An assessment of feral cat (*Felis catus*) abundance at Dragon Rocks Nature Reserve and some implications for fauna conservation.

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Introduction.

Dragon Rocks Nature Reserve (DRNR) has supported a successful reintroduction of the Numbat (*Myrmecobius fasciatus*), as part of the Numbat Recovery Programme (Friend, 1994) and is a proposed Western Shield Fauna Reconstruction Site. As part of the fauna reconstruction, a further five-six locally extinct species may be translocated to the Reserve.

Anecdotal evidence exists that feral cat numbers at DRNR have increased in recent years. Sightings by District staff, during reserve inspections and operational fox baiting, have become more frequent. Furthermore, feral cat sightings have recently been more common on internal Reserve access, when they have previously been mostly restricted to the Reserve boundaries (K. Wheeler and D. Plumb, pers. comm.). Neighbouring landholders have also noted an increase in feral cat sightings, in recent years (D. Plumb, pers. comm.).

Concerns have been raised that the presence and apparent increase in the feral cat population is having a continued adverse affect upon native fauna populations. Regular fauna monitoring exercises, by District staff, continue to yield few native mammals, despite the on-going fox control programme (D. Plumb, pers. comm.). Inspection of several Numbat carcasses, both at DRNR and at Karroun Hill NR, has indicated a cause of death consistent with that of feral cat predation.

As a preliminary step to addressing these concerns, a survey of the feral cat population was conducted at DRNR between 12 and 15 June 2000. The exercise was coordinated with a survey of Numbat activity such that the resources required for the two projects were shared. During the exercise, aspects of feral cat control were discussed with District staff and field instruction in trapping techniques conducted. Preliminary assessment was made of feral cat abundance, distribution, diet and reproductive condition. This information is discussed in the context of current knowledge. Implications for current and proposed fauna conservation at DRNR are discussed and an appraisal of some feral cat control options presented.

Method.

Measures of Abundance –

Relative abundance of feral cats was assessed through a combination of trap success and track assessment. The trapping technique employed is summarised here and described in full by Algar *et al.* (in prep.).

Trapping Technique –

Each trap set consisted of a blind channel, approximately 40cm wide and 80cm deep, cleared into existing vegetation. All overhanging vegetation was cleared from the channel and dead vegetation placed to prevent all other access, when necessary. An audio (F.A.P.) and olfactory (Pongo) lure was placed at the back of each trap set (see Algar *et al.*, in prep.). Two Victor Soft Catch® leg-hold traps were placed at the entrance to the channel and foam pads placed under the pressure plates, to prevent soil compaction and restriction of trap function. Traps were then covered lightly with fine, dry sand. A stick (~2cm ∅) was placed immediately in font of the trap set, the full width of the channel opening. This guide stick is used to encourage animals to step over the obstruction, thus placing added weight directly onto the pressure plate. Traps were placed at 1km intervals, immediately adjacent the vehicle access.

Track Assessment –

Previous track activity was cleared from the transect by dragging a heavy chain behind the vehicle, during trap placement. The following morning, the location, number and relative size of individual predator tracks was observed and recorded. Track assessment is generally used in addition to trapping, as an indication of the number and behaviour of individuals that do not encounter or enter a trap set, on a given day. This technique was abandoned after the first day as the particular transect used was unsuitable for accurately assessing track activity.

Trapping Regime –

Twenty trap sets were placed initially, over a 19km transect (Transect 1). Transect 1 was established on the afternoon of 12 June. As there was a low trap success and activity count, after the first night, this transect was shortened (to 14km/15 trap sets) and a second transect established (Transect 2). Transect 2 consisted of ten trap sets over a 9km transect and was established the afternoon of the 13 June.

The transects were principally through heathlands or mallee over melaleuca thicket, on pale sand, with a varied content of laterite. Low mallet forest occurred on stony and/or loamy crests and loamy drainage lines. Transect 1 was roughly central to the Reserve and bounded on both sides by native vegetation. Transect 2 was on the boundary of the Reserve and bounded to the west by agricultural pasture paddocks.

Trapping was abandoned due to rainfall on 15 June as wet soil restricts trap function. Transect 1 was operated for three nights (one night with twenty trap sets, two nights with fifteen trap sets), delivering 50 trap-nights. Transect 2 was operated for two nights, delivering 20 trap-nights.

Necropsy –

Captured cats were dispatched, in the trap set, with a hollow-point .22 in. round. Sex and capture weight of all individuals was recorded and a broad estimation made of age class. Examination was made of the digestive system to identify key prey items. The reproductive system of female cats was examined for foetuses or placental scarring.

Samples of brain, muscle, whole blood, liver and faeces were taken to assist with external studies on disease, parasitology and genetics of feral cats, and the implications for fauna conservation.

