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Reproduction of the Jaguar (*Panthera onca*) in Captivity: a Focus on Cub Development and Maternal Care

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B. Alessandra Corrado Berney

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To my mother and father, in honour of the cats of our hearts – big, small, and blue!

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Thank you to the EFBC for contributing in sharing their rich data and expertise, enlightening me on the true 'behind the scenes' of big cat captive breeding, and allowing me to meet new furred friends.

Facilities

Project Survival's Cat Haven

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Exotic Feline Breeding Compound
Feline Conservation Center

3718 60th Street West
Rosamond, CA 93560
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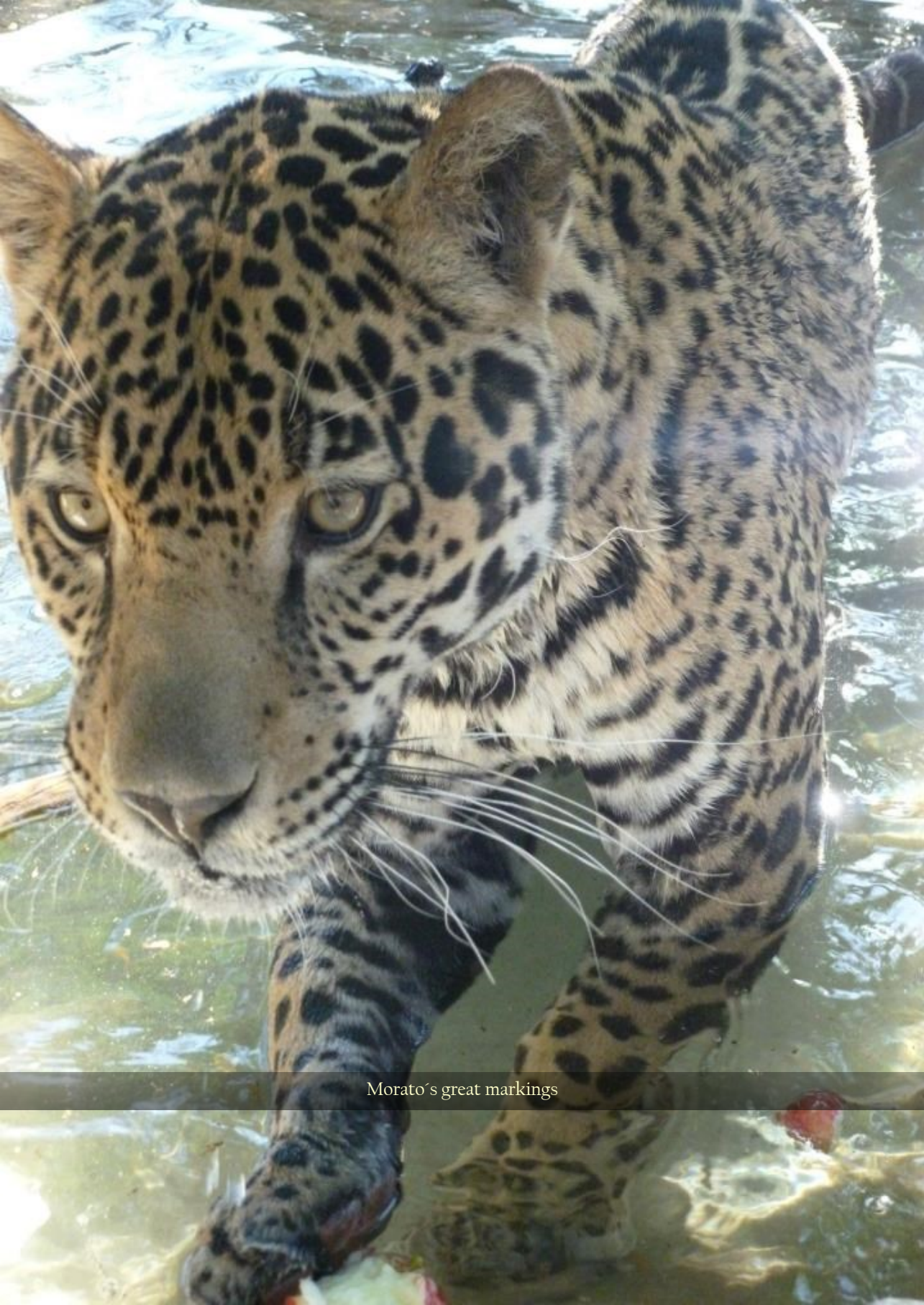
INDEX

INDEX OF IMAGES



Morato´s great markings

ABSTRACT

The main objective of the research project is to develop an ethogram for jaguar (*Panthera onca*) cubs, covering the first ten weeks of their lives. The study also examines the maternal-filial relationships in jaguars, through a comprehensive and integrated approach. It also offers the opportunity to explore the complex field of jaguar reproduction in captivity, providing a more inclusive perspective on cub raising methodologies. Data was obtained with the help of two leading facilities in jaguar breeding, research and conservation: Project Survival 's Cat Haven (Dunlap, California, USA), and the Exotic Feline Breeding Compound - Feline Conservation Center (Rosamond, California, USA). Both facilities allowed access to their cub health charts, which record both the physical and behavioural development of cubs, up to ten weeks of age. Based on the data, tables were drawn, and the behaviours were recorded and distinguished. Our observations concluded that agonistic behaviours occur with greater abundance and variety than affiliative ones, indicating that these behaviours have a greater impact and importance in terms of jaguar survival throughout their independent adult phase. The behaviours that fall within the categories of 'feeding', and 'elimination' depict an obvious transformation, moving from immediate post-natal behaviours to behaviours that will prevail throughout adulthood. The study indicates that 'Play' behaviour holds a significant role, reflecting the development of basic skills necessary for future survival, ranging from areas of reproduction, hunting, and defence. This is an area that requires deeper, and individualized study, as it reflects the gradual acquirement of skills and behaviours distinctive to the species.

RESUMEN

El principal objetivo del proyecto de investigación es desarrollar un etograma para cachorros de jaguar (*Panthera onca*), que cubra las primeras diez semanas de su vida. El estudio también examina las relaciones materno-filiales en jaguares, a través de un enfoque amplio e integral. Además, ofrece la oportunidad de explorar el complejo campo de la reproducción del jaguar en cautiverio, ofreciendo una perspectiva más incluyente sobre metodologías de crianza de cachorros. Los datos fueron obtenidos con la ayuda de dos instalaciones principales en la cría de jaguar, la investigación y la conservación: Project Survival's Cat Haven (Dunlap, California, USA), y el Exotic Feline Breeding Compound - Feline Conservation Center (Rosamond, California, USA). Ambos permitieron el acceso a los animales, además de aportar cuadros de salud, que presentan un registro del desarrollo físico y comportamental de los cachorros cubriendo sus diez semanas primeras semanas de vida. En base a estos datos, se crearon tablas descriptivas, de donde se pudieron sacar las conclusiones sobre comportamientos vistos en cachorros de jaguar. Nuestras observaciones concluyeron que los comportamientos agonísticos suelen presentarse con más abundancia y variedad que las filiales, indicándonos que hay una mayor necesidad por que se desarrollen estos comportamientos, en términos de la sobrevivencia del jaguar. Los comportamientos que caen dentro de las categorías de comportamiento 'alimentación', y 'eliminación' reflejan una transformación evidente entre comportamientos post-natales inmediatas y comportamientos que serán más presentes en el estado adulto del jaguar. El estudio indica una gran importancia en el comportamiento de juego, un área que requiere profundización en etapas posteriores de desarrollo.

