Assessing the Effectiveness of Strategies Used for Species Reintroductions in Africa

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Abstract

With global biodiversity loss being a major problem in modern times, the conservation of existing species is becoming more important. One conservation method that is becoming more prevalent is rewilding, which includes translocations to restore species in areas where their populations may be declining and to maintain ecological networks. Different strategies have been used depending on the species and the environment. These strategies include selecting genetically diverse individuals, selecting suitable environments, providing pre-release bonding periods for social animals, and providing veterinary care before and after release. In this literature review, I will attempt to analyze the different strategies scientists utilize during translocations and their successes by reviewing various case studies. To have the most successful result – which would be measured using the survival and birth rate of the reintroduced population, its impact on surrounding species, and its ability to adapt to change – scientists should use combinations of these strategies depending on the species being reintroduced.

Introduction

Global biodiversity loss in the Anthropocene

Humans have made increasingly significant impacts on the world such as deforestation, poaching, and pollution. The increasing influence humans have on the environment has led some people to describe this current period as the Anthropocene. These impacts have ultimately caused some species to either become extinct in certain areas of the world or become entirely extinct. The decrease in the number of species in certain areas has led to a drop in biodiversity in those places. This is a problem because the loss of species can cause ecosystems to collapse if their roles are not replaced. Now, scientists are searching for ways to prevent species from disappearing from their natural habitats and attempting to bring back those species to the areas they had already disappeared from.

Rewilding efforts

One of the conservation practices that scientists have been using more recently involves translocations, in which individuals of an endangered/threatened species are moved to a new area where that species may be missing or lacking in number and they are introduced there. The goal of this is to bring back the species to these places to encourage increases in biodiversity again and ultimately restore not only the population but the ecosystem as a whole.

Since reintroductions are quite costly in terms of both time and money, it is not yet possible to reintroduce every single species that has faced population declines due to issues such as habitat loss and poaching. Therefore, scientists have to first make the decision of which species to reintroduce. It would make sense to reintroduce species such as keystone species – species that have drastic impacts on the ecosystem or occupy unique roles – since their absence from an area could cause the ecosystem to collapse. This makes it beneficial to reintroduce these species since they most likely would bring about change the fastest compared to other species that have interchangeable roles.

However, some species are selected due to their economic rather than ecological benefits. These species are oftentimes charismatic species, and while they may not have the greatest impact on the ecosystem, they are very popular among people. A lot of these species are chosen to gain support from more people which would be beneficial when raising money for those reintroductions (Hayward et al, 2009). For example, while pandas are not considered keystone species, they are well-known charismatic species because of their popularity and have been used before as a symbol for conservation.

After considering the different methods scientists use to ensure a successful reintroduction, it brought up the question of which method is the most useful. In this literature review, I will attempt to analyze the different strategies scientists utilize during reintroductions and their successes by reviewing various case studies.

Methods

The search engine I used to facilitate my literature review was Google Scholar and I used the keywords, “reintroduction of species in Africa”, which resulted in around 59,300 results. My research process took around two months from April to May 2024. I searched for research articles on reintroductions taking place after 1995, since that was around the time in which reintroducing species became a more common conservation strategy. I initially selected papers covering broader overviews of reintroductions, such as comprehensive reviews of reintroductions of top predators or carnivores in Africa. However, to delve into this topic more deeply, I then decided to use more specific case studies and analyze them separately to determine individual components that made up their reintroductions that may not have been covered in those comprehensive reviews. I also included papers that predicted the successes and failures of possible reintroductions using models and population graphs. After reading through the successful case studies, I used the same combination of keywords but selected reviews of failed cases to understand factors that may have contributed negatively to the reintroductions. I attempted to select a variety of case studies that focused on different species. In total, I reviewed six case studies including three carnivorous and three herbivorous species residing mostly in southern Africa (Figure 1).

