CHAPTER

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Rescue, rehabilitation, translocation, reintroduction, and captive rearing: Lessons from the other big cats

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Introduction

The capacity to rescue, rehabilitate, and release wild (or captive) individuals back into the wild to supplement existing or recreate lost populations can be extremely useful components of a conservation "toolkit" ensuring long-term persistence and recovery of large felid populations. What these processes all have in common is that they require "hands-on" management, i.e., animals are either captured in the wild or managed in captivity with the intent of release back into the wild. Individuals in distress (wounded, diseased, and starving) may be captured in the wild (rescued), held in captivity (for rehabilitation and/or assessment),

Snow Leopards
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and released back into the wild (reintroduction/translocation). Additionally, individuals may be raised in captivity (from wild or captive sources) for restoration or supplementation of a wild population. In nearly all cases, these types of management actions are highly controversial. When the primary goal is long-term viability of a wild population, "rescue" attempts of lone individuals may often seem to have little to do with conservation objectives, and often require excessive investments of time, labor, and funding (Jackson and Ale, 2009). For this and other reasons, such management protocols need to be critically examined before they are applied to a large felid population in the wild.

However, with social media instantaneously spreading information of conflicts, interactions, and appearances of animals in distress, the global demand for effective and professional responses will only grow in the foreseeable future. This form of "instantaneous spotlighting" represents both a problem and an opportunity. The global public will expect responses, and the absence of an appropriate response (e.g., because it is not a conservation priority) will often be deemed unacceptable. However, the value of such rescue efforts as a media tool to influence local, national, and international opinions should not be underestimated, and may be an important component of an outreach program to foster support for big cat conservation. Therefore, while in the short-term rescue and rehabilitation efforts may require significant financial and logistical investments, payoffs in terms of public and political support for conservation initiatives may make such efforts worthwhile.

Captive rearing is a labor-intensive, major financial investment that should only be considered when effective alternatives do not exist. Some of the same skills needed for rescue and rehabilitation can be applied to captive breeding programs intended to supplement or restore wild populations. Both types of activities require the ability to care for animals that will eventually be released into the wild and therefore these animals must not only retain a healthy fear of humans but also must be capable of successfully hunting wild prey. While some projects have invested millions of dollars attempting to re-wild large felids, others appear to have had some success on a "shoestring" budget. Therefore, determining the key components of a captive breeding or rehabilitation program will assist in managing the financial costs of such efforts and improve chances of success.

While there are multiple rehabilitation and release examples for other large felids, there have been relatively few incidents where handling of wounded or stray snow leopards (*Panthera uncia*) has been necessary. Currently, there are at least two examples of rehabilitation centers being created for snow leopards.

In 2002, The Nature and Biodiversity Conservation Union (NABU) opened a Snow Leopard Rehabilitation Center in Sasyk-Bulak Valley of Issyk-Kul District in Kyrgyzstan, the first in Central Asia. The center was built in order to keep confiscated animals in their natural habitat and hopefully to release them back into the wild after recovery. The enclosure covers $7000\,m^2$ and has held up to seven snow leopards. The main goals and objectives of the Rehabilitation Center are to save endangered wildlife, promote a positive attitude toward wildlife among local communities; treat, care, and rehabilitate injured wildlife; and release wildlife back into the wild after rehabilitation. However, to date, no snow leopards have been released back into the wild from the NABU rehab center, either because animals were badly injured (e.g., were missing a paw after being caught in a steel trap) or because they were taken at a young age and never learned to hunt wild prey.

In 2015 the Parks and Wildlife Department of Gilgit-Baltistan, Pakistan, with assistance from the Snow Leopard Foundation, created a rehabilitation center initially to house a single female snow leopard who had been kept in a roadside enclosure since its rescue from the wild in late 2012. There were also plans to use the facility for the treatment of other snow leopards that may come into captivity, as well as for captive breeding, educational, and recreational purposes. Because the snow leopard brought to the rehab center had already spent 2 years in a roadside facility and was acclimated to people, she was not considered a candidate for release. An attempt to mate this female with a male that had come into captivity elsewhere in Pakistan was unsuccessful. While the initial intent of this center was not release back into the wild, collectively the experiences to date demonstrate how difficult it can be to have the proper facilities, training, and plans for rehabilitation, recolonization, and release efforts to be successful for snow leopards.

Given the growing threats of human encroachment and climatic changes on snow leopards and their habitat, the need for rescue and rehabilitation of snow leopards will no doubt only grow. Additionally, there are likely to be other reasons to improve the capacity to manage snow leopards in captivity and release them back into the wild. Given the current patchy nature of snow leopard habitat and ongoing fragmentation due to human activities, the need for genetic restoration/augmentation may arise more quickly than expected. At the same time, with changing environmental conditions associated with climate change and human pressures, it may not be long before consideration of supplementation, restoration, or even assisted colonization into newly suitable habitat might be considered as options for snow leopards. To be prepared for such management options in the future, it is useful to consider examples and lessons learned from work with other large felids. In this chapter, we review four case studies from around the world to understand what potential opportunities and pitfalls lay ahead for their implementation with snow leopards.

