EX SITU STRATEGIES FOR REDUCING IMPACTS UPON SENSITIVE SMALL MAMMAL SPECIES

F.H. EMMERSON, Zoological Resources, PO Box 340, Pahrump, NV 89041

MICHAEL J. O'FARRELL, O'Farrell Biological Consulting, 2912 North Jones Boulevard, Las Vegas, NV 89108

1993 TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 29: 45-48

Abstract: Various strategies best grouped under the term *ex situ* are appropriate for reducing environmental impacts upon populations of sensitive mammalian species. Best known among these is propagating animals in captivity both to conserve gene pools and to provide animals for reintroduction when prospective habitat becomes available. This enterprise has been applied mostly to large, charismatic mammals, and seldom to small, cryptic species. Advanced reproductive technologies may maximize reproductive potential of captive animals. These are undergoing rapid expansion and development and include artificial insemination, cryopreservation, and embryo transfer. When imperiled by impending disruption of habitat, entire local populations of a species may be translocated. Examples of potential difficulties in this context are given. We use the term "repatriation" to reference a scenario in which a population is removed from an area of disruption, held in temporary captivity, then returned to its original capture site. In this technique, exclusion fencing can be the key element in preventing passive colonization during the population's absence. We urge that legacies of captivity be identified and accounted for in separate or concurrent studies involving these *ex situ* projects. We also recommend that private and public institutions develop and operate facilities for holding small mammals during these projects.

Ex situ strategies have been developed for managing populations of mammals in the interest of conserving their species. The best known of these is captive propagation. Where there is available habitat, reintroduction follows captive propagation.

Genetic material may also be conserved by cryopreservation of embryos and semen. Reproductive potential may be enhanced through artificial insemination and embryo transfer. When no habitat exists for reintroduction, these techniques are especially important because genetic material may be banked until populations can be reintroduced.

In addition to these techniques is translocation of a population from one area to another, to enhance the likelihood of the animals' persistence in the wild. Another option is taking the population from the wild, housing it for eventual return to its site of capture, a little-used process.

The purposes of this paper are (1) to delineate briefly the *ex situ* methods now used for reducing adverse effects of human activity upon mammalian species, (2) to propose that repatriation be added to this list, and (3) to encourage the study of the legacies of captivity and the development of facilities for *ex situ* projects.

CAPTIVE PROPAGATION

The fruits of captive propagation of mammals for conservation are documented. For example, American and European bison (*Bison bison* and *b. bonasus*, respectively), Arabian oryx (*Oryx leucoryx*), Mongolian wild horse (*Equus przewalskii*) were saved from certain extinction through propagation in public zoos and private parks (Martin 1975). Beck and Wemmer (1983) present a complete case study on the captive history and conservation of Père David's deer (*Elaphurus davidianus*), a species extinct in the wild.

Large, charismatic mammalian species have benefited most from captive breeding, but efforts to save "medium-sized" mammals such as the golden lion tamarin (*Leontopithecus rosalia*) and black-footed ferret (*Mustela nigripes*) have also received public notice. Bats, rodents, shrews, and mammals of similar size account for the majority of mammalian species, but are not represented in captive breeding efforts in keeping with their diversity of taxa.

Although maintaining living pools of wild species in zoos and parks is a burgeoning enterprise which is constrained only by space shortages and limited operating budgets, zoological park professionals do not see it as an end in itself. All serious propagators of wild animals know that habitat availability is crucial to wildlife conservation. This principle unites all of conservation biology. Captive propagation, therefore, is not a substitute for viable wild populations, but is one of a number of efforts to conserve rare and imperiled species. Literature documenting these efforts is voluminous. Tudge (1992) has done a service by consolidating information on captive propagation, including technology, with discussions on philosophy and economics.

REPRODUCTIVE TECHNOLOGIES

Reasons for employing sophisticated technologies for conservation breeding are many: Housing large numbers of animals is expensive, and so is moving them between cities for prescribed matings. Placing captive wild animals together for courtship may involve risk of injury or death. There may be few individuals of a species and some may exhibit incompatibility, infertility, or poor parenting skills.