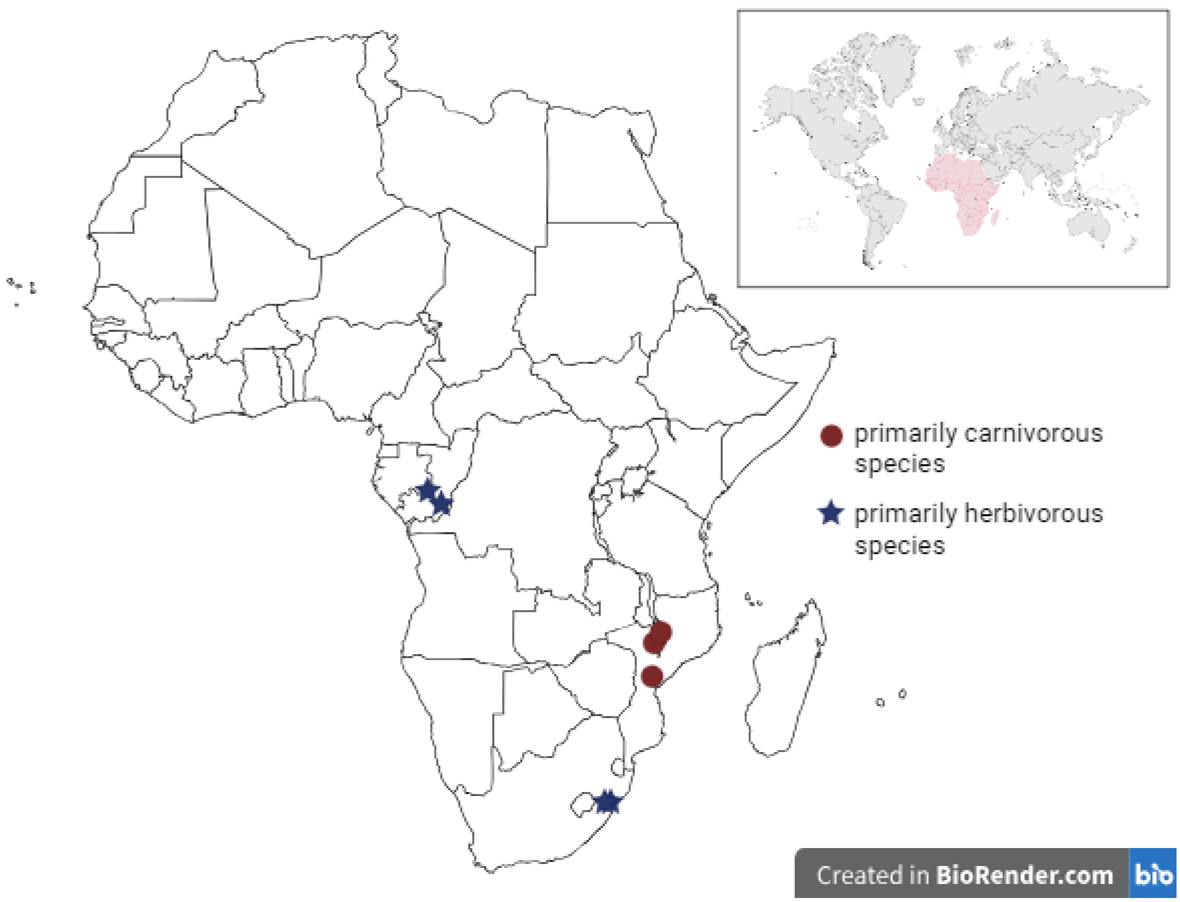

Figure 1. Map of the locations of each case study analyzed in this paper. Each red circle on the map of Africa represents the location of reintroduction sites in case studies focusing on

primarily carnivorous species. Each blue star represents the location of reintroduction sites in case studies focusing on primarily herbivorous species.

Results

Summary of literary review/case studies

The first successful case study I reviewed was a reintroduction of Western lowland gorillas (*Gorilla gorilla gorilla*). The first releases occurred in 1996 and took place in Lesio-Louna Reserve, while the later releases occurred in 2001 in Batéké Plateau National Park. A total of 51 gorillas were released. There were eight deaths/disappearances, all from natural causes. The annual survival rate was 97.4%, and the first-year survival for infants was 81.8%. The annual birth rate for the gorillas in the reintroduction was similar to the annual birth rates for wild gorillas (King et al, 2011).

In another case study, two species were reintroduced: leopards (*Panthera parda*) and lions (*Panthera leo*). Six leopards and three lions were released during 2011 and 2012 into Majete Wildlife Reserve and were monitored over a six-month study period. All reintroduced individuals survived longer than two and a half years after their release, and no lion mortalities occurred during the study, making this case study successful. Additionally, the lion pride had four litters of seven cubs, increasing their numbers from three to eleven lions. Five leopard cubs were observed being born and reaching sub-adulthood or adulthood by the end of the study (Brier-Louw et al, 2019).

Another successful field case study was the reintroduction of cheetahs (*Acinonyx jubatus*) into Liwonde National Park. From 2017 to 2018, a total of seven cheetahs were released on four different occasions. Four cheetahs survived, one cheetah died, and two cheetahs' statuses were unknown due to insufficient data. This brought the success rate to 57% (80% excluding the cheetahs with uncertain statuses). Cub survival was 60% (Sievert et al, 2022).

The fourth case study was an African wild dog (*Lycaon pictus*) reintroduction that took place in Mozambique. Two packs were released into Gorongosa National Park – one in 2018 and the second in 2019 – and were observed post-release over a 28-month study period. It was deemed as a successful reintroduction, considering there was a 73% survival rate and all deaths occurred from natural (not human-related) causes. Furthermore, the population recruited a total of 82 non-founders (pups), and 23 survived to one year old. The African wild dogs' range expansion increased by 117% (Bouley et al, 2021).

The last two case studies are recorded as failed reintroductions. The first failed attempt was an oribi (*Ourebia ourebi*) in KwaZulu-Natal, South Africa. Ten oribi were released in 2004 on a farm neighboring Fountainhill Estates, a private breeding facility. Only one oribi survived a year after release. The other nine oribi died relatively quickly following release, with seven dead two months post-release. Common causes included predation by natural predators and poaching (Grey-Ross et al, 2009).

