Best Practice Feral Pig Management in the Burdekin River Catchment

Technical Report to the Dalrymple Land Care Committee

and

Bureau of Rural Sciences:

National Feral Animal Control Program

By

Dr. Jim Mitchell[A] (Principal Investigator) and Alexander Kanowski[B]

[A]Senior Zoologist – Department of Natural Resources Mines and Energy

[B]Queensland University – Gatton Campus

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Abstract

This study examined the control and cost effectiveness of three feral pig management techniques (trapping, aerial shooting and aerial baiting) in the dry tropical savannah of north Queensland. In total, 203 pigs were controlled over a two month period; 81 by trapping, 65 by aerial shooting and 57 by aerial baiting. Estimated population reductions of 74%, 64% and 59% were achieved for trapping, aerial shooting and aerial baiting respectively. Aerial shooting was the most cost effective at a cost of $25.90 / pig controlled. Aerial baiting was ranked next ($34.19/ pig) and trapping was the least cost effective ($62.90 / pig). Feral pig movements were examined by radio tracking 8 feral pigs over four months. No movements out of the river system were recorded.

Comment: Mentioning only two out of the three trapping areas is a bit confusing in abstract, just leave for results and discussion sections.

Introduction

Feral pigs (*Sus scrofa*) are considered by landholders in the Dalrymple Shire to be a significant threat to grazing and agricultural industries. Feral pig activity in riparian areas in the Burdekin Catchment destabilises creek and river banks contributing to erosion and sediment transfer to the Great Barrier Reef. Feral pigs carry weed seed such as parthenium (*Parthenium hysterophorus*) from the riverbanks to the open country and associated gullies. Feral pigs also cause major damage to potato, melon and hay-growing agriculture. A major concern of the beef industry in north Queensland is the risk of an exotic disease outbreak and how to control feral animals that may harbour disease. Pigs carry diseases such as Q Fever and leptospirosis, which do occur in the Burdekin Rangelands. The Dalrymple Shire Pest Management Plan encourages adoption of best practice management options to reduce the number of feral pigs in the shire.

Current feral pig control techniques in the Dalrymple Shire include hunting with dogs, trapping, shooting and baiting. There is however no quantitative information available on the control and cost effectiveness of these various techniques specific to the dry tropical savannah bioregion. There is also a significant lack of scientific information regarding the ecology of feral pigs in this habitat.

This study aimed to compare the control and cost effectiveness of three feral pig management strategies to provide a basis for improved property management of feral pigs by local landholders. The movement of feral pigs was also investigated to provide landholders with a better understanding of feral pig ecology within the dry tropics savannah.

This study was instigated by the ‘Dalrymple Landcare Committee’ to provide local landholders with a basis for determining the most suitable or “best practice” feral pig control technique suitable to this dry tropical habitat.

Project Objectives

1. Establish a range of feral pig population monitoring systems on 12 selected areas on beef grazing properties on river frontage of the Burdekin River and associated major tributaries, north Queensland.
2. Apply three feral pig management strategies on these selected areas along the river frontage.
3. Derive the best practice management strategy for this dry tropical savanna habitat.
4. Derive a range of feral pig ecological information for this habitat.
5. Transfer this information to feral pig stakeholders throughout the dry tropical savanna regions of Australia.

Methodology

Study site

The study was conducted on the Burdekin and Star Rivers in the Dalrymple Shire, north Queensland. The study site extended over 200 km of river frontage from the township of Greenvale (E145^{o} 7$^{'}$ 0"; S18^{o} 58' 0") to the property of Paynes Lagoon 130km north of Charters Towers (E146^{o} 1$^{'}$ 3"; S19^{o} 24' 45"). The habitat consisted of riparian woodland vegetation (*Melaleuca* and *Eucalyptus* spp.) with associated open savanna and woodlands on the river frontage.

The three feral pig control techniques (treatments) assessed were aerial shooting, aerial baiting and trapping. An experimental non- control treatment was also established. Each treatment was applied to three discrete replicated 'areas', each extended along five km of river frontage and separated from the other treatment areas by a minimum distance of seven kilometres. In total, for the four treatments (three pig control treatments and the non-control treatment), 12 areas were established on twenty participating properties (Table 1).

