Longevity Of 1080 Meat Baits In Central Australia

FINAL REPORT TO NATIONAL FERAL ANIMAL CONTROL PROGRAM (NFACP)/BUREAU OF RURAL SCIENCES
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By

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EXECUTIVE SUMMARY

Meat baits laced with 6-7 mg 1080 per bait are used for the control of dingoes in the Northern Territory. However, little is known about the longevity of such baits, how quickly they are taken and their efficacy against dingoes in the central Australia. These three factors were investigated by this project.

Most meat baits placed on soil in predator-proof cages remained toxic to dingoes, foxes and feral cats for at least eight months regardless of whether they were protected from rain or not. However, when actual dingo control programs were monitored (n = 3 stations), approximately 90 per cent of meat baits were taken within 2-4 days. Those baits not immediately taken will remain a hazard to domestic animals, particularly farm dogs, for a considerable period and precautions need to taken to avoid accidental poisoning of these non-target species.

Three dingo control programs were undertaken by placing 1080 meat baits near water points (bores) with known dingo activity on each station. The impact of these control programs on dingo numbers was variable. Baiting was effective on two stations but not the third. Where successful, the actual reductions in dingo numbers ranged from 50 to 70 per cent, which is similar to that achieved by dingo control operations elsewhere in Australia. The failure of our control program on the third station was not due to the lack of bait-take as approximately 80 per cent of baits were taken within 4 days. The most likely cause of this failure was the presence of ephemeral water-bodies along the Finke River which could not be baited. Thus some of these dingoes crossed the track transect used as an index of abundance but were not exposed to baits because they could drink at waterholes without poison baits.

Baiting around selected water points had a localised impact on dingo populations. However, this technique was effective in removing those dingoes which utilised the artificial water points and hence were likely to be interacting with cattle. Such an outcome has benefits to both conservation and the pastoral industry, as problem dogs are removed without placing the long-term survival of dingoes at risk. Such campaigns may well be the best option for dingo control in many pastoral areas as they only remove problem dogs in the immediate area rather than resulting in the large scale removal of dingoes. The latter can actually result in an increase in the damage caused by dingoes because the new animals which recolonise baited areas can be less efficient, but more active hunters.

RECOMMENDATIONS

- That precision measuring instruments are used when making dosing solutions of 1080. This needs to include precision balances and a means to accurately measure added water (e.g. graduated cylinder or weigh on the balance).
That landholders are advised of the considerable longevity of 1080 meat baits in arid and semi-arid environments. Although most baits are taken within four days, any baits which remain after predator control programs are likely to provide a hazard to farm dogs for at least eight months.

The placement of poisoned baits around the main water points for dingoes proved an effective control technique. However, where possible, baiting campaigns should not be undertaken when ephemeral water bodies which can not be baited are present or when substantial alternate food sources are available.

BACKGROUND

1080 meat baits are used throughout Australia for controlling pest canids (Thomson 1986; McIlroy et al. 1988; Fleming and Parker 1991; Thompson and Fleming 1991), particularly in arid and semi-arid areas utilised by the pastoral industry. 1080 meat baits are also a vital component of control strategies aimed at foxes for both agricultural and conservation purposes. In the Northern Territory most control activities are directed towards alleviating the impact of dingo predation on the pastoral industry, where control programs are undertaken largely through the localised placement of 1080 meat baits around specific water points and/or along tracks. The Parks and Wildlife Commission of the Northern Territory (PWCNT) is the agency responsible for overseeing these operations.

Although 1080 meat baits may remain toxic for only short periods under some conditions found in eastern Australia (0.5-2 months in high rainfall areas; Fleming and Parker 1991, G. Saunders pers. comm.), there is no information on how long such baits remain toxic under the climatic conditions experienced in arid Australia. The rate at which these baits are removed by dingoes in these areas is also unknown. Both these factors have potential implications for nontarget species and because of safety concerns for cattle-dogs, can also influence the ability of pastoralists to restock or muster areas after baiting.

The aim of this project was to:
1) determine the longevity of 1080 in the meat baits used for dingo control programs in the Northern Territory
2) determine the rate at which these baits are taken during routine dingo control operations in central Australia
3) monitor the effectiveness of 1080 meat baits as a control option against dingoes. Appropriate changes to baiting protocols can then be recommended to landholders undertaking dingo poisoning campaigns in arid and semi-arid Australia.

PROJECT OBJECTIVES

The objectives of this 12-month study were:

• determination of the longevity of 1080 poison in meat baits in arid Australia
• examine whether there is any relationship between the degradation patterns observed and the weather variables measured during the trials (temperature, rainfall)

• measure the rate at which meat baits are taken during ‘routine’ dingo control operations

• determination of the efficacy of 1080 meat baits against dingoes in arid Australia

• advise pastoralists and other interest groups of outcomes which could improve their management of the impact of dingoes.

METHODS

Longevity of 1080 in baits

The 1080 longevity trials were located in Palm Paddock within the Finke Gorge National Park, NT.

