August, some 4 weeks after baiting, by which time the baits were either taken or had deteriorated to such an extent that it is highly unlikely they posed a threat to the public. During post-bait surveys we saw only three baits on the transect tracks.

Due to time constraints, we were able to carry out four rather than five nights of tracking over 100 km of transects – 50 km in each cell (Fig. 1). Pre- and post-bait surveys of the spoor of introduced predators were carried out over the period 30 June – 4 July and 28-31 July 2018 respectively. Aerial baiting of the eastern cell was carried out 4-5 July at ~50 baits km^2 (dropped in clusters of 50 baits at 1 km intervals), while ground baiting of the western cell was carried out in two operations – the first operation on the 4-5 July when baits were machine delivered along the tracks at ~200 m intervals. The operation was repeated 7-8 July, giving a total ground/track baiting intensity of I0 baits per km of track (equating to ~3.2 baits km^2). Some short sections of track that were inaccessible to the bait machine were baited using a quad bike. A total of 243 km of tracks in the western cell were ground baited.

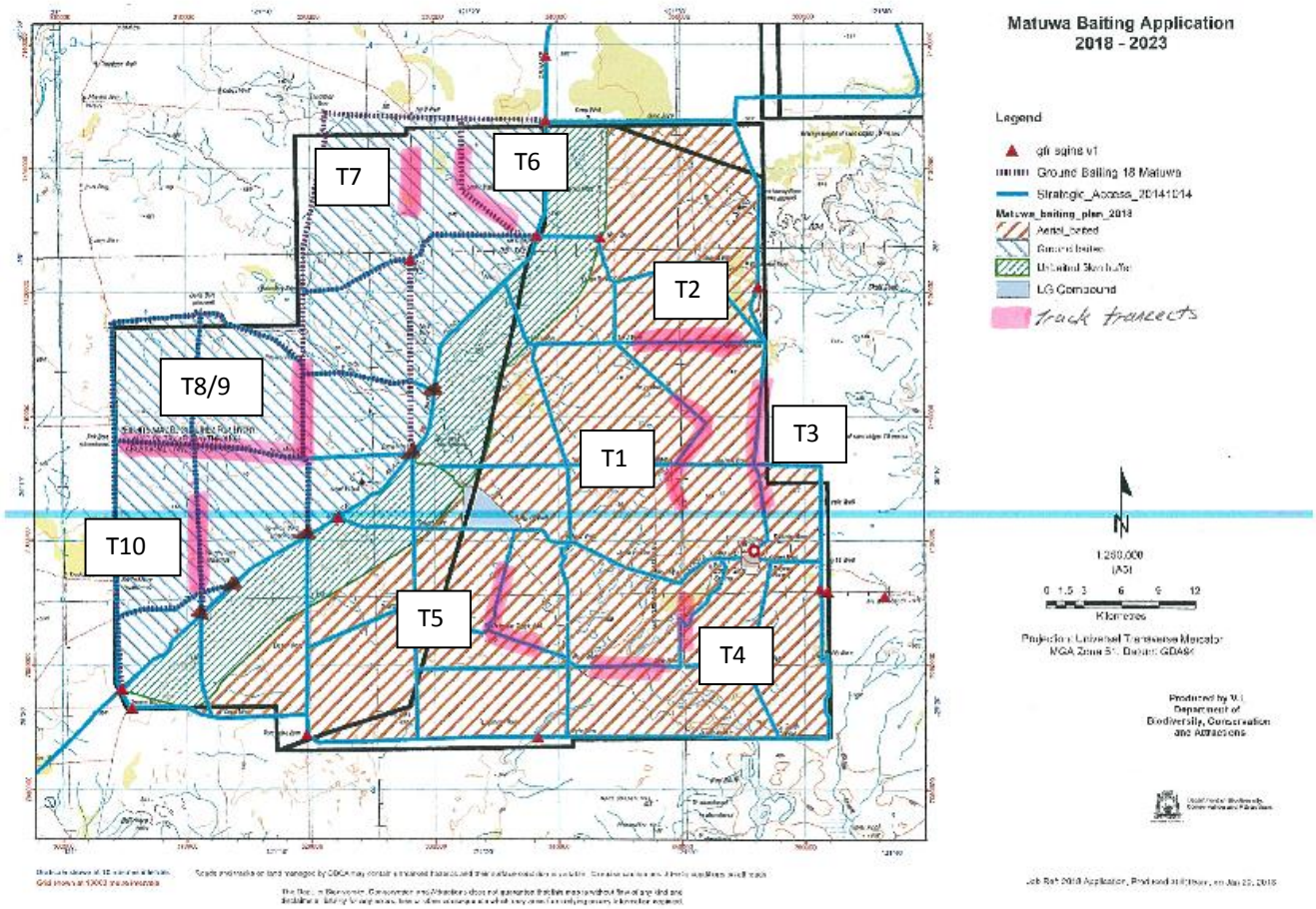

Figure 1: Baiting treatment cells and introduced predator tracking transects

Plate 1: Signage for the ground baiting trial

Training in predator transect surveys was provided to Martu Rangers (Chris and Richard) who, not surprisingly, proved to be excellent trackers. Training also included how to record tracks on the data forms. Rangers will require quad bike accreditation before carrying out this work independently, and will probably need a refresher on using the data entry forms and analysing the data.

Plate 2: DBCA Volunteer Errol Thoomes explaining how the ground bait machine works to Martu Rangers.

Plate 3: Martu Rangers Chris and Richard were trained in the introduced predator tracking method.

Bait longevity trial