Samba & Rosie

1. INTRODUCTION

1.1. LITERATURE REVIEW

The jaguar (*Panthera onca*), originally referred to as yaguarete, or 'true beast' is exactly what its name deems it to be, standing as one of our few surviving titans remaining in the Americas, charismatic and awe-drawing. Now feared but once venerated, the jaguar represents a Latin American hallmark, its most sought-out representative, and a symbol for power and perseverance. The species belongs to the class Mammalia, order Carnivora, family Felidae, and genus *Panthera*.

Jaguars hold the title of largest cat of the Americas, similar looking in pelage to their cousin —the leopard—, jaguars are much more robust and have the shortest limbs proportionately to their bodies. Both bearing rosettes, however the jaguar displaying spots within those rosettes. Their coat ranges from pale yellow, to tan, to dark reddish, to melanistic. The trait for melanism is in fact dominant in jaguars, with their rosettes occasionally still mildly visible through the melanistic coat. These cats have a surprisingly large head circumference, as well as extremely powerful jaws, leading the cats to be known for their formidable jaw size and strength.

Coming as a surprise to many researchers, there lies no genetic variation distinguishing jaguar subspecies. While it was once stipulated that eight subspecies could be distinguished based on skull characters: *P. onca arizonensis* (Arizona jaguar/Arizona, New Mexico), *P. onca centralis* (Central American jaguar/ El Salvador south to Colombia), *P. onca goldmani* (Goldman's jaguar/ Yucatan Peninsula south to Belize), *P. onca paraguensis* (Paraguay jaguar/ Matto Grosso in Brazil to northern Argentina and Paraguay), *P. onca peruviana* (Peruvian jaguar/coastal Peru), *P. onca veraecrucis* (Vera Cruz jaguar/eastern and southeastern Mexico to Texas) (Seymour, 1989), this was disproved through genetic (Eizirik *et al.*, 2001; Ruiz-Garcia *et al.*, 2006) and morphological (Larson, 1997) analysis. However, some evidence stands for four incompletely isolated phylogeographic groups across: Mexico and Guatemala, southern Central America, northern South America, and South America south of the Amazon river (Eizirk *et al.*, 2001).

With wild populations displaying a declining trend (Caso *et al.*, 2008), the implementation of conservation strategies is imperative in maintaining stable numbers. "If threats continue at the current rate the species will likely qualify for Vulnerable in the near future." (Caso *et al.*, 2008). Yet it goes without saying that it is impossible to conserve something, should a healthy understanding of what exactly is necessary for its survival, be lacking. This dilemma introduces the benefits of holding specimens in captivity, thus forth enabling the opportunity for thorough and detailed study of the species, its behaviour, and the factors influencing its survival. While field observations have offered critical knowledge on subjects such as dietary needs or tolerance to human interference, the area of reproduction and cub rearing remains an obscure topic.

Breeding practices in captivity have thus offered novel information on courting behaviour, oestrus cycle duration, gestation periods, weaning age, and many other valuable characteristics. Furthermore, a deeper understanding of cub rearing, their requirements, and the implications of such, offers participators in the field a secondary means to support population growth, should numbers in the wild continue to drop, and a more "hands-on" strategy be required to salvage a species. Such is the case of the Amur leopard (*Panthera pardus orientalis*), where numbers in the wild have dropped to a shocking 35 individuals approximately, earning it a "Critically Endangered" status since 1996 (Jackson & Nowell, 2008). It is unlikely that this species be preserved in the wild, as a minimum of 250 individuals is necessary to maintain reasonable genetic diversity. With around 35 individuals remaining in the wild and only about 200 individuals in captivity, the odds are grim. Nonetheless, experts in the area are attempting to at least preserve a captive population, so as to avoid the complete annihilation of the species; as well as control the threats that have so devastated wild populations – including human encroachment, habitat loss, and poaching (Jackson & Nowell, 2008).

After performing a complete literary review on research concerning jaguars, it became apparent that there were only a handful of articles focusing on reproduction, and less-to-none on maternal care or cub development. For this reason, this particular area of research was established as deserving of deeper understanding and investigation. Additionally, through the support and involvement of two reputable jaguar-breeding facilities (Project Survival's Cat Haven and the Exotic Feline Breeding Compound – Feline Conservation Center), novel data on cub rearing and development is offered, with insights on both maternal care as well as details on hand raising cubs. The effectiveness of mother-raising versus hand-raising cubs born in captivity will be examined in a qualitative manner. Finally, alternative conservation strategies, such as tactics stemming from conflict aversion approaches, will be discussed.

Along with synthesizing current research available on the species, this thesis aims to offer both original and unique data on jaguar reproduction in captivity, providing a better understanding of maternal care and cub rearing. Furthermore, the research piece will contribute to areas involving conservation, as well as sustainable development, suggesting effective future implementation of conservation strategies, concerning both captive efforts and those focused on wild populations. Current conservation efforts concerning jaguars will be reviewed, and recommendations of future actions will be proposed.

