Charles University
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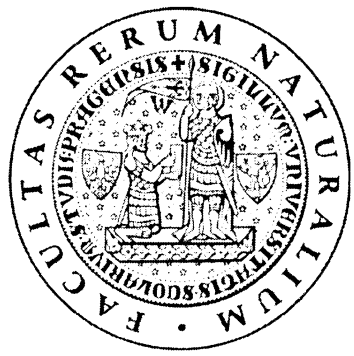
Problems Concerning Carnivore Reintroductions

Problémy reintrodukčních programů šelem

Baccalaureate Thesis
Bakalářská práce



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Abstract

Reintroduction is defined as an attempt to establish a species in an area that was once part of its historical range, but from which it has been extirpated or became extinct. During today's extinction crisis, reintroduction projects have been increasingly employed. However, reintroduction is a costly and time-consuming enterprise, with only about one quarter of all species reintroductions resulting in viable populations.
The problems of animal reintroductions are vast and include the reversal of the factors that caused the original extinction; provision of a suitable stock of animals for reintroduction; and adequate human and financial resources. Experience with carnivores suggests that their problems are potentially more severe. The first major problem comes with the stock, which can be either captive-bred animals or individuals removed from wild populations. Captive-bred carnivores often show behaviors associated with tameness that makes naturalization difficult, and moreover such animals can be also dangerous for humans. During captivity they risk losing hunting and social skills. On the other hand, using translocated carnivores has its disadvantages as well, such as homing and a lack of suitable individuals. Furthermore, large carnivores and many smaller ones are difficult to reintroduce because they have high habitat requirements and engender human antipathy. In my thesis I describe the problems concerning carnivore reintroductions and I offer possible solutions to them.

Abstrakt

Pojmem reintrodukce označujeme navrácení druhu do oblasti svého historicky původního výskytu, kde vyhynul nebo byl vyhuben. V dnešní době rozsáhlého mizení druhů se reintrodukce stali atraktivním nástrojem ochranářské biologie a jejich počet stoupá. Reintrodukce jsou ovšem drahé a časově náročné, pouze zhruba čtvrtina reintrodukčních pokusů vede k založení životaschopné populace. Problémy reintrodukčních programů jsou rozsáhlé. Zahrnují odstranění mnoha typů příčin, které vymření způsobily, obstarání vhodných zvířat k vypuštění i potřebné lidské a finanční zdroje. Dosavadní zkušenosti s reintrodukcemi šelem dokládají, že tyto problémy jsou pro ně ještě závažnější. První hlavní problém se týká budoucích zakladatelů populace, kterými mohou být buď uměle odchovaná zvířata, nebo jedinci odchycení v přírodě. Šelmy odchované v zajetí často vykazují známky krotkosti, která představuje nebezpečí jak pro ně, tak pro lidi, s kterými se zvířata mohou setkat po vypuštění do přírody. Taková zvířata mají rovněž horší lovecké i sociální schopnosti. Na druhou stranu, vypouštění zvířat odchycených z divokých populací v přírodě také má určité nevýhody jako je homing. Navíc, ne vždy je možné odebírat jedince z přírody, protože populace ohrožených druhů jsou často řídké, v horším případě se daný druh v přírodě už nevyskytuje. Reintrodukce šelem jsou rovněž náročné z toho důvodu, že tato zvířata mají vysoké biotopové nároky a často se jedná o konfliktní druhy. Ve své bakalářské práci popisuji tyto problémy vztahující se k reintrodukcím šelem a navrhuji možná řešení.

Key words: carnivores, reintroduction, translocation, conservation biology, captive breeding, landscape fragmentation, anthropogenic impact

Klíčová slova: šelmy, reintrodukce, translokace, ochranářská biologie, chov v zajetí, fragmentace krajiny, vliv člověka

Contents

1.Introduction

Today we're facing a great loss of biodiversity; many species are becoming rare and often disappear from their natural habitats locally or globally. While the exact rates of extinctions are unknown, studies indicate that it is at least 4 orders-of-magnitude faster than background rates evidence in the fossil record. The overwhelming majority of losses are due to anthropogenic forces mainly by habitat destruction and, to a lesser extent, over-exploitation of certain species.

People are realizing their wrong doing and the usage of conservation biology is increasing. Various conservation efforts are implemented including reintroductions. Reintroduction projects attempt to reestablish species within their historical ranges through the release of wild or captive-bred individuals following extirpation or extinction in the wild (IUCN 1998). Translocation is a reintroduction that moves exclusively wild individuals from one part of their historical range to another. The problems of reintroductions are vast and the success rate is poor. Many conservation biologists are critical to this technique arguing that they are too difficult and expensive and should be avoided. They argue that the money could be used better and would rather the money be given to projects conserving and extending the ranges of existing populations. However, reintroductions have proved to be a viable conservation effort and have the potential to save endangered species and to some extent restore the original diversity. It is worth concentrating on these problems to attempt to successfully restore animals to their rightful place.

