MEASURING PREDATOR CONTROL EFFECTIVENESS: REDUCING NUMBERS MAY NOT REDUCE PREDATOR IMPACT

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ABSTRACT: The fundamental assumption in the management of predators is that reducing predator numbers will reduce their predation impact on livestock. Research on dingoes (*Canis lupus dingo*) has shown this assumption to be incorrect in beef production areas in northern and western Queensland. Aerial and ground baiting with 1080 (fluoroacetate) is the principal dingo-control method used in extensive pastoral areas of Australia. This paper compares four approaches to measure the effectiveness of these control programs. Dingo abundance was reduced in 11 of 13 baiting campaigns monitored with almost two-thirds of these producing >50% reduction. However, concurrent decline in dingo abundance occurred in non-baited areas due to seasonal changes in dingo populations. When this was taken into account, less than half of the control programs produced >50% reduction. The time taken for dingoes to recolonize baited areas is also an important measure of effectiveness. In two-thirds of the control programs, conducted in the first nine months of the year, dingoes recolonized prior to the period of peak calving (November/December) when the biggest threat to calves existed. The timing and the scale of control programs affect the rate of re-colonization. Calf loss was subsequently higher and occurred more frequently in baited areas compared to non-baited areas. Seasonal conditions, the status of prey populations and the impact of control programs on social organization and prey selection, are key factors affecting calf predation. Control programs should be assessed by measuring impact rather than changes in predator numbers. The assumption that a direct relationship exists between predator numbers and impact is not valid for dingoes in beef production areas in northern Australia.

KEY WORDS: cost/benefit, 1080 baiting, effectiveness of control, beef cattle, dingoes, re-colonizing, dispersal, prey switching

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INTRODUCTION

Throughout mainland Australia, dingoes (*Canis lupus dingo*) are regarded as serious pests of livestock. Dingoes are consequently declared as pests under state legislation throughout Australia. Queensland, similar to other states in Australia, provides a 1080 (fluoroacetate) baiting service to graziers to keep dingo populations and presumably livestock losses at acceptable levels. Most control programs are applied during the fall and winter following the annual cattle muster and when reptiles (goannas, *Varanus* spp.) are less active. Like all such predator control programs, the fundamental assumption is that reducing predator numbers will reduce their impact.

In 1993, I commenced a project to evaluate the impact of dingo predation on the beef industry in the extensive pastoral areas of northern and central Australia. One of the objectives of the study was to evaluate the effectiveness of 1080 baiting programs.

METHOD

My approach to measure calf loss was to select two large cattle stations (800 and 9000 km^2) with owners agreeable to having dingoes left alone on one-half of the property, but have them regularly baited on the other half. The two halves of each property were separated by a buffer (12 and 30 km). In each half, we individually ear tagged and monitored around 200 known-pregnant cows with similar age, breed, management, nutrition and disease status. By identifying those individuals that were previously pregnant that subsequently returned non-lactating (i.e., lost their calf) and working out the theoretical age of the calf, we separated pre-natal losses from post-natal loss. As reproductive performance data show no difference in postnatal loss between beef cattle herds under these conditions, we assumed that the difference in calf losses between the baited and unbaited paddocks was due to dingoes. The relative abundance of dingoes was regularly surveyed before, and after, baiting and at other times of the year using tracking stations. The method of monitoring dingo abundance is detailed in Allen and Engeman (1995) and Allen, et al. (1996).

During this project, 13 baiting programs were conducted between 1993 and 1998, and 100 to 600 kg of 1080-poisoned bait were layed each year. Baits were layed from vehicles and from aircraft by station personnel. By monitoring adjoining non-baited areas as well, our experimental approach allowed us to evaluate the effectiveness of these programs in four different ways:

1. Measuring the percentage reduction in predator abundance after baiting;
2. Measuring the percentage reduction in predatorabundance after baiting, taking into account seasonal changes in predator activity in a non-baited area;
3. Measuring the time taken for baited populations to return to within 10% of the pre-control level (taking into account seasonal changes); and
4. Comparing calf predation losses between baited and non-baited areas.