Results.

Details of captured feral predators are presented in Table 1. Trap success, for the entire exercise was 0.12 cats/trap-night. Transect 1 yielded 0.04 cats/trap-night and Transect 2 yielded 0.20 cats/trap-night. A kitten entered a trap set, on Transect 2 (14 June), but failed to trigger either trap. Trap function was inhibited by rainfall that was sufficient to cause failure, under the weight of adult animals.

Table 1: Capture details of trapped feral predators.

DATE	TRANSECT	SPECIES	SEX	AGE	CAPTURE WEIGHT (kg)	STOMACH VOLUME (%)	STOMACH CONTENT	COAT COLOUR	PREGNENT	FOETUS/ SCARS
13/06/00	1	F. catus	M	ADULT	4.95	0	n/a	tabby	n/a	n/a
14/06/00	2	F. catus	M	ADULT	5.10	100	rabbit	tabby	n/a	n/a
14/06/00	2	F. catus	M	ADULT	3.60	0	n/a	tabby	n/a	n/a
14/06/00	1	F. catus	M	ADULT	3.25	0	n/a	tabby	n/a	n/a
14/06/00	2	V. vulpes	M	ADULT	5.75	0	n/a	n/a	n/a	n/a
15/06/00	2	F. catus	F	ADULT	3.25	0	n/a	tabby	no	2
15/06/00	2	F. catus	M	ADULT	5.75	100	rabbit	ginger	n/a	n/a

Most captured animals had empty stomachs, however two individuals had recently eaten rabbits (*Oryctolagus cuniculus*). There was no evidence of any other prey items within the stomachs of captured animals. All animals were adult and apparently healthy.

Track counts conducted after night one, on Transect 1, yielded three recent cat tracks, two recent fox tracks and one fresh cat track. The fresh cat track was produced by the individual captured that night.

The 'recent' tracks were observed and noted because the access was too wide to allow the clearing of all previous activity. The tracks were noted as recent, not fresh, because they did not continue over the cleared transect itself.

The combination of trap success and track counts for Transect 1 indicate a relative density of 21 cats/100km. Track counts were not conducted for Transect 2, however the trap success there indicates that the relative density was at least 55 cats/100km.

Three Western Grey Kangaroos (*Macropus fuliginosus*) were captured during the exercise. All three were captured on Transect 1. Two of the three animals had dislodged the trap set and attempted to flee. Both were located within 100m of the original trap location. Two of the three were dispatched because they had sustained injuries (broken femur and dislocated hip) that would have caused distress and compromised survival.

Discussion.

Table 1 indicates a marked bias toward the capture of male cats. Elsewhere there has been a slight overall bias toward the capture of males, through this technique (Algar *et al.*, unpub. data; Project Eden, unpub. data). This bias is particularly evident in the first two or three days trapping, in a particular area. Therefore the weight of the bias, recorded here, may be a function of the short time period, over which trapping was conducted. Trapping data from elsewhere also indicate seasonal variations in this sex bias. More pronounced bias toward the capture of males is consistent with periods of high female oestrus and with the nursing of young. Therefore the overall sex bias, recorded in W.A., appears to be explained by permanent and seasonal differences in home range usage by male and female cats. Male felids generally have a slightly larger range than do females and their activity is more evenly distributed throughout this area. Female felids tend to have a distinct, relatively small core to their range, in which they spend most of their time (Kitchener, 1991; Yamane *et al.*, 1994; Jones and Coman, 1982). Disparity in home range usage is more pronounced, during certain seasons, because males range significantly further during periods of female oestrus (Yamane *et al.*, 1994) and the activity of females is greatly reduced during nursing (Martin, 1982; Jones and Coman, 1982). It is possible that female cats exhibited both these conditions, during the study. The captured female was oestrus and the late break to the season may have extended the summer/autumn breeding period (see for example Jones 1989), leaving a significant proportion of females nursing young. The presence of a kitten (as opposed to a sub-adult) on Transect 2 is further evidence that breeding had extended further than might normally be expected.

The rate of capture of macropods (*ie Macropus fuliginosus*), during this study, is significantly higher than that recorded elsewhere. This species has not been captured previously, despite more extensive trapping elsewhere, within its range (Goldfields). Captures of macropods have previously been regarded as accidental and a result of trap placement on/near thoroughfares or daytime shelters. Although macropods appeared to be particularly abundant, during this study, there appears to be a degree of overt attraction of *M. fuliginosus* to the current trap arrangement. The current technique clears all overhanging vegetation, from the trap set because it is thought that cats will more readily enter such an arrangement. Leaving or deliberately placing vegetation, over a trap set, at a height greater than that of a feral cat, may deter/exclude macropods. The current trap arrangement is highly successful and all care should be taken to ensure that any modifications do not compromise trap success.

