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The Suitability of the Jaguar (*Panthera onca*) for Reintroduction

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Summary

As the largest and most iconic felid in tropical America, jaguars, *Panthera onca*, and jaguar conservation have received a good deal of attention by the public and conservationists alike. Jaguars are widely distributed throughout Central and South America, and exist within a wide variety of habitats and conservation contexts. Therefore it is somewhat surprising that, to date, no true jaguar reintroduction studies have been undertaken. While there have been a few incidents of jaguar releases (usually relocations of wild-born animals), even these have lacked pre- and post-release observations or data collection. Currently, there are few, if any, circumstances in which jaguar reintroductions would be feasible or desirable (i.e. where suitable habitat exists, but where threats and resident jaguar populations are absent). However, high rates of habitat conversion as a consequence of human development and the resultant isolation of local populations increase the likelihood that such circumstances may arise in the near future. To that end, current studies of jaguar population biology, ecology and behaviour, as well as models of successful carnivore reintroduction project organization and design will prove invaluable assets to any jaguar reintroduction projects. Such models can and

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should be incorporated in undertaking jaguar reintroduction projects should they become necessary.

Introduction

Large carnivores are fundamental elements in ecosystems (Morrison *et al.*, 2007), known to shape behaviour, distribution and abundance of their prey (Berger *et al.*, 2001a; Terborgh *et al.*, 2001; Sinclair *et al.*, 2003). Additionally, they influence ecosystems well beyond single-species interactions through trophic cascade effects (Crooks & Soule, 1999; Berger *et al.*, 2001b; Cote *et al.*, 2004; Morrison *et al.*, 2007). For example, Terborgh *et al.* (2001; 2006) found higher densities of herbivore prey species and lower densities of saplings in "jaguar, *Panthera onca*–free" sites than in sites with a full complement of neotropical predators, demonstrating that the absence of top predators can have an impact on vegetation structure and diversity. Large carnivores, however, are highly vulnerable to extirpation by humans, and intact top-predator faunas are becoming increasingly rare (Morrison *et al.*, 2007).

The jaguar has been singled out as a flagship, umbrella and landscape species whose conservation is thought to assist in the preservation of its entire community (Noss, 1990; Terborgh, 1992; Terborgh *et al.*, 1999; Gittleman *et al.*, 2001; Sanderson *et al.*, 2002b; Coppolillo *et al.*, 2004). As a flagship species, jaguars garner attention as charismatic megafauna, capturing the imagination of the general public across their range. As an umbrella species, they have broad ramifications for conservation of biodiversity and ecosystem protection because these cats often live in tropical areas where biodiversity is high. Protecting jaguars with their large home ranges, therefore, is thought to ensure protection of vast amounts of biodiversity under their "umbrella" (Noss, 1990; Gittleman *et al.*, 2001). As a landscape species, jaguars are wide-ranging and live in an ecologically and jurisdictionally complex landscape (Sanderson *et al.*, 2002a; Coppolillo *et al.*, 2004). Their requirements in time and space make them particularly vulnerable to human alteration and use of wild landscapes (Sanderson *et al.*, 2002a). Achieving effective jaguar conservation, therefore, requires addressing threats facing large swaths of critical habitats, assuring presence of adequate prey species and addressing impacts of the local communities that are ultimately responsible for the landscape heterogeneity.

As the largest felid in the Western Hemisphere, jaguars are an important icon of wildness throughout much of Central and South America. Yet the jaguar remains the least studied of all "great" cats (Valdez, 2000) and has been extirpated from more than 50% of its historic range (Sanderson *et al.*, 2002b). The situation is worse in Mexico and Central America, where jaguar populations exist in only 33% of their former range, and 75% of the populations that do exist are reduced in number (Swank & Teer, 1989; Sanderson *et al.*, 2002a; Marieb, 2005). Despite its internationally protected status, the jaguar's range continues to decrease (Fuller & Swift, 1985; Seymour, 1989; Sanderson *et al.*, 2002a; Marieb, 2005; IUCN, 2006). As current trends continue, jaguar reintroductions may become inevitable to restore extirpated populations and rebuild intact ecosystems.