RESULTS

Method 1—Percentage Reduction of Dingo Activity Between Pre- and Post-baiting Surveys

This analysis (Table 1) shows that most baiting programs (85% or 11/13) resulted in reduced dingo

Table 1. Effectiveness of baiting as calculated by changes in dingo abundance before and after baiting. Index represents the number of dingo tracks per tracking station.

Date	Bait (kg)	Pre-Index	Post-Index	% Change In Abundance
Property 1				
5/94	100	0.400	0.195	51.3% ↓
10/94	100	0.250	0.099	60.4% ↓
5/95[1]	100	0.110	0.120	9.0% ↑
11/95[2]	100	0.070	0.625	793.0% ↑
7/96	100	0.625	0.180	33.7% ↓
9/96	200	0.117	0.052	55.6% ↓
8/97	250	0.570	0.200	64.9% ↓
Property 2				
7/95	350	0.090	0.010	88.9% ↓
7/96	250	0.290	0.280	3.4% ↓
9/96	350	0.280	0.080	71.4% ↓
8/97	400	0.240	0.000	100.0% ↓
9/98	450	0.128	0.098	23.4% ↓
9/98[3]		0.860	0.320	69.8% ↓
MEAN REDUCTION DUE TO BAITING 55.8% ↓ (Deleting 11/95 result due to re-invasion.)				

[1]Baiting primarily to control reinvasion along the boundary.
[2]Post-baiting survey conducted five months after baiting.
[3]At the end of the project both baited (upper figure) and former "non-baited" (lower figure) treatment areas were baited together.

abundance. Dingo activity was reduced by >50% in 62% of the control programs. If a reduction in dingo numbers equated with reduced predation losses, one could justifiably conclude that dingo control programs were generally successful based on this evaluation method.

Method 2—Reduction in Predator Abundance After Baiting, Taking into Account Seasonal Changes in Predator Activity

Characteristically, dingo activity peaks in the fall in the breeding season, declines steadily over winter and reaches its lowest point in late spring during whelping. Removing seasonal effect from the abundance estimates (Table 2) reduced the number of baiting campaigns that produced >50% reduction in dingo activity from eight of thirteen programs in Method 1, to five of eleven programs (46%). In one situation (Property 2, July 1996), Method 1 calculation shows baiting had minimal effect on the population. However, when seasonal changes in activity in the non-baited area are considered, a more significant effect on the baited dingo population had been achieved. A proportion of the observed population reduction, ascribed to dingo control, is a seasonal decline in dingo activity rather than reduced dingo abundance.

Method 3—Duration of Baiting Effects

Only three of eleven baiting programs, (27%) reduced and maintained dingo populations below pre-control levels for more than six months (Table 3). Another three programs may have maintained low dingo populations just beyond six months, but the timing of the follow-up survey did not allow the exact month to be determined. Six of nine baiting programs (67%) conducted in the first nine months of the year resulted in re-colonization occurring sometime over the summer when calves are potentially their most numerous and vulnerable (<3 months old). Calving peaks in late spring to early summer (November to December). Assuming that the intended purpose of 1080 baiting is to reduce dingo populations when calves are most vulnerable, few baiting programs conducted over areas of 400 and 2000

Table 2. Effectiveness of baiting adjusted for seasonal changes in activity.

Date (Month/Year)	% Change Pre- to Post-Baiting (Baited Area)	Seasonal Effect Pre- to Post-Baiting (Non-Baited Area)	Baiting Effect
Property 1			
5/94	51.3% ↓	31.1% ↓	29.2% ↓
10/94	60.4% ↓	3.5% ↑	61.7% ↓
5/95	9.0% ↑	64.3% ↓	No Effect (304% ↑)
11/95	793.0% ↑	655.0% ↑	No Effect (36% ↑)
7/96	71.2% ↓	18.4% ↓	64.7% ↓
9/96	55.6% ↓	22.2% ↓	22.1% ↓
8/97	64.9% ↓	62.8% ↓	5.7% ↓
Property 2			
7/95	88.9% ↓	193.0% ↑	94.3% ↓
7/96	3.4% ↓	217.0% ↑	55.5% ↓
9/96	71.4% ↓	86.0% ↓	No Effect (105% ↑)
8/97	100.0% ↓	33.3% ↓	100.0% ↓

Table 3. Effectiveness of baiting calculated by Method 3, measuring the time interval between baiting and recovery (within 10% of pre-control and non-baited population).