1.2. DISTRIBUTION, HABITAT, AND HOME RANGE

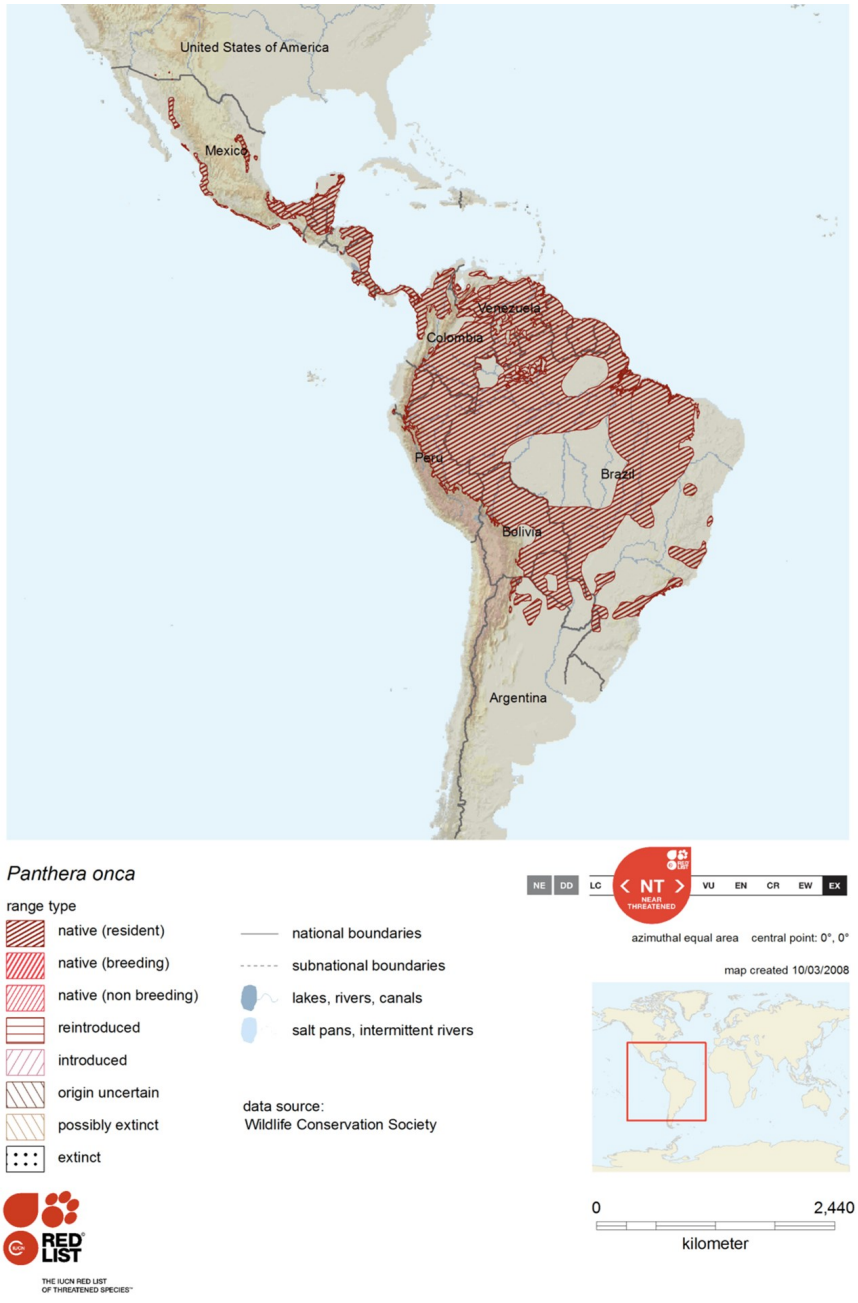


Image 1. Wildlife Conservation Society. (2008). *Panthera onca*. In: IUCN 2013. IUCN Red List of

The jaguar finds itself as the largest wildcat of the Americas, currently spanning across an area of 8.75 million square kilometres (Sanderson *et al*., 2002b). Found across Central and South America, the jaguar occupies territories from Northern Mexico to Northern Argentina. While once found as far north as the United States, the species has now become regionally extinct there, limited to temporary crossovers and appearances in New Mexico and Arizona. However, none of the sightings included individuals with cubs, indicating that there are no residential populations. The same can be said for Southern Argentina, where sightings have become rare, if not obsolete. As a result of habitat loss and fragmentation, as well as persecution, jaguars are believed to currently occupy a mere 46% of their historic range (Sanderson *et al*., 2002b), with the Amazon basin harbouring 88% of the species' Extent of Occurrence. This is not to say that the Amazon basin is the most suitable environment for the jaguar, but possibly the least disturbed.

The species is native to Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, and Venezuela; it has unfortunately become regionally extinct in El Salvador, Uruguay, and essentially the United States (Caso *et al*., 2008). Due to its extensive range, the jaguar can be found across a multitude of habitats, however its preferred environment tends to be tropical. Given that they are a riparian species, they are often found in seasonally flooded swamp areas, pampas grassland, thorn scrub woodland, and dry deciduous forest (Nowell & Jackson, 1996). The Pantanal, the Paraguayan Chaco, and the Caatinga reflect areas of high suitability (Torres *et al*., 2007), suggesting a high probability for survival.

While females' home ranges are believed to be determined by food abundance, male home ranges are in turn seemingly defined by the distribution of females (Sandell, 1989). Jaguars are primarily nocturnal and crepuscular, however their activity patterns may vary according to their location, and the activity patterns of their preferred prey. Some studies have indicated that they are active for about 50-60% of each day (Schaller & Crawshaw, 1980; Rabinowitz & Nottingham, 1986; Crawshaw & Quigley, 1991), with males travelling across significantly larger distances (3.3+1.8 km) than females (1.8+2.5 km) (Crawshaw & Quigley, 1991). Furthermore, distances covered seem to be larger in the dry season, which is likely explained by the lower abundance of prey availability (Crawshaw & Quigley, 1991).

Density estimates vary from place to place, with the highest density observed in Belize's Cockscomb Basin Wildlife Reserve, where 6-8 adult jaguars were believed to be present per 100 km² (Rabinowitz & Nottingham, 1986). Other studies have offered slightly varied results, influenced of course by the habitat, its level of disturbance, as well as prey to predator ratios. Seemingly 1.7-4 adults per 100 km² have been observed in Brazil, Peru, Colombia and Mexico (Sunquist & Sunqujist, 2002). Jaguars have been found to overlap home ranges more so than other big cats, however they rarely overlap across the core areas – which is where a significant part of their hunting occurs (Azevedo & Murray, 2007). In the same study, the researchers found that females held home ranges of at least 10 km², within the ranges of males. Males maintained larger home ranges, varying from 28-40 km², which overlapped slightly with other males. However, signs of aggression or coexistence were uncommon, suggesting communication (Rabinowitz & Nottingham, 1986).

Some of the locations ranking highest suitable for jaguar survival, so far reflect some of the lower densities, with 2.27-5.37/100 km^2 in the Paraguayan Gran Chaco (Cullen, 2005), 4.5/100 km^2 in the Colombian Amazon, with a lower density (2.5/100 km^2) in unprotected areas (Payan, 2008), and 3.5/100 km^2 in the Caatinga (Silveira, 2004).

Nonetheless, jaguar home ranges reflect significant variation across locations, number of roads, seasons, prey size, and the early months of cub raising (Hoogesteijn & Mondolfi, 1992). It is central to emphasize the significant differences reflected by males and females, as well as females with or without cubs, in terms of movement and habitat use. Males seem to venture further from their natal home range, whereas younger females appear to remain relatively close. Moreover, certain studies indicate that a female cub may be allowed 17% to 40% of their mother's home range, taking over 75-85% should the mother die (Hoogesteijn & Mondolfi, 1992).

Differences in habitat use amongst the sexes may be influenced by competition for mates, cub rearing, and other behaviours that differ between male and female large carnivores. A study performed by Conde *et al.* (2010) indicated that, although both male and female jaguars prefer tall forest, females also preferred short forest, whereas males avoided it. Furthermore, females significantly avoided roads, however males did not and were more likely to journey into low-intensity cattle ranching and agriculture areas. Females' avoidance of roads led to their habitat being much more severely fragmented than that of males, as well as the fact that they are less likely to range widely like males (Hoogesteijn & Mondolfi, 1992; Brown & Lopez-Gonzalez, 2001).

1.3. DIET

The jaguar has been defined as an opportunistic feeder due to its unrestricted consumption of a diverse array of prey species. While often considered the 'pit bull' of the wildcat family, the jaguar is built on bulk —ranging from 40 to 140 kilos—. It possesses incredibly strong jaws with which it crushes its prey's skull (Schaller & Vasconcelos, 1978; Mondolfi & Hoogesteijn, 1986), enabling it to feed on a multitude of species, ranging from capybara to caiman. Such fierce jaw strength has been speculated to be an adaptation to cracking open or tearing through thick reptilian skin or turtle carapaces (Emmons, 1987). Taking the extensiveness of its geographic range into account, it is logical that the habitat across which the species finds itself also varies substantially, which is consequently reflected in the availability and selection of prey (Emmons, 1991). While jaguars prefer larger mammalian prey (Weckel *et al.*, 2006), their diet has been found to include over 85 different species (Seymour, 1989). Depending on the location and availability of species, jaguars' preferential prey will differ, however, peccaries, tapirs, and deer are general favourites (Rabinowitz & Nottingham, 1986; Emmons, 1987). Furthermore, jaguars in more densely vegetated areas tend to be smaller (Rabinowitz & Nottingham, 1986), along with the prey that they consume (Emmons, 1991).

