CHAPTER 17

FELID REINTRODUCTIONS: ECONOMIC AND ENERGETIC CONSIDERATIONS

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Reintroduction and captive breeding are often touted as panaceas for extinction in the wild. The populace at large, educated in such matters by the mass media, places great faith in such wildlife technology. Furthermore, the wildlife professionals who develop recovery and management plans for endangered species often include a section on reintroduction and sometimes advocate captive breeding as a source of colonizing stock. Of all possible wildlife Issues which might be brought to the public eye, reintroduction, captive propagation, and artificial methods of reproduction have received disproportionate attention because they foster hope that in the final hour man's creative genius will avert disaster. Man is a creature of great faith, but he is also particularly gullible when high tech solutions auger to turn the tide of doom.

The capture, transport, release, and manipulation of wildlife populations is an ancient human pastime. While domestic livestock has escaped captivity on numerous occasions to establish feral populations, there have been few successful reintroductlons of wild species of birds and mammals from captive bred stock. The successes can be counted on your fingers, but no count has been made of the number of unsuccessful attempts (Table I). In contrast to this, there have been a large number of successful translocations. This is not an indictment of captive breeding as a source for recolonizatlon of wild habitat. Rather, It reflects the fact that captive propagation has not historically been of a scale sufficient to release animals Into the wild. In reality, there is no established science of reintroduction. and any such undertaking can be viewed as an experiment.

There Is a widespread public perception that wildlife management and conservation Is a straight-forward and common sense matter completely within the grasp of common man. The collapse of appropriate management protocol and the hue and cry of journalistic censure are evidence of the trust that both the public and wildlife professionals place In the ability of wildlife personnel to solve their

TABLE I. Some **successful and unsuccessful** re introductions of captive bred animals **to the** wild.

American bison (Bison bison)	1908-1915	Mchugh, 1972
European bison (Bison bonasus)	1929	Krysiak, 1967
European Ibex (Capra ibex)	1912	Grodinsky & Stuwe, in press
Arabian oryx (Oryx leucoryx)	1982-1984	Fitter, 1984

Golden lion tamarin (Leontopithecus rosalia)	1984-1985	Kliechman, et al., 1986
Wolf (Canis lupis)	1952	Mech, 1966
	1960	Merriam, 1964
	1972	Menshaw and Stephenson, 1974 Weise et al., 1975
Mountain lion (Felis concolor)	1983	Hornocker and Koehler, 1984
European otter (Lutra lutra)	1982-1984	Wayre, 1985
Hutia (Geocapromys brownies)	1985	Woods, pers comm..

problems. As wildlife biologists, it's only natural that we hold the opposite view. We maintain that the public lacks the ecological knowledge to play a useful role In the process, but recognize the importance of considering human ecology in making decisions about wildlife. We also maintain that the biological information needed to make the best decision for conservation Is often lacking or not readily available. Acknowledging these factors, we explore the energetic and economic constraints that must be considered for snow leopards before attempting reintroduction or transJocation. and we evaluate the likelihood of success given the options. Bear in mind that we are not advocating reintroduction of snow leopards, but are attempting an objective analysis in the light of existing information. Because the energetic constraints are similar between different species of large cats, we have relied on the literature for assessing the energetic requirements of the snow leopard.

DEFINITIONS

A lexicon has developed in connection with the human manipulation of wildlife populations. The terms derive from mixed usage, so before proceeding, let us summarize and define the terminology.

Reintroduction refers to releasing individuals of a species into an area formerly inhabited by the species. Holloway and Jungius (1973. p. 3) noted that reintroduction "involves rehabilitation in an area in which it (the species) became extinct in recent times." Reintroduced animals may derive from captivity or the wild. Conversely, an introduction "involves the establishment of a species in an area'in which it has never occurred before" (ibid).

Transplantation refers to "man's relocation of plant or animal species into areas where they do not occur," and most probably did not occur in the past (Johnson. 1975). This term is more or less synonymous with introduction, the difference being that a transplant implies movement of wild animals. Transplants can be categorized as accidental or planned. Ironically, the success of transplanted species has been far greater in the accidental than in the planned category.

The term recolonization is infrequently used, but refers to the establishment of the reintroduced population subsequent to its release (Pienaar, 1970).

Trans location, on the other hand, refers to moving wild animals from one part of their distributional range to another part. Thus, translocation may or may not involve reintroduction: it depends on whether the release site is inhabited by conspecifics. However, translocation almost always refers to human-mediated movement of *wild animals.*

Relocation also involves moving wild animals from one location to another within the species range, and is most often used in connection with efforts to displace individual animals that have come into conflict with human interests.

