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Reintroduction of captive-born animals

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13.1 INTRODUCTION

This paper explores the extent to which reintroduction of captive-born animals is being used as a conservation strategy, the extent to which zoos are participating, the success of reintroduction, and some characteristics of these reintroduction programmes as they relate to success. This paper does not provide guidelines for reintroduction; see Kleiman, Stanley Price and Beck (Chapter 14) for guidelines.

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13.2 METHODS AND DEFINITIONS

Reintroduction as used here refers to the intentional movement of captive-born animals into or near the species' historical range to re-establish or augment a wild population. Translocations of wild animals, and reintroductions for primarily recreational or commercial purposes are not included. Thus our definition is narrower than that of 'transloca-tion' as used in the World Conservation Union (IUCN) position statement (IUCN, 1987) and by Griffith *et al.* (1989) because it does not include movement of wild animals. Our definition is also narrower than that of 'reintroduction' and 'restocking' in the IUCN statement because it additionally excludes movement of animals for recreational (e.g. sport fishing) or commercial (e.g. game ranching) purposes. We also exclude introductions of animals outside their species' historical range.

Our data were collected in 1991 and 1992 from surveys of the published literature; bibliographies compiled by Comly *et al.* (1989) and by Kenyon (1992); returns of standardized questionnaires that we sent to reintroduction managers (included as an appendix to this chapter); and/or personal communications deriving mainly from the IUCN Species Survival Commission's Reintroduction Specialist Group (SSC/RSG) and the Reintroduction Advisory Group (RAG) of the American Association of Zoological Parks and Aquariums (AAZPA).

13.2.1 Project

We counted the number of reintroduction projects and the number of species reintroduced. A project is an administratively distinct reintroduction, where captive-born animals have actually been released anywhere in the world between 1900 and the present. Our database thus differs in two additional ways from that of Griffith *et al.* (1989), which included only projects conducted in Canada, the USA (including Hawaii), Australia and New Zealand, between 1973 and 1986. Our database includes as separate projects reintroductions of the same species into distinct populations, e.g. the reintroduction of Arabian oryx (*Oryx leucoryx*) in Oman, Jordan and Saudi Arabia. Our database thus contains more reintroduction projects than reintroduced species. Additions to the same population by successive reintroductions, even if carried out by different administrative authorities, are not counted as separate projects. In a few cases we were not able to distinguish between different projects reintroducing the same species to different populations. For example the bald eagle (*Haliaetus leucocephalus*) was reintroduced in at least 25 states of the USA and Canadian provinces, but we were unable to ascertain which effort released captive-born eagles and which and how many were administratively distinct: we counted all of these as one project. We similarly compressed the number of projects for white-tailed sea eagles (*Haliaetus albicilla*), peregrine falcons (*Falco peregrinus*), lammergeiers (*Gypaetus barbatus*), wild turkeys (*Meleagris gallepavo*), and Indian gharials (*Gavialus gangeticus*). These compressions result in our underestimating the number of reintroduction projects but do not affect the number of species.

13.2.2 Species

We used project managers' determinations of species and did not attempt reclassification.

13.2.3 Captive-born animals

A project was counted if there was evidence that at least one captive-born animal was reintroduced; this underestimates the number of projects and species since in 16 projects we were unable to find evidence confirming our impression that captive-born animals were reintroduced. Note that a project introducing captive-born animals may also have released rehabilitated or translocated wild-born individuals, but the number of reintroduced animals in this paper refers only to the number of captive-born animals. In 10 projects we confirmed that some captive-born individuals were reintroduced, but no estimate of numbers was found; these projects and species are included in the database but are not used in calculations involving the number of animals reintroduced. In five other projects only the minimum number of captive-born animals was stated (e.g. 'at least 60' or 'more than 100'); in these cases we used the lowest number provided. All of these sources of error tend to underestimate the number of captive-born individuals reintroduced.

Animals, e.g. sand lizards (*Lacerta agilis*) (Spellerberg and House, 1982) and Kemp's ridley sea turtle (*Lepidochelys kempi*) (Burchfield, 1985), born or hatched in enclosures in the natural habitat are considered captive born. An individual of an oviparous species is said to be captive born from an egg laid and hatched in captivity or an egg laid in the wild and hatched in captivity. Individuals from eggs laid in captivity and hatched in the wild are considered wild born. Thus a crane (*Grus* spp.) hatched in captivity and placed as a hatchling under a foster parent in a wild nest is considered captive born, but it is considered wild born if hatched under a foster parent in a wild nest from an egg laid in captivity. Infants hatched in the wild and raised or 'head-started' in captivity are considered wild born.