As adjuncts to the usual sequence of courtship, mating, birth, and rearing of offspring in captivity, procedures have been developed to enhance the productivity of scarce captive resources. Cryopreservation of both semen and embryos allows banking of genomes. Embryos have been transferred both surgically and non-surgically between species. Embryo transfer frees a female from carrying a pregnancy to term and increases her reproductive output by allowing her to be bred sooner than otherwise.

Dresser (1988) summarized routine and developing techniques in use through 1987. Such efforts have advanced since her report, and can be expected to include their use *in situ* as zoological park professionals take these activities to the field.

In 1987, a gaur (*Bos gaurus*) embryo was transferred non-surgically to a Holstein cow (*Bos taurus*) for the first time (Dresser 1988). In another breakthrough, the first non-domestic cats (leopard cat, *Felis bengalensis*) from artificial insemination and sperm banking were born at the New York Zoological Park in 1992 (Howard and Doherty 1992). These are but two milestones among many achievements in reproductive technologies of the past several decades.

REINTRODUCTION

Zoo-born offspring have been reintroduced when habitat was available and when geopolitical conditions offered hope of future management in the recipient states or countries. Ryder (1991) reported on the biological and political problems encountered during an attempt to arrange the reintroduction of the Mongolian wild horse into its country of origin. Generally, propagation schemes have surged ahead of opportunities for reintroduction, creating further stress upon already scarce resources. In addition, the emphasis placed upon large, popular mammals is dictated by allocation of exhibit space in zoos and aquariums in response to public interest. Funding is more readily obtained from the institutions' governing authorities for cats and primates than for rodents and bats, often to the dismay of curators and directors and to the detriment of reintroduction opportunities.

Most goal-directed propagation schemes, whether for wildlife or domestic stock, produce unavoidable surpluses: In order to have enough, you wind up with too many. Disposition of surplus further confounds the problems of captive management. Members of the American Association of Zoological Parks and Aquariums (AAZPA) are bound by mandatory standards for the disposition of surplus animals which forbid their transfer to institutions or persons unlikely to give them adequate care. Also, animals deemed surplus to the propagation effort may not be ideal candidates for release to the wild, because of age, genetic background, reproductive history, or health.

Several entities combine data management and population genetics with *ex situ* propagation to make the captive breeding/reintroduction effort efficient and effective. The International Species Information System (ISIS) is a database of individual histories on over 600,000 vertebrate specimens. Population geneticists use these data as part of Species Survival Plans (SSPs) for taxa in need of urgent attention. In this way, participating institutions combine their collective holdings of given species and manage them as a single captive population. (See Seal 1988 for a summary of data management for ISIS and SSPs). The Captive Breeding Specialist Group (CBSG), an international network of more than 450 volunteer experts, is actively pursuing and coordinating programs for hundreds of taxa (Seal 1992).

TRANSLOCATION

Occasionally, a single animal or a population must be moved from one part of its range to another. Translocating a "problem" animal (one whose activities have collided with human desires for space and safety) makes exciting television. Moving an entire local population to new habitat within its historic range is a greater challenge, although not particularly photogenic. Even though the public is probably ready to accept translocation as a means of conserving wildlife, press reports are few of successful programs to keep this possibility before the people. Moreover, translocation is fraught with difficulties, which range from the political to the technical. A report on marsh deer in Brazil (Wortman et al. 1991) is a textbook on translocation under difficult circumstances, made even worse in this instance by flooding caused by development. Animals are usually translocated because of an impending ecological disaster. Time and funding may be short, causing arrangements to be made in haste.

During a translocation study of the federally endangered (Kramer 1988) Stephens' kangaroo rat (*Dipodomys stephensi*) in western Riverside County, California (O'Farrell 1993), we, too, encountered unanticipated problems. Superficially, translocation appears a straightforward exercise in trapping and releasing the largest number of animals in the shortest possible time. However, impending habitat disruption required that animals be captured, although suitable habitat was not yet available. Therefore, a period of captivity was required while unoccupied areas were transformed into acceptable habitat.