Cattle often fall victim to jaguar predation in areas where cattle ranchers are established amidst prime jaguar habitat, thus fuelling the conflict between man and predator. Cattle, particularly calves, characterize an 'easy meal'. Whereas certain studies have suggested that it is more likely for the males to venture out into anthopogenized landscapes hunting calves, females were more likely to avoid such scenarios (Conde *et al*., 2010); other studies, on the other hand, have indicated alternative distribution patterns. One study offers qualitative data on a female jaguar with one cub, which preyed upon calves. The female would hunt, conceal, and eviscerate the prey, returning with her cub the next day to consume it. Her estimated kill rate with one offspring was from 0.67 to 1 calf per day (Conde *et al*., 2010). As human access to jaguar habitat increases, resource selection and space use by jaguars may be transformed (Cavalcanti *et al*., 2009). Due to the vastness of jaguar distribution, it is impossible to apply a "one size fits all" approach to their prey selectiveness and hunting habits, therefore individualized studies on key areas of jaguar suitability would be more effective.

1.4. INTERACTIONS AND SOCIALITY

The jaguar and puma (*Puma concolor*) share a sympatric distribution (Scognamillo *et al*., 2003), which has led researchers to question how they preserve a balanced coexistence. Whereas studies indicate that they do not exercise spatial, nor temporal segregation, jaguars and pumas seemingly avoid conflict through major segregation in their food habits. Jaguars selected for large prey and pumas for medium-sized prey. It is believed that habitat heterogeneity may be another influencing ecological factor (Scognamillo *et al*., 2003). Furthermore, studies demonstrated a significant overlap between the activity patterns of the predators and their main prey species, implying that both the jaguar and the puma adjust their activity based on that of their prey so as to reduce their foraging energy expenditure (Foster *et al*., 2013). This may explain the slight variations in seasonal differences of activity levels, according to their selected size of prey (Scognamillo *et al*., 2003).

In terms of intraspecific interactions, jaguars may be more social than we once assumed. As previously discussed, jaguars reflect higher degrees of home range overlap than most other big cat species, with some studies indicating proximities of under 200 metres between individuals more often than expected (Cavalcanti *et al*., 2009). Studies by Schaller & Crawshaw (1980) described several cases of jaguars travelling or hunting together, including one case of four jaguars hunting in the same small area for a week, or another instance where sightings of a male with a female and 2 large cubs were recorded. Such incidences may suggest the occurrence of intra-specific social interactions beyond courtship and litter raising (Cavalcanti *et al*., 2009). Nonetheless, it has been observed that females may maintain spatial avoidance during the wet season (Cavalcanti *et al*., 2009), which also when most cubs tend to be born, due to greater prey abundance (Rabinowitz & Nottingham, 1986). The same cannot be said for female-male interactions however, where females have been spotted associated with males at a higher frequency than expected; suggesting either low cub survival rates or higher degrees of sociality. It is critical to keep in mind that "solitary" is not the opposite the antithesis of sociality, as emphasized by Leyhausen (1965).

1.5. THREATS

Joining up to 28% of our worlds terrestrial carnivore species, jaguars have fallen victims to the growing consequences and concerns related to expanding anthropogenic environments. These declines have been majorly related to regions of high human density and their consequent impacts such as intensive agriculture, persecution, and fragmentation (Ceballos & Ehrlich, 2002; Cardillo *et al*., 2004). With an estimated 83% of the land on Earth having anthropogenic influences (Sanderson *et al*., 2002a), and a world population growing exponentially, what hope is there left for the jaguar, should we continue with such unsustainable practices. Jaguars now only occupy 46% of their original range (Sanderson *et al*., 2002b). Modification of the land is by far the most serious threat, acting as a catalyst to ignite and intensify consequential anthropogenic conflict and disturbances. Modifying and fragmenting the landscape means jaguars are left with a reduced availability of prey. When the animal's home range is compromised, it is forced to occupy human-used terrain. By expanding into the jaguar's territory, we are undecidedly inviting that animal to share a closer, but conflicted, interaction with us.

With the rapid development of roads and wide-ranged urbanization, much of the jaguar's historical range has become fragmented, confining the species to a series of "islands", where many are not so bountiful in terms of prey or mate availability. As the optimal habitat decreases, "edge-effects" increase, with humans posing a greater imposition on the susceptible species (Foster, 2008). Generally, the more human activity an environment sees, the smaller the available reserves for the animal; causing more intense edge-effects tan those observed in large reserves (Harcourt *et al*., 2001; Parks & Harcourt, 2002). When this top predator consequentially inevitably preys on the nearby livestock, the conflict between Man and predator thickens and jaguars fall victims to persecution by humans, fomenting the negative relationship amongst the two. Fragmentation of the jaguar's environment not only has dire effects over jaguar ecology, but the effects carry through across the food chain. As previously discussed, jaguars are generalist hunters, and while they prefer to consume larger prey, their diet is flexible and thus may adapt to prey on more abundant species in their newfound restricted habitat. This in turn will alter the ecology of other local species.

The reduction of prey abundance not only hinders the survival for current predators, but also may be detrimental to successive reproduction as females are unlikely to reproduce in an unstable or unprofitable environment. Pregnancy and the successive months of cub raising are energetically demanding therefore reproductive rates are likely to drop in such hostile environments. Moreover, should they successfully reproduce their young or they themselves may perish, as lactating mothers require a greater food intake to support themselves and their cubs. Another alternative is that mothers finding themselves in an environment lacking abundant prey species may thus rely on hunting livestock; which in turn may lead to her persecution and the perpetuation of conflictive relations. Furthermore, a lack of prey quantity and quality may also induce lowered fecundity (Foster, 2008). The slower reproductive rates of big cats, means that we cannot afford to hamper reproduction in the wild any further, particularly if we intend to continue being so reckless with standing populations. Co-existence is crucial.

Several studies have indicated that it is the males that are more likely to be responsible for predation than the females; probably due to the fact that the males can afford to take great risks than females, and/or due to their more expensive home range providing higher occurrences of encounters (Rabinowitz, 1986; Linnell *et al*., 1999; Sáenz & Carrillo, 2002). Persecution may fall as a consequence and be influenced by an array of factors, including: innate versus learned behaviour, sex of the cat, the degree of habitat fragmentation and the proximity to human dwellings, the abundance of prey, proximity to wooded areas, and also the health of the animal (Linnell *et al*., 1999; Polisar *et al*., 2003). Ranchers often exhibit a zero tolerance to predators, despite possibly low to no predation rates and will often eliminate the animal on sight (Rabinowitz, 1986; Hoogesteijn, 2000). Oftentimes, it is human-induced injuries that cause predators to prey on easier domestic livestock (Rabinowitz, 1986; Hoogsteijn, 2000).

Jaguars are also often victims of trophy hunting. The 20th century embodies a period where jaguar populations plummeted as a consequence to the commercial skin trade. 1969 claimed the skins of around 10,000 jaguars —imported into the US alone— (Smith, 1976; McMahan, 1982; Rabinowitz, 2006). Fortunately, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was established in 1973 and incorporated the jaguar, putting its unrestrained trade to a halt. All of the countries encompassing the jaguar range have become CITES members and commercial jaguar hunting has declined (Sunquist & Sunquist, 2002). Currently, fragmentation, and consequently the direct persecution from livestock owners, combined with reductions in habitat and wild prey availability stand as the main threat to jaguars (Foster, 2008).

1.6. REPRODUCTION

Little is known on jaguar reproduction in the wild and/or captivity. Fieldwork studies are beginning to offer some insights into the subject, with studies on captive populations providing supporting information. The reproductive season is believed to be year-round, with peaks in the rainy season due to a greater abundance of prey (Rabinowitz & Nottingham, 1986). However, females have been found pregnant in April as well as October, with subsequent cub births in September, January, and July; therefore a definitive mating season cannot be identified (Cavalcanti *et al*., 2009). Rabinowitz & Nottingham (1986) collected data which suggested that a females home range will overlap with the home range of more tan one male, as well as the previously established fact that a males home range is likely to engulf the home range of numerous females, suggesting that jaguars may follow a polygynous and promiscuous mating system, with higher instances of social interaction than believed (Rabinowitz & Nottingham, 1986). A study Cavalcanti *et al.* (2009) suggests that females either have a low conception rate, a low cub survival rate, or perhaps jaguars are more social than initially accounted for.