2.Reintroduction Biology

2.1 History

Humans have moved captive-raised and domestic animals from one place to another for millennia, whether by intention or not. There is also a long history of translocating wild animals, predominantly for the purpose of supplementing game species and to solve human–wildlife conflicts (Linell et al. 1997, Seddon 1997, Jule et al. 2008). However, reintroducing species for conservation purposes is a relatively new activity that has developed to help to save endangered species from extinction.

It's difficult to identify the first true reintroduction, but it is considered to be the 1907 release of 15 American bison *(Bison bison)* into a newly-established reserve in Oklahoma that resulted in a great success (Kleiman 1989). Seddon et al. (1997) name it as a well prepared project that anticipated the need for careful planning, prerelease health-risk assessment, strong local community support, and the use of corporate and media backing; a model for reintroductions that was not often upheld in the decades to follow. In the 1970s and 1980s there were a number of well publicized reintroductions of a few charismatic animals including the Arabian Oryx *(Oryx leucoryx)* in Oman (Spalton et al. 1999), golden lion tamarins *(Leontopithecus rosalia)* in Brazil (Kleiman and Mallinson 1998), and Peregrine Falcons *(Falco peregrinus)* in North America (Cade et al. 2000). These successful projects helped promote reintroductions as a valuable conservation tool and they became commonly used (Seddon et al. 1997). However data suggest the majority of reintroductions failed to establish viable populations and that little was being learned in the process (Griffith et al. 1989, Wolf et al. 1996, Fischer and Lindenmayer 2000). This situation led to calls for greater monitoring and to the formation of the Reintroduction Specialist Group (RSG) under the auspices of the World Conservation Union's (IUCN) Species Survival Commission (SSC) (Stanley Price and Soorae 2003). The RSG was created in 1988 to provide guidance for increasing numbers of wildlife reintroduction projects globally and later on created Reintroduction Guidelines (IUCN 1998). These guidelines advise managers and scientists who are directly responsible for planning, approving, and carrying out reintroductions.

The number of reintroductions has increased greatly since the end of the century in all vertebrate and invertebrate taxa. For example in the period from 1900 to 1992 there were 123 mammal species reintroduced and in 1998 it climbed up to 218 mammal species

(Stanley Price and Soorae 2003). However, the reviews have found that reintroductions worldwide have poor success rates ranging from 26% to 68% (Griffith et al. 1989, Wolf et al. 1996, Fischer and Lindenmayer 2000). As a consequence of the low success rate there has been an exponential increase in monitoring and also an explosion in the number of reintroduction-related papers in past twenty years (from less than five per year during the early 1990s to over 50 per year currently) (Armstrong and Seddon 2007). Unfortunately, these publications are mostly descriptive accounts of reintroduction programs or retrospective analyses (Armstrong and Seddon 2007). However, such an increase in the numbers of species reintroduction projects and reintroduction-related publications implies that there is now a recognizable field of reintroduction biology.

2.2 Problems of Reintroductions

Though it is better than it was 30 years ago, with better research and overall support, there still remain obstacles and the overall success, which means that reintroduction attempt results in a self-sustaining population (Griffith et al. 1989), is still low. Griffith et al. (1989) provided the first comprehensive analysis of the status of reintroduction as a conservation tool and later a follow-up survey was conducted by Wolf et al. (1996). The most up-to-date large scale survey was conducted by Fischer and Lindenmayer (2000), taking a slightly different approach than the two previous studies. These reviews highlight factors that contribute to the success or failure of a reintroduction project and basically discover similar facts and trends.

First, from these reviews and other literature (Yalden 1993, Miller et al. 1999, Breitenmoser et al. 2001) it is clear that habitat suitability is the most important factor, and if it is not chosen properly the reintroduction may be destined to fail from the beginning. It is necessary that conditions have improved substantially for the reintroduced stock to have a reasonable chance of surviving (Yalden 1993, Breitenmoser et al. 2001). In other words, the reason(s) for their extinction in the first place must not still exist, or exist at a fraction of what they did. Eliminating, and sometimes even discovering those original problems, often proves to be quite difficult. They also vary and could be a combination of fragmentation, degradation, and other human activities such as hunting. There's also the possibility of irreversible and substantial changes too big (too expensive) to overcome making the original habitat, the choice habitat, unviable. Another consideration is that ecosystems may have been altered considerably when predators were removed. The

conditions these species meet as they return may therefore be quite different from the time when they went extinct. This includes the effect of carnivores on their prey populations such as the wolves' predation on elk in Yellowstone National Park. The reviews showed that success improved with increased habitat quality and Griffith et al. (1989) concluded that without a high-quality habitat, translocations would have a poor success rate regardless of how many animals were released. Also, reintroductions into the core of a species' historical distribution were more successful than those on the periphery or outside the range.