A simple bait environmental longevity trial was also established during this field trip. Three sites with different substrates (sandy, clayey, stoney) were selected and 6 numbered toxic baits (sprayed with Coopex) were set 8 m apart at each site and photographed daily for 10 - 11 days (thanks to Cheryl, Corrie and Dave). The trial was repeated but with a set of fresh baits that were not treated with Coopex. In addition to photographs, bait condition was also assessed visually.

Plate 4: A caged bait on clayey soil – bait longevity trial.

Plate 5: Bait longevity trial Site 1 Site2 Site 3

Weather during and after baiting

As can be seen from Figure 2 below, rainfall for the 12 month period July 2017 to June 2018 was about 11% above average (292 mm). The last significant rainfall (>5mm) prior to aerial baiting on 4-5 July was 9 mm on 8th June. No significant rain fell during or within 4 weeks of baiting. At 1.5% moisture content (to 30 cm) (about 10% of field capacity) soil condition was 'dry'.

Minimum and maximum daily temperatures for Wiluna during and one week after baiting are shown in Figure 3 (temps at Matuwa are similar to Wiluna). During baiting, conditions

were sufficiently cold to reduce reptile activity but there was noticeable small mammal (hopping mice, mulgara, etc.) spoor. However, while nights remained cool to cold, daytime maxima increased soon after baiting to the low and mid-20s, which is not ideal (too warm), resulting in increased reptile activity during the day. Cats are primarily nocturnal hunters and overnight temperatures were sufficiently cold to suppress reptile activity with the exception of some small snake species. It was a near full moon during baiting – cats are thought to have better night vision than native animals (no hard evidence), so a full moon would favour native animals in terms of their ability to see predators. We suspect cat hunting success is probably higher on darker nights.