Case study 1. Planning a jaguar reintroduction in Argentina: Combining science, publicity, and public policy

The jaguar (*Panthera onca*) is the largest terrestrial predator in the Neotropics, where it has been extirpated from 54% of its original range and is globally classified as near threatened (Caso et al., 2012). In Argentina, the species is classified as critically endangered after a 95% decline of its historical range (Aprile et al., 2012), and it presently occurs as 3 disjunct populations that total approximately 200 individuals within the Yungas, Chaco and Atlantic Forest ecoregions in the northern part of the country (Di Bitetti et al., 2016).

During the 20th century, the jaguar disappeared from the Iberá region in Corrientes Province, northeastern Argentina (Parera, 2004). In 1983, the provincial government of Corrientes established the 13,000 km^2 Iberá Nature Reserve (INR) to protect an entire river basin covered by wetlands, grasslands, and patches of forest. In 1999, The Conservation Land Trust (CLT) purchased 1500 km^2 inside INR with the intention of creating a 7000 km^2 national park. As negotiations for creation of the park proceeded, CLT began exploring the potential for restoring viable populations of extirpated mammals, including the jaguar. CLT led a two-staged process, first assessing feasibility of a jaguar reintroduction, then planning how best to conduct it.

Assessing the feasibility of a jaguar reintroduction into INR

Kelly and Silver (2009) recommended that any such initiative should “be contingent on the proper combination of suitable habitat, sociocultural tolerance by local and national communities and the resources in time, money and expertise to carry out such a project responsibly,” largely following recommendations from other experts (Kleiman et al., 1994; Macdonald, 2009). Accordingly, the feasibility study addressed three main issues.

Habitat suitability

To assess whether there is sufficient suitable habitat within INR for a viable jaguar population De Angelo (2011) conducted a GIS-based habitat suitability assessment using existing information on habitat types, presence of cattle and human populations, roads and human access, watercourses, and distribution/abundance of potential prey. De Angelo (2011) estimated that INR contained 2500 km^2 of quality habitat and 4000 km^2 of suboptimal habitat that is currently protected and almost devoid of humans or livestock. Within this potential jaguar core area, based on densities obtained from similar landscapes, "*70 to 90 jaguars could create a significant population with high chances of long-term survival, even though it would need proper genetic and demographic management*" (De Angelo, 2011).

Public support

To determine whether there was sufficient support for a large carnivore reintroduction, Caruso and Jiménez Pérez (2013) assessed the attitudes of both urban and rural residents of Corrientes Province. They discovered that 95% of the people support the return of jaguars with results independent of the respondent's gender, age, or location. These results were obtained prior to any media campaigns to promote jaguar reintroduction, suggesting that jaguars were already viewed very positively by the public. Caruso and Jiménez Pérez (2013) suggested that for Corrientes Province the jaguar could act as a bridge between a proud provincial heritage and a hopeful future in which ecotourism could provide a means of economic development. With such strong local support, the only other groups that could thwart jaguar reintroduction would be scientists, conservationists, or government officials. We discuss engagement with these groups below.

Capacity and commitment

The final component of a preliminary assessment was identifying an organization willing to commit long-term resources and expertise to lead such a complex endeavor. In this case, CLT would clearly fill this role, as it had already invested more than 5 million US$/year for conservation activities in INR for the previous 16 years and was committed to maintain this level of investment until their lands are donated to the government and all extirpated species were re-established. Also, since 2006 CLT had established and trained a team that had experience in successful reintroduction programs for giant anteaters and pampas deer (Jiménez Pérez, 2013).

Planning and negotiating a jaguar reintroduction plan

Once it was determined that INR had sufficient habitat, public support, organizational capacity and commitment, the best technical strategy had to be designed to mesh with the best political strategy before negotiating with agencies responsible for authorization. To derive a technical reintroduction plan with high probability of success, representatives of CLT first visited other jaguar conservation projects, such as in the Brazilian Pantanal, and other felid reintroduction programs, such as the rewilding initiative at Pilanesberg National Park and the South China Tiger Project (both in South Africa), the Iberian Lynx ex situ conservation program in Spain (see below), and two tiger reintroduction projects in India. Second, over a period of 4 years, CLT held meetings, workshops, and consultations with jaguar experts from Argentina, Brazil, Europe, and the United States, plus other international experts in large felid reintroductions. These activities included national and regional experts as advisors and supporters in an adaptive planning process that produced a strategic vision document (CLT, 2012), which has been updated regularly.

This strategic vision was based on the following premises: (a) with a total national population of only 200 individuals, it was not ethically or biologically justifiable nor politically feasible to translocate wild jaguars from other regions of Argentina to INR; (b) at this phase of the program it was also not politically or administratively feasible to obtain permits for translocation of jaguars from a healthy population in neighboring countries like Brazil; however, it was believed that such permits might be possible in the future if initial successes could be demonstrated; (c) due to the above constraints, the first animals to be released should be born from captive jaguars in a facility within INR and provided the opportunity to learn to hunt native prey while avoiding any positive stimulus from or affiliation to humans; (d) the facility and first release site should be located within remote high-quality habitat inside INR to minimize dispersal to less secure areas; and (e) with an initial captive-born nucleus established, wild jaguars potentially translocated in the future would be less likely to show homing instincts or disperse away from the area.