The next thing to consider is the stock. This includes having animals that are taxonomically and genetically identical or reasonably similar to the original population (Yalden 1993). Also crucial is having enough animals to establish a breeding population without depleting the donor population in the case of translocation, or having a viable population raised in captivity (Yalden 1993). All three reviews showed that reintroductions of exclusively wild-caught animals were more successful than those of captive-reared animals. Results of all three reviews agreed that larger numbers of released animals positively affected translocation success. Threats to small populations include environmental and demographic stochasticity (e.g. Allee effect) and various genetic problems such as inbreeding and genetic drift- loss of genetic diversity.

Along with these biotic problems there are also numerous technical (abiotic) difficulties. Many projects underestimate careful planning and well-trained and dedicated staff with the appropriate expertise that is crucial to program success. Reintroduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds (IUCN 1998, Sarrazin and Barbault 1996) to carefully design the project.

It is recommended by IUCN that reintroduction programs incorporate feasibility studies and preparatory, introduction, and monitoring periods (IUCN 1998). Unfortunately, the monitoring period that should follow reintroductions often remains neglected or is documented only in 'grey' literature (Sarrazin and Barbault 1996). However Jule et al. (2008) implies that long-term monitoring of released animals needs to be increased, in order to determine their success over a number of years, and also be published for future reintroductions. However funding for such activities is all too often hard to come by.

Funding and physical resources are always a problem in conservation biology, and reintroduction programs are expensive. For example Kleiman et al. (1991) estimated the total cost of the seven-year program to reintroduce the golden lion tamarin at $1,083,005;

around $22,500 per surviving animal. Fischer and Lindenmayer (2000) found that very few case studies (3%) reported the cost of the program. It would be useful for the planning and fund-raising stages of any relocation program if more information was available regarding the cost of such projects. Besides reporting the costs, the publications fail to help future projects in other ways.

Much of the reintroduction literature is generally not accessible to wildlife managers and conservation biologists (Sarrazin and Barbault 1996). As mentioned earlier, most of the publications are mainly descriptive accounts of reintroduction programs or retrospective analyses (Armstrong and Seddon 2007). Moreover reintroductions that fail are less likely to be published so there can be little learned from the mistakes (Fischer and Lindenmayer 2000). The field of reintroduction biology needs to make the outcomes of relocation projects better available for future wildlife managers to learn from past mistakes.

After all these problems and overall low success many authors imply that finances and effort could be used better and as Lindburg (1992) emphasized, many biologists argue that the large amount of money necessary for a single-species reintroduction could be spent far more usefully to protect whole ecosystems from destruction.

2.3 Reintroductions of Carnivores

In my thesis I focus on carnivores for several reasons. First, carnivores are a largely endangered group, and they have been widely extirpated. In most cases, natural recolonization is no longer an option; therefore reintroductions have become an important conservation tool. Carnivores are long-lived, have extensive social learning and have a relatively long generation time, which means their populations do not quickly recover from extensive decline. They are particularly sensitive to ecosystem changes; especially to the consequences of habitat fragmentations and they suffer from conflicts with humans. Human-carnivore conflicts are generally related to livestock, and as a result carnivores have been heavily persecuted (Miller et al. 1999, Woodroffe 2003). As a result of ecosystem changes and human conflicts many carnivores have been eliminated from most areas in a manner disproportionate to species of other trophic levels.

Second, carnivores are well represented in reintroduction projects and therefore there are many publications available concerning carnivores reintroduction. In fact carnivores and artiodactylids (e.g. ungulates) are the two most reintroduced orders within mammals

(Seddon et al. 2005). One reason for this is that carnivores often have disproportionate effects on ecosystem processes and play key roles in regulating ecological interactions between trophic levels. Moreover many carnivores also play umbrella and indicator roles and so restoring carnivore species can have positive effects on the entire ecosystem. They are also used as flagship species because of their attractivity, so their reintroductions are more likely to get finances and public support.

Finally, carnivores seem to be disproportionately difficult to re-establish via reintroduction (Miller et al. 1999). One of the complicating factors is that the ecology of some carnivore species is insufficiently understood for effective conservation. To monitor the progress and the success of a reintroduction program of such elusive animals is difficult, long lasting and expensive task (Breitenmoser et al. 2001). The other major problems of carnivore reintroductions are discussed in this thesis.

