Impacts of pit size, drift fence material and fence configuration on capture rates of small reptiles and mammals in the New South Wales rangelands

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ABSTRACT

As part of regional biological surveys 51 sites were established in the rangelands of western New South Wales, Australia. To investigate the impacts of pit size, drift fence material and fence configuration on capture rates small vertebrates each site consisted of two 20 l bucket traps with two configurations of flyscreen drift fences (transparent), two PVC pipe traps with the same two configurations of fencing, and two PVC pipe traps with dampcourse (opaque) in the same two configurations. PVC pipe traps caught more species and individuals than 20 l plastic buckets (41 versus 38 species, 232 versus 208 captures, respectively when pooled across the two fence configurations using flyscreen). Four fences radiating in a cross pattern from a pit caught 41% more individuals, but not the number of species, compared to two radiating fences (463 versus 328 captures) when pooled across the two pit types and the two fence materials. Capture success was influenced by the fence material used, with mammals being more often captured when using flyscreen fences and reptiles more often when using dampcourse fences (28 versus 18 and 256 versus 283 captures, respectively). The arboreal skink *Cryptoblepharus carnabyi* showed the strongest difference in the number of captures between flyscreen (27 captures) and dampcourse (67 captures) when used in conjunction with PVC pipe. If a broad biological survey is to be undertaken then a mixture of pit sizes and fence materials is warranted within the survey design. If population studies are the primary concern, then consideration of the benefits of increased capture rates versus costs of installing additional fencing needs to be including in the planning of the field sampling.

Key words: Pitfall traps; drift fence material; drift fence design; small vertebrate trapping; trap type.

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Introduction

Pitfall traps, also known as pitfalls or pit traps, have been widely used in both vertebrate and invertebrate surveys world wide (e.g. Cockburn *et al.* 1979; Read 1985; Bury and Corn 1987; Morton *et al.* 1988; Friend *et al.* 1989, Hobbs *et al.* 1994; Ward *et al.* 2001; Brennan *et al.* 2005; Thompson *et al.* 2005; Ribeiro-Júnior *et al.* 2011). The pitfall traps used in many studies vary widely in depth and diameter and are often used with drift fences of various materials. Drift fences of varying lengths have shown to increase capture rates by acting as barriers to animal movement, directing them towards the pitfall traps (Braithwaite 1983; Morton *et al.* 1988; Friend *et al.* 1989). Pitfall traps may either be dry (to capture live animals) or wet (filled with a preservative which kills all captured animals and may no longer be approved of on ethical grounds for capturing vertebrates e.g. guidelines by the Animal Research Review Panel and NSW Department of Primary Industries - Animal Welfare Branch. http://www.animalethics.org.au/policies-and-guidelines/wildlife-research/pitfall-traps accessed 10 Mar 2013), and may have coverings or door mechanisms to alter their selectivity or effectiveness (Howard and Brock 1961).

The use of pitfall traps became increasingly widespread in Australia in the 1970s and 1980s (Braithwaite 1983). Many vertebrate studies of that era were conducted in open, often arid, habitats and deployed long continuous drift fences with dry pitfall traps placed every five to 10 m along their length without investigating their effectiveness in comparison with other trapping methods (e.g. Menkhorst 1982; Caughley 1985) and this could have lead to imprecise results. Therefore, there has been a growing number of studies on the efficiency of trapping methods, for both invertebrates (e.g. Ward *et al.* 2001; Brennan *et al.* 2005) and vertebrates (e.g. Cockburn *et al.* 1979; Read 1985; Bury and Corn 1987; Morton *et al.* 1988; Friend *et al.* 1989, Hobbs *et al.* 1994; Thompson *et al.* 2005; Ribeiro-Júnior *et al.* 2011) with or without drift fences (Braithwaite 1983; Bury and Corn 1987; Friend *et al.* 1989), and on optimal trapping effort in terms of sampling duration and repetition (Moseby and Read 2001). The overall aim of these studies was to allow ecological researchers to select study methods that will obtain the required data to answer their questions for the least amount of effort expended on trapping. Trials of these studies have taken place in various habiats, e.g. open arid habitats (Read 1985; Morton *et al.* 1988; Thompson *et al.* 2005; Moseby and Read 2001), tropical open woodlands (Braithwaite 1983; Friend *et al.* 1989) and forests (Bury and Corn 1987; Webb 1999; Ribeiro-Júnior *et al.* 2011). No consensus on the relative merits of various pit sizes and fence configurations seems to have emerged, nor has the impact of the type of fencing material used been extensively investigated. Despite this gap of knowledge, guidelines on how to conduct fauna surveys for environmental impact assessments incorporating recommendations about appropriate pitfall trapping methodologies, have been released by government conservation agencies (EPA&DEC 2010). The choice of methods recommended or required by such guidelines will influence the likelihood of various species being detected and consequently how the information can be interpreted (Thompson *et al.* 2005).