While a few jaguar translocations have occurred, to date, no true jaguar reintroductions have taken place. This leaves us to compare the potential for jaguars to be reintroduced based on lessons learned from reintroductions of other species. It is widely accepted that reintroductions, especially carnivore reintroductions, have a poor success rate (Yalden, 1993; Reading & Clark, 1996; Breitenmoser *et al.*, 2001; Armstrong & Seddon, 2007). However, the potential for success has increased recently due to numerous advancements, including the establishment of the IUCN (International Union for the Conservation of Nature and Natural Resources) Reintroduction Specialist Group (Stanley Price & Soorae, 2003), better reporting beginning in the 1990s, especially substantial increases in peer-reviewed publications, and the rise of restoration ecology (van Wieren, 2006) and reintroduction biology (Armstrong & Seddon, 2007). In addition to the helpful reintroduction guidelines provided by the IUCN Reintroduction Specialist Group, Reading and Clark (1996) also describe an interdisciplinary approach to improve the success rate of carnivore reintroductions. They define three aspects that should be considered in any carnivore reintroduction programme: (1) biological/ecological and technical aspects; (2) valuational (human dimensional) aspects; and (3) organizational aspects. Below, we examine the potential for jaguar reintroduction using the Reading and Clark (1996) framework.

Biological, ecological and technical aspects

Important considerations for jaguar reintroductions are: habitat requirements (space and available prey), behaviour, demography, physiology, genetics and also knowledge of effective release protocols.

Jaguar ecology and natural history

While jaguars have long been icons of wildness, beauty and mystery, little is known of the daily existence of these solitary felids. Information on space use comes from only a handful of telemetry studies in limited habitats, and describes jaguar home-range size as 10–40 km^2 in Belize (Rabinowitz & Nottingham, 1986), and 52–176 km^2 in the Brazilian Pantanal (Soisalo & Cavalcanti, 2006). Clearly, for a release site to hold a viable population of jaguars, it will have to be large (Frankham, this volume). Recently, a number of studies have used remote camera trapping to estimate jaguar abundance and population density within currently protected areas. For example, jaguar densities are high in Belize, ranging from ~6–11 jaguars per 100 km^2 for rainforest habitats (Silver *et al.*, 2004; Miller & Miller, 2005), while the Bolivian Chaco has lower densities from ~2–5 jaguars per 100 km^2 (Maffei *et al.*, 2004). Maffei *et al.*, (in press) present a useful review of density estimates across the jaguar's range. This may serve to determine the number of cats that a reintroduction site of a particular size could potentially hold, and thereby provide some basis for estimating minimum area size requirements for reintroduction sites necessary to support a viable reintroduced population. For example, using 500 animals as the effective population size necessary to maintain the adaptive potential of a species (Frankel & Soule, 1981), then area requirements would range from 4545–25,000 km^2 for jaguar densities of between two and 11 animals per 100 km^2, respectively. Alternatively, preferred prey abundance might prove to be a better method of estimating carrying capacity than area requirements (Hayward *et al.*, 2007b).

Reintroduction sites must contain adequate prey populations. Given that the jaguar's distribution extends from northern Sonora Mexico, through Central America and down to northern Argentina (Sanderson *et al.*, 2002a), it is not surprising that this range encompasses a wide variety of habitats. These include xeric, arid scrublands, swampy grasslands, montane forests, lowland tropical rainforests, dry deciduous forests, tropical pine forests and mangrove swamps (Sunquist & Sunquist, 2002). Consequently, jaguars have highly variable prey requirements across their range (e.g. Rabinowitz & Nottingham, 1986; Emmons, 1987; Crawshaw, 1995; Aranda & Sanchez-Cordero, 1996; Taber *et al.*, 1997; Troëng, 2000; Garla *et al.*, 2001; Novack *et al.*, 2005; Weckel *et al.*, 2006; Azevedo & Murray, 2007). Jaguars are considered to be opportunistic predators, and they have been found to eat tapir (*Tapirus* spp.), caiman (*Caiman* spp.), armadillo (*Dasypus novemcinctus.*), peccary (*Tayassu pecari* and *Dicotlyes* spp.), and even coatimundi (*Nasua nasua*), skunk (*Mephitis* spp.), turtle eggs and cattle (*Bos taurus*). In some areas, they subsist on large prey (>20 kg); in other regions, they primarily eat medium sized prey (10–20 kg). Although they will eat small prey in marginal habitats, their physical characteristics suggest they have evolved to prey on large vertebrates (Carbone *et al.*, 1999).