First, I concentrate on captive breeding of carnivores, describing its major problems and offering solutions. Some problems of this technique are documented with most animal species and are quite universal. However there are some problems unique to carnivores which make it more difficult than captive-breeding other species.

In the final chapter, I discuss the difficulties of carnivore reintroductions after their release; specifically the conflicts with human that make reintroductions of carnivores extraordinarily difficult. These conflicts include direct persecution as well as the effects of land use and land fragmentation.

3. Captive Breeding

While conducting a reintroduction, one of the main criterions is having suitable animals. The animals should be taxonomically and genetically the same as, or reasonably similar to the original population. Next, an adequate number of these individual must be available to establish a breeding population without depleting the donor population. You must also have animals with the correct age/sex structure to offer a reasonable chance of success (Yalden 1993).

There are two possible sources: individuals translocated from wild populations or animals raised in captivity. Using animals bred in captivity seems to work well with some species such as ungulates, particularly the Arabian oryx and Przewalski's horse (*Equus ferus przewalskii*).

For many other taxa including carnivores the use of captive-bred stock is more problematical and wild-born animals are preferable for reintroductions. Reviews showed that reintroduction projects using translocated wild animals were significantly more successful than those using captive-bred animals (75% vs. 38%; Griffith et al. 1989; 71% vs. 50%; Wolf et al. 1996; 31% vs. 13%; Fischer and Lindenmayer 2000). Similar results were obtained specifically for carnivores by Jule et al. (2008) also proving that reintroductions using captive-bred animals are less likely to succeed. Their results show that wild-caught carnivores survived significantly more (53%) than captive-born carnivores (32%). Moreover, Griffith et al. (1989) and Snyder et al. (1996) recommend releasing captive carnivores only when there are no other alternatives in species recovery. This was the case of the black-footed ferret (*Mustela nigripes*), which was saved from extinction by being captive bred and returned to its natural range (Russell et al. 1994).

However, translocating carnivores also has some disadvantages such as homing (returning to the original capture site over very long distances) and other incidental post-release movements that may lead to conflict with humans. This has been well documented with translocation of wolves and bears (Clark et al. 2002).

Translocation is still the more used technique while reintroducing large mammals because captive breeding proves to be quite difficult. They are big animals that need lot of space and often suffer in captivity with an inability to establish a viable population. Clubb and Mason (2003) focused on caged carnivores and they proved that especially species with wide-ranging lifestyles in the wild respond poorly to captivity and suffer from the

highest frequency of stereotypy and the largest extent of infant mortality. This can be seen with captive polar bears *(Ursus maritimus)* and lions *(Panthera leo)*. Clubb and Mason (2003) imply a fundamental improvement would be a provision of extra space, which is often impossible because of the space capacity of zoos and other breeding institutions. Also enrichment of the captive environment is crucial to reduce the development of stereotypies. Stereotypies are typical for captive-bred wide ranging carnivores such bears and that may have an effect on reintroduction survivorship. Vickery and Mason (2003) observed captive-bred bears that developed stereotypic behavioral patterns and found that such performance is sometimes associated with decreased behavioral flexibility and reduced attention to the environment. Therefore such bears are less likely to react well in the wild to new situations and changing environment, due to their abnormal behavioral persistence.

More problems burdening captive breeding come from the fact that rearing conditions differ from their wild environments and the animals become progressively adapted to captivity. In captivity, the animals can hardly gain experiences necessary for survival in the wild and after release they often show a loss of natural behaviors and reduced fearfulness. Deficiencies especially significant to carnivores, can be seen in foraging/ hunting and social interactions; and for smaller species, predator avoidance.

Attempts to reintroduce the African wild dog *(Lycaon pictus)* repetitively failed for numerous reasons. A major problem is the loss of their hunting ability, which is in this species a socially-learned skill that fails to develop in captivity (Frantzen et al. 2001). Dogs in captivity become dependent on humans for food and are poor hunters when transplanted to the wild. Mills (1991) describes that after reintroduction in Zimbabwe had to be recaptured because they stayed near human butcheries. After the relocation five died from starvation and the remaining five were shot, since they lack the wild dogs' habit of avoiding people.

Similarly, three captive-bred male cheetahs (*Acinonyx jubatus*) released in Kruger National Park, South Africa, were too dependent on man and had to be recaptured because of continued attacks on poultry. They also encountered and fought with resident cheetahs, which also shows a lack of social interactions skills due to captivity (Mills 1991).