The aim of this study was to investigate some of the influences of variations in pit diameter (15cm PVC pipe versus 29cm bucket), fence material (mesh versus solid) and fence configuration (single orientation either side of the pit opening versus two orthogonally aligned orientations crossing at the pit opening) on the capture rates of small reptiles and mammals. The value of having drift fences as part of pitfall traps for increasing capture rates when surveying small mammals and reptiles has been demonstrated (Bury and Corn 1987), particularly in arid environments (Braithwaite 1983; Friend *et al.* 1989) so only fenced arrangements were investigated during this study.

Methods

Study area

The Western Division is an administrative area comprising mainly leasehold semi-arid to arid rangelands occupying almost half of New South Wales, Australia. Biodiversity surveys were carried out from 1994 to 1996 as part of the regional landuse planning process in two sections of the New South Wales Western Division (Figure 1) adjacent to the wheatbelt in central NSW. The freehold land in the wheatbelt was intensively cleared and cropped before 1990, with cropping expanding from the south east (Bedward *et al.* 2007), eventually reaching the Western Division boundary beyond which clearing and cropping permits were required to convert grazing leases to more intense uses. Details about the aims and results of the regional surveys are provided in Mazzer *et al.* (1998) and Smith *et al.* (1998).

The Northern Floodplains Region covered predominantly alluvial plains and rolling downs supporting a variety of woodlands, shrublands and grasslands described in Smith *et al.* (1998). The Southern Mallee Region covered predominantly sandplains and dunefields with the vegetation dominated by mallee communities, woodlands and spinifex grasslands described in Mazzer *et al.* (1998).

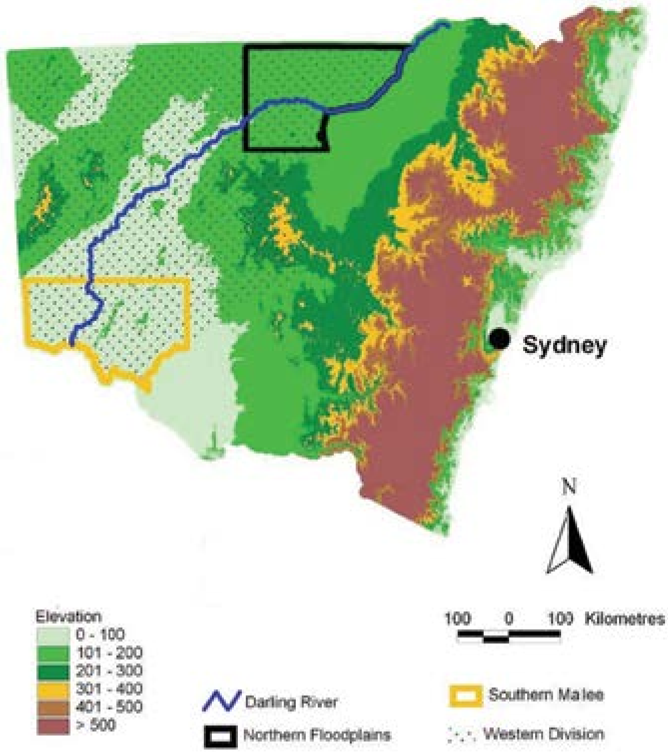

Figure 1. The location of the two planning regions on the western lowlands of New South Wales.

Trapping

Thirty nine sites were established in the Southern Mallee Region, and 12 sites were established in the Northern Floodplains, west of the Barwon River, to compliment pre-existing sites and datasets such as Ellis and Wilson (1992), Dick and Andrew (1993) and Smith (1993). All sites were in currently or previously grazed properties that had varying levels of clearing disturbance such a shrub removal.