Based on these principles, a three-step jaguar reintroduction plan for INR was derived. Phase one would include construction of a breeding facility for captive jaguars from zoos that would produce viable offspring born in large pens situated on the best habitat inside the reserve. Also, media reports regarding individuals born at the facility would assist in promoting the jaguar reintroduction program across Corrientes. In Phase Two, jaguars born and raised onsite (demonstrating the ability to successfully hunt and avoid human contact) would be released inside INR to establish a core population. Ideally, the establishment of such a nucleus would help to initiate Phase Three, which would include capturing, translocating, and releasing wild jaguars from viable populations in neighboring countries to boost demographic growth and genetic viability of the reestablished population. Homing behavior of wild translocated animals would be minimized through soft releases from acclimatization pens.

After receiving input from national and international experts, the program had to be reviewed and approved by the provincial and national wildlife authorities. Initial meetings with provincial authorities soon made clear that they were only willing to approve the first phase—an on-site breeding facility—before considering possible authorizations of jaguar releases. Approval of the first phase by provincial authorities required a year and a half of meetings and adjustments to the strategic document. Approval by national authorities required another 2 years of protracted negotiations involving more meetings and formal presentations. In December 2014, an on-site jaguar breeding facility was approved by both regional and federal authorities. Construction had already began in a remote area of INR in September 2013, and the Experimental Jaguar Breeding Center was ready to hold two captive breeding pairs and their offspring by the time the plan was approved. Technical details are described in the management plan (Solís et al., 2014).

Negotiating and achieving final governmental authorization was probably the most taxing and, at the same time, most critical part of the entire process. With permits in hand, the first female jaguar was transferred to the breeding center in 2015 after going through a quarantine phase. Along the route to the center, the jaguar was met with unexpected enthusiasm from local villagers.

On January 2021, after getting authorization from provincial and national authorities for Phase 2 of the project, the first wild-born female was released with her two cubs. A second female and her two cubs were released in April, while a female born at the breeding center in 2018 was released on September 2021. Finally, a rescued wild male individual was released in January 2022. The four adult jaguars that have been released carry GPS collars, and all eight free-ranging animals are regularly monitored and in good health, hunting their own prey without any assistance from humans. The first jaguar releases were celebrated by local, national, and international media.

Conclusions on developing a reintroduction plan

Following Seddon et al. (2014), the jaguar reintroduction project in INR is both a *rewilding* initiative to restore the ecological role of the jaguar as the top predator in this vast wilderness, and a *species conservation* initiative to recover a critically endangered species at the national level. Nevertheless, despite the existence of extensive high-quality habitat, strong support by local residents and the scientific community for the reintroduction effort, and the existence of a capable and committed organization to see the process to fruition, there were still significant bureaucratic and political obstacles to overcome before approval and initiation of the project. Perhaps the most useful lesson is that delineation and approval of a feasible reintroduction plan require wisdom, patience, persistence, communication skills, empathy with other points of view, and sufficient flexibility to adapt an "ideal" vision to political and bureaucratic constraints so that implementation becomes a reality.

Case study 2. The Iberian lynx: Restoring a population on the verge of extinction

The Iberian lynx (*Lynx pardinus*) is a medium-sized felid endemic to the Iberian Peninsula (Spain and Portugal). Formerly widespread, only about 100 individuals remained in the wild in 2002 in 2 isolated populations in Andalusia Province of southern Spain (Andújar-Cardeña and Doñana) (Guzmán et al., 2004). Given the small size of this remnant population, the Iberian lynx was the only felid species listed as "Critically Endangered" (IUCN, 2003). Starting in 2002, four consecutive EU-funded conservation projects were developed by the Andalusian Regional Government of the Environment to halt the decline of the remaining populations (mainly by increasing carrying capacity, decreasing mortality rates, and managing population genetics) and restore extinct populations through reintroductions (Simón, 2013). A captive-breeding program was initiated in 2004 with the main goal of providing individuals for release (Vargas et al., 2008). Here we summarize methods and results of the reintroduction program that began in 2006, and continues to the present. As a result of these efforts, the IUCN downlisted Iberian lynx to "Endangered" (IUCN, 2015).

Identification of suitable habitat

Optimal areas for reintroduction were selected in a two-stage process: (1) preselection based on GIS habitat suitability analyses and (2) definitive selection based on fine-scale field studies of habitat suitability, prey density, public support and potential threats. In the first stage a suitability model using presence/absence data (generated both by radio-tracking and photo-trapping studies conducted between 2002 and 2006) was generated (Gill-Sánchez et al., 2011). Beginning in 2006, 11 areas were preselected throughout the Iberian Peninsula as optimal for Iberian lynx reintroduction based on the habitat suitability analyses, size (a minimum of 10,000 ha), and the potential for integration into a metapopulation (Gaona et al., 1998; Palomares, 2001). Between 2007 and 2014, fine-scale studies collected data on habitat quality, rabbit (*Oryctolagus cuniculus*) density (the Iberian lynx's primary prey), public support, and threats analyses. All values derived by these methods were compared with the same variables obtained within the current range of Iberian lynx (Simón, 2013). To date, six areas have been selected for reintroductions. First releases began in Guadalmellato in 2009 and continue to the present.