Domestication and dependency on man is a severe problem; animals become dependent on humans for food and show reduced fear to humans which may endanger the animals as well as humans. Bremner- Harrison et al. (2004) observed a variation in boldness that was assessed in captive-bred swift fox *(Vulpes velox)* reared for future

reintroduction, and tested for influence on survival after release. Individuals previously judged as bold, died within six months after release into the wild. These bold individuals indicated low fear and therefore they were less likely to avoid predators, conspecifics or anthropogenic stimuli that may pose a risk. Such animals are less suitable for reintroduction programs.

Also previous experiments show that selection for traits such as tameness can often be strong in captivity and when selection is strong, major changes can occur quickly. For example in only 20 generations, Belyaev (1979) was able to produce almost fully-domesticated forms of silver foxes *(Vulpes fulva);* exhibiting typical dog-like characteristics such as two breeding periods per year, drooping ears and behavioral traits such as tail wagging and a tendency to lick the hands and faces of humans.

When it comes to reintroductions of large carnivores, tameness becomes an even more problematical issue because it puts at risk also humans and domestic animals. Captive-raised pumas (*Puma concolor*) in Florida had less fear of humans and were more likely to engage in puma human and puma–livestock encounters than wild-caught pumas (Beldon and McCown, 1996).

Frankam (2008) states that the most effective means for minimizing genetic adaptation to captivity is to minimize the number of generations in captivity. Returning species to the wild as rapidly as possible is an obvious solution, but often this is impossible since the impact of humans in their natural habitats and other factors endangering the species are still present. Next, the contact with humans during captive breeding should be completely avoided and an experimental approach should be used to prepare the animals for wild.

There has been an increase in attempts to reduce the negative effects of captive breeding and experiments to find the best ways to rear animals in captivity. For example Biggins et al. (1999) experimentally compared the effect of various alternative rearing strategies on foraging behavior and the survival of black-footed ferrets. This experiment determined that ferrets reared in quasi-natural outdoor pens placed over prairie dog (*Cynomys leucurus*) burrows had better prey-catching skills, had higher rates of survival and reproduction. The cage-reared ferrets made longer nightly moves and dispersed further from release sites which put them in higher risk. This showed that prerelease experience can affect post-release behaviors and the survival of captive-bred animals.

Vargas and Anderson (1999) studied ontogeny of predatory skills of black-footed ferrets raised under different captive conditions. They found that both maturation and experience increased the likelihood of a black-footed ferret making a successful kill. Also

they found that black-footed ferrets exposed to greater environmental complexity (an enriched cage, including encouragement of food-searching behaviors) were also more likely to make a kill than ferrets raised in a deprived environment. This proves predatory behavior is shaped during maturation and experience and cage enrichment are major factors for post-release survival.

To gain knowledge and experience in preparation for black-footed ferret releases, studies were first conducted on the closely related Siberian polecat *(Mustela eversmanii).* To investigate the development of food searching behavior they subjected young captive-raised polecats to a simulated prairie dog colony. Older Siberian polecats located prey significantly quicker than younger polecats, but all age groups spent a great deal of time in surface activity not directed toward a burrow, exposing themselves to the risk of predation (Miller et al. 1990a). This shows how the captive-raised animals lose their natural behavior of locating prey and predator avoidance.

Anti-predator behavior might be no longer expressed by animals that have been isolated from predators; therefore mortality caused by predation is another significant factor limiting the survival of released captive-bred animals. For this reason, some conservation biologists include anti-predator training in pre-release preparation procedures.

Anti-predator behavior was more closely investigated in study of Siberian polecats (Miller et al. 1990b). Three age groups of Siberian polecats were viewing models of their natural predators and simultaneously experiencing a mildly aversive stimulus (being shot at with elastic bands). The team found out that the animals can improve quantitatively the efficiency of their responses on predators (take refuge in their burrows more quickly and increase the time spent hiding after encounter) as a result of aversive experience in the past.

Experimental approaches done in captive breeding proved to be useful but experiments are rare. This is partly because it is done with endangered species and their numbers are low. However, there have been experiments with non-endangered species that may be applied to endangered species. A big advantage of working with non-endangered species is the presence of a control group in the wild (Mathews et al. 2004). Another reason for experiments not being that frequent is that they require additional finances in an already expensive captive breeding program. The experiments described during the reintroduction of captive-raised black-footed ferrets are regarded as being time-consuming and expensive (Breitenmoser et al. 2001).

It is generally known that captive breeding is an expensive technique which extends the already high cost of reintroduction programs. Further, the captive breeding is demanding of space, and currently there is not enough room in zoological institutions to accommodate all species that are threatened with extinction.