13.2.4 Zoo involvement

A zoo is said to be involved in a reintroduction project if at least one of the reintroduced captive-born animals, or at least one of its documented ancestors, lived in a zoo. We defined 'zoo' to include zoos, aquaria, wildlife parks, arboretums, living museums, nature centres and other institutions for which public exhibition is the principal function. Animals were counted as having come from a zoo even if they were kept only in the off-exhibit facilities of such an institution. Animals that were kept in research stations, game farms, and hatcheries were not counted as having come from a zoo, even though the public may visit such institutions.

13.2.5 Tropics

A reintroduction is said to have occurred in the tropics if the animals were released between the Tropics of Cancer and Capricorn (23°, 27′ N and S, respectively).

13.2.6 Threatened taxa

A reintroduced species or subspecies is considered threatened if it appears in the *1988 IUCN Red List of Endangered Animals* (IUCN, 1988).

13.2.7 Pre-release training

We tried to determine if the captive-born animals were trained, acclimatized, or medically or genetically screened before release. Pre-release training includes such measures as inducing golden lion tamarins (*Leontopithecus rosalia*) to search for hidden and spatially distributed food and to move around on natural vegetation in their cage (Beck *et al.*, 1991); inducing black-footed ferrets (*Mustela nigripes*) to find and kill prairie dogs (*Cynomys ludovicianus*) in large outdoor enclosures (Oakleaf *et al.*, 1992; A. Vargas, pers. comm.); and inducing thick-billed parrots (*Rhynchopsitta pachyrhyncha*) to handle pine cones (a primary food source) and encouraging them to fly in pre-release cages (Wiley, Snyder and Gnam, 1992).

Nile crocodiles (*Crocodylus niloticus*) were fed live fish which they had to catch in pre-release holding pools (Morgan-Davies, 1980). Black lights were placed in the outdoor cages of elf owls (*Micrathene whitneyi*) to attract insects so that the owls could learn to catch and eat insects (J. Lithicum and B. Walton, pers. comm.). Prior to reintroduction, masked bobwhite quail (*Colinus virginianus ridgwayi*) were harassed by humans, trained dogs and hawks; the quail were allowed to escape, presumably having acquired fear of potential predators (Carpenter, Gabel and Goodwin, 1991). The same programme later grouped naïve masked bobwhite quail with wild Texas bobwhite quail (*C. v. texanus*) which occupy similar habitat and are not threatened. The Texas bobwhites demonstrated food-finding and anti-predator behaviour to the masked bobwhites in acclimatization cages and after reintroduction (the Texas bobwhite were sterilized to prevent hybridization).

This is not a complete list of pre-release training efforts but serves to illustrate the range of techniques. While housing captive-born reintroduction candidates with skilled conspecifics to demonstrate behaviours crucial to survival was considered to be training, simply providing foster parents or conspecifics for companionship was not. Hand-rearing captives, e.g. California condors (*Gymnogyps californianus*) (Wallace, 1990) and Mississippi sandhill cranes (*Grus canadensis pulla*) (Horwich, 1989) with puppets or costumes solely to prevent imprinting on humans was not considered training, but the surrogate's directing the bird to natural food was. A reintroduction project is said to have used training if at least one, but not necessarily all, captive-born reintroductees was trained.

13.2.8 Acclimatization

A project is said to have used acclimatization if at least one of the reintroduction candidates was held at or near the release site in a cage, pen, corral, artificial nest, scaffold, tower or other man-made structure for at least 24 hours before release, in order to allow the animal to become familiar with climatic conditions, landmarks, natural foods or other features of the natural environment. Training may also have taken place during acclimatization if project personnel actively presented environmental features or actively induced the animals to perform specific behaviours. For example, Hispaniolan parrots (*Amazona ventralis*) were held in a field aviary for 9–12 days before release; this by our definition is acclimatization. But they were provisioned with fruits and seeds of naturally occurring plants; thus by our definition they were also trained (Snyder, Wiley and Kepler, 1987). We would not have considered the parrots trained if they simply ate food that occurred naturally in the acclimatization aviary.