Table 1. Properties (on both sides of the river) that represent the areas that were involved in each treatment

Trapping areas	***Aerial baiting areas***	***Aerial shooting areas***	***Control areas***
• Lassie Creek / Battery	• Paynes Lagoon / Laroona	• Lassie Creek / New Moon	• Lassie Creek/ Spyglass
• Greenvale	• Mt Fullstop	• Starbright / Hillgrove	• Starbright / Valpre
• Lucky Downs	• Tarroni	• Christmas Creek/ Blue Range	• Blue Range / Mt Fullstop

Feral Pig Control Treatments

(1) Trapping

Within each trapping area, 5 panel traps were constructed, situated at approximately 1km intervals along the riverbank. Traps were fabricated from four weld mesh panels, a one-way swinging gate and star pickets for support. A specifically designed trip mechanism was used to reduce the capture of non-target species. Mixed grain and meat meal, fermented for three to seven days in cattle feed troughs was used as the

trap bait. Free feeding of open traps continued until pig activity was observed. Traps were then set and checked the following day. All captured pigs where euthanased and the number of captures their sex and weights were recorded. Trapping was continuous in the Greenvale and Lucky Downs areas for two months by three part time trappers who were trained to build and maintain traps and record all trapping details and capture results. Trapping in the Lassie Creek area was conducted by the project Principal Investigator. All costs of materials, labour and vehicle were recorded.

(2) Aerial Baiting

Baits consisting of 500g pieces of kangaroo meat were injected with 72mg of 1080 toxin and distributed from a helicopter within each of the baiting areas. A total of 250 baits (50 baits / kilometre) were evenly distributed in each area along both river banks and also at 250m each side of the river bank. The total costs of bait material labour and helicopter times were recorded.

(3) Aerial Shooting

Aerial shooting was conducted by an accredited shooter from a helicopter. Shooting was restricted to within 100 m each side of the watercourse and conducted in either the early morning or late afternoon. All pigs seen and / or shot were recorded. The total helicopter time and the amount of ammunition used were recorded for each shooting area.

Population Monitoring

Indices of pig populations within each area were measured 10 days prior to and again 14 days after the treatments were implemented. The control effectiveness for each treatment was determined by estimating the change in the pig population by the difference between the pre and post population indices. Two methods of calculating indices of pig populations were used; frequency of sign on activity plots and counts of pigs observed.

(a) Frequency of sign on activity plots.

Within each of the 3 individual areas for each treatment, three 'sites' were randomly selected. At each site, three replicated 50 m x 1m belt transect lines were established on the sand / water interface. Each transect was subdivided into a continuous series of ten, 5 m x 1 m "activity plots'. Plots were swept with a garden broom to remove existing traces of pig activity and reinspected two nights later. New signs of pig activity such as footprints, diggings or faeces were recorded as a present or absent for each plot. In total ninety activity plots were established within each area (3 sites x 3 transects x 10 plots) giving a total for the three areas of 270 plots for each treatment. The frequency of sign index (proportion of plots positive to pig sign / total number of plots in the transect) for each transect were used to calculate the average sign indices for each site, for each area and for each treatment.

(b) Counts

During the frequency of sign inspections as described above, all pigs observed within 500 m of the river frontage were recorded. Each site within each area was visited twice at 2-day intervals. Counts were conducted before and after the control treatments were implemented.

Data Analysis
The pre and post index scores were used to compared the effectiveness of each treatment. The changes in indices for each area and treatment were presented as a positive or negative change in firstly the actual index score and secondly as a percentage change. From the calculated indices and the known number of pigs taken from the trapping and aerial shooting areas, the total number of pigs estimated to be alive prior to the control treatments could be calculated (Eberhardt 1982). For the aerial baiting areas, the numbers of pigs calculated to be alive prior to the treatment were assumed to be similar to the aerial shooting areas. Thus from back calculation of the Eberhardt equation, the number of pigs controlled by aerial baiting could be estimated.

Economic Costs
All expenses associated with the three feral pig control treatments were recorded.. Costs were calculated from the landholder perspective; labour and vehicle costs were only factored-in from the property gate. From the total costs and the number of pigs controlled for each treatment, the cost effectiveness in terms of the cost to control each pig for each treatment was calculated. The various costs associated with each treatment are defined in Table 2.