Captive populations of endangered species are often characterized by a few founders and relatively small population sizes (Montgomery et al. 1997) and therefore face both inbreeding depression and a loss of genetic variation. Therefore during captive breeding it must be managed to either keep the population large enough or be managed in such a way that erosion of genetic variability by random genetic drift is minimized and inbreeding is avoided. Inbreeding depression affects the reproductive fitness and as well as loss of genetic variability increases the risk of extinction (Frankham 1995). It has been documented in many studies including captive carnivores, making the reintroduction attempts difficult e.g. reintroduction of Mexican wolves (*Canis lupus baileyi*) (Hedrick and Fredrickson 2008) and gray wolves *(Canis lupus)* (Laikre ad Ryman 1991). Loss of genetic diversity (Frankham 1999) reduces the ability of species to adapt in response to environmental change and as a result animals are less likely to survive when returned to the wild. Therefore every captive-breeding program must require a proper genetic management strategy to alleviate the effects of these adverse genetic changes (Frankam 2008, Hedrick and Fredrickson 2008).

Some evidence suggests that reduced genetic diversity due to small population size may enhance susceptibility to disease (Thorne and Williams 1988). Whether or not this is true, disease problems have been common in captive populations. The frequency of disease outbreaks is partly a result of enhanced exposure, especially to exotic pathogens for which they have only little resistance (Snyder et al. 1996). Although disease risk also exists in wild populations, such risks often involve diseases to which the populations have had previous exposure and have developed some resistance (Snyder et al. 1996).

Therefore animals should be bred in isolated, single-species facilities located in the natural range. Also pre-release screening of the captive-bred individuals should be conducted in order to avoid the spread of exotic pathogens into the wild (Snyder et al. 1996, Mathews et al. 2006). Again, the big disadvantage of these measures is that they make captive breeding more expensive.

Overall, from all these difficulties it is quite visible that captive-breeding carnivores is entailed with many problems that are not easy to overcome. However, negative effects can

be ameliorated by reducing contact with humans, creating opportunities for hunting and encouraging the formation of natural social groups while the animals are still in captivity. While using translocated animals is optimal, rarely there are large enough source populations left in the wild. This is why it's highly important to improve captive breeding techniques.

4. Human Conflict

4.1 Negative Attitudes

The most important premise for a successful reintroduction is that the reasons for the initial decline have been understood and that limiting factors have been removed (Kleiman 1989, Yalden 1993, Breitenmoser et al. 2001). This claim concerns ecological resources (such as a suitable habitat with an adequate prey base) and the attitudes of people towards the carnivores to be reintroduced. Eradication of carnivores was often the result of habitat degradation, decreased prey numbers and direct persecution. Jule et al. (2008) investigated carnivore reintroductions that have been published since 1990 and they found the most common cause of death was by human means. This included intentional killing such as shooting and poisoning but also indirect conflicts such as automobile driving accidents. This review shows that these are still the main factors in carnivore recovery that heavily complicate reintroduction programs. Even in areas where the ecological conditions for the return of large carnivore are favorable, the basic attitude of local people may still be negative. Even though Kellert et al. (1996) discovered there has been a dramatic change in public attitudes towards carnivores in just a few decades, the attitudes of local people are often negative because they will be the ones who have to share resources with these animals. There are big differences between urban and rural attitudes toward reintroduction. For example, a 1995 Tennessee survey found that 61% of local residents were in favor of an American black bear reintroduction compared to 81% for non-locals (Clark et al. 2002 by Peine et al. 1995). This is noteworthy because rural attitudes best reflect those most likely to be affected by the reintroduction program (Clark et al. 2002).

There are many reasons why the local people oppose reintroductions. One of them is a concern regarding land-use restrictions (Clark et al. 2002). Fears of restrictions and strong libertarian attitudes have played major roles in the opposition to the black-footed ferret reintroductions (Reading and Kellert 1993). Such restrictions could affect hunting, mining, grazing, logging, and access to public lands.

But mostly, negative attitudes are linked to the potential danger to humans and because of their predatory habits, which cause the main conflict between carnivores and humans. For example, the diet of lynx is basically formed of valuable game such as roe

deer *(Capreolus capreolus)* and chamois *(Rupicapra rupicapra)*, but also includes sheep and red deer *(Cervus elaphus)* (Stahl et al. 2001, Jedrzejewski et al. 1993).

In areas where large carnivores have returned following an absence, or where wild prey is otherwise scarce, depredation rates can be very high. This is partially because the livestock guarding tradition among herdsmen has been lost in the absence of large predators, and now that the predators have returned, herdsmen have been slow to readopt those husbandry practices (Musiani et al. 2003). Musiani et al. (2003) documented this during his study in southern Europe where wolves had been extirpated in 19th century and there was no need for these techniques any longer. The high predation on livestock makes reacceptance difficult, and there are few solutions to satisfy both parties.