13.2.9 Medical screening

A project is said to have used medical screening if the choice of reintroduction candidates was based at least in part on medical considerations (Woodford and Rossiter, Chapter 9). This includes certification of freedom from certain communicable diseases as indicated by quarantine, vaccination requirements, deparasitization requirements, freedom from debilitating injury or deformity, weight or age minima/maxima, reproductive viability and other health-related criteria. Before release, red wolves (*Canis rufus*) were given injectable parasiticides, and were vaccinated against rabies, distemper, canine parvovirus, hepatitis, leptospirosis, corona-virus and parainfluenza (Phillips, 1990). Prior to shipment to Oman, Arabian oryx (*Oryx leucoryx*) chosen for reintroduction had to be certified to be free from tuberculosis, brucellosis, leptospirosis, rinderpest, parasitic mange, foot and mouth disease, anthrax, and bluetongue, and additionally had to be vaccinated against foot and mouth disease, anthrax, clostridial diseases and pasteurellosis (Stanley Price, 1989). Before shipment to Brazil for reintroduction, golden lion tamarins were given antihelminthics, vaccinated against rabies, radiographed to screen for extreme diaphragmatic thinning, and determined to be free of antibodies to callitrichid hepatitis (Bush, Beck and Montali, 1993; Montali and Bush, 1992). Medical monitoring or treatment only after release does not qualify a project as having used medical screening.

13.2.10 Genetic screening

A project is said to have used genetic screening if the choice of reintroduction candidates was based at least in part on genetic or pedigree considerations. These include descent from founders over-represented in the captive population, e.g. scimitar-horned oryx (*Oryx dammah*; Gordon, 1991), sufficient unrelatedness to produce minimally inbred offspring after release, e.g. Arabian oryx in Oman (Spalton, 1991), descent from lineages with or without specific genetically influenced phenotypes, e.g. diaphragmatic thinning in golden lion tamarins (Bush, Beck and Montali, 1993), or descent from non-hybridized lineages. A project is said to have used genetic screening if reintroductees were chosen from lineages originating in the specific area of the planned reintroduction, i.e. from the same putative subspecies or local population, e.g. Chocowhatchee beach mice (*Peromyscus polionotus allophrys*; Wood and Holler, 1990) and Puerto Rican crested toads (*Peltophryne lemur*; Johnson and Paine, 1989; Miller, 1985). In a programme to re-establish the swift fox (*Vulpes velox*) in Canada, Herrero, Schroeder and Scott-Brown, (1986) chose founders of a captive breeding population from the geographically closest population in the USA; the programme was thus said to have used genetic screening. These authors stated further that post-release selection would recreate locally adapted gene complexes that might be absent in stock originating from more southerly locations.

A project is said not to have used genetic screening if pedigrees of the source captive population were known, e.g. Lord Howe Island woodhen (*Tricholimas sylvestris*) (Miller and Mullette, 1985), or the source population was genetically managed, but genetic considerations were not used to select reintroduction candidates.

13.2.11 Post-release training

We also tried to determine if the reintroduced animals were trained, provisioned or monitored after release. Post-release training consists of, for example, active presentation of natural foods, e.g. grasshoppers to golden lion tamarins, or inducing the monkeys to move over natural vegetation (Beck *et al.*, 1991). Post-release training is also exemplified by demonstration of food-gathering and nest-building skills to reintroduced chimpanzees (*Pan troglodytes*) (Carter, 1981).

13.2.12 Provisioning

A project is said to have utilized provisioning after release if the animals were given food, water, and/or shelter-boxes or nest-boxes at least once after release. The animals need not have consumed the food or water or used the boxes. Reintroduced Mauritius kestrels (*Falco punctatus*) were trained before release to come to a whistle to get mice or chicks. This allowed them to be provisioned easily after release, and additionally allowed fully independent kestrels to be called in for identification after several years (Jones *et al.*, 1991). These kestrels were also given artificial nesting boxes after release. Reintroduced American burying beetles (*Nicrophorus americanus*) were given carrion on which to lay eggs (Amaral and Morse, 1990), and reintroduced Puerto Rican crested toads were given water, not for drinking but as a medium to prevent dehydration (R. Johnson, pers. comm.); we consider these both to be provisioning.