One study indicated an average time of 3 years in between litters, with the initial age of reproduction being between 2.5 and 3 years. Average litters were deemed to carry 2 individuals, however numbers ranged from 1 to 4. With an average lifespan in the wild of 10-13 years, should a female give birth to one cub every three years, her number of cubs per lifespan (cpl) would be 2-4 cpl, and a litter of 2 cubs every three years would provide a cpl of 6-9 (Warshall, 2013). Mondolfi & Hoogesteijn (1986) concur that age of sexual maturity for females is 2-3 years old for females, and add that it is 3-4 years for males. This coincides with their age of independence, which is reached at 1.5-2 years of age. An oestrus cycle ranging from 22-65 days, averaging at 37 days, was determined in studies by Sadleir (1966), Stehlik (1971), and Leal (1979), with an oestrus lasting 6-17 days. Other studies have offered slightly diverging numbers, where the oestrus cycle length for one female jaguar was 47 days, with an oestrus of 12 days. Data provided by Hemmer (1976) indicate a gestation period ranging from 91-111 days, with an average of 101 days. Data collected within one of the facilities where this present research work was developed offered an average of 103-day long gestation period for one captive female. Primary data collected at both facilities offering data for this theses research question (Project Survival's Cat Haven and the Exotic Feline Breeding Compound - Feline Conservation Center) suggested litter sizes ranging from 1 to 4 cubs, with an average of 2 cubs per litter. This coincided with numbers offered in a study performed by Hoogesteijn & Mondolfi (1992).

Cubs remain completely dependent on their mother's milk for the first 10-11 weeks and are not completely weaned off until about 5-6 months of age (Sunquist & Sunquist, 2002). At which point, cycling may resume itself 2-3 weeks after lactational anestrus (Soares *et al*., 2006). At 15-18 months, jaguars will hunt and travel independently within their mother's range, while maintaining interactions (Quigley & Crawshaw, 2002; Sunquist & Sunquist, 2002). At around 24 months, young jaguars disperse, leaving their mothers.

As a consequence to their enigmatic nature, jaguars stand as one of the least understood big cats, with many gaps remaining across their research. While most accounts offer information on their distribution, diet, ecosystem roles, as well as conflicts with humans, little information is offered concerning their reproductive habits, or parental care. Despite their cryptic behaviour, jaguars have not been fortunate enough to escape the growing epidemic of species falling into endangered status, all too often as a consequence to anthropogenic impacts. Such activities have decimated jaguar populations, leaving about 15,000 remaining in the wild. As a result, the third biggest cat in the world is now classified as "Near Threatened" (Caso *et al*., 2008) under the IUCN Red List, as of 2002, and has been included into Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Appendix 1, as of 1975. This has triggered the necessity for maintenance of captive population, in order to safeguard the species. Details on the current captive population can be found under the Appendix, issued by the ISIS database keeping system, as "ISIS database species holding list".

1.7. CURRENT CONSERVATION STRATEGIES

The addition or loss of a species within a natural area can provoke an ecological cascade, reshaping the land, its ecology, species composition, and the physiology. This was indisputably observed in the Yellowstone National Park, in the U.S.A., when wolves were reintroduced in 1995, eventually provoking even the rivers to change their course. The introduction of even a small population of wolves caused a change in animal species distribution, which in turn lead to a change in plant composition and ecology, eventually leading to physical changes of the land through the alteration of the rivers.

According to "Panthera", a leading wildcat conservation organization which aims to 'ensure the future of wild cats through scientific leadership and global conservation action', three leading forces stand in the way of jaguar endurance: habitat loss and fragmentation due to the conversion of lands to agriculture, urbanization and the development of roads, direct hunting by people —mainly ranchers trying to protect their livestock—, and lastly, insufficient prey abundance brought on by excessive human hunting and habitat loss, which in turn leads jaguars to rely on domestic prey instead. It is understandable how ranchers, depending on their livestock to make a living, would express a low tolerance towards stalking jaguars. The conflict becomes entangled in a catalytic negative cycle, where human impacts and intrusions onto the jaguars' natural home range in turn generate a need for the jaguar to exit its natural comfort zone —areas of dense cover—, so as to access areas of pasture which assure easy prey. This in turn fuels the conflict between Man and predator and all too often provokes the issuance of lethal control over the jaguars. It is surely inevitable that encroaching the jaguars' land further and further, exhausting their natural prey volumes, together with holding livestock close to the forest cover without a cleared buffer in between, will undoubtedly lead to jaguar predation on domestic prey. It is near impossible to convince ranchers, like poachers, to stop killing jaguars on account of their intrinsic value. Which leads us to one of the key aspects of wildlife conservation: in order to preserve a species, any species, we need the people's support —mainly those that are directly affected by coexisting with the species at hand—.

Conservation activists must address the ranchers' plight. Their livelihood is at stake, therefore any means to ensure its survival, reflects a means to ensure the survival of the jaguar. Several methods of anti-predator livestock management have been effective in discouraging attacks on livestock, reducing the conflict, including: improved fencing, electric fencing, night corrals, night watchman, reduced reliance on natural water bodies, maintaining a cleared buffer between the pasture and the nearby forest, ensuring herds with vulnerable calves remain closer to human residences, incorporation of guard animals into the herd, such as water buffalo, donkeys, dogs (Foster, 2008). The clearance of buffer strips between pastures and natural vegetation, as well as good quality fences appeared to be associated with lower attack rates (Foster, 2008). Unfortunately, a persistent lack of money in developing countries is often the first obstacle impeding such measures; Economic support from the international community would be critical in order to encourage predator-friendly farming (Foster, 2008).

Some slightly more radical solutions than anti-predator livestock management include: translocation of livestock predators, wild prey recovery, and economic incentives to protect the predator (Foster, 2008). Translocation is a very delicate process, much easier said than done, where at the time of release —little remains in our hands, as to the livestock predator's faith—. The jaguar must be released in an area with sufficient prey abundance and cover, not to densely populated by other jaguars, far away from urban or rural communities. Wild prey recovery achieved by restricting game hunting and/or through population augmentation (Foster, 2008).

Another concern threatening the future of jaguars is the unceasing fragmentation of their land. The development of roads and urbanization is leaving jaguars more and more isolated, having no way to commute across the vast areas of their natural home range. This was first realized by Alan Rabinowitz, jaguar expert, in the 1980s. Rabinowitz was concerned that as jaguar became more and more isolated, this would lead to a higher degree of inbreeding, making them more susceptible to hereditary diseases. Rabinowitz, now the CEO of "Panthera", petitioned government officials of Belize to establish protected areas for these cats. His plea was granted in 1984, with Belize's Cockscomb Basin to be the very first jaguar preserve. While this initiative was momentous at the time, more protected areas like this need to be established, in order to ensure habitable and safe places for the jaguar, guaranteeing its endurance. Moreover, these protected areas should issue tighter legislation and systematic enforcement of these laws, in order to avoid protected areas purely on paper, as opposed to in practice.