In Italy, it's been suggested opening a hunting season for wolves, but this might be too premature a measure since there are only 300 to 400 in the region. It's also possible to use more shepherd dogs or reintroduce large, wild herbivores to provide more food sources. These have been advocated as a means of reducing attacks on livestock, but their actual effectiveness is still under discussion (Merigi and Lovari 1996).

Another possible solution is to translocate the animals to a different area (Linnell et al. 1997), however attempts to translocate wolves proved to be quite ineffective because many either returned to where they were caught or became problems in their new locations (Linnell et al. 1997). Aversive conditioning such as electric has also not yet proven effective with wild wolves (Fritts et al. 1992). Yalden (2003) ultimately states that where conflict with pastoral agriculture is inevitable it is essential to establish a compensation scheme well before the reintroduction starts. The IUCN and scientists emphasize the need for an effective and comprehensive public education and outreach program that also occurs well ahead of releasing animals into re-introduction sites. However this doesn't always help as local people can be quite persistent with their attitudes.

The existence of conservation education programs did not influence the survival of re-introduced wild dogs (Davies and du Toit 2004) in Zimbabwe. African wild dogs are persecuted for allegedly preying on livestock (Fanshawe et al. 1991). Local people's attitudes towards the dogs appear to be partly based on human prejudices. A killing method sometimes used by the dogs, ripping at the abdomen to disembowel prey, is seen as cruel. Other misconceptions are that wild dogs regularly kill more than they need and terrorize their prey (Woodroffe and Ginsberg 1999). These myths generate hostility towards wild dogs and local people persecute them. There have been numerous attempts

to reintroduce wild dogs in Zimbabwe but without success because of direct killing by the people (Davies and Du Toit 2004). Notably, the same reintroductions have been successful in South Africa despite the same negative public perceptions (Lindsey et al. 2005). The major factor is that in South Africa, conservation areas are generally fenced; with the fences being regularly patrolled (Gusset et al. 2008).

The reputation of the wolf in North America as a vicious killer of livestock and big game and a threat to human safety complicated the reintroduction of wolves into Yellowstone and central Idaho (Smith 2006). Local people who would live near the wolves once they were reintroduced resented people living in far-away cities who were lobbying and funding the reintroduction (Bangs and Fritts 1996). They noted the city dwellers would not have to deal with the wolves once they were restored. The program planners were aware of this rural/urban controversy and, with the USFWS and National Park Service (NPS), conducted unprecedented public outreach and communication: public meetings in towns around the to-be-affected area and press releases in newspapers, magazines, television and radio occurred for years prior to the wolves' release. Several preliminary studies and an Environmental Impact Statement were also published. Despite all of this, when the wolf reintroduction occurred many people claimed they were not informed. They claimed the government said the wolves would be restricted to Yellowstone Park (a main focal point of the public outreach program was that the wolves not be confined to the park). Moreover, distinct groups comprised mostly of farmers and ranchers opposed to the reintroduction filed several lawsuits against the program (Fritts et al. 1997).

Despite all of this wolves were successfully captured in Canada and reintroduced to Yellowstone and central Idaho in 1995 and 1996 and are now considered ecologically recovered in Yellowstone National Park (Fritts et al. 1997). However, negative attitudes are still present among many residents of the area, particularly livestock producers. People who were opposed to wolf reintroduction are still opposed and routinely seeking short-term political fixes. Numerous lawsuits have ensued and are still ongoing (Smith 2006).

In contrast to the well-published and well-designed reintroduction of wolves in Yellowstone, the reintroduction of the Eurasian lynx in Switzerland was poorly done. The release of only a few animals in the Swiss Alps and Jura Mountains were carried out clandestinely without any public information, and some even without the required permission (Breteinmoser et al. 2001). Those who initially released the lynx believed that

they were best protected when left alone and with no information on the project disclosed. Although this strategy appeared successful initially, it may have amplified and maintained the controversy. The rural mountain communities are in opposition of the large predator, and it is assumed that illegal killing is still the highest single cause of mortality (Breitenmoser et al. 2001). In a public opinion poll in Valais, in Switzerland it was found that most hunters' associations formally accept the lynx as a part of their autochthonous fauna. Others still regard the lynx as a pest and – although the species is protected by law in Switzerland – state frankly that they would shoot lynx given the opportunity (Haller 1992 by Breitenmoser et al. 1998). Similar situation is in Šumava, Czech Republic, where several lynx were translocated from Slovakia and established there a vital, expanding population. Even though this translocation was a carefully designed project, forerun by public outreach and supplement of education materials, 80% of the mortality is due illegal killing. Lynx are shot by members of the Czech national forest service for preying on roe deer and by poachers for its precious fur (Červený et al. 2006).