All meat baits were housed in predator-proof cages constructed from weld-mesh (50 mm x 50 mm) with a bird-wire covering (10 mm diameter holes). However, to improve the cage/substrate interface, cage-bottoms were constructed from the bird-wire only. All cages were 100 cm long x 66 cm wide x 21 cm high. Where present, roofs were made from clear Alsynite (89 per cent UV light penetration) and measured 160 cm x 120 cm. All roofs were situated 5-6 cm above the cage. Roofed cages also contained a wooden floor which was elevated 5-10 cm above the ground. All wooden floors and the bottom of the unroofed cages, were covered with 2-3 cm of soil from the immediate surrounding area. Care was taken to locate all cages away from water run-off areas.

Fresh bullock meat was used for all baits; 200-400 g pieces were allowed to stand (air-dried) overnight to enable ‘skin’ formation. The following morning (Day 0) these baits, which now weighed between 100-250 g, were injected with 1.5 ml of a 4.4 mg l⁻¹ 1080 solution. Assuming the Commercial Tenate Brand of 1080 used was 92% pure, this equates to a nominal dose of 6.1 mg per bait. A sample of the dosing solution was also frozen for later analysis.

At Day 0, eight baits were placed in each cage with, at least 7-10 cm spacing between each bait. One bait per cage was subsequently removed for each of seven sampling periods: Day 0, then two, four, eight, 16, 24, and 32 weeks after bait lay. The remaining bait in each cage was a ‘spare’ which was collected and bagged at the final sampling period. Sampling commenced on 26 March 1998 and was completed on 5 November 1998. All sampled baits were placed into individual resealable plastic bags and kept at -4 to -18°C until analysis.

The sodium monofluoroacetate (1080) content of the meat baits was determined as follows by Landcare Research, New Zealand. An aqueous extract was obtained by soaking each minced bait in an alcohol/water mixture overnight followed by homogenising and centrifuging to remove the fibre. An aliquot of each extract was mixed
with acetone, centrifuged and then added to 50 ml two per cent sodium chloride and 15 ml ethyl acetate. This sample was then acidified with hydrochloric acid and converted to the dichloroaniline derivative with N, N’-dicyclohexylcarbodiimide (DCC) and 2, 4-dichloroaniline (DCA). The derivative was evaporated, taken up in cyclohexane and cleaned on a silica cartridge eluted with toluene. Fluoroacetate concentration was then quantified by gas chromatography on a BP-5 capillary column with electron capture detection (Ozawa and Tsukioka 1987; 1989). The meat baits were adjusted for a recovery of 97 per cent from spiked dried meat (n = 4), and 74 per cent from fresh meat (higher moisture content; n = 5). The limit of detection was 0.02 mg in meat with an assay variation of ± 6 per cent (95 per cent confidence limits).

The effect of rainfall on bait longevity was tested on the sandy soil substrate using five matched pairs of the predator-proof cages; one with and one without a roof. There were 1-3 m between each cage in a matched set and approximately 20 m between each pair. The grid pattern for these pairs was roughly circular, and was approximately 20 m from the Stevenson Screen weather station. Soil crust pH of this land unit is 8.75. To examine what microflora were present in the soil, 20-30 ml soil samples (1-8 cm depth) were collected from the undisturbed soil directly adjacent to each unroofed cage for each sampling period. Soil samples were kept at 7°C until analysis.

To determine the influence of substrate type on 1080 degradation patterns, five unroofed cages were also located on a rocky sandstone substrate. Except for the absence of soil from the bottom of these cages, the number of baits used and the collection schedule were identical to that described above. This site was approximately 200 m from the sandy substrate site.

The presence or absence of fungi and insect damage was recorded for all baits at all collection periods. Rainfall, and ambient and soil temperature (depth 5 cm), were monitored daily at the sandy substrate site using an ENVIRODATA AUSTRALIA EASIDATA data logger.

**Bait Take and Localised Effects on Dingo Populations**

The rate of bait removal, and the reduction in dingo numbers during ‘normal’ baiting campaigns in Central Australia were assessed on three pastoral properties in the vicinity of the Finke Gorge National Park; Henbury, Owen Springs, and Undoolya stations. Two sub-sites, 40-70 km apart, were used on each station. One sub-site received poison meat baits (prepared as described above), the other unpoisoned baits (experimental control).

In areas of known dingo activity the area around three to four water points (usually water troughs) was baited on each station as per standard practice. This involved using track counts of dingoes in the immediate vicinity of each water point to estimate the number of dingoes present. Ten baits for each estimated dingo were then laid around each water point using a roughly circular transect and the number of baits removed from each water point was recorded one, two and four nights after bait lay.
An index of predator activity was obtained before and after baiting to assess the impact of the baiting campaigns on the surrounding dingo populations. A 20-25 km track transect was established ‘perpendicular’ to the central water point, and in late afternoon, all tracks were cleared from this transect using a drag and an All Terrain Vehicle (quad motorbike). The following morning the tracks of dingoes, foxes and feral cats were recorded in two ways:
1) odometer readings were used to record when a predator entered and left a transect, which when used with a ‘1 km giving-up rule’, provides an estimate of the number of predators present
2) the presence/absence of each predator was recorded for each 1 km ‘block’ along the transects (see Edwards et al. 1999).