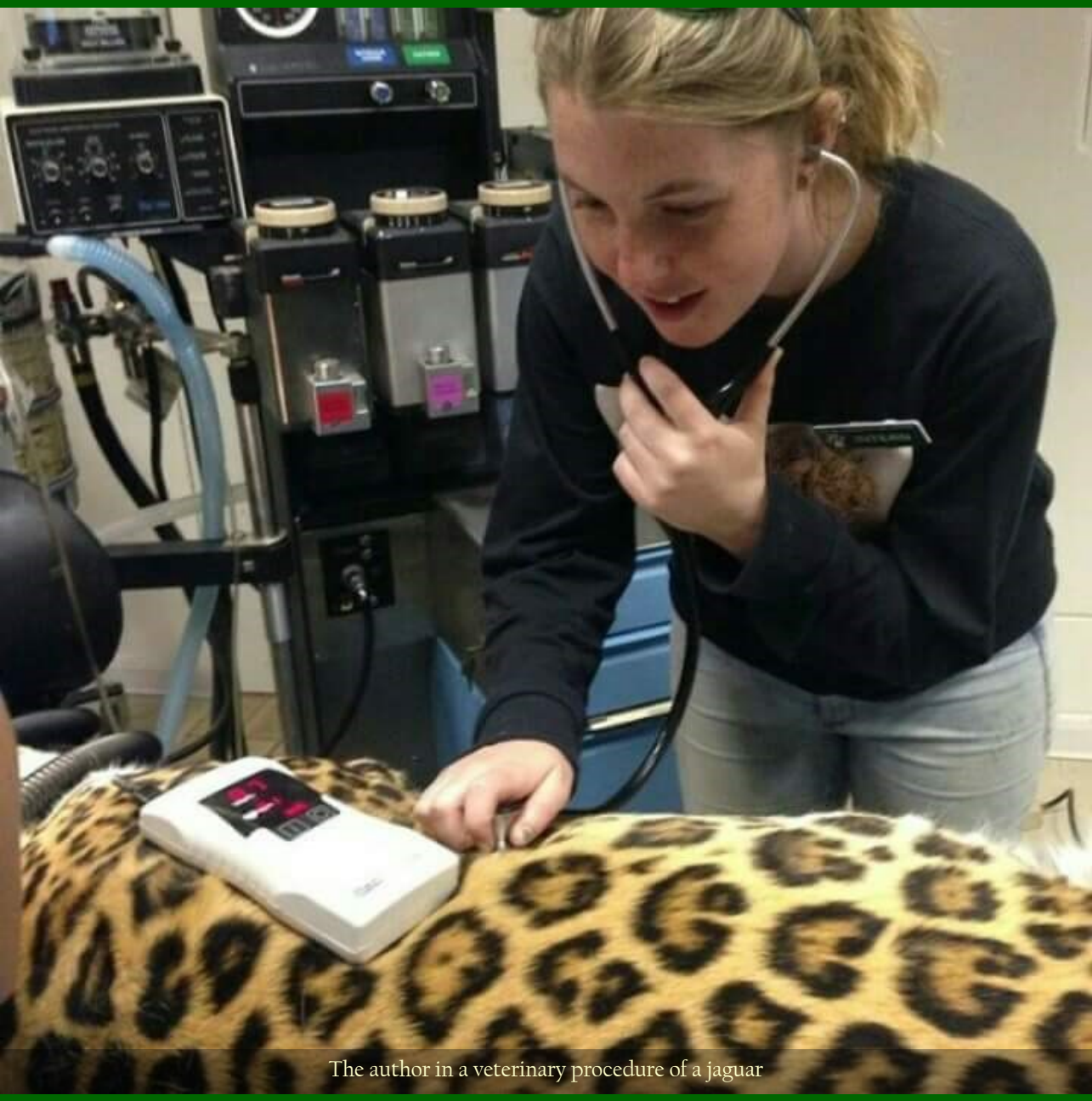
The Jaguar Freeway is a remarkable plan, unique in its nature, which attempts to address the issue of land fragmentation and isolated jaguar populations. While IVF procedures, as described in previous chapters, serve as a great aid to enable genetic flow, it is always best to do what it takes to preserve a species' natural area and ability to disperse throughout it, before relying on secondary more invasive protocols. The Jaguar Freeway, or The Jaguar Corridor Initiative, is a forward conservation effort designed by the "Panthera" organization, which seeks to link jaguar core populations, through urbanized environments, from northern Argentina to Mexico. The goal is to enable jaguars to safely travel across the areas which they are naturally found in, thus forth preserving their genetic integrity. Though the establishment and reinforcement of protected areas is vital for their survival, this is not to stay that jaguars will limit their mobility to these areas alone. Coming as a shock to many jaguar specialists, but now clearly established throughout research and well-founded organizations such as the IUCN, jaguars cannot be genetically separated into distinct subspecies —despite their tremendous area of cover, and difficulties with fragmentation—. This offers insights into the extensiveness of land they can cover across their lifestyles. This striking realization further supports The Jaguar Corridor Initiative, as it conveys the large distances that jaguars travel —for food, for mates, for cover— and the importance of maintaining paths or corridors for accessible travel. In order to succeed, "Panthera" is working on building partnerships and agreements with the government, locals, and international conservation organizations, in order to ensure safe passage.

The project first involved mapping out suitable areas for jaguars to inhabit, as well as areas which jaguars actually move through, in order to later establish relationships with the affected land owners in the hopes of establishing safe passage for jaguars, whilst establishing methods of compensation for their jaguar-friendly attitudes. According to Quigley & Herrero (2005), there are no unprovoked attacks by jaguars on people, and provoked attacks are exceptionally rare.

Many cat lovers discuss the idea of re-introduction. While this method was attempted in the past, it had not been exceedingly successful. This is due to a number of reasons. Firstly, jaguars, like most other big cats, rely on their mothers for the first two years of their lives to teach them all the skills essential to their survival. It is very difficult for humans to teach these lessons in turn; skills such as hunting, or understanding social cues in order to establish mates, can be particularly complicated. Furthermore, it relies very precise and consistent management in order to assure that the cubs do not become too strongly imprinted onto the humans that raised them —if the program required them to be mother raised that is—. A common fault to most people supporting this strategy, is that these cats will almost inevitably learn that their food is provided by humans, and once in the wild are likely to go in search of humans in order to access food in turn. This kind of scenario fuels the conflict between Man and cat, posing a danger to the local people as well as to the animal. Some wildcat reintroduction programs have been successful however, such as that of the Iberian lynx (*Lynx pardinus*), where second generation cubs have been successfully bred and raised by their mothers in a semi-captive situation, and later released into Doñana's National Park, in the South of Spain. Furthermore, in the case of the jaguar, the threats that have caused their demise in the wild, and the consequent need for captive populations, persist. Until we get these under hand, jaguar numbers will continue to drop in the wild. We must treat the causes, not the symptoms.

Morato in water with his melon

For this reason, the author believes education is the leading tool in assuring jaguar conservation. It is urgent that the world adopts a more conscious mind-frame. As conservation activists however, we must not be intolerant to those expressing a lack of tolerance towards the species we fight to conserve. We must become familiarized with their plights and needs, in order to develop creative and comprehensive ways to satisfy them, in a sustainable manner. Conservation shares a similar dynamic to any business, paralleling a supply and demand relationship. If people's needs are being heard, then they will not retaliate by mindlessly shooting a jaguar approximating their livelihood, or hunting one for its pelt, for example. If ranchers are educated on the value of jaguars, its intrinsic, ecological, and economic role as a top predator, while offering methods to alleviate the conflict, they are much more likely to comply to the principles we urge them to share with us. If a humble worker is educated on the economic benefits which could be provided to him as a by-product of eco-tourism centered round jaguars, or offered employment for example, guarding the animal instead of harming it, would this not satisfy his realistic economic needs? As mentioned before, we must treat the source, not the symptoms. By understanding what draws people to act in undesirable ways, a sustainable midpoint may be achieved, so as to satisfy both parties. But none of this can be done without education —educating conservationists on the struggles that push people down such paths, and educating the 'offenders' on alternative, sustainable solutions—. At the end of the day, the most important point to understand, is that it is not a question of two parties or two extremes —we are all on the same team, working towards a common cause, the preservation of our species, our Earth, it natural riches and ecology, and all of those complex and countless species that make up this incredibly alive planet—.