While there are some exceptions, jaguar diets tend to reflect the relative abundance of various prey species in an area (Sunquist & Sunquist, 2002). Data can be used from previous diet studies to determine the likely prey composition of an area. Reintroduction sites will need to be surveyed for adequate prey prior to jaguar release, but estimating the carrying capacity of jaguar in a given habitat based upon prey abundance can be problematic. While there is little information on how much wild cats eat, Emmons (1987) estimated that jaguars consume 34–43 g/kg of body weight per day. For a 34-kg jaguar, this translates into 1.2–1.5 kg per day, which is similar to what zoos feed captive jaguars (Emmons, 1987). Space requirements from telemetry studies, combined with prey data from diet studies, can provide guidelines to examine potential reintroduction sites for adequate space and prey. Comparison of density estimates across habitat types (Maffei *et al.*, in press) illustrates the relationship between prey abundance in these habitats and area requirements for supporting a minimum viable population.

The jaguar's wide distribution and variable prey indicates a high degree of behavioural and ecological flexibility that may make jaguars more amenable to reintroduction than more specialized species. In addition, as the competitively dominant carnivore across their range, they may be more resilient than more specialized carnivores to the reintroduction process because they are free from competitive persecution from other predators, as suggested for other top predators (Hayward *et al.*, 2007a,b). In contrast, jaguars at the edge of their distribution in Mexico have a narrower food niche than pumas, and appear more restricted to larger prey such as white-tailed deer, *Odocoileus virginianus*, and peccary (Nuñez *et al.*, 2000) and are easily disturbed by human presence (Dugleby *et al.*, 2001), possibly making them more difficult candidates for reintroductions.

Territoriality must be considered in designing a jaguar reintroduction programme. There is evidence from telemetry and camera trapping that male and female jaguar home ranges overlap substantially, both within and between the sexes (Harmsen, 2006; Soisalo & Cavalcanti, 2006). To date, however, social interactions such as home-range tenure and degree of territoriality have not

been determined. In addition, for wild jaguars, we still know almost nothing about breeding behaviour, inter-birth intervals, litter sizes, life expectancies and ages of first and last reproduction (but see Quigley & Crawshaw [2002] for some data from the Pantanal). Some of this information may be obtained from zoo populations, with the caveat that captive animals may not accurately reflect demographic rates for wild jaguars. Similarly, there is little information on jaguar physiological requirements, but jaguars are strongly associated with watercourses and streams, and they rarely occur above 1200 m in elevation (Sunquist & Sunquist, 2002).

Genetic concerns should always be considered in reintroduction programmes (Frankham, this volume). Recent genetic analyses by Eizirik *et al.*, (2001) and Ruiz-Garcia *et al.*, (2006) found that the traditional classification of jaguars into several subspecies could not be proven by genetic analysis. Thus, the original eight subspecies should not be used as management units for this species. Their results showed only that the Central and northern South American sequences were older and more basal in comparison to the two southern South American clusters, and that the Amazon River was defined as the only true barrier to jaguar dispersal, which still may be a crossable barrier. Compared to pumas, *Puma concolor* (Culver *et al.*, 2000; Walker *et al.*, 2000), jaguars have significantly higher levels of genetic diversity and, compared with leopards, which are ecologically similar and phylogentically closer, jaguars have comparable expected heterozygosity (Spong *et al.*, 2000). This suggests greater flexibility when introducing jaguars from any given area. Jaguars do not appear to be suffering from low genetic diversity, and only two genetic population clusters appear to be important. Therefore, we suggest that there are currently no identified genetic impediments to reintroductions, but that founder animals should originate from a population cluster that is consistent with the proposed reintroduction site.

