Available online at www.sciencedirect.com
SCIENCE DIRECT®
Biological Conservation 121 (2005) 569–577
BIOLOGICAL CONSERVATION
www.elsevier.com/locate/biocon

Keeping fit on the ark: assessing the suitability of captive-bred animals for release

F. Mathews *, M. Orros, G. McLaren, M. Gelling, R. Foster

Department of Zoology, Wildlife Conservation Research Unit, University of Oxford, South Parks Road, Oxford OX1 3PS, UK

Received 22 October 2003; received in revised form 4 June 2004; accepted 7 June 2004

Abstract

Reintroduction programs are widespread but have low success rates, particularly when captive-bred animals are used. There are high financial costs, and important ethical concerns about animal welfare. We have explored the concept of utilizing a behavioural approach to assess the suitability of captive-bred animals for release. We compared the behaviours of wild-bred and captive-bred animals in identical novel environments, using bank voles, *Clethrionomys glareolus*, as a model. The wild animals provided an adaptive baseline against which the behaviour of captive-bred individuals was compared. Although captive-bred voles displayed some wild-type behaviours – nest building and burrowing – despite lacking previous opportunities to do so, they were unable to utilize a key food resource and were less dominant. We suggest that a similar approach could be applied to species of conservation concern in order to rank available animals in terms of likely suitability for release. It could also help to identify characteristics that appear deficient in captive-bred animals, or to evaluate the impact of interventions such as environmental enrichment.

Keywords: Reintroduction; Captive breeding; Fitness; Behaviour

1. Introduction

Captive breeding is recommended in 63% of species recovery plans in the USA (Tear et al., 1993), and for 34% of the 3500 vertebrate taxa examined by Seal et al. (1993). Yet successful reintroductions are rare (Kleiman, 1989; Seddon, 1999; Beck et al., 1994) and failure rates are not improving (Fischer and Lindenmayer, 2000). Survival can be poor even following intensive pre-release preparation (e.g. Beck et al., 1991). Reintroductions are also expensive, and may introduce pathogens to extant populations (Cunningham, 1996). Finally there are ethical questions about the welfare of released animals (International Academy of Animal Welfare Sciences, 1992). In the UK at least, the release of wild animals that have poor chances of survival may be illegal (Abandonment of Animals Act, 1960).

Captive-bred subjects may display increased morbidity and mortality compared with translocated wild-bred animals (e.g. Ginsberg, 1994). Generally, however, few data are available to explain why reintroductions fail. Despite guidelines stating the need for evaluation (Kleiman et al., 1994; World Conservation Union/Species Survival Commission Re-introduction Specialist Group, 1995), the results of reintroductions are rarely published (Beck et al., 1994). This may be due to lack of monitoring, insufficient project duration (Beck et al., 1994) and reluctance to report failures (Sarrazin and Barbault, 1996).

Although a range of characteristics has been proposed as influencing reintroduction success, including group size, feeding niche and activity patterns (Stanley-Price, 1989), most are untested experimentally. Some general conclusions about the importance starting

* Corresponding author.
E-mail address: fiona.mathews@zoology.ox.ac.uk (F. Mathews).

0006-3207/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biocon.2004.06.007

population size, generation length, habitat quality, and range of the release site relative to the historical distribution, have been drawn from cross-species associative analyses (Balmford et al., 1996; Wolff, 1997). Case-studies of charismatic species have also highlighted the role of sexual imprinting (Curio, 1996) and anti-predatory behaviour (McLean et al., 1996). For a few species, intensive programs, including aversive conditioning (Griffin et al., 2000), training for hunting (Biggins et al., 1999), preparation in foraging (Dietz et al., 1987) and the use of conspecific models (Drewien and Bizeau, 1978; Derrickson and Carpenter, 1987), have been implemented. However, the findings are difficult to generalize.

Formal animal behaviour experiments are underused in conservation science (Sutherland, 1998). We suggest that they could, if focused on fundamental questions relating to evolutionary fitness, help explain why reintroductions fail, and what can be done to improve the chances of success. Released animals must not only survive to reproductive age, but must breed successfully and have offspring that also breed. Their chances of survival are dependent on whether they are adapted to the wild environment, and whether they are able to withstand predators, disease and competitors. To reproduce successfully they must obtain a mate, a breeding site (for altricial nonmobile species), and rear young. Wild animals have, on average, evolved optimal solutions to these demands (e.g. Ydenberg and Houston, 1986; Abraham, 1993). We propose that direct comparisons between captive-bred and wild animals (from environments similar to those faced by released animals), could help evaluate the suitability of captive-bred individuals for release.

Such comparisons can be made under controlled conditions, and avoid difficulties of monitoring captive-bred animals post-release. Individuals deviating considerably from the behavioural patterns of wild-caught animals are likely to survive less well in the wild than those that are more similar. This framework does not require the behaviour of the wild-caught individuals under test conditions to be the same as their usual behaviour in the wild (indeed, it would be surprising if the two were identical). Rather, we assume that wild animals have evolved behaviours optimal for their natural environment (Tinbergen, 1951). Their responses to cues in the laboratory are shaped by evolution and by the developmental stimuli experienced in the wild. The literature on animal behaviour abounds with examples. Classically, male silver-washed butterflies prefer to court a revolving drum that flashes orange spots rather than a female of their own species (Magnus, 1958); and oystercatchers prefer to incubate ostrich eggs rather than their own (Tinbergen, 1951). In both cases, the animals are responding to stimuli in ways that would maximize their fitness in the wild – their behaviours are not simply 'unnatural', even if their significance is not obvious to the human observer (Dawkins, 1999). We can therefore consider the behaviour of our wild-caught animals to represent an adaptive baseline, in terms of fitness in the wild. Here we test the working hypothesis that two characteristics contributing to immediate survival – utilization of food resources, and of nesting materials and shelter – will be less well developed in captive-bred compared with wild caught translocated animals. Similarly, dominance – a characteristic associated with reproductive success and as immediate survival – will be lower in captive-bred animals.

2. Methods

2.1. Model species

The bank vole, *Clethrionomys glareolus*, was used as a model. The species is herbivorous, and does not provide parental care post-weaning (Watts, 1969). It is therefore amenable to tests of food acquisition without additional considerations of learned hunting behaviour. Female bank voles exhibit classic behaviours of species with altricial nonmobile young (Wolff, 1997), including territoriality (Wolton and Flowerdew, 1985; Kapusta and Marchlewska-Koj, 1998), nest defence and infanticide by adult females (DeJonge, 1983). In the breeding season, there is also aggression between sexually mature males (Cody, 1982; Bandrup-Nielsen and Karlsson, 1985). Other species showing similar behavioural patterns include many rodents, rabbits and terrestrial insectivores. A rodent model is of direct relevance to several current reintroduction programs, including the water vole (*Arvicola terrestris*) and dormouse (*Muscardinus avellanarius*) (Bright and Morris, 1994) in the UK. More generally, physical constraints on the population sizes of larger vertebrates in zoos mean that future conservation efforts are increasingly focused towards smaller species (Balmford, 1996).

By using a non-endangered species we could draw our controls from the same population that founded our captive colony, permitting more appropriate comparisons of their behaviours. Most reintroduction programs keep animals in environments far removed from those in the wild. For example social interactions are almost never comparable to the wild; there are limited opportunities for physical exercise; and the maintenance of the population in captivity over many generations leads to unintentional selection pressure for animals best suited to survive and breed in captivity. Our animals were provided with environmental enrichment, but were nevertheless reared in barren conditions relative to the wild. They can therefore be considered comparable to many zoo animals.