13.2.13 Monitoring

Post-release monitoring is an active attempt to determine the size of the reintroduced population, the occurrence of births, the occurrence of deaths, causes of death, and/or the behaviour of individuals. At its simplest, post-release monitoring is an attempt to determine the existence of a population after reintroduction, i.e. to determine if any of the released animals survived. Monitoring could involve direct visual contact with the animals; determining location and activity by radiotelemetry; or inferring survival, population size or activity from faeces, prey remains, or nests. Extraordinary ingenuity has produced transmitters for such diverse species as Guam rails (*Rallus owstoni*) (Meadows, 1992) and pine snakes (*Pituophis melanoleucus*) (Burger and Zappalorti, 1988). Individual identification through tattoos, tags or bands, natural or applied body marks, transponders and/or transmitters, was used in many projects but was not a requisite for monitoring. The ease of monitoring affects the precision of estimates of post-release survivorship, reproduction and behaviour. Transmitter-equipped animals returning for provisioned food, e.g. Jamaican hutias (*Geocapromys brownii*) (Oliver *et al.*, 1986) are easily monitored while black-footed ferrets which disperse widely and quickly, shed radiocollars easily, and live secretively underground are more difficult (Oakleaf *et al.*, 1992). Frequency of post-release monitoring also influences precision. If a project used monitoring we tried to determine if monitoring attempts took place on 1–12 days per year, 13–100 days, or more than 100 days. Carter (1981, 1988) literally lived with reintroduced chimpanzees, observing them daily at very close range; her monitoring results are thus very precise and detailed. In contrast, herds descending from reintroduced wood bison (*Bison b. athabascae*) live in remote and inaccessible areas and move widely and unpredictably; periodic monitoring from aircraft yields coarser grained information (Hoefs and Reynolds, 1989; H.P.L. Kiliaan, pers. comm.).

13.2.14 Local employment

We tried to determine if reintroduction projects provided local employment or professional training opportunities, or if they had a community education programme. Local employment means providing salaries to people living in the area of the reintroduction project in exchange for working on the project. The workers need not have worked with the reintroduced animals directly; many projects have employed local people to build acclimatization enclosures (e.g. plains bison, *Bison bison*) (Loring, 1906; Sanborn, 1908), build fire breaks, restore habitat, participate in community education programmes and tourism, and serve as rangers and guards. Indirect economic benefits to local people, e.g. to merchants and hotel owners, are not counted as employment.

13.2.15 Professional training

A project offers professional training opportunities if graduate students pursued research for master's or doctoral theses at the reintroduction site. The students need not study reintroduced animals, but the subject of the research must be directly related to the conservation programme. Undergraduate participation, internships, non-thesis research collaborations and professional career development programmes are not counted as professional training.

13.2.16 Community education

A reintroduction project is said to have had a community education programme if project personnel presented lectures or slide programmes; distributed posters, T-shirts, hats or pins; participated in fairs, parades, community meetings or other cultural or civic events; visited schools, clubs or individual households; or helped to prepare stories and releases for radio, television or newspapers. The golden lion tamarin programme made the community education effort a subject of research, providing evidence of improved local support for and understanding of conservation (Dietz and Nagagata, 1986; Kleiman *et al.*, 1986; Dietz, Dietz and Nagagata, Chapter 2). The conservation program for the Bali starling (*Leucopsar rothschildi*) complements reintroduction with a community education programme that both raises awareness and retrieves genetically valuable starlings that have been stolen from the wild for the pet trade; captive-bred starlings from over-represented lineages are traded to pet owners for the genetically valuable birds and the owners are given amnesty (Seibels, 1991).

13.2.17 Release years

We tried to determine the number of calendar years in which animals were actually released in each project. We were unable to make a confident estimate for 22 projects, and for six others we could only determine a minimum number of release years. Note that there may have been many years of preparation and captive breeding before the releases, years between releases, and years of post-release monitoring, but we count only actual release years as a measure of project longevity and effort.

13.2.18 Success

A reintroduction project is counted as successful if the wild population subsequently reached at least 500 individuals which are free of provisioning or other human support, or where a formal genetic/demographic analysis (e.g. Population Viability Analysis or Population and Habitat Viability Analysis) of the sort advocated by Foose (1991) predicts that the population will be self-sustaining. The reintroduction itself need not be the sole factor contributing to population growth, and indeed other measures may have been more instrumental in population recovery. For example Rees (1989) suggests that habitat protection, predator control, regulation of hunting, and public education seem to have contributed more than reintroduction to the recovery of the Aleutian goose (*Branta canadensis leucopareia*).

13.3 RESULTS

We can document 145 administratively distinct projects in which 13 275 295 documented individual captive-born animals of 126 species were reintroduced. Table 13.1 shows these data arrayed by class, with

Table 13.1 The frequency of reintroduction projects, reintroduced species, and individual reintroduced captive-born animals, by class

	Projects	*Species*	*Individuals*
Mammals	46 (32%)	39 (31%)	2 317
Birds	65 (45%)	54 (43%)	39 054
Reptiles and amphibians	23 (16%)	22 (17%)	31 483
Fish	9 (6%)	9 (7%)	13 201 050
Invertebrates	2 (1%)	2 (2%)	1 391
	145 (100%)	126 (100%)	13 275 295

reptiles and amphibians combined. Foose *et al.* (1992) calculate that mammals constitute about 8% of all vertebrate species, birds about 19%, reptiles and amphibians about 21%, and fish about 52%. But mammals constitute about 32% of all reintroduced captive-born vertebrate species, birds about 44%, reptiles and amphibians about 18%, and fish about 7%. Thus reintroduction of captive-born mammals and birds is used more frequently than would be predicted from species abundance, and reintroduction of captive-born fish is less frequent. Further, since there are at least 300 000 species of invertebrates compared to 47 500 species of vertebrates, it would seem that reintroduction of captive-born invertebrates is very uncommon compared with species abundance. Of course it is endangerment rather than abundance that should drive the frequency of use of any recovery method, but we could not identify a representative measure of endangerment of various classes.