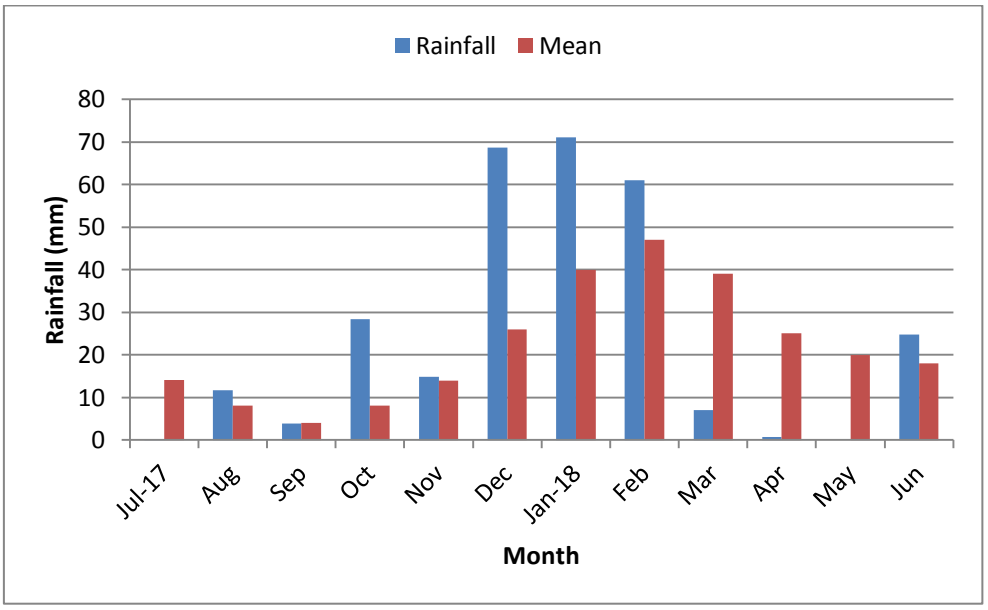

Figure 2: Rainfall for Matuwa - July 2017 to June 2018

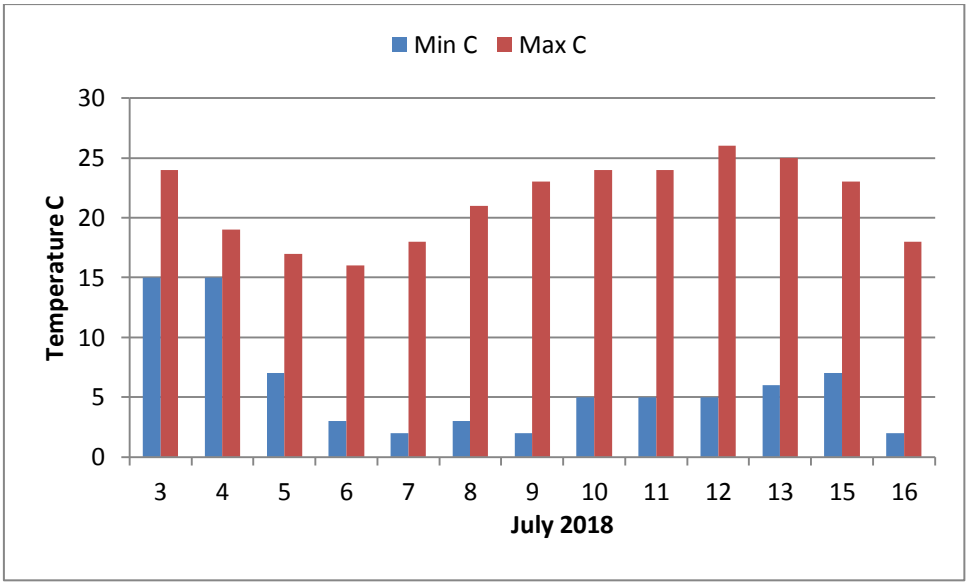

Figure 3: Daily minima and maxima, Wiluna July 2018. Aerial baiting occurred 4-5 July, ground baiting 4-8th July.

Results

Baiting

The pre- and post-bait feral cat track activity indices (TAIs) for each treatment are summarised in Table 2. The pre-bait TAIs for both treatment cells were very similar, with the overall mean being 29.5, which is almost as high as it was before aerial baiting commenced in 2003 (32.0 – Fig. 4). This continues the trend of increasing cat activity / population over the last five years despite annual baiting. Aerial baiting reduced the TAI by 13.3%, which is a similar result to last year, and ground baiting reduced it by 17.2%. Given the precision of the tracking census technique, these values are neither significantly different to each other nor are they significant in terms of baiting impact on the feral cat population, so it can be concluded that neither baiting operation was effective. As was the case last year, unfortunately, few cats took baits.