Further genetic research on wild jaguars is still needed, however, as many DNA samples used in past studies were obtained from zoos or museums. It would be ideal to collect DNA at a finer geographical scale in order to investigate the current genetic status of these wild cats more precisely.

Finally, the technical aspects of potential jaguar reintroductions will depend on information from previous studies on other species. In general, past studies on carnivores have shown that soft releases appear more effective than hard releases (Hayward *et al.*, 2007a,b). Releasing wild-caught carnivores, or a mix of wild-caught and captive animals, appears to be a more successful strategy than using only captive animals as founders (Breitenmoser *et al.*, 2001). Carnivore reintroduction projects with fewer than 20 animals released suffer from a higher risk of failure (Breitenmoser *et al.*, 2001; van Wieren, 2006), but Armstrong and Seddon (2007) caution that comparative analyses across species may give misleading information regarding release group size and establishment success.

Valuation and human dimensions

Human perception of carnivores is an important influence on the success or failure of carnivore reintroduction programmes (Reading & Clark, 1996). Local support is crucial and therefore local values and attitudes must be assessed prior to any reintroduction. Effective public-relations campaigns are required to educate the public and to develop public support for carnivore reintroduction (Reading & Kellert, 1993). Human attitudes towards carnivores are highly variable, but some trends exist. Rural people tend to express strong dominionistic and utilitarian values and are likely to favour exploitation and subjugation of wildlife (Kellert *et al.*, 1996; Reading & Clark, 1996). People with more formal education and higher incomes tend to display naturalistic values with strong interest in outdoor recreation and support for wildlife conservation. Younger people and females tend to demonstrate moralistic and humanistic values and have great affection for individual animals, opposing consumptive uses (Reading & Clark, 1996).

While their widespread distribution means that they coexist in many different ethno-cultural contexts, the attitudes towards jaguars in the human communities closest to them are variable and often poorly understood (Conforti & Azevedo, 2003; Zimmerman *et al.*, 2005). Human–jaguar conflict is ubiquitous throughout the jaguar's distribution, even if the relative effects vary from region to region. The sources of conflict include direct competition for space and food, conversion and fragmentation of jaguar habitat, overhunting of jaguar prey, livestock depredation, direct killing/poisoning of jaguars and, finally, human perceptions of large predators. By and large throughout their range, the perceptions of jaguar by people who coexist with them are rooted in the context of either fear or a sense of competition born from livestock depredation.

Jaguars are reported to kill livestock in places where they occur in close contact (Schaller & Crawshaw, 1980; Mondolfi & Hoogesteijn, 1986; Rabinowitz, 1986b; Hoogesteijn *et al.*, 1993; Mazzolli *et al.*, 2002; Conforti &

Azevedo, 2003; Polisar *et al.*, 2003; Zimmerman *et al.*, 2005; Michalski *et al.*, 2006; Palmeira *et al.*, 2008). In the Venezuelan Llanos, cattle constituted up to 56% of total prey consumed by jaguar (Hoogesteijn *et al.*, 1993). In Brazil, most local livestock owners surrounding Iguacu National Park had positive perceptions of jaguars (Conforti & Azevedo, 2003). Perception did not depend on whether residents had experienced depredation, yet still, 36.5% did not favour the presence of jaguars in the Park (Conforti & Azevedo, 2003). In the Pantanal, attitudes towards jaguar were mixed and difficult to predict but appeared more closely related to respondents' age and relative wealth than to jaguar-related benefits through tourism or costs through cattle predation (Zimmerman *et al.*, 2005).