Origin of released individuals

Both wild-caught and captive-raised individuals have been used in the reintroduction process. Both males and females were removed from a wild population for translocation when it was determined that removal would have no significant impact on the existent population (Palomares, 2002). Wild individuals were selected based on their age (young sexually mature), social status (only nonresident individuals) and genetic origin (closely related individuals were not released in the same area). Once captured, all individuals were given an extensive health assessment and placed in quarantine for 2–6 weeks to avoid the introduction of any diseases into the recovering populations. Captive individuals were selected to maximize genetic diversity and were kept in large natural enclosures with a complex environment similar to that found in the wild. Contact with keepers was minimized. Since promoting natural behaviors is considered essential for the survival in the wild (Griffin et al., 2000; Hartmann-Furter, 2009), candidates for release were only fed live prey, mainly wild rabbits (80%–100% of their diet in the phases prior to release). Mothers generally hunt and provide food for young cubs, but cubs are able to kill prey on their own as early as 103 days after birth (Yerga et al., 2012). A network of tunnels was built for rabbits in the training enclosures to mimic the complicated process of both locating and capturing prey in the wild. Moreover, unpredictability of food availability and the occasional use of hunger were used to promote exploration and foraging behavior, as well as to mimic natural conditions. To prevent association of humans with food, we developed a system of automatic feeders connected to a timer. To promote avoidance behavior toward humans, lynx-human contacts were kept to a minimum and negative stimuli (shouting or throwing water on them) discouraged contact. Human handling was avoided while social interactions with other lynx were encouraged.

A health assessment was conducted on all captive Iberian lynx to ensure only healthy individuals in good condition were released. When a limiting health problem or disease was detected during check-ups, the individual was removed from the program. The sex ratio of released individuals was kept near to 1:1 for each release year.

Release and monitoring

Released individuals were radio-tagged to allow postrelease monitoring. A soft-release approach was initially used in all areas, with enclosures of 1–8 ha built in areas of optimal habitat and prey density (Simón, 2013). The number of individuals soft-released at any given time ranged from 2 to 4 and time spent in the enclosure ranged between 3 and 210 days. Once a nucleus population (at least two pairs) of wild individuals had settled into a given area, individuals were released directly into a site (hard releases). In cases where soft releases were performed within a stable adult home range, fights between incoming individuals and resident territorial individuals were recorded.

Results and conclusions

From 2009 through 2021, 336 (305 captive-born and 31 wild translocated) Iberian lynx were released into the 6 reintroduction areas. After release, distances explored by individuals ranged from 0 to 1124 km (mean 36 km). Most releases ended with temporary or final settlement of the individual in unoccupied areas with high prey abundance (Rueda et al., 2021). Distance between the release site and the center of a home range ranged from 0 to 285 km with no variation in dispersal distance between the sexes. There were no differences in dispersal distances between soft- and hard-released individuals. Annual mortality rate in the first year after release was 0.28 and nearly identical for captive-raised (0.31) and wild-caught individuals (0.27). Reproduction has been recorded every year since the first release in all populations. The population of Iberian lynx living in the wild has increased from 59 individuals in 2002 to 1111 in 2020. The original recovery goal of 5 populations totaling 300 individuals within Sierra Morena (Simón et al., 2012; Simón, 2013) has already been vastly exceeded, yet reintroductions will continue in eight new areas by 2030. Moreover, a project focused on connecting all "nuclei" populations is currently being implemented.

These results suggest the project has been highly successful in both translocating wild Iberian lynx and developing protocols for raising young Iberian lynx for reintroduction. Similar mortality rates of captive-reared and wild translocated lynx are a strong indicator of the success of the rearing program and suggests that similar approaches may be successful with other medium and large felids. Although some human-Iberian lynx conflicts have been documented (Garrote et al., 2013; López et al., 2014), mitigation programs are in place. Well-designed programs with appropriate training to develop hunting skills and negative conditioning toward humans may be some of the key components to insure success.

Case study 3. Genetic restoration as a management tool for endangered felids: Lessons learned from the Florida panther

Many large carnivore populations have become isolated and reduced in size due to a combination of unregulated harvest and habitat loss associated with human development (Wolf and Ripple, 2017; Woodroffe, 2001). Inbreeding is inevitable in small populations and can have a major impact on long-term population viability and risk of extinction (Frankham et al., 2002; Hedrick et al., 2014). That scenario has transpired for the Florida panther (*Puma concolor coryi*), a subspecies of puma that once ranged across the southeastern United States, which is now restricted to <5% of its historical range (USFWS, 2008) and is afforded protection under the United States Endangered Species Act (Public Law 93–205; Federal Register, 1967).

Identification of a problem

In 1981, the Florida Fish and Wildlife Conservation Commission (FWC) initiated a research project on panthers that has been ongoing for >40 years (Onorato et al., 2010). Early research revealed that many of the remaining panthers exhibited congenital anomalies including high incidences of defects such as kinked tails, thoracic "cowlicks" of fur, cryptorchidism, atrial septal defects, depressed immune systems, and detrimental sperm characteristics (Roelke et al., 1993). These anomalies were presumed to be a consequence of low levels of genetic variation associated with inbreeding depression (Roelke et al., 1993). Minimum counts of panthers remaining in the wild in the early 1990s indicated the population likely consisted of as few as 20–30 individuals (McBride et al., 2008). The combination of the extremely small population size and observed impacts of inbreeding depression led wildlife managers in 1991 to establish a captive breeding program with kittens removed from the wild. The captive breeding program was discontinued in 1992 for two reasons: (1) heightened concerns that the genetic health of the wild population had reached a critical point where the continued survival of the panther population was in question and (2) logistical constraints regarding the necessary space for captive breeding facilities and the length of time needed before captive breeding might feasibly contribute to recovery (potentially several panther generations). A different, more expedient approach was necessary to reverse what appeared to be the panther's inevitable rendezvous with extinction.