Table 2. Costs associated with each control treatment

Control Technique	Item	Cost
Aerial Shooting	Helicopter charter	$330.00 per hour
	Helicopter fuel	$200.00 / drum
	Ammunition	$1.00 per bullet
	Labour - (shooting)	$17.00 per man-hour
Aerial Baiting	Helicopter charter	$330.00 per hour
	Helicopter fuel	$200.00 / drum
	Bait meat (Kangaroo)	$1.75 per Kg
	1080 Poison	$0.00
	Labour - (bait preparation)	$17.00 per man-hour
	- (poison application)	$17.00 per man-hour
Trapping	Mesh panels	$100.00 per trap
	Star pickets	$50.00 per trap
	Tie wire	$2.00 per trap
	Trap gate	$20.00 per trap
	Mixed grain (bait)	$75.00 per trap
	Molasses (bait)	$50.00 per trap
	Meat meal (bait)	$38.00 per trap
	Labour - (trap construction)	$17.00 per man-hour
	- (trap servicing)	$17.00 per man-hour
	Vehicle	$0.52 per Km

Movement Study
A total of eight pigs were radio tagged (three boars and five sows) and were opportunistically located over a period of 4 months. Feral pigs were captured in panel traps on Lassie Creek Station at a site 7 km from the Lassie Creek trapping site. The dominant sow and/or mature boars in captured groups were fitted with an ear tag transmitter and released. All remaining pigs above weaner age were fitted with

consecutively numbered ear-tags. All captured pigs were allowed two weeks to accustom themselves to the tracking devices before tracking commenced. Location bearings were entered into a software program 'Locate' to calculate location fixes for each animal. Location fixes for each individual pig where then plotted on a topographic map of the tracking area.

Results

The project commenced in July 2003 and all fieldwork was completed in December 2003 (Table 3.) In total, 203 pigs were controlled using the three control treatments at a total cost of $8900 (average $43.84/ pig).

Table 3. Project time line

Tasks	July	August	September	October	November	Dec 2003 to June 2004
Liaise with graziers & traditional owners	*****					
Property inspections	*****					
Train traditional owners in monitoring & building traps	*****	*****				
Activity transects			*****		*****	
Count Transects			*****		*****	
Establish research traps	*****					
Radio Tracking	******	*****	*****	*****	*****	
Establish control traps		*****	*****			
Trapping				*****		
Aerial baiting				*****		
Aerial shooting				*****		
Calculate best practice						*****
Extension					*****	01/04
Report Completion						03/04

Two methods of determining the best practice control technique for this habitat were assessed. Firstly the control effectiveness of each treatment by estimating the feral pig population reduction, and secondly by determining the cost effectiveness of each treatment by calculating the cost involved in controlling each individual pig.

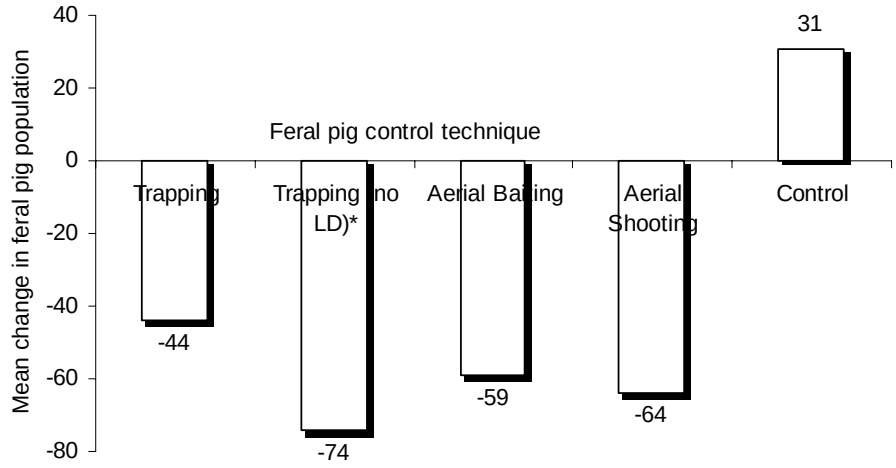
Control Effectiveness

The change in population index for each treatment area is presented in Table 4 and Figure 2 presents graphically the estimated % change in population levels for each treatment. The control effectiveness for each control treatment is discussed below.