Both for experimental design considerations and avoidance of major disturbance due to having to clear long near-straight paths to install long drift fences with numerous pits (Friend 1984; Webb 1999), single pits with their associated drift fences, were trialled.

The centre of each site was marked with a 1.8m steel post (Figure 2) to allow easy site establishment and subsequent relocation. Six pitfall traps were placed equi-distant (25 m apart) in a circle of 25 m radius focused on the centre of each site, except where adjustment ($\pm$ 1 m) of the location of the hole was required due to trunks and roots (Figures 2, 3 and 4). Holes were dug with a motorised auger and each pit was inserted (Figure 5). Six different pitfall trap types, each of which consisted of a specific pit size, fence material and fence arrangement, were used. Four pitfall traps consisted of white PVC water pipe which measured 60 cm in depth and 15 cm in diameter (Figure 3), with a metal lid used to seal the bottom, and two pitfall traps made of a 20 l white plastic bucket which measured 38 cm in depth and 29 cm in diameter (Figure 4), each with a specific drift fence type and number of fences as outlined below.

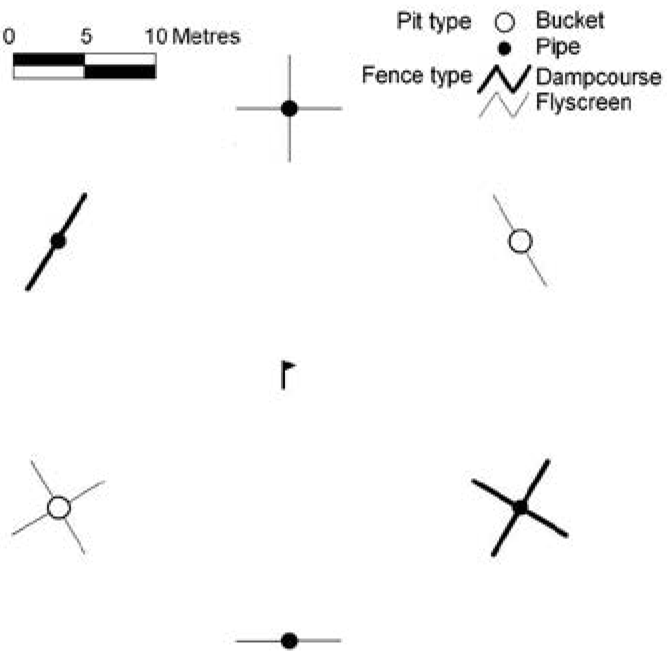

Figure 2. The layout of the pitfall traps around a central site marker showing the distribution of the combinations of pit sizes and fencing materials used.

Figure 3. Establishing the centre of a sand dune site with the person in the background standing where one of the pitfall traps is to be installed 25 m from the centre stake.

Figure 4. Laying out the ring of pitfall traps on a sandplain site with a bucket pitfall trap with four flyscreen drift fences in the foreground. Note the use of the bucket lid as a cover above the pit to provide shelter from sun and rain.

Figure 5. Installing PVC pipe as a pitfall trap on a sandplain site. Tubes on the right show the size of the smaller pits used and have steel rods taped onto them in preparation for installing the drift fences.

Figure 6. Installing drift fences at a pitfall trap on a floodplain site. Buckets on the left show the size of the bucket pitfall traps used.

Drift fences were erected with each section being 5 m long and 20 cm high (Figure 6) and composed of either fibreglass flyscreen mesh (allowing the fence to be seen through) or black plastic builders dampcourse (making opaque fences) (Figure 7). These fences radiated from the edge of each pit with two fences providing a total of 10 m as recommended by Friend *et al.* (1989). This left a gap in the fence above each pit to allow for easier retrieval of animals without dislodging the fence, particularly from the 15 cm wide pipes where the gap from the edge of the pit to the fence would have only been 75 mm (Figure 8). The options to investigate the influence of additional fencing were either to make the individual fences longer than Friend *et al.* (1989) or to

