

Southern brown bandicoots can be successfully returned to the wild after physiological experiments.

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Running head: successful release of bandicoots

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Abstract

Context The poor survivorship of many animals released into the wild for translocation, re-introduction or rehabilitation may be cited as a reason not to release experimental animals, but there is only limited information available on the fate of ex-research animals returned to the wild.

Aims This study tested the hypothesis that there was no difference in the recapture of bandicoots used for physiological experiments and control bandicoots.

Methods Six adult male bandicoots were trapped and maintained in captivity for three weeks for physiological experiments, then released at the capture site. Sixteen other bandicoots were captured and released immediately. Seven weeks after the release of the bandicoots used for physiological studies, follow-up trapping was carried out, and the survival, body mass and distance moved of recaptured bandicoots was recorded.

Key results Survivorship did not differ statistically for bandicoots used for physiological experiments and control bandicoots, with five of six experimental bandicoots (83 %) and 11 of 16 control bandicoots (69%) recaptured. Bandicoots used for physiological experiments lost a significantly greater proportion of body mass than control animals, but this occurred in captivity, not after release. The distance between recaptures for both groups (0-224m) was consistent with previously published observations.

Conclusions My results suggest that bandicoots maintained in captivity for non-invasive physiological experiments can be successfully released, with survivorship at least as high as that of control animals.

Implications This study provides researchers, wildlife managers, and animal ethics committees with information to assist with making judgements concerning the fate of ex-research animals.

Introduction

Scientific studies often require capture of wild individuals that are maintained in captivity for experimental procedures. At the conclusion of these studies, a decision must be made as to the fate of these research animals; options include donation to zoos or wildlife parks, maintenance of the animals in the laboratory until they die of natural causes, euthanasia, or return to the wild. For threatened or endangered species in particular, returning individuals to the wild may be the most desirable option, if the released individuals are likely to survive and reproduce. However, there are few data available concerning the fate of animals released into the wild following scientific experiments (Cooper *et al.* 2009). In light of this paucity of information, researchers, environmental licensing agencies and animal ethics committees may cite the poor survivorship of many animals released into the wild for translocation, introduction or rehabilitation (e.g. Pietsch 1994; Goldsworthy *et al.* 2000) as a reason not to release experimental animals (Cooper *et al.* 2009).

In contrast to the limited data for animals released after laboratory experiments, there is a large body of data examining the success of translocation of wild-caught individuals to another locality, introduction of captive-bred animals into the wild, or rehabilitation of sick, injured or orphaned animals into the wild (Griffith *et al.* 1989; Wolf *et al.* 1996; Fischer and Lindenmayer 2000). Many translocated, introduced or rehabilitated animals have a significantly worse survivorship and/or reproductive output than wild con-specifics (e.g. Sjöasen 1996, Fajardo *et al.* 2000; Goldsworthy *et al.* 2000). For other releases, there are insufficient comparative data with wild con-specifics to quantitatively interpret survivorship or reproduction of released individuals (e.g. Hessler *et al.* 1970; Sainsbury *et al.* 1996; Reeve 1998; Underhill *et al.* 1999). Therefore there may be ethical, ecological or economic arguments against the release of animals (Scott and Carpenter 1987; Estes 1991, 1998). In

other cases long-term survivorship or reproduction of released animals are equivalent to wild con-specifics (e.g. Augee *et al.* 1996, Ostermann *et al.* 2001, Lunney *et al.* 2004), and release may serve important conservation, education and social functions (Kleiman 1989, Tribe 2002).

Wild animals used for scientific studies are usually captured as healthy adult individuals, maintained under optimum laboratory conditions, and then returned to the point of capture. They might therefore be expected to fare better than translocated, introduced or rehabilitated animals. Indeed, high body mass and good body condition, familiarity with the release environment, and being wild born with a well-developed suite of survival skills all have positive impacts on post-release survival (Griffith *et al.* 1989; Augee *et al.* 1996; Fischer and Lindenmayer 2000; Lunney *et al.* 2004). Research animals returned to the place of capture have these attributes, and female yellow-footed antechinus (*Antechinus flavipes*) released after laboratory studies survived at least as well as wild con-specifics (Cooper *et al.* 2009). All recaptured experimental antechinus also had a full complement of pouch young, indicating that they could also reproduce post-release. Here I investigate the survivorship of adult male southern brown bandicoots (*Isodon obesulus*) returned to the wild after being held in captivity for physiological experiments.