Table 4. Activity indices pre and post treatment application and the number of pigs controlled for each treatment area.

Treatment	Treatment Area	Activity Index Pre-Control	Activity Index Post-Control	Change in Activity Index	Pigs Controlled (n)
Trapping	Lassie Creek	0.04	0.05	+1	21
	Greenvale	0.46	0.08	-38	60
	Lucky Downs	0.13	0.22	+9	7
		0.21	**0.12**	**-9**	**88**
Aerial Baiting	Paynes Lagoon	0.47	0.16	-31	-
	Mt Fullstop	0.21	0.01	-20	-
	Tarroni	0.17	0.18	+1	-
		0.28	**0.12**	**-16**	**57 (estimated)**
Aerial Shooting	Lassie Creek	0.28	0	-28	41
	Starbright	0.2	0.01	-19	16
	Christmas Creek	0.2	0.24	+4	8
		0.22	**0.08**	**-14**	**65**
Control	Lassie Creek	0.18	0.18	0.0	-
	Starbright	0	0.13	+13	-
	Blue Range	0.22	0.21	-1	-
		0.13	**0.17**	**+4**	

Figure 2. The mean percentage change in the estimated feral pig population for each treatment. Note – Trapping is presented as two scenarios - all trapping areas combined and also with Lucky Downs (LD) area excluded.



1. Trapping

Traps were monitored from 27th August to the 13th October for the Greenvale and Lucky Downs areas (396 trap set nights) and from the 15th September to the 30th October for the Lassie Creek area (56 trap set nights). Lassie Creek had only 4 traps in working order when the trapping commenced, compared with five traps at Greenvale and Lucky Downs. In total 88 pigs were captured; 21 in Lassie Creek, 60 in Greenvale and 7 at Lucky Downs.

Comment: Already mentioned in methodology

Pig population indicis for the three trapping areas are shown in Table 4. Overall there was a decrease in the activity index of 9 in the three trapping areas, which represents a negative 44% population change. However the Lucky Downs trapping area experienced some trapper/landholder concerns. The trapping effort in this area was inconsistent and not fully maintained with the result that only 7 pigs were captured in this area. This result was obviously aberrant and so to avoid bias in calculating trapping and cost effectiveness, this area was deleted from some of the analysis. The exclusion of Lucky Downs data resulted in a negative 0.37 change in the activity index representing a population decrease of 74%. The pre-control pig population within the Greenvale and Lassie Creek trapping areas was calculated at 109 pigs (10.9 pigs / km of river frontage). From the counting transects, 14 pigs pre-control and 0 pigs post-control were observed within the trapping areas.

2. Aerial Baiting

Aerial baiting was conducted on the 14th and 15th October. In total, 360 kg of meat baits were applied to the three baited areas – approximately 250 baits / area. Pre and post activity index scores are presented in Table 4 . Overall there was a decrease in the activity index score of 16, which represents a negative 59% change in the pig population within the aerial baiting areas. Baiting took 4.6 hr of helicopter time. An estimate of the number of pigs controlled during the aerial baiting was obtained by assuming the pre control population was identical to the population of 100 pigs calculated from the aerial shooting areas. Thus using the Eberhardt (1982) equation, an estimated 57 pigs were controlled in the aerial baiting areas. From the counting transects, 18 pigs pre-control and 0 pigs post-control were observed within the baiting areas.

3. Aerial Shooting.

Aerial shooting in the three shooting areas was conducted on the 14th and 15th October. In total 65 pigs were shot during 2.9 hrs of helicopter time (22.4 pigs per hour). The pre and post control activity index scores are presented in Table 4. Overall there was decrease in the activity index score of 14, which represents a mean negative change of 64% in the pig population in the aerial shooting areas. The pre-control pig population was estimated to be 100 pigs. This represents a pig density of 6.7 pigs / km in the river frontage. For the transect counts, 18 pigs pre control and 0 pigs post-control were observed in the shooting areas.