The Reserve boundary appears to be a focus for feral cat activity. As rabbits appear to concentrate in these areas, grazing in adjacent paddocks, feral cats may be drawn to the concentration of prey.

The only dietary item noted in cats at DRNR was the rabbit. In Australia, rabbits generally constitute by far the greatest proportion of feral cat diet, by occurrence, weight and volume (Martin *et al.*, 1996; Risbey *et al.*, 1999; Catling, 1998; Molsher *et al.*, 19???; Triggs *et al.*, 1984; Jones and Coman, 1981; Coman and Brunner, 1972). In the presence of this apparently reliable and preferred food source, feral cat dietary breadth is greatly reduced, sometimes to the total exclusion of all other dietary items (this study and Project Eden, unpub. data). When rabbits are permanently or seasonally uncommon, feral cats predate a much broader range of species, particularly native fauna, allowing good adult survivorship, when prey is relatively depressed (Jones and Coman; 1981, 1982). Seasonal variation in feral cat stomach volume has also been noted (Project Eden, unpub. data). When their staple (rabbits) is in seasonal decline, both dietary breadth and stomach volume are, on average, greater. When rabbit kittens are abundant, they are predated almost exclusively and the stomachs of trapped cats are more frequently empty. These periods are when other prey items (such as native murids) are also more abundant. However there is a tendency to predate more substantial prey, less often, when possible. Kitchener (1991) notes this also and discusses the energetics behind the tendency for felids to predate certain taxa, under certain conditions.

Despite little direct overlap in diet (Risbey *et al.*, 1999, Triggs *et al.*, 1984; Catling, 1988) and little evidence of direct predation (Triggs *et al.*, 1984; Catling, 1988; Risbey *et al.*, 1999), the assertion that feral cat abundance may increase, following fox control (this site; Algar and Friend, 1994; Algar and Smith, 1998), appears to be real. The phenomenon has been measured previously (Christensen and Burrows, 1994) and its implications discussed and questioned (Christensen and Burrows, 1994; Martin *et al.*, 1996; Risbey *et al.*, 1999). Current fox baiting techniques are usually ineffectual to feral cat populations (see for example Christensen and Burrows, 1994) and this situation of elevated feral cat numbers, and its implications, may be more widespread than discussed here.

Table 2 presents some examples of feral cat density estimates, from elsewhere in Western Australia. These estimates have been obtained from several variations of the methods described above. The technique has varied both because the method is still under development and because conditions at the various study sites have governed which methods are practical. These are the only estimates available and it appears at this stage, that because they are all based upon the same assumptions and essentially measure the same variables (ie cat activity on vehicular tracks), that they are at least comparable. Feral cat density estimates from DRNR are relatively high, compared to the figures presented in Table 2. Failure of fauna translocations, to the Gibson Desert, occurred when feral cat abundance was near to 26 cats/100km (Christensen and Burrows, 1994).

Table 2: Estimates of feral cat relative density at selected locations in Western Australia.

DATE	LOCATION	TRANSECT LENGTH (km)	RELATIVE DENSITY (cats/100km)
September 1992	Gibson Desert NR post canid baiting, pre felid baiting)	30	26.1
September 1994	Gibson Desert NR (non-baited)	30	16.6
September 1994	Gibson Desert (baited with an early prototype cat bait)	30	8.6
August 1998	Argyle Diamond Project	32	68.8
October 1998	Dirk Hartog Is	48	22.9
January 1999	Wanjarri NR (mulga)	45	17.8
February 1999	Wanjarri NR (spinifex)	45	26.7
February 1999	Albion Downs Station	50	33.7
April 1999	Albion Downs Station	36	16.6

Dickman (1993, 1996) provides reasonable reviews of the possible impacts of feral cats, on native fauna, but recognises that direct experimental evidence is lacking. Newsome *et al.* (1989) indicate that predation by feral carnivores has the capacity to limit prey populations and Christensen and Burrows (1994) and Gibson *et al.* (1994a) strongly implicate feral cat predation in the failure of fauna translocations, to mainland Australia. Although rabbits are generally a staple, in Australia, native mammals are also predated and are a staple, in certain locations (Triggs *et al.*, 1984). Perhaps the greatest impact of feral cat predation is through the elevation of cat numbers when rabbits are abundant, and the functional shift to other prey species, when rabbits decline/are controlled (Molsher *et al.*, 19??, Catling, 1988; Jones and Coman, 1981). The prevalence of certain size classes (Catling, 1988) and taxa of prey, in feral cat diet, may indicate the potential of rabbits to act as a buffer to the predation of other species. Seasonal fluctuations in rabbit populations, particularly of predator-vulnerable young, suggest that any 'buffering' would be seasonal and relate only to the adults of larger species.