In the Venezuelan Llanos, high depredation rates and shooting of livestock-killing jaguars are commonplace, often maiming cats and potentially creating future marauding jaguars (Hoogesteijn *et al.*, 1993). Cultural attitudes such as "machismo" elevate jaguar-killers to local heroes in their communities in Venezuela (Hoogesteijn *et al.*, 1993) while, in Northern Belize, attitudes of dominion and domination over wildlife drive Mennonite ranching communities to kill large numbers of jaguars as an interpretation of God's design (personal observation).

There is no question that jaguars can become cattle-killers and, after this occurs, it is difficult to alter this behaviour (Rabinowitz, 1986b). However, several studies give excellent suggestions for modifying ranching practices and thereby minimizing this risk (Hoogesteijn *et al.*, 1993; Polisar *et al.*, 2003; Azevedo & Murray, 2007). Changing ranching practices surrounding a reintroduction site will undoubtedly be necessary and will require a large educational and technical campaign before reintroduction.

In addition to conflict over livestock, humans tend to fear jaguars. In Brazil, 52% of interview respondents viewed jaguars as a risk to human life (Conforti & Azevedo, 2003), yet there is very little evidence for unprovoked attacks by jaguars on humans. This is in stark contrast to tigers, lions and leopards which have a long history of attacking and killing humans (Guggisberg, 1975). Educational campaigns could allay these fears about jaguars and make reintroduction programmes easier.

The fact that jaguars project powerful cultural and symbolic values across their range means that it may be easier to garner support for such a charismatic species compared to lesser known species (Westman, 1990). However, as noted above, it is obvious that human valuation of jaguars is very complex. Reintroduction of jaguars will require assessment of the local communities' values,

recognition of the type of values held and, if they are anti-reintroduction, will require public educational campaigns to address concerns and alter values. Change in values is slow, especially in established communities or social groups (Williams, 1979), but is not impossible. Reading and Clark (1996) describe how change in values can be accomplished. This value shift may be the largest stumbling block to potential jaguar reintroductions in the future.

Organizational aspects

Just as the extensive range of the jaguar finds a high level of variability in the habitats and human cultural contexts in which they are found, the political and support capacity for potential reintroductions will also be highly variable. In countries with limited governmental capacities, the burden of resource and technical support for a reintroduction may come from non-governmental organizations (NGOs) and/or academic institutions.

To prevent failure being caused by an individual or organization lacking necessary expertise, the organizations responsible for reintroductions should be well matched to their tasks (Clark & Westrum, 1989; Clark *et al.*, 1989.). Since reintroduction science is in its infancy, reintroductions should be treated as carefully designed experiments, allowing us to learn from experience (Falk *et al.*, 1996; van Wieren, 2006). This generally points to including an academic institution with strong biology or wildlife sciences programmes (including carnivore ecology) as a key player in reintroductions. While academic institutions (and some governmental organizations [GOs] and NGOs) have scientific qualifications and can identify and train good students to research, design and implement scientific reintroduction studies, they are rigid in their academic requirements and timelines. Therefore, including an academic institution will require 1–2 years for study design and scientific training (usually for graduate students). This should not be an impediment considering the time it will take to garner public support through education and outreach prior to a carnivore reintroduction programme. For example, the red wolf, *Canis rufus*, reintroduction to Alligator River Wildlife Refuge in North Carolina, USA, began in 1987, 3 years after the reintroduction site was located. In those 3 years, the US Fish and Wildlife Service completed an intensive effort in contacting, educating and listening to concerns of local residents in order to facilitate local acceptance (Banks, 1988; Phillips & Parker, 1988; More & Smith, 1991).

While academic institutions can direct the science of reintroductions, biologists often do not have the skills or necessary expertise to address the concerns of surrounding communities or local governments. This task may be better suited either to researchers in human dimensions or to appropriate GOs and NGOs. For jaguar reintroduction programmes, especially in developing nations, this task will more likely fall on the shoulders of NGOs. As an example, the Wildlife Conservation Society, the Belize Zoo and the Belize Audubon Society have educational programmes for school children to teach jaguar ecology and conservation. Such organizations are already well placed to engage with the public should jaguar reintroductions be considered.