Developing a plan for genetic restoration

In 1994, the FWC, National Park Service, US Fish and Wildlife Service, and nongovernment organizations, along with experts in the field of carnivore biology and conservation genetics convened to develop an alternate approach to recover the Florida panther. The result was a plan to release eight female pumas from western Texas (*Puma concolor stanleyana*) into the wilds of South Florida (Seal, 1994). Pairing these females with wild male Florida panthers was predicted to improve levels of heterozygosity in the population (Seal, 1994). Pumas from Texas were chosen because Florida panthers historically experienced a level of gene flow with that subspecies when panthers were distributed across their historical range throughout the Southeastern United States.

This periodic exchange of breeding animals ceased when panthers became isolated in South Florida. Genetic restoration would therefore mimic this gene flow that used to occur naturally. In theory, genetic restoration had the potential to improve the long-term outlook for the panther through revitalized genetic variation and in turn result in a population comprised of individuals that may genetically more closely resemble those that were historically distributed across the Southeastern United States. Females rather than males were selected for release because managers could more accurately document the level of genetic introgression by sampling kittens from litters of radio-collared Texas females. Documenting the litters of uncollared female panthers sired by a male Texas puma would be nearly impossible.

The plan for genetic restoration was not without critics. For instance, Maehr and Caddick (1995) proposed that outbreeding depression could result and lead to the loss of localized adaptations. While such a scenario merited contemplation, the overall consensus was that genetic restoration held the most promising, expedient, and perhaps last chance to avert the extinction of Florida panthers.

Implementation and results

Between March and July 1995, eight female pumas from west Texas were released at five different locations in South Florida (Onorato et al., 2010). Upon release, the Texas females adapted quickly to the vastly different landscape. By October 1995, less than 6 months after release, a Texas puma produced the first documented admixed litter. Accounting for the 90-day gestation period for pumas (Currier, 1983), fertilization by a male Florida panther occurred less than 3 months after release. Eventually, a minimum of 20 kittens born to Texas pumas were documented (Onorato et al., 2010). In subsequent years, breeding by the F1 generation of admixed panthers was verified, along with several backcrosses to the Texas pumas. An extensive assessment of the effects of genetic restoration on the panther highlighted the benefits that ensued (Johnson et al., 2010; Van De Kerk et al., 2019). Admixed panthers exhibited a lower prevalence of kinks, cowlicks, cryptorchidism, atrial septal defects, and sperm anomalies while showing marked improvements in genetic heterozygosity and survival rates of both kittens and adults (Benson et al., 2011; Hostetler et al., 2010; Johnson et al., 2010; Van De Kerk et al., 2019). Furthermore, population viability analyses demonstrated that genetic restoration had a significant impact improving the outlook for the long-term persistence of the panther population (Hostetler et al., 2013; Van De Kerk et al., 2019). The benefits associated with genetic restoration are perhaps best exemplified by the most recent minimum count data that shows an increase from 26 in 1995 to 149 panthers in 2015 (McBride and McBride, 2015).

Conclusions

While other factors invariably played a role in the dramatic turnaround for the Florida panther (including acquisition and protection of >120,000 ha of land, wildlife highway underpasses, legal protection under the Endangered Species Act) genetic restoration can most certainly be deemed a success (Johnson et al., 2010; Onorato et al., 2010). In retrospect, there is little doubt that managers in 1994 assumed some level of risk when deciding to implement genetic restoration of a large carnivore in situ. Only limited control over the progression and outcome of genetic restoration was possible. While panthers remain endangered, the outlook for recovery today is much improved compared to two decades ago. The lessons learned from our experiences with genetic restoration in Florida should be contemplated for use in other regions of the world where options of releasing conspecifics into the wild to reinvigorate dwindling wildlife populations have the promise of averting future extinctions.

Case study 4: Rescue, rehabilitation, and reintroduction of Amur tigers into historic range in the Russian Far East

Historically, the best habitat for Amur, or Siberian tigers (*Panthera tigris altaica*), probably existed in northeast China and the Korean peninsula, but today at least 90% of the remaining wild population resides in the Russian Far East. Tigers originally also occurred along both sides of the Amur River—in Amur Oblast and the Jewish Autonomous Region (JAR) in Russia, and in the Lesser Khingan Mountains of Heilongjiang Province China (Heptner and Sludskii, 1992; Ma, 2000), but animals in these areas largely disappeared in the 1970s and 1980s. Today, although suitable habitat remains in this historic part of its range, nearly all Amur tigers reside in the Sikhote-Alin Mountains of Primorye and Khabarovsk Provinces, Russia and in south-west Primorye and the neighboring Changbaishan Mountains of Jilin Province, China (Hebblewhite et al., 2012; Miquelle et al., 2007).

Orphaned tiger cubs are not uncommon in the Russian Far East, perhaps because females with cubs are more likely to stand their ground and protect cubs, making them more susceptible to poachers with firearms. In the past, most orphaned cubs went into captivity since there were no facilities for rehabilitation, although there were a few attempts to retain cubs in the wild (Goodrich and Miquelle, 2005). However, because these few individuals had little impact on dynamics of the Sikhote-Alin population, estimated in 2005 at 430–500 individuals (Miquelle et al., 2007), these rescues, rehabilitations, and releases back into the wild were little more than animal welfare cases.