Despite indications of feral cat predation, the Numbat is apparently surviving well at DRNR. Most sites surveyed, during this exercise, indicated continued Numbat activity. Predation pressure by feral cats may be relatively low because of the apparent focus for activity, on the Reserve boundary. It may also be because of the relatively sparse distribution of the Numbat and the lack/low density of other larger mammals, within the Reserve proper. Other potentially re-introduced mammals may exhibit a similar preference to rabbits for grazing adjacent paddocks or be of habit that creates a greater focus for feral cat predation, within the Reserve proper.

Feral predator control is the single most limiting factor to the success of fauna translocations, to mainland Australia (Short *et al.*, 1992; Christensen and Burrows, 1994; Gibson *et al.*, 1994b; Burbidge, 1999). Predation by introduced carnivores, at DRNR, is likely to impact greatly upon current and proposed fauna reconstruction efforts. These efforts may be compromised if the problem is not adequately addressed.

Current methods of feral cat control involve a combination of baiting and trapping. Due to the dietary tendencies described above, feral cats will not always readily accept baits. In this context, rabbit abundance impacts greatly upon bait acceptance by feral cats (Algar and Angus, 2000). Baiting at DRNR is likely to be most efficacious when rabbits are in seasonal decline. The timing of this decline will vary with prevailing seasonal conditions (Project Eden, unpub. data) and will not necessarily be sufficient to bring about a significant dietary shift, in the feral cat population (Triggs *et al.*, 1984; Jones and Coman, 1981, Molsher *et al.* 19??). Therefore coordination of rabbit control, with that of feral predators, may be required to achieve efficacious baiting.

The rate of bait distribution and the frequency of reapplication required to maximise efficacy are currently not known. Requirements have proven to be dependant upon seasons and highly site-specific. Preliminary measures of baiting efficacy, to determine optimum timing, distribution and reapplication, at DRNR, will be required before a successful baiting campaign can be undertaken. Permanent monitoring transects, for the measurement of both rabbit and introduced predator activity, are essential to this process.

Single, once-off, aerial baiting alone has not always been sufficient to achieve a suitable level of control. Therefore trapping may be required to supplement the control achieved through baiting. Trapping, in itself, has proven highly efficacious, under certain circumstances and a good trap success was achieved during this study. Cats have been completely removed from two 100km^2 blocks, through trapping, at a semi-arid site (Algar *et al.* 1999) and trapping was the key to successful eradication, at an island location (Algar and Burbidge, 2000). However the process is relatively labour-intensive and not efficacious unless carefully planned (Algar and Angus, in prep.).

The success or otherwise of feral predator control is likely to impact greatly upon the success of current and proposed fauna reconstruction programmes at DRNR. Timing and input required for successful cat control have proven highly site-specific and subject to prevailing seasonal conditions. Successful control is certainly feasible at DRNR and the challenges are in achieving an acceptable baiting efficacy and addressing the problem of reinvasion.

Recommendations.

In the context of the above, the following recommendations are made.

1. Establish a permanent transect to monitor the activity of feral cats. If a suitable transect cannot be located, visitation of scent stations may be an alternative.
2. Conduct an introduced predator control programme that includes treatment of the feral cat, prior to proceeding with further fauna translocations to the Reserve. Establish a clear goal as to the level of control desired.

Option 1 -

- Conduct an extensive trapping programme for feral cats, across the Reserve, using all available vehicle access. Duration of the exercise will depend upon the level of control desired.
- Monitor reinvasion (through point 1) to determine the frequency of repetition required.
- Obtain an experimental permit to include the feral cat sausage bait in summer-time baiting of the Reserve (from ground and air). Note that trapping prior to this will preclude an accurate assessment of bait-uptake, as there will be an insufficient sample size. Baiting efficacy can only be inferred from returns from point 1.
- Should baiting prove efficacious, consider a coordinated rabbit baiting which may improve bait acceptance.

Option 2 -

- Establish a permanent spotlight transect to monitor rabbit activity at regular intervals.
- Conduct a series of bait uptake trials, across seasons, to establish an optimum baiting period. If a suitable transect cannot be located, the use of chemically labeled baits will be necessary. The destructive sampling required for using labeled baits precludes short-term repetition, because of diminished sample-size.
- Determine whether or not there is a link between rabbit activity and bait acceptance. Should a link be determined, consider a rabbit control programme to extend the seasonal period of bait acceptance.
- Should baiting prove efficacious, establish a baiting regime that maximises impact (based on returns from point 1). Modifications to both baiting density and frequency may alter efficacy.

- Deploy toxic baits only at periods when bait acceptance is likely to be high.
- Should baiting alone not achieve/sustain the level of control required, conduct a suitable trapping programme.

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