Table 13.2 shows the average number of reintroduced individuals per project and species, arrayed by class. Note that the number of reintrodu-

Table 13.2 The average number of individual captive-born animals reintroduced per project and species, by class

	Project	*Species*
Mammals	50	59
Birds	620	737
Reptiles and Amphibians	1 431	1 499
Fish	3 200 263	3 200 263
Invertebrates	696	696

ced individuals was not available for two bird projects (one species), one herpetological project (one species), and five fish projects (five species). The differences between classes may reflect differences in litter sizes and growth rates, as well as in relative ease of handling and transporting vertebrate eggs, fry, tadpoles and adults. Ounsted (1991) has already noted that the preponderance of bird over mammal reintroductions is due in part to the ease of manipulating and fostering eggs. The two invertebrate reintroduction projects were largely pilot feasibility studies; because of the ease of handling eggs, larvae and even the small-bodied adults, we would anticipate large average numbers of individuals per project if reintroduction becomes a widely used recovery tool for invertebrates.

13.3.1 Zoo involvement

Zoo-bred animals or the captive-bred descendants of zoo animals were reintroduced in 76 (59%) of the 129 reintroduction projects for which we could confidently determine whether zoo-born animals or their descendants were used. As there are about 350 zoos and aquaria in the developed world, on average only about one in five has been involved in reintroduction. This is a rough estimate since some projects used animals from several zoos while some zoos have been solely responsible for several projects. We did not count as zoo-born one chimpanzee born in a road-side zoo, removed from its mother on the day of birth, and sold to a private party on the next day. This animal was ultimately reintroduced to the wild (Carter, 1981), but this did not seem to reflect meaningful zoo involvement in this project. Zoo-bred mammals were reintroduced in 37% of the 76 projects, birds in 41%, reptiles and amphibians in 20%, fish in 3%, and invertebrates in none (the Cincinnati Zoo is now involved in captive breeding of North American burying beetles but no zoo beetles have yet been reintroduced, but see Pearce-Kelly, Chapter 17). These proportions approximate the distribution of animal classes in all reintroductions (Table 13.1), suggesting that a zoo-bred species of any class is equally likely to be reintroduced.

Since some projects released zoo-bred and non-zoo-bred (but captive-born) animals, we could not determine precisely how many zoo-born animals have been reintroduced. But a minimum of 20 849 animals (1958 mammals, 8271 birds, 10 620 reptiles and amphibians) were released in these projects. This is the equivalent of the collections of only three or four major North American or European zoos combined.

Of course, zoos participate in reintroduction in ways other than providing zoo-born animals for release. For example, the Gladys Porter Zoo provides husbandry expertise in the Kemp's ridley sea turtle reintroduction but does not provide zoo-born turtles. The Frankfurt Zoological Society is a major financial supporter of the golden lion tamarin reintroduction, but has provided only two zoo-born tamarins. Many zoos feature reintroduction in their public education programmes.

Nevertheless, it does not appear that zoos are the primary proponents, animal providers, funders, or managers of reintroduction programmes. State and federal wildlife agencies are involved in a vast majority of reintroductions, including many of those where zoo-born animals were released, and appear to be the major driving force.

13.3.2 Tropics

Only 30 (21%) of 144 projects released animals in the tropics (we could not determine the precise release location of one project). The vast majority of reintroductions have been sited in temperate North America, Europe, and Australia/New Zealand. This too is consistent with the conclusion that state and federal wildlife agencies manage reintroduction projects, since these organizations are particularly well funded and well staffed in the developed temperate world. Mammals were released in 11 (37%) of the 30 tropical projects, birds in nine (30%), reptiles and amphibians in 10 (33%), and fish and invertebrates in none. Thus zoo-bred reptiles and amphibians are more likely than expected to be reintroduced in the tropics, and birds and fish less likely, based on their proportions of all reintroduction projects (Table 13.1).