4.2 Fragmentation

Intensive human land use is responsible for habitat fragmentation and alternation that results in more direct and indirect conflicts with humans. This is emphasized in Europe where the land alternation and human population densities are very high. However there have been some reintroduction efforts into the small protected areas. The most notable have been the reintroductions of lynx to several west and central European mountain ranges, and the return of bears to Austria (Breitenmoser et al. 2001). Unfortunately, the protected areas of Europe are generally too small to support more than a handful of individual large carnivores, thus requiring them to live in the multiuse landscapes where conflicts are most likely to occur.

The patchy distribution of suitable habitat and construction of linear barriers such as highways and railways can lead to higher mortality due to carnivore-vehicle collisions. Even short motorway sections can play a significant role as barriers. In Slovenia, a stretch of motorway 30 km long accounted for 31% of the total mortality of brown bears *(Ursus arctos)* in the area (Kaczensky et al. 1996). It's been documented that in Switzerland road kills and poaching of reintroduced animals account for 70% of all deaths (Schmidt-Posthaus et al. 2002).

A lot of times in fragmented areas there isn't a sufficient amount of prey which leads to predation on livestock which are much more vulnerable than wild animals (Yalden 2003). With an adequate and constant prey base, carnivores will have smaller home ranges and wander over less territory (Miller et al. 1999). Fewer animals will therefore be exposed to the high mortality associated with reserve boundaries. Conflict with people on reserve borders is the major cause of mortality of large carnivores living inside reservations, and it represents roughly 89% of the mortality for grizzly bears (Woodroffe and Ginsberg 1998). Therefore, wide-ranging carnivores in small reservations are most vulnerable because they are more often exposed to the population sink that exists at the reserve boundary (Woodroffe and Ginsberg 1998). Even smaller carnivores such as fisher are sensitive to habitat fragmentation (Lewis and Hayes 2004).

However dense networks of roads and other land use changes largely contribute to dispersal mortality, isolating the individual animals. Even if large animals survive in fragmented habitats for long periods of time, their evolutionary potential is diminished. The evolutionary potential of large carnivores is necessary if they are to play a long-term role in ecosystem processes. The forces of natural selection in small, isolated populations will be eventually overwhelmed by the randomized effects of genetic drift (Soulé 1996).

By Vandel et al (2006) one of the factors that may have limited the population's development in the Vosges Mountains, France, where the reintroduction of lynx failed, was its demographic isolation, caused by high road density and mountain ranges.

All of these problems clearly have one thing in common: human activity. Direct killing, indirect conflicts and habitat fragmentation result in the highest losses of released animals. Wilderness areas with few humans inhabitants who are sympathetic to the idea are therefore the most suitable and preferable locations for reintroductions of carnivores.

5. Conclusions

- Reintroductions are technically difficult and expensive projects with low success rates; reintroduction biology is still in its infancy and a lot is left to learn to improve project outcomes.

- Reintroduction projects must be better documented. In order to learn not only individually, experience should be published to make it available to other people. It is important not only to advertise the success stories but the failures as well, because often lessons from those that failed are more valuable.

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political/public support. While designing a project, adequate funding for all program phases including the preliminary phase and long-term monitoring should be secured. Monitoring of re-established carnivore populations is often inadequate and is often limited to the release phase and some immediate years following. A large proportion of programs didn't integrate long-term monitoring into the project design. Authors often declared the success of a project after only a few years after the animals were released. It's therefore difficult to determine how many 'successful' projects failed at a later stage.

- It is desirable that source animals come from wild populations. If there is a selection of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics to the original sub-population. Removal of individuals for re-introduction must not endanger the wild source population. Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed and after it is guaranteed that these effects will not be negative.

- Captive bred animals usually lack some behavior crucial in survival in the wild such as hunting and social skills, so they should be given the opportunity to learn these skills in the captive environment through training. It's particularly important in

carnivore captive-breeding program to avoid close-contact with humans; stock intended for eventual release should be reared away from public display. Care should be taken to ensure that potentially dangerous captive bred animals are not too confident in the presence of humans, as they might be a danger to local inhabitants and/or their livestock.

- Availability of a suitable habitat is crucial: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the foreseeable future. The possibility of natural habitat change since extirpation must be considered. Identification and elimination or reduction to a sufficient level of previous causes of decline must be seen. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration program should be initiated before the reintroduction is carried out.

- When reintroductions are attempted, it is essential to gain the fullest support and understanding of the human population in the release area; legal protection is required, but it is not sufficient by itself. It is not enough to gain the (typically urban) majority of public opinion in favor of a reintroduction; eventually the hunters and livestock owners living in the areas of release (those typically in disfavor) will decide the outcome of the reintroduction. An insurance/compensation scheme for livestock losses as well as proper information and education outreach programs should be instituted well before the release.

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