Evidence of any interaction between the three predators was recorded. The abundance of rabbits and kangaroos for each kilometer of the track transects was also estimated from the presence of unique tracks: None = 0; Low = 1-5; Medium = 6-10; High >10 estimated animals present. Depending upon their repeatability track counts were undertaken for three to four consecutive nights immediately prior to bait lay and then repeated after each dingo population had been exposed to the baits for five consecutive nights. Track counts were undertaken at both sub-sites simultaneously (i.e. those with and without 1080 poison). Except for the presence of the 20-25 km track transects, our procedure reflected standard practice as much as possible.

Predator numbers were also similarly monitored on the circular track transects (approximately 800 m) around most water points where bait was laid.

RESULTS
All tasks, outputs and outcomes for the project were achieved and these are presented below.

Longevity trials
Loss of 1080 from baits
The amount of 1080 recorded in the baits immediately after their injection on Day 0 was quite variable. Mean (SD) concentration of these baits was $6.4 \pm 1.1$ mg 1080 per bait ($n = 14$, range: 4.7 to 8.8 mg). This excludes one Day 0 bait which only contained 3.5 mg which was believed to be in error. With this bait included (i.e. $n = 15$) the mean was $5.9 \pm 1.3$ mg. The nominal concentration was expected to be 6.1 mg per bait assuming 92 per cent purity for the Commercial Tenate Brand 1080 powder and using 1.5 ml of the resulting 4.1 mg ml$^{-1}$ 1080 solution. However, later analysis revealed that the dosing solution actually contained around 4.9 mg 1080 ml$^{-1}$. The limit of detection for aqueous solutions was 3 mg L$^{-1}$ ± 10% (95% C.L.). No 1080 was detected in unpoisoned meat baits ($n = 5$).

Irrespective of the time of collection, the amount of 1080 for all baits assayed ranged from 0.6 (after eight months) to 8.8 mg (a Day 0 bait). However, even after eight months of exposure, 67 per cent of the baits remaining at this time (10 of 15) contained greater
than 2.5 mg of 1080, and only 9% of all the exposed baits (8 of 90 baits) contained less than this amount (Table 1).

Table 1: The minimum and maximum amount of 1080 (mg per bait) found in the meat baits for the three different treatments (n = 5). The number of baits for each sample period containing greater than 2.5 mg 1080 is also shown. Separate baits were collected at each time period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Sandy no Rain</th>
<th>Sandy with Rain</th>
<th>Rocky with Rain</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Months)</td>
<td>Min Max No &gt; 2.5 mg</td>
<td>Min Max No &gt; 2.5 mg</td>
<td>Min Max No &gt; 2.5 mg</td>
</tr>
<tr>
<td>0.5</td>
<td>3.2 6.5 5</td>
<td>5.8 8.1 5</td>
<td>3.5 7.0 5</td>
</tr>
<tr>
<td>1</td>
<td>1.6 6.9 3</td>
<td>3.3 6.6 5</td>
<td>2.8 6.5 5</td>
</tr>
<tr>
<td>2</td>
<td>1.8 6.6 4</td>
<td>3.0 6.5 5</td>
<td>3.5 6.8 5</td>
</tr>
<tr>
<td>4</td>
<td>0.8 6.4 4</td>
<td>2.6 6.2 5</td>
<td>3.4 4.8 5</td>
</tr>
<tr>
<td>6</td>
<td>3.2 7.3 5</td>
<td>2.8 4.8 5</td>
<td>2.8 5.0 5</td>
</tr>
<tr>
<td>8</td>
<td>2.4 7.0 4</td>
<td>0.6 4.7 4</td>
<td>1.1 5.2 2</td>
</tr>
</tbody>
</table>

The degradation patterns for the three treatments are given in Fig. 1. As rain occurred within 18 days of bait lay we were able assess the effect of rain on the loss of 1080 from the baits. Degradation patterns for the two treatments with exposure to rain were similar, and displayed an exponential loss of 1080 (SYP, \( y = 6.08 \times 10^{0.039X} \), \( r = 0.92 \), \( n = 7 \); RKP, \( y = 5.99 \times 10^{0.039X} \), \( r = 0.94 \), \( n = 7 \)). That is, there was an initial rapid loss of 1080 and this then slowed after 1-2 months (Fig. 1). However, the baits without exposure to rain (SNR) displayed quite a different degradation pattern. Some baits quickly lost some of their 1080 while others lost little 1080 over the 8 month trial period; thus the amount of 1080 recorded in these baits was also quite variable (Fig. 1, Table 1).

Fungal growth was only evident on those baits exposed to rain on the sandy substrate and then only immediately following rain. There was very little evidence of insect damage to the baits and we had no interference with the cages by dingoes or foxes over the trial period.
Fig. 1. The persistence of 1080 in meat baits with and without exposure to rain in central Australia.

SYP, sandy substrate with rain; SNR, the same sandy substrate without rain (i.e. roofed cages); and a rocky substrate with rain (RKP) which was situated about 200 m from the sandy soil site. N = 14 at Day 0, and 5 baits per treatment per time period were collected thereafter.
Total weekly rainfall (bars) and cumulative rainfall (line) for the trial period are also shown.