The other failed case study I reviewed was a reintroduction of rock hyraxes (*Procavia capensis*) into Umgeni Valley Nature Reserve. Two groups were released on separate occasions. The first group of seventeen hyraxes was released in 2006, and after 87 days, none were observed alive. The second group was made up of nine hyraxes and released in 2007. Like the previous group, none of the hyraxes survived. After 18 days, all were reported dead, with the exception of one hyrax whose status was unknown (Wimberger et al, 2009).

Individual selection

Aside from selecting the species for reintroduction, it is important to choose the individuals carefully (Figure 2). There are many different factors to consider when selecting individuals for reintroduction. One factor is the age of the individuals. By analyzing the different case studies, I noticed that most reintroduced individuals were adults at the start of their release. While there were a few juveniles/subadults, very few were young or seniors. For example, while the African wild dog reintroduction did release five yearlings, the other 29 individuals were adults (Bouley et al, 2021). The presence of young in the rock hyrax reintroduction wasn't beneficial since they died relatively quickly and one group of pups born in the holding cage died a day after their birth. The scientists involved in the rock hyrax reintroduction acknowledged that including the pups wasn't ideal, but they were unwilling to postpone the release date since prolonging the time and repeating health checks and other processes was thought to add stress (Wimberger et al, 2009).

Reintroduced individuals can be sourced directly from the wild, but some are also captive-born or have spent a longer time in captivity. In the case studies of the lion and leopard reintroduction, the cheetah reintroduction, and the African wild dog reintroduction, conservationists only used wild-caught individuals and their survival rates were high (Brier-Louw et al, 2019; Sievert et al, 2020; Bouley et al, 2021). The scientists involved in the cheetah reintroduction hypothesized that the cheetahs' high survival rate even in the presence of lions could in part be due to their backgrounds since the cheetahs that were taken from reserves with lions may have been able to adjust their behavior accordingly (Sievert et al, 2020). Moreover, the oribi reintroduction used only captive-bred individuals, and only one oribi out of the ten total survived. The scientists involved in the oribi reintroduction suspected the captive-bred oribi's "tameness" could have been a factor contributing to their high mortality rates (Grey-Ross et al, 2009).

While all this points to the use of wild-born individuals as having greater success, data from the rock hyrax reintroduction could lead to the opposite conclusion. While none of the individuals in this reintroduction were recorded to have survived, all wild-caught hyraxes were reported dead or unknown after 18 days post-release while it took almost 70 days longer for the captive hyraxes to have the same result. However, this could be attributed to the fact that the captive group had an additional eight individuals and that other variables could have affected the results (Wimberger et al, 2009).

It isn't necessary to source individuals only from captivity or from the wild. Scientists can supplement groups of wild individuals with captive ones. In the western lowland gorilla reintroduction, a decision was made to include eight captive borns with the other 43 wild-born gorillas. The reason behind this was the decreasing availability of wild-born gorillas for reintroduction. The overall annual survival rate was high (97.4%) and there was no statistical evidence proving that there was a notable difference between the survival of captive-borns and wild-borns since their survival rates were similar (King et al, 2011).

There is also a genetic factor to consider in this decision. Genetic diversity is important to maintain long-term success in conserving the species (Hayward et al, 2007). Oftentimes, especially in carnivore reintroductions, the founder populations are smaller, and this can cause detrimental genetic problems to arise. One issue that can stem from small founder populations is the decrease in genetic diversity. To solve this, one solution is to source individuals from different groups or areas. For example, the cheetah reintroduction, cheetahs were selected from five different locations in South Africa (Sievert et al, 2020).

Release site selection

Before the individuals are acquired, it is important to select the location of the reintroduction (Figure 2). Sometimes, reintroductions take place in the species' historical range or in areas where a species' population has been known to exist before. This has been a common factor among successful case studies such as the lion and leopard reintroduction and the African wild dog reintroduction, and it has been absent from the failed oribi reintroduction (Briers-Louw et al, 2019; Bouley et al, 2021; Grey-Ross et al, 2009). However, this may not be a major factor in determining whether or not an area is ideal for a reintroduction. A useful method in determining the suitability of an area for performing reintroductions is conducting surveys and assessments on the land. These assessments, such as the one utilized by the successful African wild dog reintroduction, typically review factors such as the size of the land and prey/predator densities (Bouley et al, 2021).

Prey and predator densities are important factors to look into. As previously mentioned, they may be included in land surveys. In the African wild dog reintroduction, one of the reasons why Gorongosa National Park was chosen was because it had a relatively smaller density of large carnivores (potential predators) with only a population of lions being the main resident population of large carnivores (Bouley et al, 2021). In the cheetah reintroduction, Liwonde National Park was also chosen after referring to the amounts of each inhabitant – specifically the low number of competitors and high number of prey (Sievert et al, 2020).