The author in a veterinary procedure of a jaguar

1.8. JAGUAR REPRODUCTION IN CAPTIVITY AND *IN SITU* INTERVENTIONS

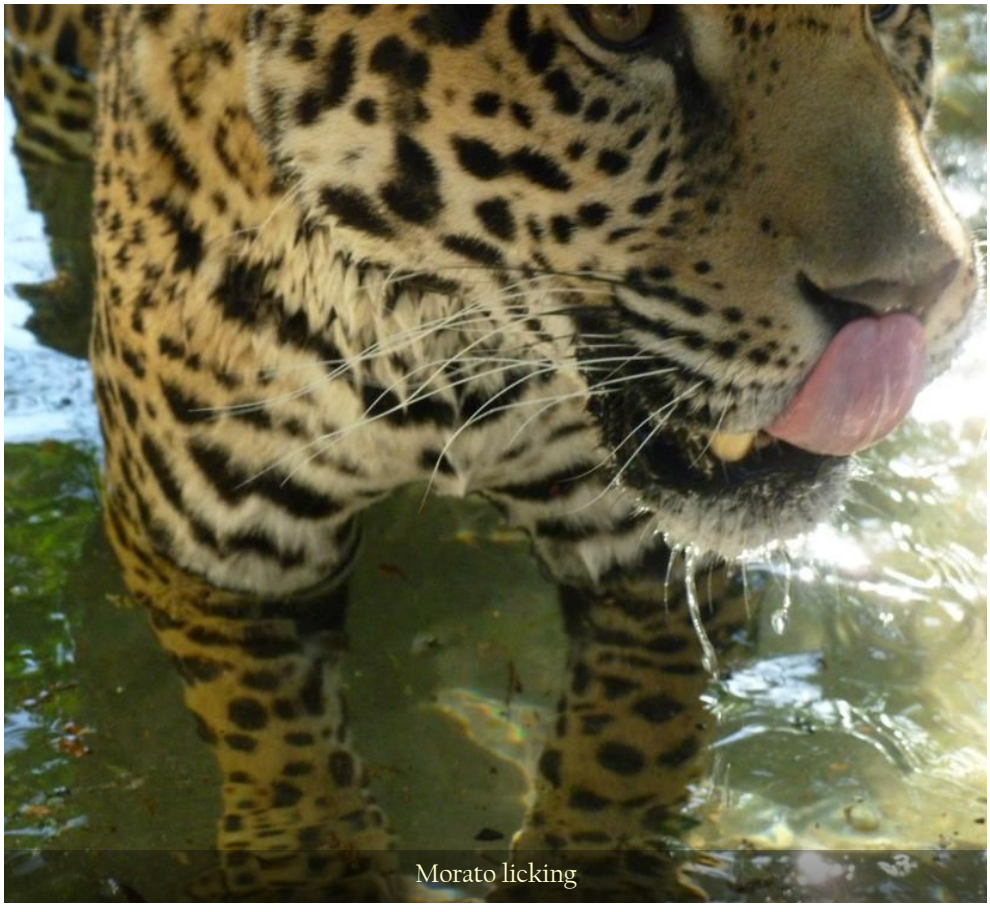
Given the previously discussed on-going concerns, assisted reproductive efforts are critical in stabilizing the steadily declining jaguar population numbers. Efforts must be developed both in the wild and in captivity to discontinue, if not reverse such a trend. While the ideal conservation strategy is that of a proactive nature as opposed to a reactive nature, preserving the animal's natural habitats so they may flourish amongst it themselves, instead of tarnishing the landscape and then having to re-stock populations elsewhere, (whether it be in the wild or captivity) is not always a plausible strategy. While great efforts are being invested into the construction of corridors connecting the jaguar's now very much fragmented landscape, as well as fighting for the implementation of protective regimes —not just on paper but also in practice, jaguar reproduction in captivity acts as a means to safeguard the population—, as well as ensure genetic diversity. High reproductive rates will help a population counteract human induced mortality (Frank & Woodroffe, 2001).

Furthermore, understanding more and more of a species' dynamics and behaviour will be crucial for fuelling and designing effective future conservation strategies. Additionally, animal husbandry practices can also be beneficial in engaging the public and educating them on the current 'conservation climate', spreading a greater appreciation or respect for these creatures. Jaguars are not merely predators, but instead stand as a key species in the ecosystem, as well as our culture and society. The extinction of such a charismatic species would have more than just ecological repercussions. The following chapter discusses means for assisted reproduction techniques in the wild, as well as reproductive efforts in captivity; drawing a comparison between hand raising cubs, versus allowing them to be mother raised. Both methods pose strengths and downfalls, and require examination at a more case-specific qualitative level, as opposed to a more generalized quantitative overlook.

1.9. ASSISTED REPRODUCTION TECHNIQUES

Jaguar numbers are declining, and with that so is the genetic variability amongst them. As fragmentation develops, jaguar populations become further and further isolated, limiting the potential for diverse genetic exchange. Furthermore, with persecution of this species persisting, the remaining available gene pool becomes more and more restricted. Should this become further limited, conservation efforts will become near impossible, as is the case of the Amur leopard —where great extents must be reached in order to find adequate mates with sufficient phylogenetic distance—. Consequently, reproduction in captivity, using meticulously selected bloodlines, as well as assisted reproduction techniques on wild populations, have become imperative tools in both increasing numbers as well as assuring healthy genetic variability. Assisted reproduction techniques have been deemed essential tools in enabling genetic exchange amongst *ex situ* locations, facilitating the reproduction of animals with physical or social impairments, accelerating the rapid growth of populations, correcting un-balanced sex ratios, regulating litter sizes, and permitting the exchange of genetic material between *in situ* and *ex situ* populations (Morato & Barnabe, 2001).

Artificial methods include artificial insemination (A.I.), *In Vitro* fertilization (IVF), or embryo transfers (E.T.). They possess significant potential as tools aimed at safeguarding jaguar populations and have been successfully applied to a number of other felid species, such as cheetahs (*Acinonyx jubatus*) and clouded leopards (*Neofelis nebulosa*). Semen collection and analysis, oocyte recuperation, maturation and IVF and embryo transfer, as well as monitoring the functionality of the testis and the ovaries, are all critical reproductive techniques, which have been used in a number of other felid species already (Morato & Barnabe, 2001). Faecal samples provide rich information allowing the study of the female oestrus cycle, examination of testicular functionality, analysis of the influence of seasonality on reproductive activity of males and females, insights on the link between sexual behaviour and hormonal profiles, as well as the identification of testicular and ovarian faults; while drawing comparisons in such characteristics between wild and captive populations (Morato & Barnabe, 2001).