Ground baiting, fully costed including salaries and overheads, vehicle running (including travel to and from Manjimup) and bait costs was $8,400 for 243 km baited. Cost of aerial baiting was about $60,000 and the cost of reducing the cat TAI by 1% was 9.2 times higher than ground baiting (Table 1). Assuming there are 450 cats on Matuwa, then the cost per cat removed is about $1,000 for aerial baiting and about $110 for ground baiting based on current TAI data. However, this assumes that all cats in the ground baiting cell, at some stage, patrol the tracks and encounter a bait. If there are cats that do not use the tracks, then clearly these would not encounter a bait - there is a higher probability that all cats will encounter a bait following aerial baiting. The problem is not bait encounter but bait uptake - yet again, most (85-90%) cats showed no interest in the baits, regardless of how they were delivered.

Unlike cat activity, dog activity was very low with the overall mean pre-bait TAI being 1.5, increasing to 3.2 post-baiting. However, given the low numbers, these differences are insignificant – as with all census sampling techniques, the values are less significant at low detection rates. However, these data suggest dogs did not take the baits.

Cats are able to irrupt following good seasons (rainfall), as can be seen from Figure 4 (e.g., winter 2016 to winter 2017). We observed a similar irruption following good seasons in the Gibson Desert Nature Reserve in the early 1990s. In good seasons, cats can breed twice per year and successfully raise 3-4 young. Females are reproductively mature at 6 months, and together with reinvasion, their numbers can increase rapidly.

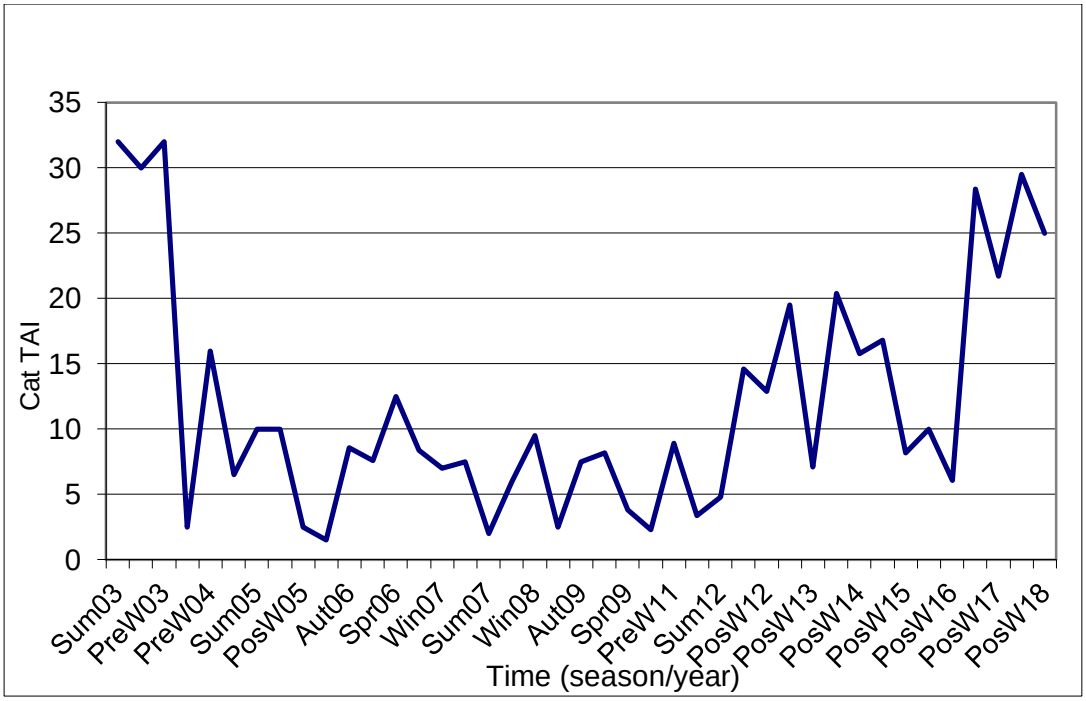

Figure 4: Feral cat track activity index (TAI) for Matuwa (Lorna Glen) from pre-baiting in summer 2003 (Sum03) to post-baiting in winter 2018 (PosW18). Annual aerial baiting commenced winter 2003 and was successful. There has been a stepped increase in cat activity since 2012/13.