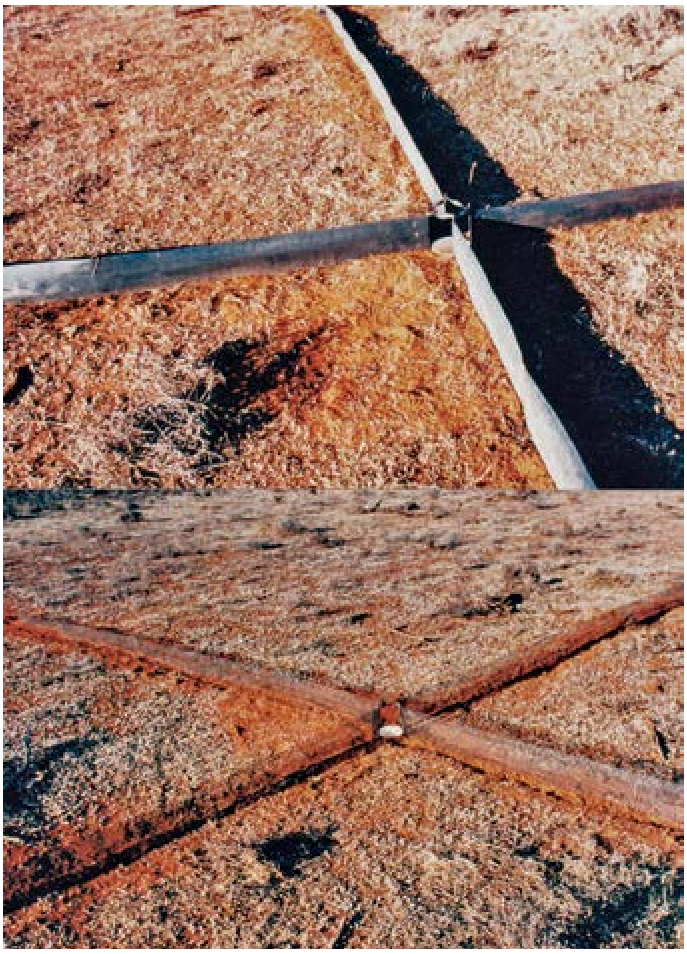

Figure 7. PVC pipe pitfall traps on a sandplain site showing the difference in appearance between dampcourse (top) and flyscreen (bottom) fences.

Figure 8. Removing a gecko from a 15cm pit. Note how the fences stop at the edge of the pit providing easier access for animal removal and a visual break in the fence line. Rubber bands between opposing fences help to maintain the tension in the fences. Heat welds at the ends of the fences to make hems to put over the steel rods are faintly visible parallel to the ends of each fence.

increase the complexity of their arrangement. Since only one option could be included it was decided to investigate the untested suggestion of Morton *et al.* (1988) that cross arrangements of drift fences with their associated pits would be the most efficient, the number of fences radiating from each pit alternated between two and four (Figure 2). The coding used to describe the pitfall trap types (pit size/fence combination) is given in Table 1. The ends of each fence had been folded over and either heat welded or stapled to make a hem through which a 6 to 8 mm diameter metal rod would fit (Figure 8). For installation the fences were pulled tight and rods were driven into the ground through the hems. If the disturbed ground around a pit was too soft to keep the rods upright the rods were attached outside of the PVC pipe using masking tape around the pipe (Figure 5) or were inserted in pre-drilled holes in a flange near the top of the buckets that would be below the final ground level. Thinner wire pegs with clip arrangements at the top supported the middle of each fence and the bottom of the fence was buried a few centimetres into the ground.

Table 1. Descriptions of the six pitfall trap types used on each site.

Pit type	Fence type	number of fences	Code
PVC Pipe	Flyscreen	2	P2F
		4	P4F
	Dampcourse	2	P2D
		4	P4D
Bucket	Flyscreen	2	B2F
		4	B4F

Traps at each site were open for eight to ten days in one spring and one autumn sampling period, resulting in a total of 921 days of trapping effort for each type of pit and fence combination. Between the two survey periods of each site the PVC pipe traps had spun metal caps that covered them and extended 50 mm down the outside of the pipe installed, while the buckets were removed because their lids were not considered strong enough to withstand stock or kangaroos walking on them. All vertebrates captured were identified to species, marked with indelible ink to detect recaptures and released adjacent to their point of capture. Because the survey sites were heterogeneous in regards to the landform and vegetation communities they were set in, captures across all 51 sites were pooled. The resultant frequencies were compared between pitfall trap types and between taxonomic groupings using Chi-squared (χ^2) goodness-of-fit tests (Sokal and Rohlf 1995).