BASIC CONSIDERATIONS

Holloway and Jungius (1973) outlined four main phases in the process of reintroduction: 1) feasibility studies, 2) preparation, 3) release, and 4) follow-up. The reader is referred to this excellent paper. and Jungius (1985), for full details. We will dwell only on particular aspects of these phases as they relate to snow leopards.

Consideration No 1: Feasibility — Can the Habitat Sustain a Reintroduction?

Before animals can be reintroduced or translocated, it is critical to know with certainty that the potential release site contains sufficient food for survival of the colonizing animals and the expanding population which it would generate. The fact that snow leopards occurred there in the past does not mean the reasons for their absence are no longer present. Data from both captive and field studies illustrate the feasibility of estimating the energy needs (McNab, 1963). However, an important distinction must be made between the energy required for maintenance and the requirement for successful reproduction.

Energy values for maintenance are remarkably constant across cat species. From data on captive leopards [Barbiers. et al, 1982). it is estimated that approximately 1.5-2.5 kg/day (3000-4000 kcal/day) provide a free-ranging 45 kg felid (e.g., snow leopard size) with a maintenance diet. If we now create the hypothetical situation of a 45 kg snow leopard preying mainly on ungulates the size of blue sheep [ca. 55 kg), minus 30% (16.5 kg) because not all parts of the carcass are edible (Hornocker, 1970), we find that each snow leopard requires about 26 prey items the size of blue sheep per year (1 large prey item per 14 days). Similarly. Jackson and Ahlborn (1984) estimated that a snow leopard would require 23-30 large prey per year. Field data on mountain Hons, which are similar in size to snow leopards, indicate they kill one large prey (mule deer ca. 46 kg) every 10-17 days (Hornocker. 1970: Shaw. 1977; Ackerman et al., 1982), which suggests that the estimates for snow leopards are reasonable approximations. Jackson and Ahlborn (unpublished data) estimate, based on changes in consecutive daytime locations of radio-collared snow leopards, that they make a large kill about every 10 to 15 days. If we extend the scenario one step further, and assume a cropping rate of 10% (Schaller, 1972: Sunquist. 1981). then each snow leopard requires a population of 260 blue sheep sized prey from which it can crop the requisite number of prey. Like other large felids. snow leopards also feed on small animals (marmots, hares, and pheasants), but we have limited our discussion to large prey for the sake of clarity.

However, a maintenance diet will not support the nutritional needs of a female raising young. Field data from tigers and mountain lions indicate that a female requires about three times the amount of energy for maintenance to raise two to three cubs to maturity (Seidensticker, 1976: Sunquist, 1981; Ackerman et al., 1982; Shaw, 1977; see Figure 1).

This increased energy demand has a significant effect on the required prey base. Our hypothetical female snow leopard with two cubs would now have to kill one ungulate the size of a blue sheep every five days, or 73 prey per year. Using the same 10% cropping rate, a maternal female would require a population of 730 blue sheep from which she could satisfy her energy demands. By contrast, a population of only 260 blue sheep was required in the maintenance scenario.

Maternal females face an additional constraint, because they are initially confined to an area in close proximity to the den, and are thus restricted in their foraging radius. Field data on leopards, tigers, snow leopards and mountain lions reveal a dramatic reduction in the maternal home range immediately following the birth of cubs. Under these conditions, females must locate and kill prey, feed, and return to the den every 24-36 hours (Seidensticker. 1977; Sunquist, unpublished data: Jackson and Alhborn. unpublished data; Maehr. pers. comm.). Thus, prey distribution and "catchability" (Bertram. 1973) are quite important for successful reproduction. Localized resources are vital to females in the first two months of maternal dependency when cubs are largely immobile. According to our estimates, we would predict that the prey density on Jackson and Hillard's (1986) Nepalese study site would exceed 18 prey the size of blue sheep per square kilometer (980 kg/km^2).

Of course, the number of prey removed by other mammalian predators, including man. must also be factored into the analysis. The snow leopard appears to have few potential competitors, and of those known to be present, only the wolf is likely to dispatch large ungulates. Wolf densities, however, appear to be low in Nepal and Pakistan (Schaller, 1977). Considerable numbers of prey may be taken by aboriginal hunting (Jackson. 1979; Jackson and Hillard. 1986). but there are few available estimates on which to assess human impact. Some snow leopards do, however, live in areas remote from human impact. Given these unknowns, however, it is best to consider potential release sites which harbor ungulate populations In excess of the minimum estimate for *a* reproducing snow leopard population.

This simple formula allows the wildlife biologist to address the first step towards predicting the success of a rcintroduction. The amount of potential food for snow leopards in any given area can be estimated. It is also possible to approximate the amount of food needed to sustain a maintenance population without reproduction, and a reproducing population.