Month of Baiting	% Reduction (Method 2)	Survey Date of Recovered Population	Interval	Season Re-colonized
Property 1				
5/94	29.2%	9/94	<4 mths	June-Sept.
10/94	61.7%	—*	>7 mths	—
5/95	0	—*	>6 mths	—
11/95	0	5/96	<6 mths	Nov.-May
7/96	64.7%	—*	2 mths	—
9/96	22.1%	4/97	<7 mths	Nov.-April
8/97	5.7%	5/98	<8 mths	Apr.-May
Property 2				
7/95	94.3%	6/96	<11 mths	Aug.-June
7/96	55.5%	11/96	<3 mths	July-Sept.
9/96	0	11/96	<2 mths	Sept.-Nov.
8/97	100.0%	—*	>12 mths	—

*Area rebaited before dingoes had recovered to pre-control level.

km² (Property 1 and 2, respectively) are effective. Coordinated dingo control programs applied in spring and extending over much greater areas than this may reduce dingo populations and retard their re-colonization at this critical period.

Method 4—Effectiveness of baiting programs at reducing predation losses

Direct cost of baiting varied each year with operators, the number of baiting programs, bait quantity, their method of distribution and bait source. Calculated cost for each baiting program is shown in Table 4.

Relative to the potential economic loss of dingo-predated calves, the cost of baiting is trivial, amounting to the equivalent value of half a dozen calves or <1% of the calves produced each year. However, losses due to dingoes could not be detected when seasonal conditions were average or better. Highest loss of calves, and the highest frequency of years where losses were detected occurred in the baited areas, not in the areas where dingoes were left alone (Table 5). Only once in seven years of monitoring was there a detectable calf loss (9%) in the unbaited half of the properties. In three out of seven years a predation loss was measured in the baited area. In the worst year, a 32% calf loss was recorded in the baited area and no detectable loss in the adjoining unbaited area. Invariably, the baited areas that had suffered losses had been quickly re-colonized by dingoes, sometimes within weeks. The data also show that calf loss is significantly correlated to below average rainfall years.

Table 4. Details of baiting programs conducted during the project.

Date	Bait Type	Quantity (kg)	Source	Purchase/Preparation Methods/Hours	Distribution Methods/Hours	Total Cost ($A)
Site 1						
5/94	Kangaroo	100	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 1.5 hr Ground 10 hr	355
8/94	Kangaroo	100	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 1.5 hr Ground 10 hr	380
5/95	Kangaroo	100	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 1 hr Ground 10 hr	380
7/96	Dried Kangaroo	100	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 1 hr Ground 10 hr	380
9/96	Dried Kangaroo	200	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 1.5 hr Ground 10 hr	480
8/97	Kangaroo	250	Commercial Pet Meat	6.0 mg Injected 6 hr Transport	Air 2 hr Ground 10 hr	570
Site 2						
8/95	Beef	350	Station Product	6.0 Injected 16 hr Preparation	Air 5.2 hr	1208
7/96	Beef	250	Station Product	6.0 mg Injected 15 hr Preparation	Air 2 hr Ground 16 hr	1000
10/96	Beef	350	Station Product	10 mg Tumbled 12 hr Preparation	Air 2 hr Ground 12 hr	1120
7/97	Beef	400	Station Product	10 mg Tumbled 24 hr Preparation	Air 3 hr	1310
9/98*	Beef	450	Station Product	10 mg Tumbled 24 hr Preparation	Air 4.5 hr	1545

*At the end of the project baits were distributed over both treatment areas >4200 km².