13.3.3 Threatened taxa

Seventy (48%) of the 145 reintroduction projects released species or subspecies listed in the IUCN Red Data Book as threatened. Additionally, the Aleutian goose was listed as threatened when its reintroduction began, and in all likelihood wood bison, plains bison and wood ducks would also have been listed as threatened. Père David's deer (*Elaphurus davidianus*) is extinct in the wild and therefore not listed as threatened. Including these, 27 of 46 (59%) mammal projects released a threatened taxon, as did 21 of 65 (32%) bird projects, 16 of 23 (70%) reptile and amphibian projects, nine of nine (100%) fish projects, and two of two (100%) invertebrate projects.

13.3.4 Some characteristics of reintroduction projects

Table 13.3 summarizes some characteristics of reintroduction projects. Pre-release acclimatization was more frequently used (76% of all projects) than pre-release training (35%). This was true for mammals, birds, and reptiles and amphibians, probably reflecting the greater costs of pre-release training, and the limited evidence for its effectiveness (Kleiman

Table 13.3 Characteristics of reintroduction projects

Factor	*Proportion of projects (%)*[a]			
	All[b]	*Mammals*	*Birds*	*Reptiles and amphibians*
Pre-release training	35	36	48	7
Acclimatization	76	82	83	56
Medical screening	46	60	47	31
Genetic screening	37	35	34	46
Post-release training	12	12	19	0
Provisioning	63	69	84	13
Monitoring	96	97	98	87
Local employment	53	50	64	54
Professional training	56	52	64	54
Community education	70	59	76	77
Release years[c]	6.51	3.03	6.09	7.50

[a]Due to lack of information, overall percentages are based on between 59 and 104 projects.
[b]Fish and invertebrate projects are included in the overall percentages but are not shown separately because of small sample sizes.
[c]Average number of years in which animals were released.

et al., 1986; Snyder, Wiley and Kepler, 1987). Post-release training (12% of all projects) was less commonly used than pre-release training (35%), probably reflecting the logistical difficulty of training free-ranging, often widely dispersed, reintroductees.

Pre-release training was used more frequently for mammals (36% of projects) and birds (48%) than for reptiles and amphibians (7%). Likewise, acclimatization was used more frequently for mammals (82%) and birds (83%) than for reptiles and amphibians (56%). Despite comparable levels of post-release monitoring, there was more post-release training for mammals (12%) and birds (19%) than for reptiles and amphibians (0%), and there was more post-release provisioning for mammals (69%) and birds (84%) than for reptiles and amphibians (13%). The same general trends are apparent in the fish and invertebrate subsamples. All of these trends probably result from the conclusion that foraging, locomotor, and anti-predator behaviours, and other behaviours essential for survival, are more heavily dependent on learning and specific environmental experience in mammals and birds. Reptiles and amphibians might thus be expected to require less pre-release preparation and post-release support. But there are no significant differences in reintroduction success rate among the three class samples (see below).

There are fewer release years for mammals (3.03 per project) than for birds (6.09) and reptiles and amphibians (7.50). To the degree that the number of release years is positively correlated with reintroduction success (Griffith *et al.*, 1989), this may retard the success of mammal reintroduction projects. But again there are no significant differences in success rates between mammals, birds and reptiles and amphibians.

Kleiman, Stanley Price and Beck, (Chapter 14) provide a comprehensive compilation of guidelines for reintroduction. These include stringent pre-release veterinary screening and genetic screening, and strong community relations programmes. Careful consideration must be given to pre-release training and acclimatization, and post-release support. Our data suggest that to date reintroduction managers have largely met guidelines regarding acclimatization (76% of projects), post-release provisioning (63%), post-release monitoring (96%) and community relations (53% offered local employment and 70% offered community education programmes). But there appear to be serious shortfalls with regard to pre-release training (35% of projects), medical screening (46%) and genetic screening (37%). In view of the potentially catastrophic effects of communicable disease on a remnant population of conspecifics or on a natural ecosystem (Bush, Beck and Montali, 1993), the low frequency of medical screening is of great concern. Indeed, in addition to our frequencies for medical and genetic screening being low, they are based on fewer than half of the known projects since we could not even determine from available sources whether there had or had not been screening.

13.3.5 Is reintroduction successful?

We can find evidence that only 16 (11%) of the 145 reintroduction projects were successful as defined above. These 16 projects reintroduced captive-born wood bison, plains bison (two projects), Arabian oryx (Oman), Alpine ibex (*Capra ibex*), bald eagle, Harris' hawk (*Parabuteo unicinctus*), peregrine falcon, Aleutian goose, bean goose (*Anser fabalis*), lesser white-fronted goose (*Anser erythropus*), wood duck (*Aix sponsa*), gharial (in India), Galapagos iguana (*Conolophus subcristatus*), pine snake (*Pituophis melanoleucus*), and Galapagos tortoise (*Geochelone elaphantopus*).