Consideration No 2: What Are the Sources **of Animals** for Reintroduction?

Wild and captive populations are the two main sources of animals for reintroduction. and economic considerations are the ultimate determinations of which source is preferred. However, there are a number of initial practical considerations. For example, captive bred stock is a logical source of release animals if. a) the captive population is secure, b) the species is easily bred in sufficient numbers in captivity, and c) the animals are able to acclimate well to release. If there is no source of wild stock which generates an annual surplus, then also, captive stock is the only option. North American game fish such as trout are an example of a species in which farmed stock is a productive source. Conversely. If captive bred animals do not generate an annual surplus, or adjust to the wild with difficulty, or are large and costly to transport, then wild populations, if they exist, deserve examination as a possible source of animals for reintroduction.

For a wild population to be a viable source of donors, there must be sufficient annual recruitment of young animals. In most vertebrate populations annual recruitment due to reproduction can be viewed as surplus, because only a fraction of these animals become resident and replace losses within the breeding population. Subadult and young adults normally disperse from their natal ranges, and at this time, mortality appears to be high. Those dispersers which settle and become residents elsewhere become reproductive, while another segment of the dispersers may become transients, as described by Schaller for the Serengeti lion (1972), Smith (1984), and Smith at al. (1987) for the tiger.

It is the population's recruitment portion which is probably best fit to replenish viable habitat unoccupied by the species. The reason is that these animals are young adults, would have the necessary predatory skills to survive, and are physiologically primed to establish residency following a phase of dispersal and exploration. While resident adult cats match the younger set in all these characteristics, their removal from the social network could reduce reproduction in the resident population (Smith et al. 1987). In addition, older animals would have reduced life expectancy and thus diminished reproductive potential. For these reasons, it is probably best to view the resident breeding population as donors, and the progeny as propagules for colonization elsewhere. However, this information can only be acquired at considerable cost and effort.

In a rare and elusive species such as the snow leopard, it is desirable to know something about the density and geographic limits of the wild population before the decision is made to remove animals. This requires a small competent team of field biologists familiar with the habitat and the species' ecology. This kind of information cannot be gathered as easily as it can on large cats in more accessible areas, and the logistical costs will be considerable.

Consideration No 3: What Are the Costs of Acquiring and Preparing the Colonizers for Release?

The captive breeding of carnivores is a costly enterprise, but let us deliberate on the costs necessary to captive breed snow leopards for release into the wild. We can save considerable time by dispelling the idea that adult captive bred cats are adequate candidates. All

evidence at hand indicates that young cats are the most likely candidates to acquire through captive training the predatory skills necessary for their survival. However, if one reflects a moment on what is necessary to accomplish this, enthusiasm is quickly dampened. Young leopards should probably be exposed to whole carcasses at an early age. Domestic stock might be an adequate nutritional substitute. but anecdotal evidence suggests that such acquired tastes may prove counterproductive in the long run. The alternative then would be to sijpply the animals with native prey. This necessitates that the facility be sited in a remote montane locality amidst an abundance of prey. Once the cats are at the age of learning to kill for themselves, it would be necessary to introduce live prey to them in a large enclosure (Bogue and Ferrari. 1976). The ability to capture as many as several Himalayan tahr or bharal on a weekly basis is a major challenge. The most significant point here is that such an endeavor would be an experiment. With the exception of the lion Elsa, and the tiger Tara, which may be viewed as rehabilitations (Adamson. 1960: Singh. 1975), there have not yet been any successful reintroductions of captive bred large cats, at least on a scale meaningful to the goals of reintroduction. There is, however, an ongoing and exhaustive effort to condition captive bred Florida panthers (mountain lions) for release into the wild, but the costs of the operation are in the range of $US 300,000.

The Economics **of Reintroducing Captive Bred** Leopards

It is beyond the scope of this paper to develop a reintroduction plan for the snow leopard, but is possible to sketch the basic program elements and costs, and in doing so initiate consideration of some critical factors.

Reintroduction of captive bred leopards will require an acclimation facility where the cats can become familiar with the types of foods they will encounter In the wild and develop predatory skills for self sufficiency. Such a facility would have to be In a remote montane habitat. Young cats could be shipped to this facility from the zoo of their birth immediately after weaning, or the acclimation facility could also be a propagation center and generate offspring for release.