4. Experimental Control

Pre and post control activity index scores are presented in Table 4. Overall there was a increase in the activity index of 4, which represents a positive 31% mean change in the pig population within the three experimental control areas. For the transect counts 6 pigs pre control and 0 pigs post-control were seen within the experimental control areas.

Cost Effectiveness.

All activities associated with each treatment were costed for each item (Table 5) using the standardised costs in Table 2. The total costs and the cost effectiveness for each treatment were then calculated and presented in Table 6.

Table 5. Costs of individual variables associated with each treatment and the total costs of each variable for the three areas for each control treatment.

Treatment	Item	Quantity	Total cost
Aerial Shooting	Helicopter charter	3.9h	$1,287.00
	Helicopter fuel	1	$200.00
	Ammunition	130	$130.00
	Labour - (shooting)	3.9h	$66.30
Aerial Baiting	Helicopter charter	3.6h	$1,188.00
	Helicopter fuel	1	$200.00
	Bait meat (Kangaroo)	360kg	$630.00
	Labour - (bait preparation)	4	$68.00
	- (poison application)	2	$34.00
Trapping (2 areas only)	Mesh panels	9	$900.00
	Star pickets	9	$450.00
	Tie wire	9	$18.00
	Trap gate	9	$180.00
	Mixed grain (bait)	9	$675.00
	Molasses (bait)	9	$45.00
	Meat meal (bait)	9	$342.00
	Labour - (trap construction)	20	$340.00
	- (trap servicing)	100	$1,700.00
	Vehicle	860	$447.00

Table 6. The total costs and cost effectiveness ($ / pig) for each treatment. Note * = number of pigs controlled is estimated by assuming a pre-control population estimate in the aerial baiting areas (100 pigs) is similar to the aerial shooting areas.

Treatment	Total costs	Number of pigs Controlled	Cost to control each pig
Aerial Shooting	$1,683.30	65	$25.90
Aerial Baiting	$2,120.00	57*	$37.19
Trapping	$5,097	81	$62.90
Total Costs	**$8900**	**203**	**$43.84**

Feral Pig Movements.

A total of 74 location fixes (Table 7) were obtained for the 8 feral pigs (5 females and 3 males). One female was found dead after 2 weeks and was excluded from further analysis. Two males and one female were unable to be located for the last 4 weeks of the study. The female was trapped at the end of the study (in the trap where she was initially captured) with a flat battery in the attached tracking device. The other two males could not be located after an exhaustive ground and aerial search, so flat batteries in the radio tracking device were also suspected.

All tagged pigs were located within 200m of the river system throughout the duration of the study. The maximum distance a pig moved along the river was approximately 2 km from the initial capture point. The three pigs with numbered ear tags were also observed within 1 km of their initial capture point throughout the duration of the study. All three were recaptured at the completion of the study within 1km of their initial capture points. None were observed outside the river system.

Table 7. Number of location fixes for all radio tagged feral pigs

Pig ID	Sex	Total Location fixes
Lana	F	20
Ben	M	3
Spot	F	10
Peggy	F	6
Randy	M	11
Kristy	F	21
Joe	M	3

Discussion

When estimating the best practice feral pig control technique for this region, two main aspects of each control technique should be considered. Firstly, the efficiency in reducing the feral pig population, and secondly, the overall cost effectiveness ($ cost for each pig controlled) of each technique.

The most effective control technique in terms of pig population reduction was trapping followed by aerial shooting and then aerial baiting. Comparisons are difficult however, as the trapping program should be considered as a long term technique as it was conducted over a two month period compared to the short term one day aerial shooting and baiting programs. The average control effectiveness for all three techniques combined was an estimated 66% population reduction. Table 8 compares the control effectiveness of various feral pig control techniques obtained from research conducted elsewhere in Australia.

Table 8. Control effectiveness of feral pig control techniques obtained from other Australian studies.