In 2012, the A.N. Servetsov Institute of Ecology and Evolution, of the Russian Academy of Sciences, with support from the Russian Geographic Society, completed construction of a tiger rehabilitation center in Alekseevka, Primorye, in time to receive a female cub orphaned at approximately 4 months of age (Rozhnov et al., 2021). In 2013, five more tiger cubs arrived at the facility, all 3–5 months of age. Since then, the NGO Amur Tiger Centre has overseen the rehabilitation of another nine tigers (ANO Tiger Annual Reports: http://amur-tiger.ru/en/about_us/). Instead of the standard practice of sending these cubs to zoos, or releasing them back into the remaining tiger population in the Sikhote-Alin, it was decided to attempt to use the majority of these tigers ($n = 13$) to recolonize lost habitat in the JAR and Amur Oblast, where tigers had been absent for nearly 40 years.

Rescue and rehabilitation of orphaned cubs

In most cases, local villagers or hunters contacted authorities when abandoned cubs appeared. In every instance, attempts were made to confirm that cubs were indeed abandoned. Techniques for capturing cubs varied with their size and condition: some were so weak they could simply be wrapped in a jacket and carried out, while others in better condition required immobilization before handling. Cubs were often held in temporary facilities near the capture site for treatment (administering fluids, first feeding, and medical needs) and physical assessments before being transferred to the rehabilitation center. Cubs were kept in quarantine for 1 month before release into one of the six enclosures at the center. Most cubs were kept alone in an enclosure or jointly with another cub of the same approximate age (sometimes of the same litter). One female died while still in quarantine, apparently from a viral infection (FHV). No other tiger cubs showed any symptoms of illness, though many were in poor condition upon capture. Blood was collected from cubs upon arrival and prior to release and screened for 17 pathogens. Tigers had antibodies to feline calicivirus (3 of 6), *Toxoplasma* *gondii* (3 tigers), feline panleukopenia virus (5 tigers), *Trichinella* sp. (1 tiger), and were negative for all other 13 pathogens tested. Because these four pathogens are common in wild tigers of the Russian Far-East (Goodrich et al., 2012; Naidenko et al., 2012), all cubs were still considered suitable candidates for release.

Chain-linked fencing 4.5m high (with an inward overhang of 1m at the top) enclosed pens ranging in size from 0.3 to 0.7ha. Natural vegetation was retained in the enclosures, but degree of cover varied in each, from largely forested with brushy undercover to mostly open tall grass fields. Water was available ad libitum. Human contact with animals throughout the rehabilitation period was minimized by placing sheeted material on enclosure fences to block visual contact, by installing multiple video cameras to monitor activities remotely, and by providing food through boxed enclosures that could be opened remotely. Tigers were fed almost exclusively wild game, although the first cub was fed some beef (without the hide). At 7–8months of age, small live prey (domestic rabbits and pheasants) were presented to cubs, who actively hunted these prey. When cubs reached 11months of age, live young wild boar (*Sus scrofa*) and young sika deer (*Cervus nippon*) were released into the pens. Larger prey (subadult/adult wild boar and sika deer) were presented to tigers older than 15months of age after their permanent teeth were fully developed. For the 6months prior to release, tigers were provided only live natural prey items, and thus, were wholly dependent on their own abilities to capture prey. Intervals between presentation of live prey ranged from 7 to 12days. Each cub had successfully killed at least 24 wild boar and/or sika deer before it was considered ready for release (Blidchenko et al., 2015). New stimuli, especially in relation to hunting, were presented to tiger cubs at appropriate times relative to their ontological development (Yachmennikova et al., 2018).

Before release, individuals were tested for their reaction to human presence. A person walked along the perimeter of a tiger enclosure while observers (via the remote video system) scored the reactions of the tiger(s). None of the tigers attempted to approach the encroaching human or showed any signs of aggression.

Reintroduction of cubs into historic range

Suitability assessments were conducted at potential release sites in the JAR and Amur Oblast (Aramilev, 2013). Yearly surveys of ungulate densities conducted in protected areas and hunting leases suggested that prey densities were adequate to support tigers. The sites selected for initial releases were all in remote locations. Extensive discussions and agreements with government agencies and governors of these regions occurred prior to release, and special funds were allocated to ensure local wildlife agencies would be able to monitor tigers after release. Teams with experience in resolving human-tiger conflicts were also prepared to travel to the sites if necessary. Educational and outreach programs were conducted in villages close to release sites prior to release. No extensive surveys were conducted to assess public opinion of the reintroduction program, although informal assessments suggested many local people were opposed to the idea of returning tigers to the area (Aramilev, 2013).

From spring 2013 through spring 2021, a total of 13 tigers (8 females, 5 males) were released into the recovery region, usually at the age of 18–20months (Rozhnov et al., 2021), mimicking the time when subadult tigers normally disperse from their natal home range (Goodrich et al., 2010). All were affixed with GPS collars and were monitored for the lifespan of the collar (ranging from 3months to 3years). Camera traps are also used to monitor individuals and the growing population.