There are pros and cons to both methods. Zoos could provide a reliable source of stock for acclimation and release, and the genetic relationship of the animals would be known. The disadvantages would be the red tape involved in arranging shipments, the problems of meeting deadlines, and the air freight costs. An in *situ* propagation facility would bypass these requirements, but there are inherent liabilities in relying on a single propagation center in a remote location: 1) Epidemic could wipe out the population. 2) The leopards' adjustment to the new setting would likely delay .initiation of breeding at the new site for one or more years, postponing the first release. 3) There would be additional costs for a propagation facility. It seems reasonable to assume that several litters of leopards would be desired per year, which would require a leopard population of 6-8 unrelated breeding pairs. Capital costs for facility construction are estimated at $208,000, and annual operating costs (personnel, veterinary services, and travel) would require about $17.580 (Table II).

If sufficient funding could be generated, perhaps a hybrid approach would maximize the chances for success within a reasonable timeframe. However, there Is one other option that merits consideration.

The Economics of Translocating Wild Leopards

We contend that the probability of successful reintroduction is far greater if young wild leopards are the colonizers. However, the logistical challenge and costs of capturing and transporting wild snow leopards is probably greater than for any other species of cat. Simply locating a population and identifying the social and reproductive status of its members Is a major undertaking both financially and in the amount of time required.

There are two approaches to obtaining cats for translocaticm: translocate whatever you catch, or select only those cats meeting the criteria. The temptation to be non-selective will be great given the nature of the program, but could be a foolhardy strategy if the resident population is small and vulnerable. Removing the breeding nucleus could in the worse case jeopardize a viable population for the sake of a well-intentioned but optimistic experiment of unknown prospect. So, the need to know the animals is important. The problem is that identifying the social status of the cats (i.e.. sex. age. reproductive condition, resident or transient status) would require a major investment of funding, and is likely to be regarded by administrators as far-fetched.

In most situations, distance and terrain would dictate that helicopter transport be used to minimize stress on the animals and reduce transit time.

ACCLIMATION. TRAINING, RELEASE AND **FOLLOWUP**

Careful research, consultation and evaluation should precede the development of a release plan. If captive-bred animals were to be used, the training of predatory skills and the establishment of criteria for predatory competence would be additional elements in the plan. The success of the reintroduction can only be determined by monitoring the released animals. Therefore, a team of wildlife biologists experienced with radio-telemetry is another necessary aspect of the program. Because the movements and activity of reintroduced leopards cannot be predicted, it is vital to attempt to track the animals on a daily basis. Aerial tracking on a weekly basis of course would be ideal because of the difficulty of negotiating steep terrain by foot. The resulting data base would be of great importance for guiding future decisions.

TABLE II. Capital and maintenance costs of a facility for breeding and acclimating leopards for reintroduction into the wild. The facility is envisioned as encompassing 24 ha, and contains approximately 3000m of 4m high heavy gauge chain link fence.

Capital Expenses	
Breeding & acclimation facility (© $US 36/meter fencing including labor)	$108.000
Living quarters for staff [@ $17.000 per residence)	$100.000
Total	$208.000
Maintenance Expenses	
Shikaris [@ $5/day x 4)	$ 7.300
Veterinary services (© $500/year retainer fee)	$ 500 •
Wildlife biologists (@ 1 trip/month x 2]	$ 2.400
Supplies & equipment	$ 2.000
Total	$17.580

CONCLUSIONS

The snow leopard is probably the most challenging species of felid to reintroduce into native habitat. Although the remote montane environment is not likely to bring about conflict with man and domestic livestock, it presents special logistical problems to establishing an acclimation facility and monitoring the activities of the released cats. In addition, politically sensitive border areas of the Himalaya add a further constraint on use of aircraft to transport animals for release and monitor their subsequent movement using radio-telemetry.

In developing a plan for reintroduction, many factors must be considered; we have analyzed some of the economic and energetic considerations. Energetic considerations are critical to appraising the prey base of potential release sites, and the minimal prey base capable of sustaining a snow leopard population can be deduced by simple calculations based on a knowledge of felid energetics. Estimation of prey abundance, on the other hand, requires a thorough familiarity of seasonal movement patterns of the ungulates, and a reliable and consistently applied population census methodology.

Cats for colonization can be translocated from other wild populations, or can be the progeny of captive leopards. Young adults are the ideal candidates for reintroduction regardless of captive or wild origin, but wild born leopards translocated to the release site probably have the greatest chances of survival and adjustment to the release area. Translocation does not require an elaborate facility for acclimation and training of predatory skills, both of which are necessary to condition captive born animals for release. A captive breeding facility situated at or near the release site is another option, but delayed initiation of breeding, possibility of epidemic, and genetic limitations are detractions which should be carefully considered.

Economic constraints are likely to limit the scope of a reintroduction program, but they should not be allowed to compromise the effort. The goals of reintroduction can be successfully achieved by developing a thoughtful and feasible strategy, by acknowledging the scientific nature of the undertaking, and by professional management of the program.

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