Government agencies (e.g. Departments of Forestry, Natural Resources, Environment, etc.) will also be involved in any potential jaguar reintroduction programme. Government agencies tend to be characterized by bureaucracy with rigid hierarchies and fixed rules and regulations, while NGOs tend to have a more flexible organization with a risk-embracing style (Reading & Clark, 1996; Slotow & Hunter, this volume). These styles can clash, resulting in conflict, communication breakdowns and delays. Therefore, it will be necessary to form a multidisciplinary jaguar reintroduction team, with members that are aware of the internal structures of their own, and the other, organizations involved. There will undoubtedly be numerous stakeholders (e.g. black-footed ferret recovery efforts included more than 20 organizations [Clark & Harvey, 1988]), but efficiency can be enhanced with a team of well-trained professionals who possess problem-solving experience and the ability to work with an interdisciplinary team (Reading & Clark, 1996).

Any potential reintroduction will have to start with a reintroduction feasibility study. At this stage, stakeholders will be identified and experts contacted. The minimum required personnel and stakeholders for a jaguar reintroduction programme are similar to other carnivore introductions, but a high priority should be placed on pre-and post-release monitoring of jaguar, since there has been no reintroduction research undertaken for this species. Often socio-political considerations are more concerned with the removal of problem jaguars from sensitive areas and are less concerned with adding to our knowledge base concerning the impacts and components of reintroduction protocols. It is incumbent upon conservation biologists to resist reintroductions/translocation projects if their design does not adequately commit resources of time and funding for improving our understanding of jaguar reintroductions. Furthermore, while methodological rigor should be of paramount importance in future jaguar introductions, unfocused monitoring is

an inefficient use of conservation funding (Armstrong & Seddon, 2007). Monitoring should be designed to address questions *a priori* and should be driven by scientific questions, not vice versa—in other words, the research should not be driven by monitoring (Armstrong & Seddon, 2007). Numerous questions in reintroduction biology remain unanswered (Armstrong & Seddon, 2007), and a more strategic approach integrating biological aspects, human dimensional aspects and stakeholder organizational aspects, will allow us to advance the field and gain maximum knowledge from any single reintroduction programme.

Jaguar translocation history

To date, there have been no formal translocation programmes involving reintroducing jaguars into previously inhabited, but currently uninhabited areas. This is primarily due to a lack of suitable sites with available prey. Most previously inhabited sites have been converted to other uses, and other more "intact" sites lack adequate prey. In contrast, there have been numerous instances of translocating "problem" jaguars (ones that kill livestock) to other areas already occupied by jaguars. These attempts have been either opportunistic and/or clandestine translocations (personal observation) or have been formal translocation programmes (Hoogesteijn *et al.*, 2002). In general, translocations of problem jaguars have not been successful. For example, a male problem jaguar in Argentina was shot and killed by local people within 1 week of release (Crawshaw, 1995) and, in Belize, a translocated, cattle-killing, female immediately began to prey on cattle in her new location until she was hunted and killed (Rabinowitz, 1986a). For most other opportunistic or programmatic translocations, there is little to no information on success or failure from such operations because few have been undertaken with monitoring before or after release: the survival of the individuals released and their impacts on the resident populations have not been documented.

Translocation/reintroduction potential

Compared with cervids and bovids, cats are generally more difficult to reintroduce because they live at low densities, require large areas with a full complement of prey species and usually need to spend time perfecting hunting and

killing behaviour, often via learning from an adult (Sunquist & Sunquist, 2002). In addition, territoriality and site fidelity are often strong for felids, putting animals reintroduced into an established population at a disadvantage.