Soil microorganisms

Up to 12 different species of microorganisms capable of defluorinating 1080 were found in the soil samples from Finke George National Park. These are in the process of being isolated and identified, but they are known to include the fungi genera *Fusarium*,
Pencicilium and Aspergillus, and bacteria from the genera Pseudomonas, Bacillus, Nocardia, Streptomyces. The relative abundance of these organisms also seemed to increase following rain (Twigg and Socha unpublished data).

**Bait-take trials**

**Rate of bait removal**

The rate of bait removal was monitored on three pastoral properties in central Australia (Table 2). Most baits were taken during the first night after bait-lay, and there was no difference in the percentage bait-take at the end of four nights between the sub sites on the three stations with and without poison baits ($t = -1.089$, $df = 4$, $P_{(2-tailed)} = 0.34$). Although a few foxes or feral cats were recorded at the sites (Table 3), most baits were believed to be taken by dingoes. The lower percentage take at the poisoned sites was probably due to the removal of resident dingoes during the baiting program.

**Table 2: Percentage bait-take for the three pastoral properties.** ‘Bait stations’ were not replenished during the trials.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Station</th>
<th>Mean</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Henbury</td>
<td>Undoolya</td>
<td>Owen Springs</td>
</tr>
<tr>
<td><strong>Poisoned:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bores counted</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total poisoned baits laid</td>
<td>79</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Bait Take (%) after:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 night</td>
<td>91</td>
<td>65</td>
<td>48</td>
</tr>
<tr>
<td>2 nights</td>
<td>99</td>
<td>67</td>
<td>74</td>
</tr>
<tr>
<td>4 nights</td>
<td>100</td>
<td>83</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unpoisoned:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bores counted</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Total unpoisoned baits laid</td>
<td>80</td>
<td>80</td>
<td>63</td>
</tr>
<tr>
<td>Bait Take (%) after:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 night</td>
<td>78</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>2 nights</td>
<td>90</td>
<td>79</td>
<td>88</td>
</tr>
<tr>
<td>4 nights</td>
<td>91</td>
<td>100</td>
<td>94</td>
</tr>
</tbody>
</table>
Table 3: The relative percentage activity* of three predators on the circular track transects around the water bores (‘bait stations’). Poisoned and unpoisoned sites are pooled and counts include the before and after poisoning values.

<table>
<thead>
<tr>
<th></th>
<th>Henbury</th>
<th>Undoolya</th>
<th>Owen Springs</th>
<th>All Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of records*</td>
<td>282</td>
<td>61</td>
<td>100</td>
<td>443</td>
</tr>
<tr>
<td>% Dingo</td>
<td>98</td>
<td>93</td>
<td>93</td>
<td>96</td>
</tr>
<tr>
<td>% Fox</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>% Cat</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

* Activity was recorded as the number of tracks crossing or travelling along each transect for each night (n = 3-4), and hence will measure an unknown combination of animal density and activity.

Effect of baiting on local dingo populations

The changes in the relative abundance of dingoes on the three stations before and after baiting are given in Fig. 2. Baiting was effective on two stations but not the third (Owen Springs). Where successful, the actual reductions in dingo numbers ranged from 50 to 70 per cent (Fig. 2, Table 4). When these reductions are calculated relative to the changes that occurred on the unpoisoned sites these percentages equate to an overall reduction of 69 to 82 per cent (Table 4). However, the effect of the control program on the third station (Owen Springs) appeared to be negligible even though most baits appeared to be taken by dingoes (Tables 2 & 3). The percentage change in the poisoned populations was estimated relative to the unpoisoned sites according to Twigg et al. (1991) as:

\[ \frac{(\text{Post-untreated}/\text{Pre-untreated} \times \text{Pre-treated}) - \text{Post-treated}}{(\text{Post-untreated}/\text{Pre-untreated} \times \text{Pre-treated})} \times 100 \]

The overall success of the baiting campaigns was examined using a two-factor ANalysis Of Variance (ANOVA) of the mean number of dingoes recorded on the track transects for each site before and after baiting, with time and treatment as factors. ‘Station’ was also used as a blocking factor (n = 3). This analysis revealed a significant effect for the treatment x time interaction \( (F = 12.37, \text{df} = 1, 33, p = 0.001) \), indicating that both factors were important in determining the outcome of our baiting campaigns. Consequently, the changes in dingo numbers before and after baiting were examined independently for the sites with and without poison bait to test whether there were any significant changes in dingo numbers after baiting. There was no significant difference in the number of dingoes recorded on the unpoisoned sites after bait was laid \( (F = 0.80, \text{df} = 1, 33, p = 0.377) \). However, on the sites baited with the 1080 meat baits, dingo numbers decreased significantly after baiting \( (F = 16.27, \text{df} = 1, 33, p = 0.0003) \).

The track counts made on the circular transects around each water point where the baits were laid yielded low and highly variable results. They were also confounded by the presence of cattle which often made the tracks impossible/difficult to read. Zero counts were therefore common at all sites both before and after baiting. In general there were no obvious trends, and there were no significant treatment effects when these data were analysed using a two-factor ANOVA.
Extension outcomes

The major findings of the project, namely the extended longevity of meat baits and their rate of removal during dingo baiting programs, have been reported to relevant organisations in central Australia. This included a presentation to the Cattlemans Association of the Northern Territory in March 1999, and a written article in the Centralian Land Management Association newsletter (see Appendix 1). PWCNT Wildlife Rangers are also making individual property owners aware of the project outcomes when they request baits for dingo control programs. Other Agencies (e.g. Conservation and Land Management (CALM), WA; NSW Agriculture & Fisheries, Agriculture Western Australia) have been advised of the major findings.