In case studies where prey/predator densities were not studied intensely, a common result was a high number of mortalities caused by predation. Predation by caracal accounted for 27% of the deaths that occurred 18 days following the release of the rock hyrax reintroduction. It caused 78% of the wild-caught hyrax group deaths alone. The scientists later reflected in the case study that the area may have had a higher predator density (Wimberger et al, 2009). Human-related dangers should also be taken into account. Common causes of death in the oribi reintroduction included not only predation by natural predators but also poaching. The release site of the oribi happened to be near human settlements which scientists speculated could be an explanation for the increased occurrences of poaching (Grey-Ross et al, 2009).

Pre-release management

Typically, there are two types of releases: soft and hard releases. In a soft release, animals are held in temporary holding enclosures (sometimes referred to as bomas) pre-release. These enclosures are usually located at the release site or in an area with a similar habitat (King et al, 2011). Holding animals in an enclosure before the release is thought to help with the individuals' acclimatization to the new environment (Briers-Louw et al, 2019). All of the successful case studies I reviewed utilized these temporary holding enclosures pre-release which suggest it could be very useful in having a smooth reintroduction (King et al, 2011; Briers-Louw et al, 2019; Sievert et al, 2020; Bouley at al, 2021).

These enclosures could be used to divide the animals into different groups prior to release. For example, when preparing to release groups of individuals in the cheetah reintroduction, scientists chose to hold the cheetahs in different bomas according to the group they were going to be released in (Sievert et al, 2020). Enclosures are also thought to promote group cohesion. In the lion and leopard reintroduction, each leopard was held in a different boma since they are solitary animals and therefore would not benefit as much from group cohesion. However, lions were held in the same boma to encourage bonding within the pride. Their bond was reported to last the entire study period considering they remained in the same pride and no dispersals occurred (Briers-Louw et al, 2019).

Utilizing bomas would also greatly benefit groups of animals that have been artificially formed. This means the individuals didn't naturally group together but were taken from different areas and placed together by scientists. The artificially formed pack in the African wild dog reintroduction was placed in the same boma in hopes of forming a more cohesive pack that would stay together after release. It also provided them additional time to establish an alpha pair and their pack hierarchy. Scientists could use this time to monitor their behavior and watch for signs of aggression. The release could occur once the pack no longer displayed aggressive behavior. While the naturally formed wild dog pack in this reintroduction also used bomas, their time in the enclosure was shorter than the artificially formed pack since they would need less socialization time (Bouley et al, 2021).

Holding animals in the holding enclosures, however, turned out to have a negative effect on the rock hyrax reintroduction. The rock hyraxes had captivity stress during their time in the enclosures which was exhibited through cannibalism and other negative behavioral signs. Furthermore, despite being kept in the same enclosure, the group ended up disintegrating. The accumulation of waste and increased activity within the enclosure was also thought to have attracted predators since most predated hyraxes were discovered near the holding cage (Wimberger et al, 2009). These occurrences could probably be avoided by carefully setting up and monitoring the enclosure. The enclosure used in the rock hyrax reintroduction was very small with an area of roughly 3.42 square meters and the limited space could have led to increased stress, waste, and activity (Wimberger et al, 2009). In the African wild dog reintroduction, the boma was much larger – around 5,000 square meters – and had electric fencing to prevent predators from approaching (Bouley et al. 2021).

Another form of pre-release management is veterinary care such as treatments and vaccinations which is important since exposure to new environments and individuals could lead to the spread of diseases or viruses (Figure 2). For instance, vaccinations for rabies and canine distemper virus were administered to African wild dogs prior to their release (Bouley et al, 2021). Rabies vaccinations were also given to rock hyraxes for their reintroduction, as well as flea and tick prevention (Wimberger et al, 2009).

Release and post-release management

After preparations are made, individuals are released (Figure 2). Not all individuals are released simultaneously or during the same year. Releasing animals in multiple phases can be beneficial. The gorilla reintroduction occurred in two phases with one prior to the year 2000 and one after. When measuring annual survival rates between the gorillas released pre-2000 and post-2000 there was a difference between the percentages. Gorillas released earlier had a relatively lower annual survival rate of 97.4% compared to the annual survival rate of 98.3% for the gorillas released later. The scientists involved in this reintroduction speculated that the additional experience they had after the first release could have made a positive impact on the later reintroduction (King et al, 2011).

Supplemental feeding is one form of post-release management. Typically, scientists will provide additional food for the first few days to weeks following release and gradually reduce the quantity and frequency to promote independence. This method was used in the rock hyrax reintroduction (Wimberger et al, 2009). Sometimes, supplemental feeding is used for female individuals having difficulties while raising their young (Hayward et al, 2007).

Veterinary care can also be given post-release if scientists find a reason to intervene for wounded individuals (Hayward et al, 2007). For example, in the gorilla reintroduction, two gorillas obtained injuries that were deemed life-threatening. One had a brain injury and the other needed a hand amputation that could have resulted in septicemia without receiving antibiotics. The two gorillas had to be removed temporarily from their release group and were later reintegrated (King et al, 2011).