Results

Pitfall traps caught 36 species of reptiles and 9 mammal species during this study. No particular combination of pit and fence material caught all the species trapped, with 36 species being the maximum caught in any one type (Table 2). Trapping success ranged from 8.5% (78 captures in B2F) to 18.5% (170 captures in P4D), averaging 14.3% (791 captures) across all six combinations of pit and fence material.

The number of individuals (and the same trends for number of species) caught in each pitfall trap type was not evenly distributed ($\chi^2 = 41.7$, $p << 0.0001$) with

Table 2. The number of animals captured in each trap type summed across the 51 survey sites. Codes for the trap types are given in Table 1. For species with more than 30 captures a Chi-squared test was performed and the probability of the observed captures being from uniform capture rates for the six pitfall trap types is given.

			Pitfall traps							
Family	Common name	Species	B2F	B4F	P2F	P4F	P2D	P4D	TOTAL	χ^2,prob
Leporidae	Rabbit	*Oryctolagus cuniculus*	0	0	0	1	0	0	1	
Dasyuridae		*Ningaui yvonneae*	0	1	0	1	0	0	2	
	Paucident planigale	*Planigale gilesi*	0	0	1	0	1	2	4	
	Narrow-nosed planigale	*Planigale tenuirostris*	0	0	1	0	0	1	2	
	Fat-tailed dunnart	*Sminthopsis crassicaudata*	2	1	2	3	0	1	9	
	Stripe-faced dunnart	*Sminthopsis macroura*	0	2	0	0	0	1	3	
	Common dunnart	*Sminthopsis murina*	2	1	4	6	1	5	19	
Burramyidae	Western pygmy-possum	*Cercartetus concinnus*	0	0	1	0	0	0	1	
Muridae	House mouse	*Mus musculus*	0	1	3	3	4	2	13	
		Total mammal captures	4	6	12	14	6	12	54	
Agamidae	Nobbi	*Amphibolurus nobbi*	1	3	3	8	7	6	28	
	Mallee dragon	*Ctenophorus fordi*	4	6	5	5	9	6	35	2.54, 0.770
	Painted dragon	*Ctenophorus pictus*	0	0	0	5	1	3	9	
	Gilbert's dragon	*Lophognathus gilberti*	0	0	0	0	0	1	1	
	Bearded dragon	*Pogona barbata*	1	0	0	1	1	0	3	
	Central bearded dragon	*Pogona vitticeps*	1	3	3	2	3	6	18	
		Total agamid captures	7	12	11	21	21	22	94	
Elapidae	Coral snake	*Simoselaps australis*	0	2	0	1	0	1	4	
	Curl snake	*Suta suta*	0	0	0	1	0	0	1	
Gekkonidae	Jewelled gecko	*Diplodactylus elderi*	0	0	0	0	1	0	1	
	Eastern spiny-tailed gecko	*Diplodactylus intermedius*	1	0	0	2	1	2	6	
		Diplodactylus steindachneri	3	4	4	5	0	1	17	
	Tessellated gecko	*Diplodactylus tessellatus*	8	17	6	10	5	10	56	9.79, 0.082
	Wood gecko	*Diplodactylus vittatus*	1	0	2	3	3	4	13	
	Northern gecko	*Gehyra dubia*	0	1	3	0	0	0	4	
	Tree dtella	*Gehyra variegata*	3	5	4	2	7	11	32	10.0, 0.075
	Bynoe's gecko	*Heteronotia binoei*	1	2	3	4	9	5	24	
	Beaded gecko	*Lucasium damaeum*	1	7	12	4	6	13	43	14.9, 0.011
	Marbled velvet gecko	*Oedura marmorata*	1	0	0	1	1	0	3	
	Beaked gecko	*Rhynchoedura ornata*	13	19	15	31	11	36	125	25.4, 0.0001
	Thick-tailed gecko	*Underwoodisaurus milii*	0	0	2	2	3	3	10	
		Total gekkonid captures	32	55	51	64	47	85	334	
Pygopodidae	Mallee worm lizard	*Aprasia inaurita*	0	1	0	0	0	0	1	
	Burton's snake-lizard	*Lialis burtonis*	0	0	0	0	0	1	1	
	Hooded scaly-foot	*Pygopus nigriceps*	0	0	1	0	0	0	1	
Scincidae	Carnaby's wall skink	*Cryptoblepharus carnabyi*	6	5	7	7	20	11	56	16.9, 0.005
		Ctenotus atlas	1	4	5	1	0	4	15	
	Murray striped skink	*Ctenotus brachyonyx*	0	1	1	1	0	0	3	
		Ctenotus regius	1	2	0	2	3	0	8	
		Ctenotus schomburgkii	0	0	5	3	1	4	13	
		Ctenotus strauchii	1	1	2	0	0	0	4	
		Ctenotus uber	0	2	0	0	0	1	3	
	Gunther's skink	*Cyclodomorphus branchialis*	0	1	0	0	0	1	2	
	Desert skink	*Egernia inornata*	1	0	1	0	0	1	3	