Two scientific publications will shortly be submitted to relevant journals.

1) Australian Wildlife Research: The efficacy and longevity of 1080 meat baits used for dingo control in Central Australia.

2) Soil Biology & Biochemistry: Defluorination of sodium monofluoracetate by soil microorganisms from Central Australia.

![Fig. 2: Changes in the mean (± SD) number of dingoes recorded on the track count transects before and after baits were laid on three pastoral properties in central Australia. Two areas were used on each station: one received poison meat baits, the other unpoisoned baits.](image)

Table 4: Changes in the track count index of abundance for the 3 predators during the baiting campaign on 3 pastoral properties in central Australia. Estimated numbers represent the mean number of “unique” individuals recorded on the 20 km track.
transects for the before and after poisoning surveys (n = 3-4 consecutive nights per survey). The percentage change has been calculated for: a) the before and after surveys on the same transect, and b) the change on the poison transects relative to those which occurred on the associated unpoisoned transects.

<table>
<thead>
<tr>
<th>Treatment/Species</th>
<th>Henbury Estimated #’s</th>
<th>% Change</th>
<th>Undoolya Estimated #’s</th>
<th>% Change</th>
<th>Owen Springs Estimated #’s</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poisoned</td>
<td>Before</td>
<td>After</td>
<td>Poison/Unpoison</td>
<td>Before</td>
<td>After</td>
<td>Poison/Unpoison</td>
</tr>
<tr>
<td>Dingo</td>
<td>7.0</td>
<td>3.3</td>
<td>-52</td>
<td>-68.6</td>
<td>4.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Fox</td>
<td>0.3</td>
<td>0.7</td>
<td>+100</td>
<td>-3.9</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Cat</td>
<td>1.3</td>
<td>0.7</td>
<td>-50</td>
<td>-77.8</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Unpoisoned</td>
<td>Before</td>
<td>After</td>
<td>Poison/Unpoison</td>
<td>Before</td>
<td>After</td>
<td>Poison/Unpoison</td>
</tr>
<tr>
<td>Dingo</td>
<td>4.0</td>
<td>6.0</td>
<td>+50</td>
<td>2.8</td>
<td>4.5</td>
<td>+64</td>
</tr>
<tr>
<td>Fox</td>
<td>0.7</td>
<td>1.7</td>
<td>+150</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>Cat</td>
<td>0.7</td>
<td>1.7</td>
<td>+150</td>
<td>2.3</td>
<td>1.8</td>
<td>-25</td>
</tr>
</tbody>
</table>

**DISCUSSION**

**Longevity of 1080 in baits**

**Bait preparation**

The variability in the amount of 1080 delivered to each bait may have been caused by several factors. These include, inaccuracies in preparing and administering the dosing solution, leakage of 1080 from some injected baits or variability of the 1080 assay. The single sample of the dosing solution analysed contained 4.9 ± 0.5 mg ml⁻¹ instead of the expected 4.1 mg ml⁻¹ which suggests our dosing solution was stronger than intended. This is possible because, although a Mettler PN1210 Electronic balance was used to weigh out the 1080 powder, the volume of water needed was added using a plastic general purpose measuring jug. We believe the very low level in one of the Day 0 baits (3.5 mg) may have resulted from operator error and/or leakage of 1080 after the bait was injected. The calibration of the automatic injection syringe was checked regularly during bait preparation. The variation in the 1080 assay for meat baits was ± 6.0 per cent or approximately 0.5 mg per bait, and thus would not account for the level of variability observed.

While the 1080 content of freshly injected baits was variable (4.7 to 8.8 mg per bait: mean 6.4 mg n = 14), all these baits, including the 3.5 mg bait, still continued sufficient 1080 to kill all target predators (Table 5). For example, the LD₉₀ for dingo is 0.123 mg 1080 kg (McIlroy 1986b) which equates to 1.72 mg of 1080 for a 14 kg dingo.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean weight (kg)</th>
<th>LD₉₀ (mg 1080/kg)</th>
<th>Amount of 1080 for LD₉₀ (mg)</th>
<th>Twice the LD₉₀ amount (mg)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dingo</td>
<td>14.0</td>
<td>0.12</td>
<td>1.68</td>
<td>3.36</td>
</tr>
</tbody>
</table>

Table 5: **LD₉₀ amounts for various predators from central Australia.**
Poison longevity

The retention time of 1080 in meat baits in central Australia was considerably longer than that reported previously for meat baits used in canid control programs. In our trial, 10 of 15 baits (67 per cent) contained greater than 2.5 mg of 1080 after eight months exposure, and only 8 of all exposed baits (n = 90) contained less than this amount. In NSW Tablelands, most 1080 is lost from Foxoff® baits (3 mg per bait) within the first 2 weeks of exposure (G. Saunders pers. comm.). However, dried meat baits in Western Australia have greater longevity than Foxoff® baits. Although a considerable amount of 1080 is lost from these baits two to three months after being placed on dry soil (baits contained three or 4.5 mg 1080 per bait), they remained toxic to foxes but posed little risk to non-target species at this time (Kirkpatrick pers. comm.). About 90 mm of rain fell during Kirkpatrick’s study. The loss of 1080 from these baits was accelerated when the baits were buried, placed on the surface of moist soil or when rainfall was >49 mm. In damp soil, buried baits become non-lethal to foxes within three to five days (Kirkpatrick pers. comm.).