Pig Control Method	Reduction in Pig Population	Source
Aerial Shooting	65%	Saunders (1993)
	80%	Saunders and Bryant (1998)
Ground Poisoning	>80%	Tisdell (1982)
	99.4%	Choquenot *et al* (1996)
Aerial Poisoning	63%	Mitchell (1998)
	49% to 81%	Mitchell (1999)
	31% to 72%	Fleming *et al* (2000)
Trapping	28%	Saunders *et al* (1993)
	69%	Caley (1994)
	83%	Choquenot *et al* (1993)

1. Trapping

The control effectiveness of trapping in this study (74%) is comparable with other studies, which range from 28% to 83%. However, the exclusion of one of the study areas (Lucky Downs) had a marked effect on the outcome. The highly biased nature of the results from the excluded site, was atypical of normal trapping programs so the exclusion of this site from the analysis was fully warranted.

Tisdell (1982) and McGaw & Mitchell (1998) considered trapping to be a relatively expensive and labour intensive feral pig control technique, suitable only for smaller scale applications. The trapping conducted in this study was limited to small areas (5km of river), and proved to be successful. If the trapping was conducted over a more extensive area then the logistics and increased labour and travelling costs may have decreased the overall cost effectiveness.

The availability of alternative food sources can influence the effectiveness of trapping Choquenot *et al* 1996). For example the availability of a large alternative food supply (such as a crop of mature grain) in the trapping area can usually render the technique relatively unsuccessful (Tisdell 1982). However in this study, the availability of a reliable food supply of ponded pastures in the Greenvale area was a significant factor in improving the control effectiveness of trapping. The pre treatment pig population in this Greenvale area was estimated from the analysis to be approximately twice the pig density compared to the other trapping areas. The availability of a high quality food source tended to concentrate feral pigs in this area that in turn greatly assisted in increasing trapping effectiveness. Thus the overall effectiveness of this technique must be considered in relation to the influence of the availability of a food source that was not available to the other control techniques.

Although trapping had the highest control effectiveness, it was the least cost effective of the three control techniques. The largest cost was associated with the initial purchase of trap materials. However this is a one off cost as trap materials can last many years, so the cost effectiveness will improve if this component is calculated over the expected life of the trap materials. Bait material costs are also a significant component of this control technique. Purchasing grain, molasses and meatmeal, as in this project, is expensive. Using readily available bait material such as dead cattle or harvested kangaroos will minimise bait material costs, however under current Queensland legislation, feeding meat (carcass) in feral pig traps is illegal.

In this study, travel and labour costs associated with trapping were substantially higher then the other techniques. This was due to trapping being conducted over a 2 month time period compared to only one day for aerial baiting and shooting. Trapping is a long term strategy and requires time for free feeding, trap construction and erection, constant checking of bait / traps and disposal of captured pigs. However, once the initial set up is completed, a trapping routine can be incorporated into normal farm routines in order to minimize travel and labour requirements. The relatively high labour and travel costs associated with this method can also be partially offset through the sale of carcasses to commercial wild game harvesters if they are available McGaw & Mitchell (1998). Tisdell (1982) and Choquenot *et al* (1996) also point out that if professionally operated, trapping has additional benefits as being a comparatively environmentally friendly and humane method of managing feral pig populations.

2. Aerial shooting.
The control effectiveness of 64% derived from this study is similar to other studies (Table 8). McGaw & Mitchell (1998) consider helicopter shooting to be a more economical option than ground shooting particularly in inaccessible areas such as marshes or seasonally inundated areas. Choquenot *et al* (1996) explain that this method is also advantageous in comparison to the other major techniques because it is species specific, requires little of landholder's time and provides a rapid knockdown of large pig populations. Large sections of the Burdekin River are inaccessible so aerial techniques are ideally suited to this riparian habitat.

The disadvantages of aerial shooting include causing local pig populations to disperse, becomes prohibitively expensive as pig populations fall and is ineffective in some situations such as dense woodland and forest (Choquenot *et al* 1996). Telemetry

studies conducted by Saunders & Bryant (1988) found in extended aerial shooting exercises that feral pigs can become attuned to the significance of a hovering helicopter and modify their subsequent behaviour, making their detection harder and hence reducing the efficiency of this technique.

Aerial shooting was the most cost effective technique in this study, less then half the cost / pig than for trapping. If the labour component is not factored in, then the cost effectiveness falls to $19 / pig. The largest cost component of this control technique was helicopter hire and fuel charges. The Robinson 22 helicopter used in this project is the least expensive shooting platform available ($330 / hr), larger helicopters such as a Jet Ranger or Robinson 44 would significantly increase costs associated with this technique. In addition, helicopter ferry costs were not allocated in the economic analysis as the helicopter used in this project was hired under special conditions stipulated by Government departments, This resulted in a significantly high ferry cost that would not necessarily be imposed in landholder organised aerial shooting programs.