Materials and methods

Southern brown bandicoots were trapped at Harry Waring Marsupial Reserve, 20 km south of Perth, Western Australia (32°11'S, 115°50'E) using wire cage traps baited with peanut butter and rolled oats. The southern brown bandicoot is a medium-sized (400-2000g) omnivorous perameloid marsupial. It is predominantly nocturnal, inhabiting scrubby heath and woodland habitats throughout south-eastern and south-western Australia (Broughton and Dickman

1991; Tyndale-Biscoe 2005). Adult bandicoots are considered to be solitary and territorial and can be very aggressive towards con-specifics (Heinsohn 1966; Thomas 1990; Jackson 2003), so this species is particularly useful to examine the feasibility of releasing animals held temporarily in captivity as there is the possibility that absent individuals may be excluded from their original territory.

Trapping was conducted during March (initial) and May (follow up) along three transects of 12 traps at 25 m intervals. Transects were 200 m apart. Traps were checked 2-4 times per night. Bandicoots were marked individually with numbered ear tags, and body mass and gender were recorded. Six adult male bandicoots were retained for physiological experiments from a single night of trapping, and the other bandicoots (controls, n=16) were released immediately at the point of capture. The physiological studies required adult, non-growing, non-pregnant, non-lactating individuals, and large males were most likely to satisfy these requirements.

Bandicoots used for non-invasive physiological experiments were housed individually in large outdoor enclosures at Curtin University with a diet of fruit, vegetables, dog food, bread with peanut butter, and *ad lib* fresh water. Open flow-through respirometry (Withers 2001) was used to measure the metabolic rate and evaporative water loss of each bandicoot at five different ambient temperatures (T_a), with each bandicoot measured in the metabolic system for 6-8 hours at each T_a and measured every 3-4 days. Bandicoots were maintained in captivity for three weeks and then released where they were caught.

Two nights of follow-up trapping occurred seven weeks after release of the bandicoots used for physiological studies. As for the initial captures, traps were checked 2-4 times per night.

The frequency of bandicoots used for physiological studies and control bandicoots recaptured on the second trapping trip was compared with a contingency table and Fisher's exact P (Zar 1999). The linear distance between the first and second capture location was calculated (the longest distance was used if animals were captured more than once during the second trapping), and along with changes in body mass, was compared for bandicoots used for physiological studies and control groups with t-tests, after testing for, and if necessary correcting for, equality of variances. StatistiXL (V1.8) was used for all statistical analyses and values are presented as mean \pm standard error.

Results

In addition to the 6 adult male bandicoots maintained in captivity, another 16 individual bandicoots (12 females, 4 males) were captured and released during the initial trapping. The bandicoots taken into captivity were significantly heavier (1299 ± 71.0 g) than those released immediately (884 ± 31.5 g; $t_{20} = 6.2$, $P < 0.001$). All bandicoots appeared to be in good physical condition. Three immediately released individuals (2 females, 1 male) had a body mass < 500 g and so were presumably immature.

A total of 45 individual bandicoots (24 females, 20 males, one unrecorded) were captured during the follow-up trapping. Five of the six bandicoots used for physiological studies (83 %) and 11 of the 16 control bandicoots (69%) were recaptured, with no significant difference in recapture success (Fisher's exact Test $P = 0.634$).

At the time of release, bandicoots used for physiological studies were 12% lighter than when originally captured (1145 ± 54.6 g; $t_4 = 30.8$, $P = 0.037$). When recaptured, bandicoots used for physiological studies (1183 ± 88.2 g) were still significantly heavier than those not used

for experiments (948 ± 35.8 g; $t_{14} = 4.01$, $P = 0.001$), but they had lost a significantly greater proportion of their original body mass; experimental animals were 91 ± 1.7 % of initial capture mass when recaptured compared to 102 ± 2.1 % for animals remaining in the wild ($t_{14} = 3.63$, $P = 0.003$). The distance between the initial and final capture point for all recaptured bandicoots was variable, ranging from 0 to 224 m (mean 115 ± 21.2 m) for bandicoots used for physiological studies and 25 to 236 m for control bandicoots (mean 115 ± 42.3 m), and did not differ significantly between these groups ($t_{14} = 0.01$, $P = 0.993$).