We naively believed that arranging for institutions to hold all the animals during the waiting phase would not be difficult, given the large number of suitable facilities in our area and given that we were able to offer per diem payment for animals' basic care. Instead, we discovered that housing animals on a contract basis was not assured. We found zoological parks more receptive than universities, the latter being better able to deal with domestic laboratory species. Universities' limited facilities are for the use of faculty and student research, and long-term use of even a single animal room is a substantial commitment. Further, universities may ask that animals be available for study. This requirement could not be accommodated by the conditions of the endangered species permit from U.S. Fish and Wildlife Service to O'Farrell; only holding had been permitted.

Two AAZPA-accredited zoological parks participated in the translocation project, but their combined off-exhibit holding capacity for Stephens' kangaroo rats was only about a quarter of what was eventually required. A facility to house the remainder of the population had to be built.

Kangaroo rats handle captivity well and are capable of living long (Crandall, 1963, pp. 223-225). However, holding them in large numbers offers opportunity for refining techniques for their confinement and husbandry. For example, kangaroo rats are housed singly. Holding equipment designed for heteromyid rodents is not commercially available. Consequently, the zoo groups were kept in units designed for laboratory mice and rats, and those in the special facility were kept in units designed and built specifically for kangaroo rats. Laboratory rodent units are equipped with hoppers to hold water bottles and feed pellets, a useless amenity for heteromyids. The units we made for the kangaroo rats featured uniform headroom and side ventilation which permitted stacking.

REPATRIATION

In a location of impending disruption to a sensitive species' habitat (e.g., excavation, building construction, or placement of a utility corridor), an exclusion fence (see O'Farrell and Stoddard, these proceedings) may be installed around the proposed site. The inhabitants are then trapped and removed. The fence precludes passive colonization by animals outside the perimeter. During the course of the disruptive process, the animals are housed as described above. When the event is concluded, peril has diminished, and the habitat has recovered, the animals are released at their original capture site. We use the term "repatriation" for this process.

Repatriation differs from reintroduction in that the animals returned are the same individuals that inhabited the area originally, rather than offspring of captive conspecifics from other geographic areas. It differs from translocation in that there is little to no net loss of habitat for the species, and incidental take on the part of the project's proponent is avoided or minimized. As a mitigation measure, repatriation has promise because it is less costly than purchasing compensation land as potential habitat for translocated animals. In fact, purchased land may prove unsuitable for a species. In repatriation, we know that the land has historically sustained the species.

Information on genetics of local populations is generally scarce, at least with respect to small mammals. Therefore, the conservative approach would be to preserve as many individuals as possible from an area being temporarily disrupted. The action area may be eventually colonized from animals outside its perimeter, but there is no assurance that genetic diversity will not suffer. The colonizers are related to the expatriates, but they are not genetically identical. Repatriation is a more conservative option.

PHYSICAL AND RESEARCH ASSETS

We hope that resource management agencies and investigators will strive to develop novel combinations of *ex situ* strategies for conserving small mammal species. Inasmuch as existing public facilities housing wild animals are overextended with their own missions and objectives, we further urge that qualified private parties be permitted and encouraged to build and operate holding facilities for small mammals pending release in translocation and repatriation projects.

Programs and techniques for the housing and breeding of heteromyid rodents, in particular, need to be carried forward for a number of California species, e.g., *Dipodomys heermanni morroensis*, *D. ingens*, *D. nitratoides*, and *D. stephensi*. These programs may build upon the recent efforts of Roest (1991) and Roberts and Rall (1993) for *D. heermanni* subspecies.

LEGACIES OF CAPTIVITY

Releasing former captives into the wild may affect both the released animals and the biota in the area of the release (Heuschele 1991). In 1992, an international conference on implications of infectious diseases relative to captive breeding and reintroductions was convened in Oakland, California (see Anon. 1992 for the agenda). Historically, studies of wildlife diseases and parasites have emphasized diseases of zoonotic potential (e.g., rabies, anthrax) or of animals related to, or frequently in contact with, human food, fiber, and companion species (e.g., canine distemper, parvoviruses, equine infectious anemia, Newcastle disease, brucellosis). Consequently, we know vastly more about the ills befalling ungulates, carnivores, birds, and primates than we do about those of amphibians, reptiles, rodents, and other small mammals.