Other indirect forms of post-release management include the monitoring and observation of reintroduced individuals. While this may not impact the outcome of the reintroduction, it is useful for determining the success and analyzing the result for future conservation efforts. The most common methods I noticed from reviewing the case studies include direct observation – either by scientists or through opportunistic sightings from tourists – as well as the use of GPS or VHF collars (King et al, 2011; Brier-Louw et al, 2019; Sievert et al, 2020; Bouley et al, 2021; Grey-Ross et al, 2009; Wimberger et al, 2009).

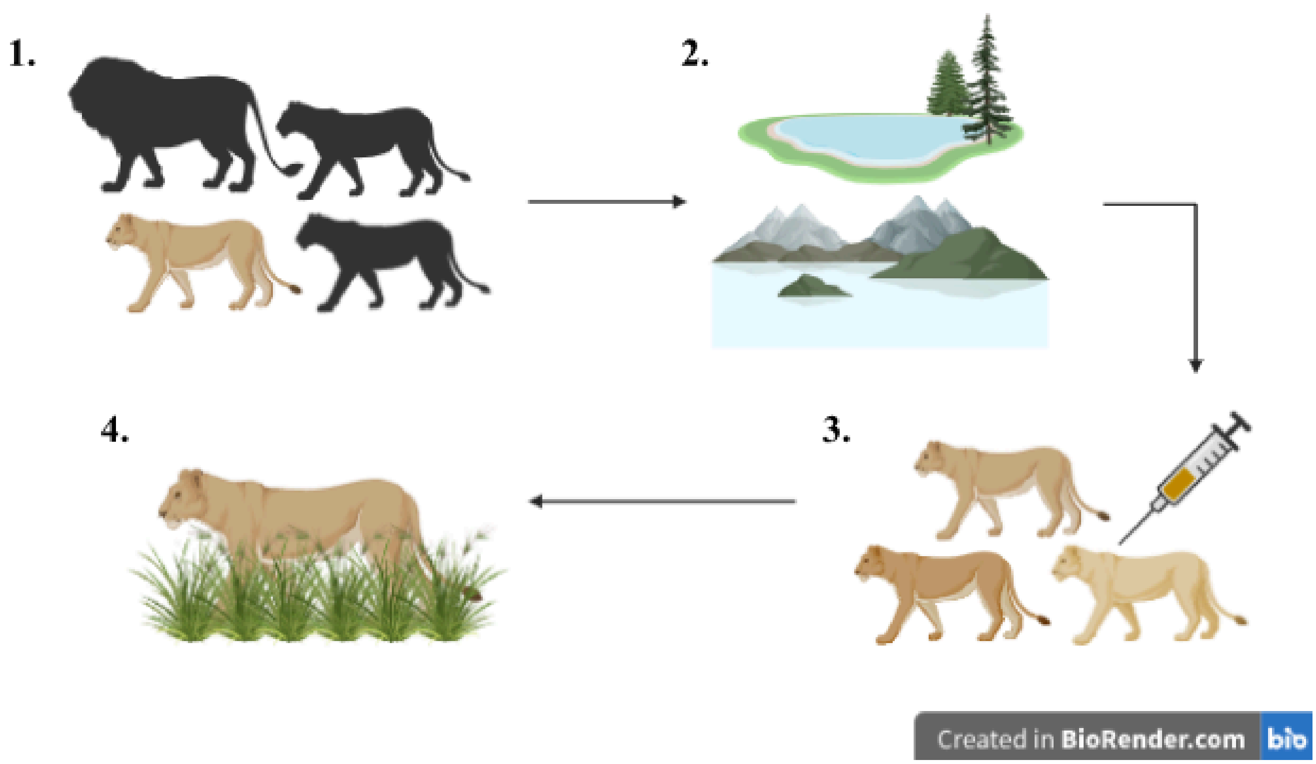

Figure 2. Visual representation of the general flow of a reintroduction. 1. Represents individual selection. 2. Represents release site selection. 3. Represents pre-release management. 4. Represents release and post-release management.

Discussion

Additional factors to consider

When reintroducing different species, it is important to cater the reintroduction to the species so that the entire process is best suited to the type of animal. Although the general process is still followed, scientists should make certain changes depending on factors such as the animal's trophic level, social life, and abundance of genetic diversity (Figure 3).

For example, the trophic level of an animal determines whether or not scientists should pay closer attention to prey or predator densities. Naturally, if the reintroduced animal is a prey animal, it would be more important to release them in areas with lower predator densities since predation has been a major cause of mortality in the case studies I have reviewed. If the reintroduced animal is a predator, it should be released in areas with higher prey densities. If possible, watching out for other extant predator populations in the area is also a good strategy since high predator densities could lead to competition and affect the success of a reintroduction.