Treatment	Pre-bait cat detections / 50 km				Post-bait cat detections / 50 km				Pre-bait TAI	Post-bait TAI	TAI Reduction (%)	Cost per 1% reduction in cat TAI ($)
	Day				Day							
	1	2	3	4	1	2	3	4				
Aerial baiting Matuwa east (T1-T5)	16	15	13	16	14	14	12	12	30.0	26.0	**13.3**	**4,511**
Ground baiting Matuwa west (T6-T10)	11	15	15	17	11	13	10	14	29.0	24.0	**17.2**	**488**

Table 1: Summary of the pre- and post-bait cat track activity index (TAI). Matuwa east (Transects 1-5) was aerial baited (~62,000 baits), Matuwa west (Transects 6-10) was ground baited (~2,430 baits). Estimated $ cost per 1% reduction in TAI is shown.

Observations on other introduced animals

Rabbit activity was slightly below average (Fig. 5). Rabbits are at low density and patchy across the property, generally localised to the higher productivity habitats such as around lakes and some sand dunes. Camel activity is relatively high (see 2017 report – similar detection rates for camels in 2018). Based on spoor, aside from one small breeding herd (sighted 18 animals), most observations were of solitary old post-breeding bulls, pairs of old bulls, or small bachelor herds of 3-5 animals.

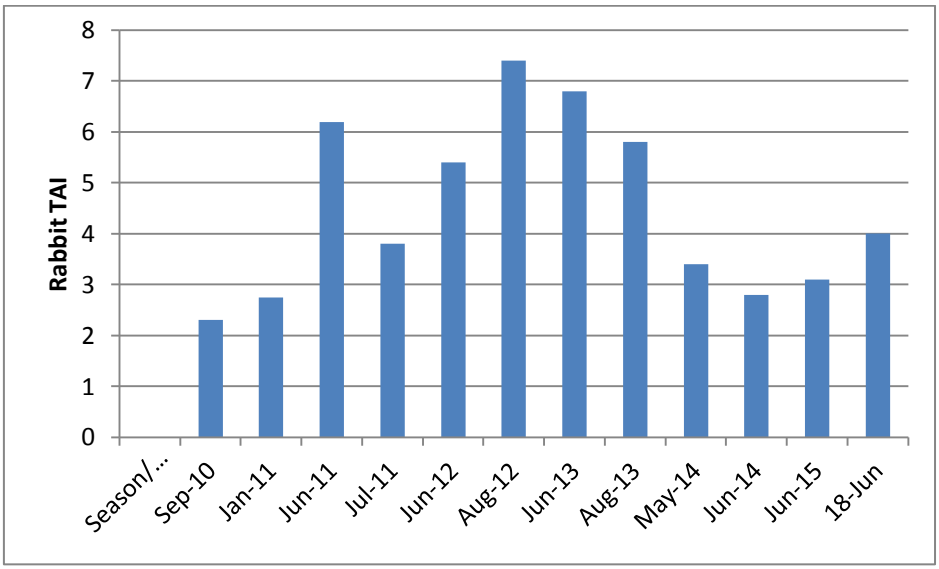

Figure 5: Rabbit track activity index (TAI) 2010-2018 (data gap 2016/2017). Long-term mean is 4.4.

Significant native fauna detections

Bilby tracks were detected on lines 1,2,3,5,8,9 and 10, bt possum tracks were detected on lines 1 and 4, indicating that these reintroduced species are persisting. Echidna tracks were detected on lines 1,3,4,5,6,8,9 and 10 and the mulgara population, although not as high as it was in 2012, is widespread and 'healthy'. Bait uptake stations and Felid Attracting Phonics (FAPs) used to monitor mulgara in the past have not been used since the introduction of cameras in 2015, so the current commentary is based on general footprint observations.

Baiting longevity trial

In all, about 360 photos were taken of individual baits during this trial (thanks Corrie and Dave). For brevity, examples only are included in this report but all photos are available on request.

Summary observations – baits with Coopex

- See temps during trial period (Table 2) – no rain.
- Site 1 had numerous small ants when setting up baits but they were gone the following day.

- Site 2 was ant free.
- Site 3 had lots of large (meat) ants on baits but they did not appear to be eating the baits.
- Over the 11 days of the trial, based on appearance (colour, shape, turgidity), the baits on all sites retained good condition for the first 4-5 days then showed signs of deterioration - discolouration (darkening) and desiccation.