			Pitfall traps							
Family	Common name	Species	B2F	B4F	P2F	P4F	P2D	P4D	TOTAL	χ^2,prob
	Tree skink	*Egernia striolata*	1	0	2	1	0	0	4	
	Narrow-banded sand swimmer	*Eremiascincus fasciolatus*	0	0	0	0	1	0	1	
	Broad-banded sand swimmer	*Eremiascincus richardsonii*	1	1	1	1	2	0	6	
		Lerista muelleri	9	13	2	10	5	7	46	9.83, 0.080
		Lerista punctatovittata	4	9	5	13	8	9	48	6.50, 0.261
	Grey's skink	*Menetia greyii*	1	9	3	7	5	6	31	7.90, 0.162
		Morethia adelaidensis	0	0	0	0	1	0	1	
	Boulenger's skink	*Morethia boulengeri*	6	3	4	12	6	2	33	11.5, 0.042
		Morethia obscura	0	0	3	2	1	0	6	
		Proablepharus kinghorni	0	1	0	0	0	0	1	
		Total scincid captures	32	52	41	60	53	46	284	
Typhlopidae		*Ramphotyphlops australis*	0	0	1	0	0	0	1	
		Ramphotyphlops bituberculatus	3	1	1	1	2	1	9	
Varanidae	Gould's goanna	*Varanus gouldii*	0	0	1	1	2	2	6	
		Varanus tristis	0	1	0	0	0	0	1	
		Total reptile captures	74	124	107	149	125	158	737	
		Total captures	78	130	119	163	131	170	791	
		Total species	27	32	35	36	31	34	55	
		capture rate (%)	8.5	14.1	12.9	17.7	14.2	18.5	14.3	

- the four fence versions catching more than the corresponding two fence versions;
- dampcourse fences catching more than flyscreen fences; and,
- PVC pipe traps with flyscreen fences catching more than the corresponding bucket traps.

At the Order level (reptiles versus mammals), the number of individuals caught in each pitfall trap type was not evenly distributed (χ^2 = 46.7, p <<0.0001). For reptiles the four fence versions of the PVC pipe traps were the most successful with dampcourse fences outperforming the flyscreen fences (Figure 9). For mammals the four fence designs outperformed two fence designs, but flyscreen was the more successful fence material (Figure 9). With regards to fence material, restricted to only the PVC pipe traps and all numbers of fences combined, there was a weak variation in the total captures between dampcourse and flyscreeen (χ^2 = 3.53, p = 0.060), with mammals tending to be caught more frequently with flyscreen and reptiles with dampcourse.

Within the reptiles there were sufficient captures of dragons (Agamidae), geckoes (Gekkonidae) and skinks (Scincidae) for analysis at the family level revealing significant differences in the pattern of captures across the pitfall trap types (χ^2 = 52.1, p << 0.0001). PVC pipes outperformed buckets but with some variation between the families being evident regarding their reaction to fence materials (Figure 10). Ten reptile species had sufficient data for individual analysis (Table 2) with only four species showing significant variation in the numbers caught by the various pitfall trap types.