Additionally, the use of temporary holding enclosures may be beneficial for a pre-release socialization period if the animal in the reintroduction is social or lives in groups. Solitary animals may not need this step of the reintroduction, however, it may still be useful to allow them to acclimatize to the new environment. In the future, it may be beneficial to conduct more reintroductions to analyze the advantages of a soft release (with the use of temporary holding enclosures) over a hard release.

Finally, the abundance of a genetically diverse population of a species in the wild can help with determining where to source the individuals in a reintroduction. Although I have reviewed case studies in which both captive and wild-sourced individuals have survived successfully post-release, I have found more in favor of reintroductions done with only wild-sourced individuals or wild-sourced individuals supplemented with captive-sourced ones. Therefore, if there is availability, it would be good to source individuals from a genetically diverse population in the wild, which would also ensure the genetic diversity of the newly reintroduced population. To enable the formation of a genetically diverse reintroduced population, scientists are also now considering creating a studbook to avoid genetic issues (Hayward et al, 2007).

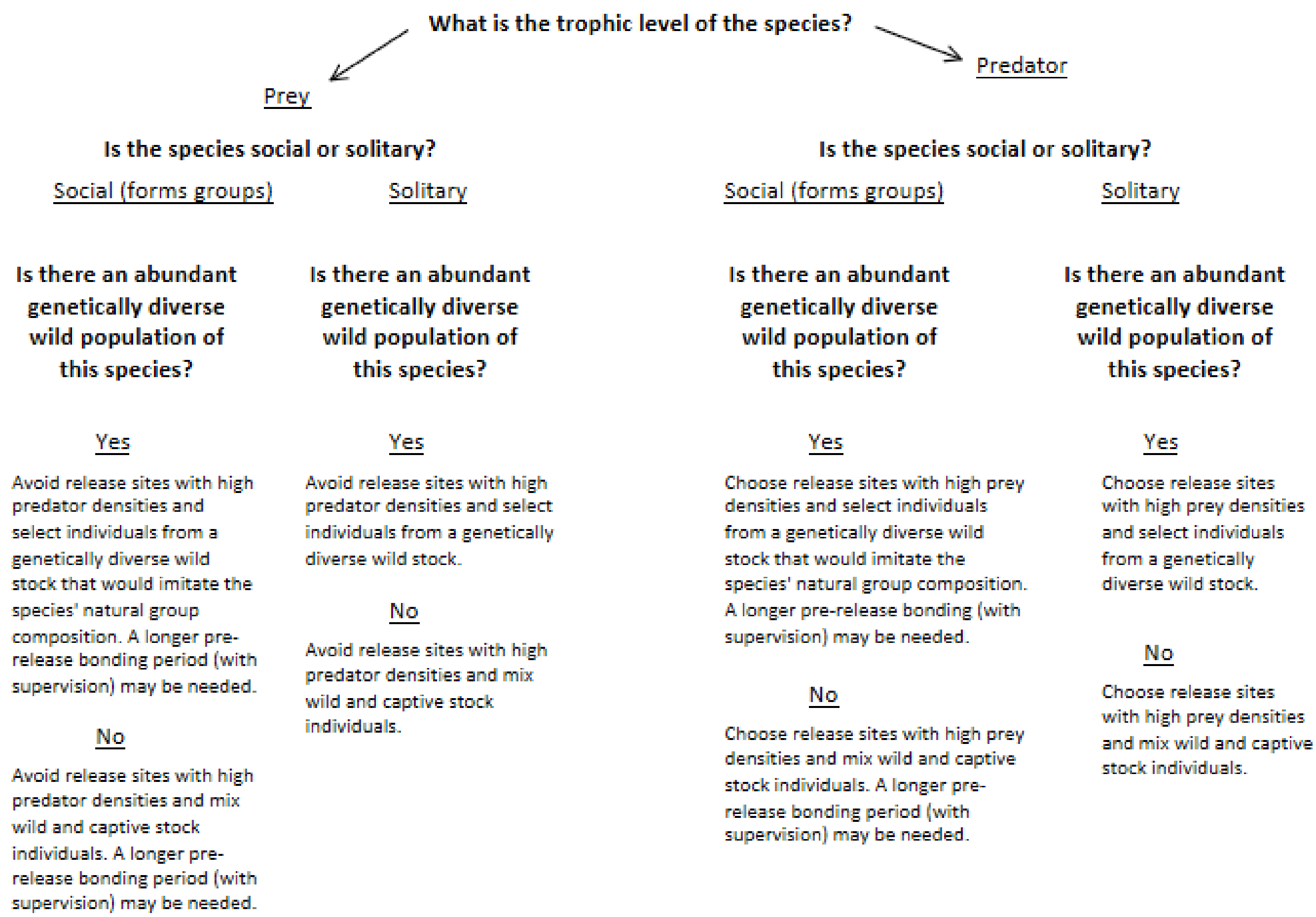

Figure 3. Decision matrix for catering reintroductions towards specific species. This is a general guide to follow when reintroducing different species depending on their trophic level, social life, and abundance of genetically diverse populations in the wild. By following each branch, a broad overview will be given for the final result on the best way to go about creating the reintroduction.