Discussion

Bandicoots maintained in captivity for physiological experiments were successfully returned to the wild, with at least five of the six surviving for seven weeks post-release. Their survivorship was at least as high as for bandicoots not used for physiological experiments. This is consistent with the survival of female antechinus released after similar physiological studies (Cooper *et al.* 2009), and Molony *et al.* (2006) suggested that for translocated hedgehogs (*Erinaceus europaeus*) a period of captivity before release of wild-born individuals may improve survival. Research animals returned to the place of capture share attributes associated with successful translocation and rehabilitation programs, such as good body condition, familiarity with the release environment and well-developed survival skills (Griffith *et al.* 1989; Augee *et al.* 1996; Fischer and Lindenmayer 2000; Lunney *et al.* 2004) and therefore a high survival rate is not unexpected.

The mass difference between bandicoots used for physiological studies and control bandicoots during initial trapping reflects the sexual dimorphism of bandicoots; males are 25% larger than females (Nagy *et al.* 1991; Broughton and Dickman 1991). Adult males were required for the physiological studies and therefore the bandicoots used for these experiments

were larger than the control bandicoots. The mass loss of the bandicoots occurred in captivity, rather than post-release. This is surprising, as other bandicoots maintained in captivity under similar conditions for the same experimental protocols gained mass (Larcombe and Withers 2007). It is unclear why my bandicoots lost mass in captivity, but they did have larger enclosures and were observed to be more active than those studied by Larcombe and Withers (2007; C. Cooper pers obs). Bandicoots in this study were also held in captivity for a much shorter period (three weeks versus two years), and so it is likely that they would have gained mass over a longer duration as they became accustomed to their new environment and diet. The mass gain of these bandicoots once released was of a similar magnitude to that of the control bandicoots, indicating that they had similar access to resources and were not competitively excluded from foraging.

The maximum distances moved by all recaptured bandicoots are consistent with maximum published home range diameters of 210-220 m for both mainland and island southern brown bandicoots (Copley *et al.* 1990; Lobert 1990). There is no evidence that the bandicoots used for physiological studies were displaced from their original home ranges following three weeks absence. None of the recaptured males had scarring of the pelage associated with interspecific fighting (Thomas 1990) or any observed injuries; all appeared to be in good physical condition. Therefore, even for an aggressive, territorial species with low social tolerance (Heinsohn 1966; Thomas 1990; Jackson 2003), mature adult males are able to withstand temporary removal and subsequent return to their territory.

Studies such as this examining the fate of wild animals released following scientific experiments are rare and generally constrained by small sample sizes (Cooper *et al.* 2009). The controlled nature of laboratory-based physiological measurements and small

experimental variability means that smaller sample sizes are typically required than for ecological studies. For example, a power analysis (Zar 1999) indicates that a sample size of six bandicoots is sufficient for a statistical difference of 0.25 units in metabolic rate at two ambient temperatures (SE = 0.03, power = 0.998; data from Larcombe 2002), but the minimum detectable difference for movement would be 310 m for two groups of bandicoots (SE = 42, power = 0.990; data this study). The number of animals captured and used for physiological experiments is the minimum statistically viable number for ethical, time and economic reasons, but then this can make it difficult to interpret the ecological results of post-release monitoring. However, the rarity of studies such as this makes these data valuable despite the limitations of small sample size. Seldom is the opportunity or resources available for follow-up monitoring of released ex-research subjects (Cooper *et al.* 2009).

Neither this study nor that of the yellow-footed antechinus (Cooper *et al.* 2009) involved invasive experimental procedures. It is possible that more invasive experiments may have a different outcome, especially since the success of release of rehabilitated animals is dependent on the extent of the original trauma and condition (Goldsworthy *et al.* 2000). Further studies are needed to determine how more invasive experimental procedures affect post-release survival. It is also interesting to determine if there are any effects on reproductive output, but only male bandicoots were studied here. However, all female antechinus released after similar physiological experiments were found to have a full complement of pouch young (Cooper *et al.* 2009).

I provide here evidence that bandicoots used for scientific experiments can be successfully returned to the wild. This provides researchers, wildlife managers, and animal ethics

committees with information to assist with making judgements concerning the fate of research animals.

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