Despite these difficulties and despite the lack of a documented history of reintroductions or translocations, the jaguar has potential for becoming a candidate for reintroduction. The jaguar's ecological profile is such that its habitat continues to shrink and fragment across its range, and the current declining status and nature of the human–jaguar conflict all increase the likelihood of reintroductions playing a future role in jaguar conservation. Current jaguar distribution maps suggest an increasing risk of populations becoming genetically isolated throughout their range (Marieb, 2005). This continued range reduction also makes it increasingly likely that local extinctions will be caused by a combination of anthropogenic and stochastic events. In some areas, future jaguar management could be on the metapopulation scale, where releases of individuals to re-establish populations or to increase genetic variation of established isolated small populations are potential options (see Davies-Mostert *et al.*, this volume, for an example of such metapopulation management with African wild dogs *Lycaon pictus*).

Areas without jaguars usually lack prey or protection from poaching and, therefore, few of these could actually support them. Suitable areas for future reintroduction will need to restore sufficient prey populations and eradicate or reduce poaching if reintroduction programmes are to be successful. There also may be potential for reintroduction to areas outside established reserves. For example, large private reserves that focus on tourism (e.g. in the Brazilian Pantanal) and that have previously lost their jaguar population due to hunting or past land-use practices, may provide opportunities for reintroduction once causes of jaguar decline have ceased or been reversed. The incorporation of ecotourism with reintroduction programmes has proven to be economically beneficial in Africa (Lindsey *et al.*, this volume) and could serve as a model for jaguar reintroductions.

Currently, there is no shortage of individuals for reintroduction/translocation. Problem or orphaned jaguar are routinely brought into captivity, and zoological parks and wildlife rehabilitation centres within Central and South America try to accommodate local drop-offs resulting from accidents and anti-depredation efforts. Government-funded zoological parks are often required to accept animals in need of placement as a result of illegal hunting or depredation control and, as a result, often have more captive jaguar than they can reasonably maintain in captivity. Therefore, depending upon the criteria for candidates, reintroducing a minimum of 20 jaguars at a site (as suggested earlier to increase success rates), could be feasible.

Conclusion

Based on recent jaguar abundance surveys (Maffei *et al.*, in press), several protected areas currently support key jaguar populations. Large areas in the Brazilian Pantanal, the Bolivian Chaco, La Selva Maya of Central America and the Amazon, are strongholds for jaguar populations. However, as habitat fragmentation and the resultant genetic isolation continue, the potential for reintroduction and translocation to re-establish populations, or to bolster current populations, increases.

Any reintroduction will need to begin with a feasibility study. We suggest forming a multidisciplinary jaguar reintroduction team to conduct this feasibility study. The responsibilities of such a team would include, but are not limited to:

- Identifying suitable empty habitat, including area requirements and prey availability, for a jaguar population;
- Identifying the reasons for the absence of jaguars from an area;
- Identifying why natural recolonization has not taken place;
- Assessing the level of protection of the suitable area;
- Identifying potential stakeholders, organizations and institutions involved in the potential reintroduction programme;
- Assessing attitudes towards jaguars in adjacent human communities;
- Identifying potential funding sources for a reintroduction programme, including the potential for long-term commitment for pre- and post-release monitoring.

We probably do not know enough about jaguar ecology to predict the response of jaguars to reintroduction and to predict the success of a reintroduction programme (cf. Africa's predators in Hayward, this volume). We will have to be guided by lessons learned from other felid translocations/reintroductions (e.g. concerning release methodology, suitable sex/age class candidates, etc.) as these are likely to be applicable also to jaguars. A strategic approach that includes biological/ecological knowledge of the species, addresses human attitudes and concerns and includes multiple stakeholder individuals or

organizations is more likely to be successful than an opportunistic, *ad hoc* approach towards jaguar reintroduction. In short, a successful reintroduction or translocation of a jaguar population is likely to be contingent on the proper combination of suitable habitat, socio-cultural tolerance by local and national communities and the resources in time, money and expertise to carry out such a project responsibly. To date, this "perfect storm" of circumstances has not occurred but, should all these factors fall into place, reintroduction of this most majestic of the New World felids may, in fact, be possible and worthwhile.

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