In our trials, 60 mm of rainfall occurred approximately 18 days after the baits were laid, and a total of 200 mm of rain fell over the eight month trial period. The impact of this on the baits appeared to be negligible. Several species of microorganisms capable of degrading 1080 where found in the soil at our sites. However, once the baits were laid, they immediately become desiccated and within a few days (two to three) resembled very dry jerky. Baits receiving rain did not become reconstituted. Thus it appears that the very dry, tough outer skin prevented the ready penetration of rain and/or microorganisms into the baits, and this prevented the breakdown or leaching of 1080 from the baits. Fungal growth was only observed on the exposed baits on the sandy soil, and then only immediately after rain.

Several of the microorganisms found in our soil samples have been recorded elsewhere in Australia and although at varying rates, are also known to degrade 1080 (Wong et al. 1992). These included Fusarium oxysporium, several species of Aspergillus, Penicillium spp. and Bacillus sp. Their presence suggests that, once the 1080 exits the bait material, there is little likelihood of 1080 persisting in these environments.

There was no difference in the degradation patterns of 1080 for the two substrates where the baits were exposed to rainfall. The degradation pattern observed for the no rain treatment is difficult to explain. Except for the exclusion of rainfall, these baits were treated identical to the other two treatments. However, these baits exhibited greater variability in their 1080 content, and the amount of 1080 present appeared to increase after six months exposure. One possible explanation for this is that 1080 can physically bind to the meat (Fleming and Parker 1991) and the release of this 1080 may vary with

<table>
<thead>
<tr>
<th></th>
<th>Fox</th>
<th>0.13</th>
<th>0.79</th>
<th>1.59</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dog</td>
<td>1.11</td>
<td>1.54</td>
<td>3.08</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td>0.20</td>
<td>0.88</td>
<td>1.76</td>
</tr>
</tbody>
</table>

* Represents a crude (over?) estimate of the LD_{100}.
different environmental conditions. It should be remembered that different baits were collected at each sample period, rather than repeated samples from the same bait.

Regardless of the degradation patterns, most baits remained lethal to mammalian predators even after eight months of exposure. Such longevity has advantages and disadvantages. It may result in increased efficacy over an extended period providing enhanced overall control. It may also lessen the effects of reinvasion by target species of areas where predator control has been undertaken. However, most baits (more than 85 per cent) were removed within four days, and although there have been reliable anecdotal reports of baits killing dingoes and foxes several months after bait-lay, the palatability of baits which are many months old is untested. Long-lasting meat baits such as those found in our trials will almost certainly provide a hazard to farm dogs, and pastoralists have been advised of this.

Effect on local dingo populations (efficacy)

As with several other studies, the effect of the 1080 baiting campaigns on our dingo populations was variable. Baiting was effective on two stations but not the third. Where successful, the actual reductions in dingo numbers ranged from 50 to 70 per cent, which is similar to that achieved by dingo control operations elsewhere in Australia. Reductions in dingo populations during other studies have ranged from 22-90% (see Best et al. 1974; Thomson 1986; McIlroy et al. 1986b; McIlroy et al. 1988; Fleming and Parker 1991; Thompson and Fleming 1991).

The failure of our control program on the third station (Owen Springs) was not due to the lack of bait-take as approximately 80 per cent of baits were taken by dingoes within four days. The most likely cause of this failure was the presence of ephemeral water-bodies along the Hugh River which could not be baited. Thus some of these dingoes crossed the track transect used as an index of abundance but were not exposed to baits because they could drink at waterholes without poison baits. This resulted in less accurate abundance-indices for this station. The efficacy of our trials was determined five to eight days after bait lay. As untaken baits were not retrieved, and although only a few baits remained, it is possible that further dingoes may have been killed after this period. The presence of a ready supply of alternate food has also been proposed as a reason as to why some dingo control operations are less successful (Best et al. 1974; McIlroy et al. 1986b). Although we did not measure the availability of alternate prey, earlier good rains meant that this was probably high at the time of the efficacy trials, which may have partially influenced the result on Owen Springs. Because cattle were always present, and other alternate foods were also abundant, not all dingoes may have been interested in taking bait.

The toxic loading used in our baits was approximately 6-7 mg 1080 per bait. This is within the range used for dingo control throughout Australia where toxic loadings vary from five to 10 mg per bait (McIlroy et al. 1986a; McIlroy et al. 1986b; Thomson pers. comm.; this study). The amount now recommended by the Vertebrate Pest Control Committee is 6.0 mg 1080 per bait. Due to our selected bait loadings, and as most baits were taken by dingoes, it is extremely unlikely that bait aversion by dingoes was a factor in the poor result on Owen Springs.
Baiting around water points had a very localised impact on dingo populations by only killing dingoes in the immediate vicinity. However, this technique was effective in removing those dingoes which utilise artificial water points, and hence, are likely to interact with cattle. This is supported by anecdotal reports from pastoralists who believe that this technique usually results in the removal of ‘problem’ dogs causing damage to cattle. Such an outcome has benefits to both conservation and the pastoral industry, as problem dogs are removed without placing the long-term survival of dingoes at risk.