3. Aerial Baiting

The aerial baiting technique achieved much lower control effectiveness than ground baiting as reported in the literature (Table 8). Ground poisoning has achieved greater than 80% to 99% population reductions. However, the only other aerial baiting research similar to this study was a wet season baiting campaign in the dry tropical habitat of Cape York (Mitchell 1999). It was calculated that the pig population was reduced by 81%.

Tisdell (1982) claims that ground application of baits can deliver a kill rate of more than 80% of the population with one application, which is generally unachievable with other forms of control. Choquenot *et al* (1996) suggests that the success rate of ground baiting could be as high as 99.4%.

Poison baiting is the most widely accepted pig control technique to rural communities as being both fast and effective (Choquenot *et al.* 1996). Toxins such as 1080, Warfarin, CSSP, and Strychnine have all been widely used for the destruction of feral pigs, although today only 1080 and CSSP are registered for this use (McGaw & Mitchell 1997). The use of 1080 has attracted some public opposition from environmental groups concerned about possible non-target impacts on native carnivores; animal welfare groups questioning it's humanness and landholders who fear the loss of working dogs (Choquenot *et al* 1996 and McGaw & Mitchell 1997).

The cost effectiveness of aerial baiting is superior to trapping, but inferior to aerial shooting. The largest cost component of this control technique was helicopter hire and fuel costs. As with the aerial shooting, a larger helicopter would have significantly increased costs. Normally a light plane, which is much more cost effective, is used instead of a helicopter. A light plane is cheaper to hire, can carry more weight and subsequently can fly longer without returning to an airfield to refuel or to reload bait.

Recommendations

For this region, control strategies can be specialised to target pig populations when they are more concentrated around water sources at the end of the dry season and where populations are localised within the riparian habitat. The radio tracking study demonstrated that pig movements were restricted to close proximity to water sources within the riparian habitat. No marked pigs were observed to leave the river system and no pigs were seen away from the river system during the course of the study.

The cost effectiveness of aerial shooting can be improved if shooting can target concentrated high density pig populations in a small specific habitat. For this project, pigs were concentrated within the riparian zone during the end of the dry season, thus targeting pigs within the river system at the end of the dry season is the most cost effective strategy. A cooperative approach to pig management by the Landcare group or adjourning landholders, can significantly reduce the high costs associated with helicopter hire, ferry and fuel cost. Aerial shooting has positive benefits of having a quick knockdown effect on the pig population, does not disrupt normal on farm activities and is environmentally acceptable.

Aerial baiting becomes more cost effective if conducted over extensive areas. This project baited only very small areas; in total only 15km of river frontage. If baiting were conducted over the entire river system with all landholders contributing, then the cost effectives of this technique would be substantially improved particularly if a fixed wing aircraft is used instead of a helicopter. As with aerial shooting, targeting concentrated pig populations in the river system at the end of the dry season will further improve control and cost effectiveness of this technique. Aerial baiting has some negative impacts, as it is seen to be environmentally unacceptable to some members of the community and can disrupt farming activities such as mustering with dogs. Problems with purchasing or procuring bait materials, organising a poisoning programme with the relevant Government authorities, and associated restrictions with using 1080, all tend to further inhibit this control technique

Trapping is very labour intensive and time consuming; landholders generally do not have the resources to establish or the time to maintain a trapping system. Trapping can be a successful strategy in reducing pig populations in specific areas where the cost/benefits warrant it (eg irrigated pasture or crop production areas). The high initial costs of purchasing traps is a limiting factor, landholders are reluctant to incur a high initial cost without any guarantee of success. However trapping does not inhibit farming activities, is environmentally acceptable, and if a commercial feral pig industry is available then a financial return can be obtained to offset trapping costs. Also trapping can be sub-contracted out to commercial pig harvesters or to local people who are willing to run a trap system for economic or social reasons. Trapping can be very cost effective to some landholders in the right situations.

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