DAY	DATE	MIN.TEMP	MAX.TEMP
1	05.07.2018	8	24
2	06.07.2018	4	18.5
3	07.07.2018	1	18
4	08.07.2018	2.5	18.5
5	09.07.2018	3.5	22.5
6	10.07.2018	2.5	24
7	11.07.2018	2	25.5
8	12.07.2018	3	27
9	13.07.2018	6	24
10	14.07.2018	3	26.5
11	15.07.2018	3.5	26

Table 2: Min. and max. temps during bait longevity trial – with Coopex

Plate 6: Example of bait (with Coopex) condition at site 1 – day 1 (left) and day 11 (right)

Baits without Coopex

- See temps during trial period (Table 3) – no rain.

- At site 3, many large (meat) ants, some (~20%) baits were eaten / hollowed by ants.
- Aside from ant attack, based on appearance (colour, shape turgidity), the baits retained good condition on all sites for the first 4-5 days then showed signs of deterioration - discolouration (darkening) and desiccation.

DAY	DATE	MIN.TEMP	MAX.TEMP
1	19.07.2018	2	27
2	20.07.2018	3	23.5
3	21.07.2018	6.5	28
4	22.07.2018	9.5	30.5
5	23.07.2018	9.5	28
6	24.07.2018	4.5	23
7	25.07.2018	4.5	24.5
8	26.07.2018	5	27
9	27.07.2018	8.5	21.5
10	28.07.2018	8	24

Table 3: Min. and max. temps during bait longevity trial – without Coopex

Plate 7: Example of bait (without Coopex) condition at site 1 – day 1 (left) and day 10 (right)

Discussion

Baiting

The feral cat density continues to trend up and is now almost as high as it was before baiting operations commenced in 2003. While ground baiting was about 9-10 times more cost effective than aerial baiting, neither baiting technique was effective at reducing the feral cat or wild dog population. As discussed in last year's report, and assuming baits were in good

condition (which they appeared to be apart from some physical deformities), possible reasons for the poor uptake are:

- There has not been a prolonged 'drought' period in the rainfall record since 2005, with only one year (2009) when rainfall was <200 mm. While wet periods drive productivity and reproduction in the arid zone, prolonged drought periods equally drive famine and contraction.
- Since the 1990s the decadal mean annual rainfall has been over 300 mm; prior to this it was mostly 200-250 mm, so the trend is one of increasing rainfall, probably leading to increasing prey availability, increasing fecundity of feral cats and decreasing bait uptake.
- Increasing incidence of bait shyness as a result of sub-lethal dose, although this is unlikely.
- The wild dog population is low, which could be driving a higher cat population, although studies at Matuwa (Mike Wysong) suggest that dogs and cats co-exist at the regional scale with localised habitat partitioning and / or avoidance behaviour by cats. We are unsure why the wild dog population is low – possibly due to control operations on nearby properties? This needs further investigation.
- A possibility is that 'natural selection' is operating. We have long known that a proportion of cats (around 25-30%) in a bait-naïve population, are 'bait wary' and will not pick up baits. It is possible that this innate wariness (risk aversion) of some individuals could be a genetic trait and that more than a decade of annual baiting has selected for a higher proportion of 'smart cats' (bait wary) in the population. This hypothesis needs further investigation because it has ramifications for the sustained baiting success of feral cat control.

Bait longevity

- Based on physical appearance, baits remained in good condition for 4-5 days after which they showed signs of deterioration (deformed, hardened, darkened, desiccated). There appeared to be no site differences. Ants were observed crawling on baits with and without Coopex, but baits with Coopex were not eaten whereas those without Coopex, were eaten.

Conclusions

Initially, aerial baiting with Eradicat© was very effective against feral cats on Matuwa but there is a trend since 2012/13 of reduced effectiveness and of an increasing cat population. This year, baiting was again ineffective. Given the cost of baiting, we question the wisdom of going ahead with aerial baiting prior to a bait uptake trial.