Localised baiting campaigns may well be the best option for dingo control in many pastoral areas as they only remove problem dogs in the immediate area rather than instigating the large scale removal of dingoes. The latter can actually result in an increase in the damage caused by dingoes as new animals recolonise the baited area, which has been attributed to increased activity and less effective hunting by the new arrivals (Allen and Gonzalez 1998).

**Effectiveness of the extension program**

While our finding that 1080 meat baits have extended longevity in central Australia did not surprise many pastoralists, they were nonetheless pleased that we could place time-lines on this. They also felt more confident that their dingo control programs were generally effective, and environmentally sound. The Centralian Land Management Association (CLMA) Newsletter (Appendix 1) reached a wide audience as did the ‘word-of-mouth’ transfer of the project outcomes. A more detailed handout (Appendix 2) was also prepared for distribution to interested parties.

**Acknowledgments**

We thank Geoff McKenzie, Dennis Matthews, and Ross Bryan for assistance with parts of this project. Geoff Wright’s group at Landcare Research, New Zealand undertook the difficult 1080 analyses. Glen Saunders provided access to his unpublished data. We were grateful to Henbury, Undoolya, and Owen Springs stations for allowing access to their properties.

**References**


Appendix 1

The article which was presented in the Centralian Land Management Association Newsletter.

Dingo baits still toxic after more than a year.

Late last year, in a program supported by the Bureau of Resource Sciences, the Parks & Wildlife Commission ran a series of trials to determine the proportion of baits that are not taken during a dingo baiting exercise, and to find out how long these baits are likely to remain toxic.

1080 meat baits were placed in wire mesh cages (to stop them from being eaten) and left out in the open for eight months. After this time, almost all baits still contained more than the lethal dose of 1080 for working dogs and dingoes, even though 200 mm of rain had fallen. It was calculated that some of the baits would still have been toxic after 18 months.

In further trials, it was found that about 12 per cent of baits (three in every 25) were still present four days after baiting. By this time, remaining baits would have had little chance of being taken, as most of the dingoes in the vicinity would be dead and the baits would be too dry to be eaten by birds.

These results indicate that baited areas will almost certainly contain toxic baits for a considerable period, possibly for as long as 18 months, or at least until dingoes re-establish in the area. Any baits remaining after a baiting operation will pose a serious risk to station dogs and where practical, these baits should be collected and destroyed after control programs are completed.

A short report outlining the results of these trials is available from Parks & Wildlife. If you would like a copy, please contact Steve Eldridge Parks and Wildlife Commission of the Northern Territory (PWCNT) on 89518288 or Bob Millington Centralian Land Management Association (CLMA) on 89534230.
1080 meat baits for dingo control:

How effective are they and how long do they remain toxic?

Background

The Parks & Wildlife Commission of the Northern Territory (PWCNT) dingo baiting program has been running since the late 1970s and is widely regarded to be an effective means of alleviating the problem of dingo predation on cattle. The baits consist of fist-sized cuts of fresh meat (usually beef or horse meat) containing 6 milligrams of 1080, which is twice the amount required to kill a dingo. They are placed strategically around watering points (bores, dams and natural waters), with no more than 40 baits laid at each point.

Over the years, several pastoralists have told of station dogs dying months after baiting, which are believed to have showed signs of 1080 poisoning. Obviously, not all of the baits laid will be taken by dingoes, and these stories suggest that uneaten baits may remain toxic for considerable periods of time. In higher rainfall areas uneaten baits are known to lose their toxicity after about two months, but there is very little information on bait longevity for arid and semi-arid areas like central Australia. Similarly, no-one knows what proportion of the baits laid during a baiting exercise remain untaken/uneaten.

Information on both of these factors would be valuable to pastoralists, as the potential hazard to station dogs may influence their decision to muster or restock an area after baiting. In late 1998, PWCNT conducted a series of trials to address these gaps in our knowledge.

Bait longevity

Bait longevity is defined as the length of time that a bait remains toxic. In our trials 1080 meat baits were placed in cages (to stop them from being taken) and left out in the open at Finke Gorge National Park. Cages were placed on both sandy and rocky surfaces to see whether bait longevity varied according to soil type. We also wanted to determine how rain affected bait longevity, so some cages were fitted with roofs to keep the baits inside.
dry. Every month, a bait from each cage was picked up and put in the freezer to stop it deteriorating any further. This continued for a period of eight months and then the frozen baits were shipped over to New Zealand to be analysed for 1080 content.

The results are presented in the following graph.