Defining success in a reintroduction

When determining the success of a reintroduction, there are some more obvious factors such as the population growth rate. When conducting a reintroduction, a common goal is to ensure that the reintroduced population can sustain itself and eventually grow. This can be achieved by having a high reproductive rate and a low mortality rate. Therefore, a population with an increasing population growth rate could be interpreted as being successfully reintroduced (Figure 4).

Range expansion can also indicate a successful reintroduction. This shouldn't be mistaken with displays of homing behavior – translocated individuals attempting to return to their original locations – since that would actually be a negative sign suggesting the individuals had no release site fidelity. Additionally, it isn't preferable if the released animals display too much exploratory behavior initially after release since this could be a sign of failure to establish a home range in the new area. Instead, a successfully reintroduced population would establish a home range first, then expand it after getting time to grow (Figure 4).

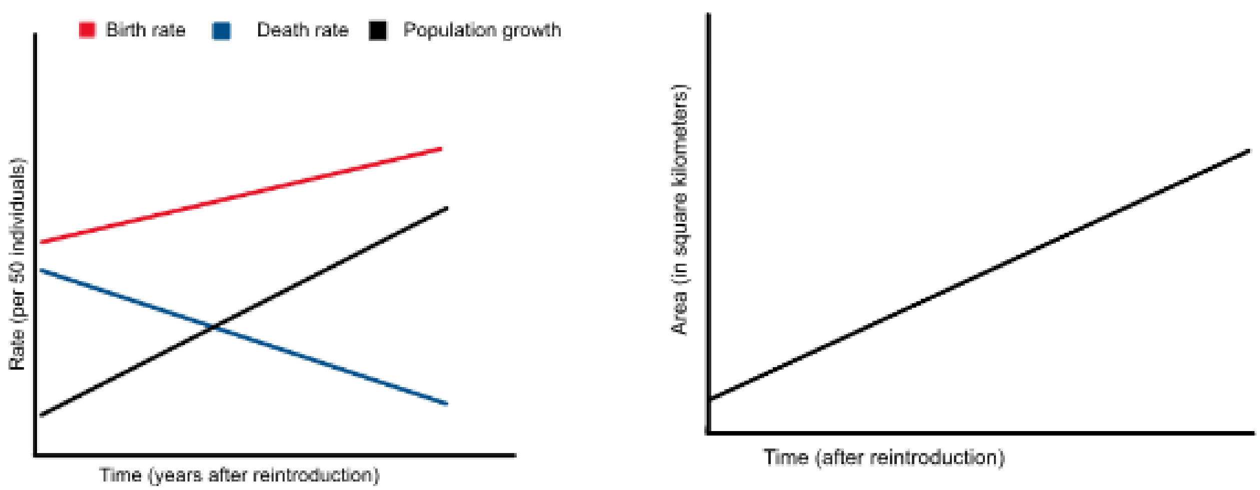

Figure 4. Examples of graphs that indicate a successful reintroduction. The first graph displays a hypothetical situation in which a population has an increasing population growth rate. The second graph visualizes a situation in which a population has acquired more territory after release and is expanding its range.

A third indicator of success is the establishment of relationships with other species in the ecosystem. This may take the longest to occur and may not be as noticeable. However, it is still important since ultimately, scientists are striving to rewire ecosystems by refilling positions with new individuals after the indigenous population has decreased. The absence of the species would also impact other species, so reintroducing that species would in turn restore relationships in the ecosystem (Figure 5).