The Rangelands Restoration project has demonstrated that aerial baiting is effective against bait-naïve populations of feral cats, but that effectiveness declines over time. The predator-free compound on Matuwa is proof that if introduced predators are eradicated, rare and endangered CWR mammals thrive, consistent with what has been demonstrated in other predator-proof compounds constructed around Australia. Rangelands Restoration has also demonstrated that reintroduced and 'free range' bilbies and brush tail possums can persist with low cat densities and there are indications that extant fauna such as mallee fowl,

echidna, some reptile species and mulgara may also benefit. We don't know whether these species will persist with the current high cat population level.

Based on the last five years, we can no longer be confident that annual baiting will always be effective against feral cats on Matuwa in the long term; we suspect it is unlikely to be effective for the reasons given above – especially the possibility that we now have a population of bait shy 'smart cats'. It has been reported elsewhere that regular baiting reduces the cat population to mostly large cats; this is not the case at Matuwa where the cat population, based on footprint size, is comprised mostly of medium-size cats, with a few small cats and a few large cats. The current trapping program should shed more light on the size / age structure of the population.

Recommendations

- Prior to aerial baiting, conduct a bait uptake trail by first checking at least 30 km of track for cat spoor. Having located where individual cats are, set up at least one roadside camera in the vicinity. Place a fresh Eradicat© bait opposite each camera. Run the trial for at least 5 nights. Check and replace baits daily - if a bait is removed, replace it with a fresh bait. Check cameras to assess extent of bait uptake by cats (other animals may have removed the baits). If >50% of cats that encounter a bait actually take the bait, then continue with aerial baiting. Such a trial would be very low cost and could save $100,000 in ineffective aerial baiting . This will require greater flexibility of aircraft operations – the decision to aerial bait, or not, depending on the results of the uptake trial.
- Alternatively, given its variable effectiveness and high cost, cease broad scale aerial cat baiting of Matuwa until there is a prolonged period of drought (e.g., 2 years of below average rainfall by say 30%).
- Should baiting go ahead, roadside cameras should be used to assess effectiveness.
- Closely monitor bilby and brush tail possum (and possibly mulgara) populations. If these appear to be declining in the face of high cat densities, *ceteris paribus*, consider intensive cat control such as trapping and ground baiting in the vicinity of known populations.
- The Western Shield funds saved by not aerial baiting could go towards feral cat control research including infectious diseases and gene drive technology.
- Alternatively, funds saved by not aerial baiting could go towards the construction of a predator free compound (such as on Wanjarri) as a holding action until a solution can be found for feral cats.

Prologue and Acknowledgements

After 30 years working on fire, ferals and native fauna in Western Australia's amazing deserts, Neil and Tub are about to retire, making this field trip to Matuwa (Lorna Glen) our last as research officers with CALM, DEC, DPAW and DBCA.

With Dr Per Christensen and Alex Robinson, we commenced arid zone work in 1988 on a project called 'Desert Dreaming', which was instigated by Dr Andrew Burbidge (CALM's then Director of Research) to better understand the reasons for the alarming decline and

extinction of arid zone medium size mammals. The project aimed to test hypotheses about changed fire regimes and introduced predators – in particular, the fox, which had severely impacted native fauna in more mesic environments. While we were aware that feral cats occurred in the deserts, our surveys in the Gibson Desert Nature Reserve (GDNR) in the late 1980s (during a severe drought), showed that they were in very low numbers, so we did not consider them a major issue. Besides, we thought baiting would be effective. In September 1991 we baited (aerial and ground) a large area (40 km x 40 km) surrounding the proposed reintroduction site near the western boundary of the GDNR (Eagle Bore). We eliminated foxes and wild dogs but had little impact on cats – but their density remained very low, so we weren't too concerned. The fauna reintroductions were scheduled for May 1992, but drought-breaking, record rainfall in the area meant we had to post-pone the project until it dried out - we re-scheduled for September 1992. Our first task on arriving on site in September was to carry out introduced predator surveys. We were dismayed to discover that while there were no foxes and very few dogs, the feral cat population had more than doubled since our last survey less than 12 months ago. Plans to fly the golden bandicoots and boodies to Eagle Bore from Barrow Island were well advanced – they arrived about a day after we had completed our predator survey – it was too late to abort the project. Despite our best efforts, the cats eventually beat us – the boodies were all predated within six weeks – the bandicoots persisted for longer (about three months) before we lost radio contact with them. Many days were spent searching for them on foot, without success. We can only assume they also succumbed to cats. To say we were downhearted is an understatement. To add to our pain, we were publically criticised by many in the scientific community and questions were asked in parliament. We dared to have a go, dared to dream, but it became a nightmare. Thankfully, our CEO at the time, Dr Syd Shea, stood by us.