This estimate of success is provisional, since our measure of success is very general and conservative. Further, the other 89% are not all failures. In some projects there is encouraging progress toward a self-sustaining population. Some projects are in their infancy and techniques are being improved. There are also indirect benefits of reintroductions where a self-sustaining wild population may never be established, namely increased public awareness and support for conservation, professional training, enhanced habitat protection, and increased scientific knowledge (Kleiman, Stanley Price and Beck, Chapter 14; Lindberg, 1992).

Griffith *et al.* (1989), in their analysis of projects involving the reintroduction of captive-bred animals and translocation of wild-born animals, and using project managers' judgments of success of their own projects, estimated that 38% of projects reintroducing captive-bred animals were successful, and 75% of projects translocating wild animals were successful.

13.3.6 Some characteristics of successful reintroduction projects

Of the 16 successful projects, five reintroduced mammals (11% of all mammal projects), seven reintroduced birds (11% of all bird projects) and four reintroduced reptiles or amphibians (17% of all herpetological projects). None of the successful projects reintroduced fish or invertebrates. Thus herpetological reintroductions are slightly more likely to be successful, and fish reintroductions slightly less likely to be successful than expected, but sample sizes are small. At present there is no evident relationship between class and success.

We have reasonably complete documentation on 14 of the 16 successful reintroduction projects, and on 62 other projects. By 'reasonably complete' we mean confirmed responses to at least six of the 11 characteristics shown in Table 13.3. Of the 62 'other' projects (not necessarily unsuccessful but not yet proven successful by our definition), 20 (32%) reintroduced mammals, 26 (42%) reintroduced birds, 11 (18%) reintroduced reptiles or amphibians, three (5%) reintroduced fish, and two (3%) reintroduced invertebrates. These proportions closely represent the class distribution of the database as a whole (see above); thus the sample of 'other' projects is representative in a taxonomic sense. However, the data from this sample are not representative of reintroduction projects as a whole since one might expect more confirmable responses from better organized and better documented projects.

Table 13.4 compares characteristics of the 'successful' and 'other' projects. Sample sizes for any one characteristic ranged from 11 to 13 for successful projects and 47 to 62 for other projects. There were five notable differences. Successful projects used medical screening and post-release provisioning less often than the other projects. This is a counter-intuitive outcome which can be a chance occurrence in a small sample, or it may mean that these measures are not essential for success. Successful projects more frequently provided local employment and community education programmes. These outcomes confirm a conclusion of the oldest project in our database. In his report on the suitability of the Wichita Buffalo Range for the New York Zoological Society's

Table 13.4 Characteristics of successful and other reintroduction projects

Factor	*Proportion of projects (%)*	
	Successful	*Other*
Pre-release training	50	32
Acclimatization	75	68
Medical screening	17	49
Genetic screening	25	35
Post-release training	8	11
Provisioning	42	63
Monitoring	100	94
Local employment	75	47
Professional training	58	51
Community education	100	62
Release years[a]	11.8	4.7

[a]Average number of years in which animals were released.

reintroduction of plains bison, J. Alden Loring wrote:

> 'In establishing this range everything possible should be done to foster good feeling between the Government and the public. To a large extent this may be done by giving employment to persons living on or near the range. These people should be made to feel that it is to their interest to watch over the animals in the range, and report everything that should be brought to the attention of the forester.'
>
> (Loring, 1906, p. 198.)

Finally, successful projects released animals in an average of 11.8 calendar years ($n = 15$) while other projects released animals in an average of 4.7 years ($n = 61$); this difference is significant (Mann–Whitney U Test, $U = 222.5$, $z = 3.06$, $p < 0.002$, two-tailed). This conforms to differences in the number of captive-born animals released. An average of 726 animals ($n = 16$) were released in successful projects compared to an average of 336 ($n = 56$) in other projects (for this calculation fish and invertebrate projects were not included in the sample of other projects since both tend to reintroduce large numbers of individuals and there were no fish or invertebrate projects in the successful sample); this difference is significant (Mann–Whitney U Test, $U = 180.5$, $z = 3.62$, $p < 0.001$, two-tailed). Griffith *et al.* (1989) found that successful translocation programmes were of longer duration and released more animals than unsuccessful programmes.

13.4 CONCLUSIONS

Reintroduction is a common conservation strategy in the temperate, developed world but is used rarely in the tropics, where the loss of biodiversity is accelerating. Only about 50% of reintroduction projects have released threatened species or subspecies, suggesting that the potential for reintroduction as a recovery strategy has yet to be realized. This shortfall is especially marked for bird reintroductions, where only 32% of projects released threatened taxa.