We suggest that rigorous study of the legacies of captivity be undertaken in conjunction with the *ex situ* techniques. This will entail experimental design for use in the field and in participating facilities as well. For example, we may intuitively assume that the best duration of time between capture and release is the least possible. This assumption deserves testing, so that decisions will maximize the conservation value of our efforts. We believe processes acting on the effectiveness of *ex situ* techniques and the legacies of captivity may be taxon-specific. As an example, species A may do well when released immediately following capture if possible, whereas species B might profit from a period of recovery between these two events. One should be cautious when extending inferences to one species from data about another.

CONCLUSION

Ex situ strategies have attained a prominent place in wildlife conservation, and their role appears poised for a dramatic expansion, if recent activity is any indication. *Ex situ* conservation schemes are not simple. Studies suggest that some efforts may prove to be fiendishly complex, not only biologically, but also economically, culturally, and politically. We need to move ahead with these studies and projects, striving to learn from their complexities in order that the goal of species conservation will be realized.

ACKNOWLEDGMENTS

Art Davenport read and commented on an early draft, and Dr. Jeanne Emmerson reviewed two early versions and made useful suggestions on presentation of the material. Dr. Dan Williams and Brad Valentine offered key recommendations on organization of the final draft. Our work on *ex situ* management of Stephens' kangaroo rat was supported by The Metropolitan Water District of Southern California, Los Angeles. The Living Desert, Palm Desert, California, and San Diego Zoo housed captive populations during preparation of release sites.

LITERATURE CITED

Anonymous. 1992. Preliminary agenda, International conference on implications of infectious disease for captive propagation and reintroduction programs of threatened species. CBSG News 3(2):28.

Beck, B. B. and C. M. Wemmer, eds. 1983. The biology and management of an extinct species: Père David's deer. Noyes Publications, Park Ridge, New Jersey. xiv + 193 pp.

Crandall, L. S. 1963. Management of wild mammals in captivity. University of Chicago Press, Chicago, Illinois. xv + 761 pp.

Dresser, B. L. 1988. Cryobiology, embryo transfer, and artificial insemination in ex situ animal conservation programs. Pages 296-308 *In* Biodiversity. E. O. Wilson, ed. National Academy Press, Washington, D.C. xiii + 521 pp.

Heuschele, W. P. 1991. The importance of infectious disease concerns in wildlife reintroductions. AAZPA Annual Conference Proceedings 1991:143-146.

Howard, J. and J. Doherty. 1992. Endangered cats produced by frozen semen artificial insemination. AAZPA Communique May 1992:12.

Kramer, K. 1988. Determination of endangered status for the Stephens' kangaroo rat. Federal Register 53(190):38465-38469.

Martin, R. D., ed. 1975. Breeding endangered species in captivity. Academic Press, London, New York, and San Francisco. xxv + 420 pp.

O'Farrell, M. J. 1993. Stephens' kangaroo rat translocation studies at the Lake Mathews Ecological Reserve. Final Report to The Metropolitan Water District of Southern California, Los Angeles.

Roberts, M. and W. F. Rall. 1993. Captive breeding of the endangered Morro Bay kangaroo rat *Dipodomys heermanni morroensis* 1993 Report to U. S. Fish and Wildlife Service. 1993:1-84.

Roest, A. I. 1991. Captive reproduction in Heermann's kangaroo rat, *Dipodomys heermanni*. Zoo Biology 10:127-137.

Ryder, O. A. 1991. International cooperation in species preservation: the Przewalski's horse reintroduction program. AAZPA Annual Conference Proceedings 1991:391-394.

Seal, U. S. 1988. Intensive technology in the care of ex situ populations of vanishing species. Pages 289-295 *In* Biodiversity. E. O. Wilson, ed. National Academy Press, Washington D.C. xiii + 521 pp.

_____. 1992. What is CBSG? What do we do? CBSG News 3(2):1.

Tudge, C. 1992. Last animals at the zoo: how mass extinction can be stopped. Island Press, Washington, D.C. and Covelo, California. 266 pp.

Wortman, J. D., P. de Oliveira, A. L. V. Nunes, W. M. Tomas, M. E. B. Santiago, M. C. Sayeg, S. Charity, M. C. Buschinelli, and R. L. Gasparini. 1991. Preliminary evaluation of a translocated population of marsh deer, *Blastocerus dichotomus*, in Brazil. AAZPA Annual Conference Proceedings 1991:500-504