While it failed as a reintroduction program, it succeeded as a research program - we learnt a lot. We learnt that island animals could be translocated to the interior mainland – it had not been done before, with many scientists saying the animals would perish. We learnt that the mainland habitat is in good condition – there was doubt about this at the time – the animals quickly established, gained weight and were breeding. They fed in the recently burnt patches and sheltered (the bandicoots) in the long unburnt patches. We learnt that some species are more vulnerable to cat predation than others and that eradication of foxes and cats is a prerequisite for re-establishing predator vulnerable species. We learnt that the fire regime had flipped with the departure of Aboriginal people, and we learnt how to patch-burn the deserts using aircraft. The main learning was that the feral cat is the barrier to successful arid zone fauna reintroductions – and in a paper we published in 1994, we claimed that cats were the primary cause of modern arid zone mammal extinctions. For the next six years, we focussed on understanding feral cats - carrying out some of the earliest radio tracking and diet studies, seasonal pitfall trapping to find out when prey species were least abundant, conducting experimental bait uptake trials, aerial baiting using a bio-marker to see what native animals were taking the baits, and we successfully carried out winter baiting using small fresh meat baits. A breakthrough came when CALM scientist Dr Dave Algar developed the Eradicat© bait. Not all of this work was published - we were driven by on ground outcomes, not publications. Others joined the fray - for the next two decades, the feral cat became the focus of much research by universities, CRCs and CSIRO – the Federal government developed a feral cat threat abatement plan.

In the mid-1990s, under instruction from the visionary Dr Shea, and with CALM's Mid-west Region, we commenced 'Project Eden' on the Peron Peninsula, Shark Bay. The plan was to fence the isthmus, remove feral sheep, goats, foxes and cats and reintroduce native animals. Sustained by a high rabbit population, the peninsula was awash with foxes and cats – amongst the highest densities recorded in the country. Baiting virtually eradicated foxes, but probably due to the high rabbit population, it was 'hit and miss'with the cats – we never got on top of them. Despite this, the removal of foxes and thousands of sheep and goats saw a remarkable recovery of vegetation and extant native fauna, but the high cat population precluded fauna reintroductions, although other scientists reintroduced mallee fowl, bilby and woylies – the latter were quickly predated by cats.

In 2002, after handing Project Eden over to the Mid-west Region, we shifted 'Desert Dreaming' to Lorna Glen (Matuwa) – it became 'Operation Rangelands Restoration'. Early cat baitings with Eradicat were successful and we were cautiously optimistic - we thought we had finally 'cracked' the cat problem. However, in the last few years, baiting has been largely ineffective and the cats have hit back. Tub and I won't be around (as employees) to go 'round three' with the cats, but we urge investment in research into novel broad area control techniques – we stand by what we said in 1994 – cats are the barrier to arid zone fauna conservation in this country. There is no solution to the feral cat problem on the horizon, and there may never be. Society doesn't have the heart to introduce infectious diseases into the feral cat population. Gene drive technology is a promising concept, but is decades away, if at all. In the meantime, to ensure the conservation of our unique arid zone fauna, predator free refugia (offshore islands and onshore compounds) are the only way forward.

We thank and acknowledge our talented and dedicated colleagues (too many to list) with whom we have worked on the bold, ground-breaking arid zone fauna conservation projects - Desert Dreaming, Project Eden and Rangelands Restoration. We make special mention of Dr Per Christensen, a steadfast 'true believer' out of Africa (Kenya), and the Goldfields Regional staff, who have been with us from the beginning. It has been a privilege to be part of it, but the war on cats is not yet won – with vision, determination, commitment and hard work, we will win.

Neil Burrows and Graeme (Tubby) Liddelow