The general pattern of 1080 content in exposed baits was an initial rapid loss of 1080 which became more gradual after one to two months. There was no difference in 1080 loss between baits on sandy surfaces and baits on rocky surfaces. The 1080 content of the covered baits (referred to as ‘No rain’ on the graph) followed quite a different pattern, with an apparent increase in the 1080 content of covered baits after six months. This cannot be easily explained, but we believe that covered baits had retained more 1080 than the exposed baits after eight months, but this was highly variable. Rain fell several times during the trials, but it had very little impact on the loss of 1080 from exposed baits. Once the baits were laid, they immediately formed a very dry and tough outer skin which obviously stopped water and microorganisms from penetrating into the baits to leach out or break down the 1080 contained inside.

Although baits were each injected with 6.1 mg of 1080, there was a lot of variability in the actual amount of 1080 contained in baits that were frozen immediately after injection. We think this was due mainly to leakage from baits after being injected but despite the loss of some 1080, all baits contained well above the lethal dose for an average-sized (14 kg) dingo.

Probably the most important findings of this trial is that most baits remained lethal to dingoes, cats and foxes after 8 months of exposure. Some baits still contained very high levels of 1080 after eight months and it was calculated that they would remain toxic to dingoes for a further four months, and to domestic dogs for a further eight to 10 months. Therefore, toxic baits may be present in a baited area for periods greater than eight months and probably up to 18 months if not picked up. The next step in our research was
to find out what proportion of the baits laid during a baiting exercise are likely to remain uneaten/untaken.

**Bait uptake**

Bait uptake trials were conducted at three sites: Owen Springs, The Garden / Undoolya and Henbury stations. These trials were designed to determine the percentage of baits taken during a baiting operation and at the same time measure the reduction in dingo numbers as a result of baiting. This was undertaken by selecting two areas about 50 km apart on each station, laying poisoned baits in one area and unpoisoned baits in the other. In each area, dingo, cat and fox tracks were counted along station tracks for three days before baiting and for three days after baiting to determine the effect of baiting on dingo numbers. The number of baits remaining at each baited water point was counted for four days after baits were laid.

The bait take results are presented in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Station</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Henbury</td>
<td>Garden / Undoolya</td>
<td>Owen Springs</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Poisoned baits:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait take (%)</td>
<td>after:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 night</td>
<td>91%</td>
<td>65%</td>
<td>48%</td>
<td>68%</td>
<td></td>
</tr>
<tr>
<td>2 nights</td>
<td>99%</td>
<td>67%</td>
<td>74%</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>4 nights</td>
<td>100%</td>
<td>83%</td>
<td>79%</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td>Unpoisoned baits:</td>
<td>Bait take (%) after:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 night</td>
<td>78%</td>
<td>60%</td>
<td>80%</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>2 nights</td>
<td>90%</td>
<td>79%</td>
<td>88%</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>3 nights</td>
<td>91%</td>
<td>100%</td>
<td>94%</td>
<td>95%</td>
<td></td>
</tr>
</tbody>
</table>

These results indicate that, in general, most baits were taken during the first night after bait-lay. After four nights, at water points baited with poisoned baits, an average of 88 per cent of baits had been taken, compared with 95 per cent at water points baited with unpoisoned baits. The lower percentage take at the poisoned sites was probably due to the death of resident dingoes. Changes in dingo numbers (recorded along 20-25 km of station track in each area) as a result of baiting are presented in the graph below. The effect of the poison baits was determined five to six days after baits were laid.
The above graph indicates that poison-baiting effectively reduced dingo numbers at Henbury and The Garden/Undoolya (by 50% and 70% respectively), but not at Owen Springs. The area where poison baits were laid on Owen Springs was in the vicinity of the Hugh River. Rainfall during the winter months of 1998 had filled several ephemeral waterholes along the river and although we attempted to lay baits around as many of these waterholes as possible, the more inaccessible ones remained unbaited. The dingoes drinking at unbaited waterholes would not have picked up baits and we believe that this is the reason for the reduced effectiveness of baiting at Owen Springs.

It should be noted that even at the two stations where baiting was effective, dingo tracks continued to be recorded after baiting occurred. This demonstrates that the effect of baiting was localised, only killing dingoes in the immediate vicinity of the baited watering points. However, it is highly likely that these individuals are the ‘problem’ dogs likely to be causing cattle damage. This suggestion is supported by our feedback from pastoralists. Such an outcome is beneficial to both the pastoral industry and to conservation, as problem dogs are removed without placing the long-term survival of dingoes at risk.

**Summary of outcomes**

- 1080 dingo baits remain lethal for at least eight months, and potentially for up to 18 months after being laid. Unless these baits are destroyed they will pose a potential hazard to station dogs.

- Whether the surface is rocky or sandy, the rate of degradation of 1080 in meat baits is similar.
- Rainfall has very little effect on the degradation of 1080 in baits after they have formed a dry, tough outer coating. This can occur in a matter of a day or two in our climate in central Australia.

- About 85 per cent of baits are taken within four nights of being laid. Most of these are taken on the first night.

- A typical baiting operation removes 50 per cent to 70 per cent of dogs in the baited area. This is consistent with the PWCNT policy of removing problem dogs without placing the long-term survival of dingoes at risk.

Acknowledgments

Thanks go to John Brumby, Jim and Andy Hayes and Ross Morton for allowing the trials to be conducted on their properties and for supplying meat for the baits. Thanks also to the many PWCNT staff who helped with the trials, and to the Bureau of Rural Sciences for their support.