All released females established home ranges ($n = 7$, status of most recently released tigress is still unclear), mostly within protected areas, although the amount of time required to settle into territories varied. Males generally traveled extensively, settling into a region only if they encountered a female. One male covered over 1200 km between May and December 2013, including an extensive wandering through the Lesser Khingan Mountains of Heilongjiang Province China, before returning to Russia after the Amur River froze over (Rozhnov et al., 2014). A second male moved over 600 km in an easterly direction following the Amur River, and also entered China, where he fed extensively on domestic animals. When he returned to Russia in December 2014, he continued to rely on domestic animals (dogs) and did not show adequate fear of humans and was therefore captured and removed from the wild. All other released tigers appear to be surviving almost exclusively on wild prey. Of 82 kills located by examining clusters of GPS locations and snow tracking (Rozhnov et al., 2021), only 3 (2 young cattle and 1 dog) were domestic: 87% were wild ungulates (including 67% wild boar).

So far, 4 females have produced 6 litters (totaling no less than 12 cubs), sired by both wild males (who occasionally disperse from the main population to the east), and rehabilitated males released as part of this program (Rozhnov et al., 2021; ANO Tiger Annual Reports: http://amur-tiger.ru/en/about_us/). Some of these offspring have survived and dispersed, adding to the population size. At least three tigers have moved across the international border into China, and then returned, suggesting that dispersal and establishment of a population on that side of the border is also a possibility if prey populations are restored there. Discussions about the creation of transboundary protected areas between China and Russia in this region are ongoing and would greatly improve the chances of developing a viable subpopulation of tigers in this region.

Conclusions

Goodrich and Miquelle (2005) suggested three indicators of success for translocating tigers in Russia that are applicable here (1) survival through the first winter with evidence of predation on wild prey; (2) lack of conflict with people or domestic animals; and (3) successful reproduction. These translocated cubs were mostly successful in meeting these indicators: (1) 11 of 13 survived their first winter and all but 1 tiger (who was recaptured) have concentrated mainly on wild prey as a source of food; (2) aside from depredation on a few dogs and cattle, conflicts with humans have been rare; and (3) multiple females have given birth and successfully reared young, with some of these cubs already dispersing across this region. Successful reproduction suggests that this group of tigers is in the process becoming a self-sustaining population, representing a rare case of restoration of tigers into their former range (Rozhnov et al., 2021).

Lessons learned

Find common ground with key constituents

Rescue, rehabilitation, and recovery operations require direct handling of animals and therefore will generally be controversial and highly scrutinized. Therefore, success will often be dictated by the preliminary work done in developing a defensible plan and garnering support from scientists, the appropriate agencies, political entities, and the public. Each of the case studies to varying extents was successful because they were able to identify key constituencies and found means of agreeing on programmatic goals and methods. The case study on jaguar reintroductions perhaps most clearly underscores the need for compromise and patience in dealing with a variety of interest groups. To conduct genetic restoration of the Florida panther, strong support from the scientific community was a critical component of garnering political support. The captive-rearing program for Iberian lynx required years of debate among local, national, and international political and scientific organizations to reach a consensus plan that is now probably the best example of using captive-raised individuals to restore a wild felid population.

Develop effective public outreach

In none of the studies did public opinion negatively impact the process, but given the strong sentiments that large carnivores generally evoke, these may be more the exception than the rule. Working to restore large felids into their former range (in three of the case studies) is likely to be controversial, so outreach to and education of the public is likely to be an important component in nearly all situations (Garrote et al., 2013; Goodrich, 2010). Incorporating a structured decision-making process as an integral part of these projects should be considered in order to improve prospects for lasting and effective conservation (Brignon et al., 2019). Rescue work with large felids receives lots of publicity both locally and globally, so while these activities may be largely viewed as animal welfare issues, they help build public and financial support for the larger goal of felid conservation. The importance of this aspect of animal rescue work should not be underestimated as a rationale for having the capacity to do such work professionally.

It is important to have a well-defined message and mechanism for getting information to the public. For example, a common misconception in Florida is that admixed panthers are much more aggressive than the "original" Florida panthers, and that they are not afraid of people (Rodgers and Pienaar, 2017). There is no scientific basis for these claims, but they are pervasive in segments of the public that are not in favor of Florida panther recovery. Therefore, it is important to be prepared to address such concerns with convincing evidence, and ideally, envisage and address potential criticisms before they work their way into the public consciousness.

The release of rehabilitated, captive-reared, or translocated animals can be effective media opportunities that are intensively covered and provide an opportunity to convey important messages to the public. In organizing such events, film/photo opportunities must be provided to media, but in a way that does not compromise the purpose of the release (or other event). Just as importantly, there should be a clear message that is defined beforehand to be conveyed to the media, remembering that they are your means of outreach to the public. The preparation of printed materials prior to the event is a good way to ensure that the proper information gets into the hands of journalists. However, it must be remembered that all events must be planned for maximum benefit to the animals, not to accommodating spectators.

Incorporate the knowledge and experience of the global scientific, zoo, and conservation communities to develop a defensible plan

Most of the case studies relied on input from experts with experience in carnivore conservation and recovery, with staff often conducting site visits to learn from others. Knowledge of how to construct facilities, plan releases, and handle animals exists, but within a relatively small circle of specialists. Having this group of experts review existing plans and advise on how best to proceed will improve prospects for success. Learning by trial and error is not recommended.

Ensure suitable habitat exists and reasons for extirpation are known and mitigated

If restoration into historical range is the goal, identification of a sufficiently large tract of suitable habitat that has some form of legal protection and sufficient prey densities is critical before any plans are initiated. Identification of the release site must be a precursor to any captive-breeding programs intended to restore wild populations of felids. Just as importantly, it must be clear why the former population went extinct, and whether those threats have been sufficiently mitigated.