Table 5. Costs/benefits of control programs and calculated predation losses.

Site/Date	Annual Cost of Control Program(s) ($A)	Predation Loss Baited Area	Predation Loss Non-Baited Area	Cost Effective
1/94	$ 735	Nil Detected	8.8%	Yes
1/95	$ 380	15.0%	Nil Detected	No
1/96	$ 860	Nil Detected (0.3%)*	Nil Detected	No
1/97	$ 570	Nil Detected	Nil Detected (1.2%)*	No
2/95	$1208	11.3%	Nil Detected	No
2/96	$2120	32.1%	Nil Detected	No
2/97	$1310	Nil Detected	Nil Detected	No

*Not statistically significant enough to indicate predation.

DISCUSSION

The method used to measure "effectiveness" of predator control campaigns can greatly influence the outcome of the evaluation. Progressively, the evaluation methods applied in this study have moved from a pest numbers focus to a method focussed on pest impact. The former shows that 1080 baiting is generally effective while the latter methods suggest baiting areas <2000 km^2 is at best, seldom effective, and at worst, contributes to predation loss.

The cost of evaluating predation impact on beef cattle is an economic issue to vertebrate pest agencies. Measuring the impact of baiting programs on pest numbers is more within their resources. This is the most likely reason why predation loss on beef cattle has not been evaluated previously.

This analysis highlights the importance of timing and scale of control programs and shows that induced perturbations in predator populations may increase the losses predators cause.

Scale of Control Programs

After the initial baiting program in 1994 on Property 1, follow-up baiting campaigns maintained low numbers of dingoes in the baited area for about 18 months. Subsequently, significant re-colonization occurred each summer. On property 2, re-colonization occurred every year before the May-July survey, but the infrequency of the surveys conducted at this site made it difficult to identify exactly when (September-May) re-colonization occurred.

Why Property 1 was not re-colonized in 1994-95 is ascribed to the baiting of several neighboring properties during this period. One adjoining property (420 km^2) had not been baited for over four decades and it is believed that this baiting temporarily buffered Property 1 from immigrating dingoes. In effect synchronized baiting reduces the supply of dispersing dingoes from adjoining properties.

A similar scenario occurred at Property 2. The baiting in 1997 and 1998 occurred simultaneously with neighboring cattle stations (combined area of approximately 50,000 km^2) and re-colonization had not reached pre-baiting levels before the next annual baiting eight months later. Earlier control programs were restricted to the baited area alone (2000 km^2). In the tropical savannas where Property 2 is located, inundation during the summer wet season and contraction of prey populations around permanent waters during the dry season probably facilitates greater temporal and spatial movement of dingoes within territories and aids in the more rapid re-colonization of vacant areas. Taking a regional approach to coordinate dingo control programs can potentially reduce re-colonization and subsequent predation loss (see Ironhurst example in Allen and Gonzalez 1998, showing an 18% increase in mean branding rate between single property and regional control programs).

Effect of Control Programs on Dingo Populations

The preferred prey of dingoes is small- to medium-sized animals. Analysis of dingo droppings collected on these test properties confirms this. However, Corbett and Newsome (1987) show that as seasonal conditions deteriorate, dingoes "switch" species to consume prey species of increasing body weight. To achieve this flexibility it requires both increased age and pack size (L. Allen and P. Thomson unpublished data), attributes obviously related to experience, hunting ability and pack coordination. Thomson et al. (1992) shows that over 80% of the dingoes that recolonize vacant (baited) areas are young dingoes under three years of age. These animals are likely to have been the low ranked members of stable packs that were evicted by the dominant territorial animals. Usually unmated, they disperse as individuals or pairs and lack the hunting experience, pack structure, and coordination of mature pack members. Re-colonized dingo populations faced with declining prey

numbers, therefore, don't have the flexibility of switching to hunt larger kangaroo species like the members of stable packs. Their alternative is to hunt calves, a less preferred prey perhaps, but one that they manage to capture and kill efficiently.

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