Some zoos and some zoo critics exaggerate the importance of reintroduction as a zoo conservation function. Reintroduction is one of a balanced suite of zoo contributions to conservation (Mallinson, 1991), but our results suggest revision of any claims about the primacy of zoos in reintroduction or the primacy of reintroduction in zoos. State and federal wildlife agencies are the major proponents and managers of reintroduction.

In two years of intense searching we were able to acquire reasonably complete information on less than 50% of projects known to have reintroduced captive-born animals. Written information documenting reintroduction procedures and post-release outcomes for over 13 million individual animals fills less than one file drawer. Both Griffith *et al.* (1989) and Kleiman, Stanley Price and Beck (Chapter 14) argue strongly for documentation and published descriptions of techniques and outcomes.

With this paucity of documentation we were forced to use very general criteria for reintroduction success. Had we used more specific criteria the sample of projects allowing confident determinations of success would have been too small to allow meaningful comparisons. In addition to providing better documentation, we need to develop specific criteria of reintroduction success and apply them vigorously and impartially.

Whether the success rate for reintroduction is 11% (this study) or 38% (Griffith *et al.*, 1989), we need to improve reintroduction techniques. Retrospective studies such as the present study will continue to suggest correlates of success. These need to be confirmed by controlled research. Research is also needed in areas where the results are ambiguous, e.g. the importance of pre-release training, medical screening, and post-release provisioning. Only with research-based improvement in techniques will reintroduction attain the success and applicability to threatened taxa needed to gain credibility as a recovery strategy.

We do know that successful reintroduction projects seem to extend over many years and release large numbers of animals. Successful projects invest heavily in the involvement of local people through employment opportunities and community education. All of these characteristics are resource-intensive, suggesting that prospects for adequate, long-term funding must be good if reintroduction is to be undertaken responsibly.

13.5 APPENDIX: REINTRODUCTION DATABASE QUESTIONNAIRE

Common name: ____________________
Family: ____________________
Genus: ____________________
Species: ____________________
(Subspecies: ________________)

Country and/or continent on which reintroduction(s) occurred: ________
Park or locale in which reintroduction(s) occurred: __________

In what year(s) were animals released? __________
Total number released: __________
Out of the total number released, how many were captive-born? (For egg-laying animals, 'captive-born' includes individuals that were removed from the wild as eggs and then hatched in captivity.)

____

Out of the total number released, how many were wild-born? ('Wild-born' includes individuals that were removed from the wild, spent time in captivity, and were then released back to the wild.)

____

PRE-RELEASE
Were releasees trained in any way prior to release? Y/N
Please describe if yes: __________
Were the animals acclimatized to the release area prior to release? Y/N
Were potential releasees medically assessed? Y/N
Please describe if yes (for example, fecal samples, blood samples taken): __________
Were potential releasees genetically assessed? Y/N
Please describe if yes: __________

POST-RELEASE
Were releasees trained after release? Y/N
Please explain if yes: __________
Were releasees provisioned after release? Y/N
Were releasees monitored after release? Y/N
If yes, were they monitored more than 100 times per year? Y/N
    12–100 times per year? Y/N
    Less than 12 times per year? Y/N

SURVIVAL

What is the total number of releasees that are known to have died after release? _________

How many releasees died during the first year following release? _________

Out of those, how many died during the first month? _________

How many releasees are known to have died **after** the first year of release? _________

What is the total number of releasees that are known to have disappeared after release? _________

How many releasees disappeared during the first year following release? _________

Out of those, how many disappeared during the first month? _________

How many releasees disappeared **after** the first year of release? _________

What is the total number of releasees that were removed after release? _________

How many releasees were removed during the first year following release? _________

Out of those, how many were removed during the first month? _________

How many releasees were removed **after** the first year of release? _________

What is the total number of births to released animals? _________

How many births occurred during the first year following release? _________

Out of those, did any occur during the first month? _________

How many births were there **after** the first year of release? _________

Mortality and birth information is current as of: _________

Was there a public awareness program associated with the reintroduction project? Y/N

Please describe if yes: ____

Were there student research projects (e.g. Master's or Ph.D. dissertations or internships) initiated as a result of the reintroduction program? Y/N

Were there local employment opportunities created as a result of the reintroduction program? Y/N

Are you willing to be listed as the person to contact for further information regarding this reintroduction project? Y/N

If so,
your name:
address:

phone:
FAX:

Comments:

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