Health care and disease screening of captive individuals and reintroduction sites

A quarantine period should be strictly adhered to when snow leopards first come into a rehabilitation center to avoid exposing other individuals to potential diseases. There already exists a set of pragmatic recommendations on health care and husbandry of newly captured individuals, including recommendations for nutrition, infectious disease risk, and necessary vaccinations of snow leopards brought into captivity and being managed for release back into the wild (Ostrowski and Gilbert, 2017). For translocations or restorations, individuals should be thoroughly screened for feline-specific diseases and other health problems. Consultation with wildlife veterinarians is imperative, and ideally, wildlife veterinarians are a part of the team that manages captive individuals and assesses sites for reintroduction, for instance, to determine if any new epidemiological threats could be problematic to a project. The occurrence of a disease in a captive individual slated for release may not present a problem if the same disease is common in the wild population (as was the case for Amur tigers), but screening both captive and wild populations is necessary to make this determination (Lewis et al., 2020). There already exists an excellent example of how to conduct disease risk assessments for big cats prior to reintroduction (Lewis et al., 2020). Screenings to assess the presence of recessive genetic disorders, if feasible, should be contemplated.

Release of captive-reared versus wild individuals

For restoration/supplementation of a population, it is almost always preferable to use wild individuals as a source. Wild individuals have already demonstrated their ability to survive in the wild and should be innately wary of humans, while some level of acclimatization to humans is almost unavoidable in captive conditions. However, wild individuals are likely to disperse further (Belden and McCown, 1996), although use of soft releases may temper that tendency. Wild Iberian lynx were released only into areas where a population was already established, thus reducing the likelihood of dispersal. When wild individuals are not available, captive rearing is an expensive, time-consuming option, but one that has demonstrated success, as in the case with Iberian lynx.

With captive-reared individuals, it is essential to minimize human contact, and probably preferable to provide negative reinforcements

Holding pens should be designed to minimize human contact (visual, auditory, and olfactory). It is especially important to avoid associating the presence of humans with food (e.g., a keeper bringing food to the enclosure). The larger the felid, the more important this issue becomes. The one tiger that was removed from the wild after release in the Russian Far East was kept in an enclosure with little cover and closest to the facilities where keepers worked and was therefore forced into closer association with humans. Assessing how large felids respond to negative reinforcements (as was done with Iberian lynx) would be a useful line of investigation assisting future release programs.

Better to release females (first)

In most cases females are likely preferred over males as the source for genetic restoration into a population that is endangered. Use of females permits researchers to more effectively document the level of admixture as reproduction of radio-collared females can be closely monitored via sampling kittens at dens, whereas pairings between translocated males and uncollared wild females already in the population are more difficult to document without extensive genetic sampling of the population.

Experience in the Russian Far East demonstrated that rehabilitated male tigers tended to disperse long distances, while tigresses more often remained relatively close to the release site. Similar long-distance dispersals of male felids in translocation projects have been documented (Belden and McCown, 1996). Therefore, it may be wise to establish a nucleus population by first releasing females, and then releasing males into the home ranges already established by females in hopes males will encounter females (through visual or olfactory cues) and be less likely to disperse.

Hard vs soft releases

Soft releases were used initially for Iberian lynx to develop a nucleus population, but once populations were established, hard releases appeared to be effective. In Florida, though the sample size was small (eight animals), no observable difference was found in movements of Texas pumas after hard versus soft releases. Hard releases were used for most tigers in Russia, but the few soft releases did not appear to dramatically impact dispersal tendencies.

Genetic restoration

For genetic restoration: (1) determine the level of genetic introgression necessary to positively impact the population that is in peril; (2) whenever possible select conspecific stock from an area that previously may have interbred with the focal population (e.g., Texas pumas and Florida panthers) so that genetic restoration is not altering the population that is endangered, but mimicking what historically happened naturally; and (3) be prepared to explain (with data, historic distribution patterns, genetics) why admixed animals are not significantly different from the original stock for which you are initiating genetic restoration.

Closely monitor released individuals

The process of translocation and restoration of felids is still in its infancy and much is still unknown. Therefore, clearly documenting the process and monitoring released individuals will greatly inform future efforts. Additionally, because skepticism and criticism are likely when releasing either wild- or captive-reared animals, scientifically defensible documentation of successes and failures is important. Basic information on kill rates (to document the ability to hunt in the wild), encounters with humans, habitat selection, and reproduction are vital to determining success. With the increased use of GPS collars, it is now possible to collect multiple locations per day that allow the fine-scale analysis of movement patterns after release. Such collars are especially useful in remote areas as they have the ability to transmit data to researchers via cellular phone or satellite networks (see Chapter 30). However, the drawbacks of GPS collars (such as short battery life, high failure rate, and size) need to be considered, and compared to the pros and cons of deploying “traditional” VHF collars. To document reproduction and mortality, having radio-collars that last 3+years is preferred and minimizes the need to recapture animals on an annual basis (something that is logistically impossible in many situations). VHF collars typically function for more than 4 years, but, for large felids, will often require the use of aerial telemetry to locate them, which is expensive, poses risks to staff, and may not be feasible in some cases.

Be prepared for conflicts and the need to remove individuals

A response plan should exist prior to translocating animals so that agencies, the public, private landowners, and NGOs are aware how felid-human conflicts will be dealt with. Having these protocols developed and approved by all stakeholders prior to releasing, a large predator is highly recommended.

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