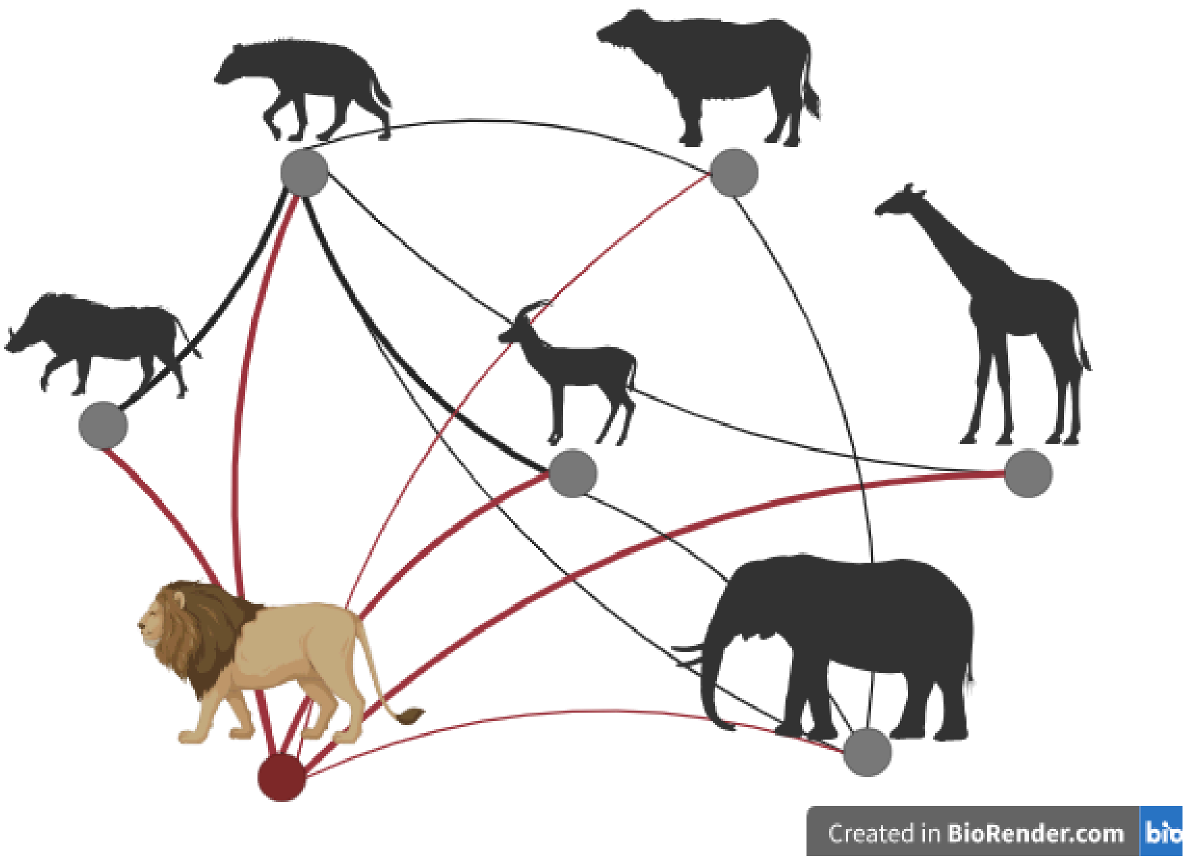

Figure 5. Ecological network highlighting a single species. This figure is meant to visualize the number of intricate interactions/relationships (such as competition, predator-prey, symbiotic) between different species within an ecosystem. Each node represents a single species. The figure highlights a single species (lion) and its interactions with the rest of the ecosystem.

Limitations

Unfortunately, there is some lack of data for the results I found. While some reasonable claims can be made from the evidence I found, there is insufficient data to prove or justify them. Furthermore, it is difficult to determine the major factor leading to the success or failure of each case study. Many actions were made for the reintroductions to take place and there is not enough evidence to pinpoint the exact action that causes the consequences. For example, the scientists who reintroduced the oribi claimed that the captive-bred individuals were more prone to predation (Grey-Ross et al, 2009). However, without data on wild-caught oribi reintroductions in the same settings, it is hard to say whether increased predation is specific only to captive-bred individuals.

This leads me to believe that there is a gap in the literature regarding the independent influences each strategy has on different species. It would be beneficial if there were more comprehensive reviews testing the effects of different strategies by reintroducing individuals under similar conditions while changing only the presence or use of a strategy for each reintroduction. A simpler, although less accurate approach, could be to increase post-release monitoring which may provide further insight for the exact results of the reintroductions and the importance of the role each strategy played.

There is another significant gap in literature regarding reintroductions of certain specific species. During my research period, I found more case studies and reviews for terrestrial mammalian species, especially lions, cheetahs, and African wild dogs. There was a noticeable drop in the number of results for other species such as marine or avian species. This may be the case because terrestrial animals may include more charismatic species which would garner more support from the public and also offer more economic benefits due to their popularity compared to other species.

Ethical considerations

Although reintroduction is becoming a more well-known method in conservation, there are still debates on whether or not there should even be reintroductions. This debate is not just centered on African reintroductions but is more of a global question that should be addressed. A big part of this debate revolves around the ethics of doing reintroductions. Some people are against reintroductions because they believe that we should let nature take its course and avoid interfering with wildlife. Other people see reintroductions as a practical solution to solving biodiversity loss. They may think that since a lot of these environmental problems are caused by humans, it is their duty to try and control/repair the damage.

Furthermore, since reintroductions are still a relatively new method, it is not entirely clear what long-term consequences there might be. This leads some people to fear that reintroductions could interfere with natural evolutionary processes. This could be true considering that translocating individuals would disturb gene pools in those locations, and new metapopulations would create a new gene pool altogether. Additionally, there is the potential to introduce pathogens/diseases along with the individuals that could be detrimental to the rest of the ecosystem, which is why it is necessary to have thorough veterinary care pre-release.

Moreover, reintroducing predators such as lions could be dangerous to nearby human or livestock populations. Alternatively, humans could be a danger to reintroduced animals if poaching activity increases. The general solution for this currently is to reintroduce animals into fenced reserves or parks to prevent negative human-wildlife interactions (Hayward et al, 2007).

With all of this in mind, some scientists are still wary of the potential consequences of reintroductions, whether positive or negative. In the future, it would be important to conduct more research regarding these ethical/moral problems.

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