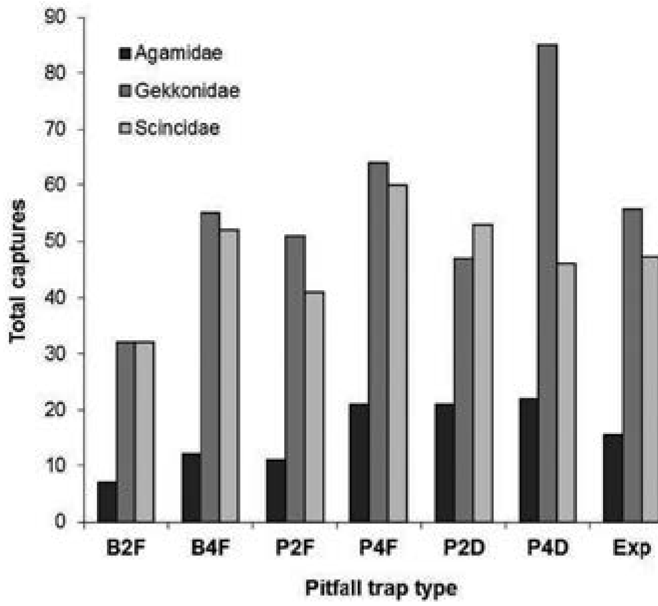

Figure 9. Total captures of reptiles and mammals in the various pit and fence combinations trialled compared to the expected value if capture rates were even across the pitfall trap types (χ^2 = 46.7, p <<0.0001).

Discussion

This study confirmed that variations in pit size and fence configuration have a strong impact on the capture rate of individuals (Braithwaite 1983; Friend 1984; Morton *et al.* 1988; Friend *et al.* 1989; Hobbs *et al.* 1994; Thompson *et al.* 2005), but also found that the material used to construct the drift fences influenced capture rate for some species, families and orders of animals. However, in contrast to

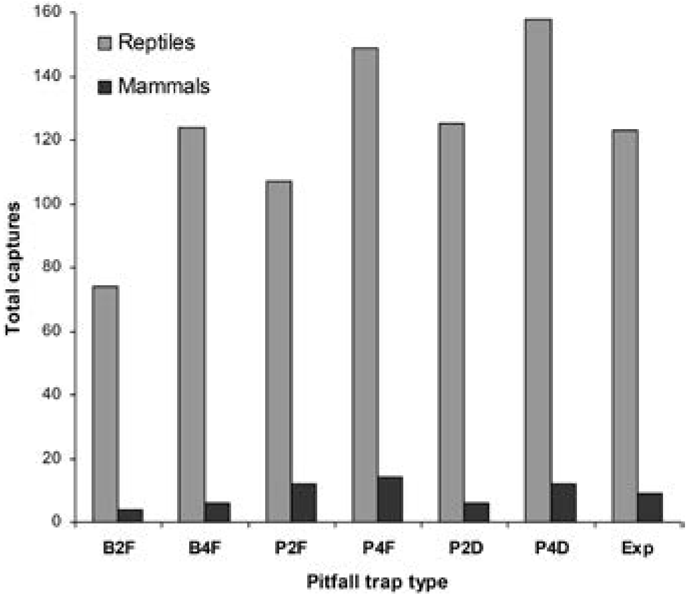

Figure 10. Total captures of reptiles and mammals in the various pit and fence combinations trialled compared to the expected value if capture rates were even across the pitfall trap types (χ^2 = 52.1, p << 0.0001)

Morton *et al.* (1988), Friend *et al.* (1989) and Thompson *et al.* (2005), this study found that configurations using PVC pipe were significantly more efficient than ones using 20 l buckets in terms of individuals captured, with the number of species captured showing the same pattern. Though there are few species in common between their studies and this one, some differences are apparent such as *Menetia greyii, Ctenotus schomburgkii* and *Rhynchoedura ornata* being captured more frequently in buckets in some of the earlier studies, but not in this study. The overall differences could be driven by local conditions causing species to be at different abundances during this study compared to other studies, by different behaviour within species in different parts of their range, or by the species composition in this study area compared to other studies. Another factor explaining higher trapping success of PVC pipes in this study could be the slightly different method of erecting fences by terminating the drift fences at the edge of the pit rather than continuing straight across the middle, as done by Morton *et al.* (1988), Friend *et al.* (1989) and Thompson *et al.* (2005), either because the entrance to the PVC pipe is less obstructed or because the gap is seen as a way through the fence and targeted by the moving animals (Figures 7 and 8). This warrants experimental investigation since it is a relatively minor change to the way drift fences are installed but may have a marked impact on trap success.

Differences between the two fence materials were limited, but overall the opaque dampcourse caught more individuals but less species than the transparent flyscreen when used in conjunction with PVC pipes. The differences were not uniform, with mammals being more frequently caught with flyscreen rather than dampcourse, and for reptiles the opposite, so the use of one or other material will affect the results of a survey. The most dramatic results was for the skink *Cryptoblepharus carnabyi* which was caught at 2.5 times the rate with dampcourse than with flyscreen fences, potentially because of this arboreal skink mistakes the dampcourse for some of its preferred habitat of fallen timber (Swan 1990) and is therefore attracted to it. Alternatively, it may be that C. *carnabyi* simply climbed over or ran along the rough surface of the flyscreen fence much the way it would on a log, but it had to walk around or along the bottom of the slippery dampcourse and thus increasing the likelihood of encountering the pit in that type of pitfall trap .

Hobbs *et al.* (1994) found little value in terms of trap success for their various crossed long fence and multiple pit arrangements when pitfall trapping, and withdrew the recommendation in Morton *et al.* (1988) for their use. At the level of the single pit pitfall traps with their independent fencing studied here there was an impact of four cross arranged fences, compared to two straight aligned fences, on the number of animals caught but the influence on capture rate was not proportional to the amount of fencing, with four radiating fences (total length 20 m) catching only 41% more individuals than the two fence (total length 10 m) arrangements (Table 2). Whether this is due to merely the additional length of the fence, changes to the effective shape of the trapping area because the additional fences intercept animals on trajectories that would miss a two fence trap (but see Luff (1975) for a discussion of the effective shape of pitfall traps), or that animals are behaviourally less able to escape from the more complicated fence arrangement is unknown. Mathematical analysis of trajectories may determine the possibilities of the former explanation whilst careful observation of various species negotiating different arrangements of fences would be needed to understand the behavioural impacts.

The influence of extra fencing needs to be considered when installing new sampling designs. When sampling at specific points, such as microhabitat or home range studies, then extra fencing should increase the capture rate at each sample point. However, when sampling landscape elements, such as vegetation patches or localised landforms, using the recommendations of Friend *et al.* (1989) and Hobbs *et al.* (1994) to have multiple independent pitfall traps, then the value of more fencing is not clear cut. If the installation of a four fence trap takes more than about 40% longer to install than a two fence trap, and installation time is limited, then installing more two fence pitfall traps in the same time should lead to more captures overall. Conversely, if the extra fencing is relatively rapidly installed, or the potential places to install the pitfall traps are limited, then the erection of the additional fencing should lead to more captures. Brennan *et al.* (2005) considered this in regards to sampling invertebrates, mainly spiders, and concluded that it could be more effective to put in unfenced pitfall traps because of the number that could be installed in limited time, and that they required less maintenance.

One caveat on the installation of extra pitfall traps is that we currently do not know the minimum, or optimum, spacing between traps with 10 to 50 m being recommended for reptiles in arid landscapes (Friend *et al.* 1989; Hobbs *et al.* 1994). Luff (1975) describes how traps can interfere with each other's trapping success rate, with each trap potentially reducing the trappable populations for neighbouring traps. Movement distances and sinuosity of their paths are unknown for many species, but mean recapture distances for some skinks and geckoes are less than 35 m (Read 1998, 1999), although James (1991) found individuals moving over 600 m. It is likely that traps would need to be spaced at least at the mean movement distance of the most mobile target species to overcome depression of trapping rates, but the number of species and the amount of field work required to comprehensively study the impacts of trap spacing would be prohibitive.

This study concurs with Thompson *et al.* (2005) that the use of a variety of pitfall trap sizes rather than a single standardised unit, as well as other survey methods, is warranted when conducting biodiversity surveys to broaden the range of species likely to be detected. In addition, this study also shows that different fencing materials can influence what species are detected, and, unlike Hobbs *et al.* (1994) working at the site scale with long intersecting fences with multiple pits, found that cross arrangements at the individual pitfall trap scale can have benefits. The relative merits of each trap configuration will not only vary between species but within species across different locations meaning that prescriptive guidelines developed on a limited geographic or taxonomic range of field results may be counterproductive if applied more widely.

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