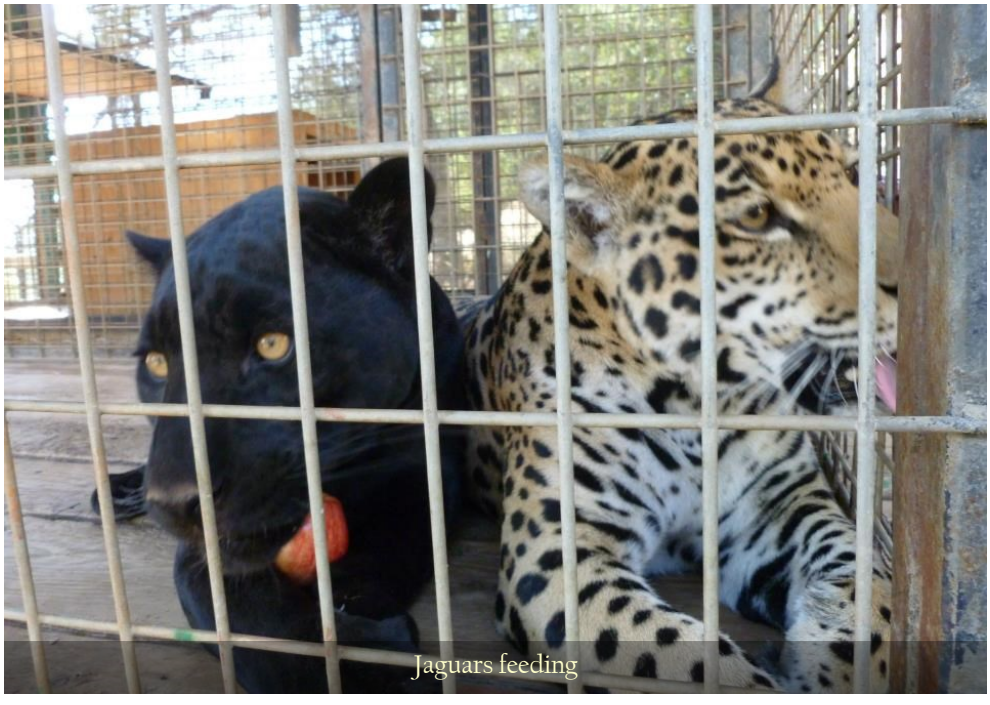
Morato licking

2. OBJECTIVES

- The research project's aims to develop an ethogram for jaguar cubs covering the first ten weeks of their lives, standing as a possible manual for reference in future captive breeding programs, as well as a means to gain a deeper understanding of the species and its founding behaviours.

- The study also briefly examines maternal-filial relationships with mother-raised cubs, offering insights on a topic significantly obscure in jaguars. It provides an opportunity to explore the complex area of captive jaguar reproduction and cub-raising, offering a more inclusive outlook on cub-raising methodologies.

- A deeper understanding of jaguar behaviour, morphology, distribution, and constitution, as well as their up-keep in captivity will be described, through the synthesis of the currently available literature on jaguars. The piece is intended to be shared across the wider scientific community and general public, communicating the value of this majestic but so often misunderstood species, and the urgency to ensure its survival.



Jaguars feeding

3. MATERIAL AND METHOD

In order to carry out this research piece and develop the cub ethogram, it was essential to work alongside two leading facilities in jaguar breeding, research, and conservation: Project Survival's Cat Haven (Dunlap, California, USA), the Exotic Feline Breeding Compound - Feline Conservation Center (Rosamond, California, USA). Each facility was worked with personally for a three-month period, during 2013 and 2014. The facilities allowed for first-hand observation of jaguar behaviour in captivity, breeding protocols, and cub-rearing. Furthermore, both facilities shared invaluable data in the form of health charts, registering the physical and behavioural developments of all cubs born within the grounds, for a period of up to ten weeks. While the data extrapolated was processed and studied across defined working periods throughout 2013 and 2014, the cub files examined span across the last twenty years and describe the births and hand rearing of sixteen cubs.

The Cat Haven was founded in 1993, by Dale Anderson. The facility exhibits over thirty cats of 13 different species, with the intention of engaging public support for their conservation in the wild by means of specific projects. With a special focus on jaguars, it supports responsible and effective captive management while encouraging respect for the natural world. It holds that the preservation of wild cats in their natural habitat should be the principle justification behind maintaining them in captivity. For this reason, it is involved with wild life specialists around the world, providing fundraising for their cause.

The Exotic Feline Breeding Compound - Feline Conservation Center (EFBC), was founded in 1977 by Joe Maynard, with its main function being breeding. It is home to over seventy wildcats and has successfully bred six different species across the years. Both facilities are non-profit organization run entirely on public donations. Cubs born within the grounds are preferably left to be mother-raised, unless the mother shows signs of poor motherhood by means of cub neglect. In which case the cubs are hand-raised and health charts are maintained in order to record their growth, feeding and excretion habits, instances of illness, as well as their behavioural development. These health charts were shared with the present author, for the elaboration of the jaguar cub ethogram, describing behaviours exhibited across the first ten weeks of their lives.

Image 2. Jaguar enclosure at Project Survival's Cat Haven, JagD, 2010

Image 3. Jaguar enclosure at Project Survival's Cat Haven, Jag16, 2013

3.1. SUBJECTS CONSIDERED IN RESEARCH

Table 1. Jaguars included in this study, pertaining to both facilities with which the research project was developed.

Jaguar	Name	Facility	Sex	MR/HR	Included in Ethogram
1	Cisco	EFBC	M	HR	Yes
2	Doc	EFBC	M	HR	Yes
3	Annie	EFBC	F	HR	Yes
4	Calamity	EFBC	F	HR	Yes
5	Cody	EFBC	M	HR	Yes
6	Casey	EFBC	F	HR	Yes
7	Bear	EFBC	M	HR	Yes
8	Butch	EFBC	M	HR	Yes
9	Rocco	EFBC	M	HR	No
10	Oz	Cat Haven	M	HR	Yes
11	Clever Girl	Cat Haven	F	HR	Yes
12	Balam	Cat Haven	M	HR	Yes
13	Samba	Cat Haven	F	HR	Yes
14	Rose	Cat Haven	F	HR	Yes
15	Santo	Cat Haven	M	HR	Yes
16	Morato	Cat Haven	M	HR	Yes
17	Rosa	EFBC	F	MR	No
18	Poncho	EFBC	M	MR	No
19	Dexter	EFBC	M	MR	No
20	Sadie	EFBC	F	MR	No
21	Nadarr	EFBC	M	MR	No
22	Myress	EFBC	F	MR	No
23	Kahn	EFBC	M	MR	No
24	Kaloa	EFBC	M	MR	No
A	Twilight	EFBC	F	MR	No
B	Jesse	EFBC	M	HR	No
C	Nacon	EFBC	M	MR	No
D	Juanita	Cat Haven	F	HR	No
E	Betia	Cat Haven	F	HR	No

***Key**: HR: Hand Raised; MR: Mother Raised; **Highlighted:** Mothers on record; M: Male; F: Female; Number: cub; Letter: Adult (Breeder)*

3.2. EFBC JAGUAR FAMILY TREE

Health charts based on first 10 weeks of hand raised cubs within this diagram were used to develop the cub ethogram. Take note of the MR/HR (mother raised vs hand raised) relationships, observing that MR females provided HR offspring and vice versa, supporting the notion that a female's upbringing doesn't necessarily limit her future capability regarding motherhood and cub care. After an initial stillbirth delivery, all of female jaguar, 'Twilight's' (JagA), future births were C-section, as a precautionary measure. On the single occasion where the mother was allowed to keep a cub, the female showed no interest or disposition to care for the cub, effectively neglecting it. The cub was therefore removed, and also hand raised.

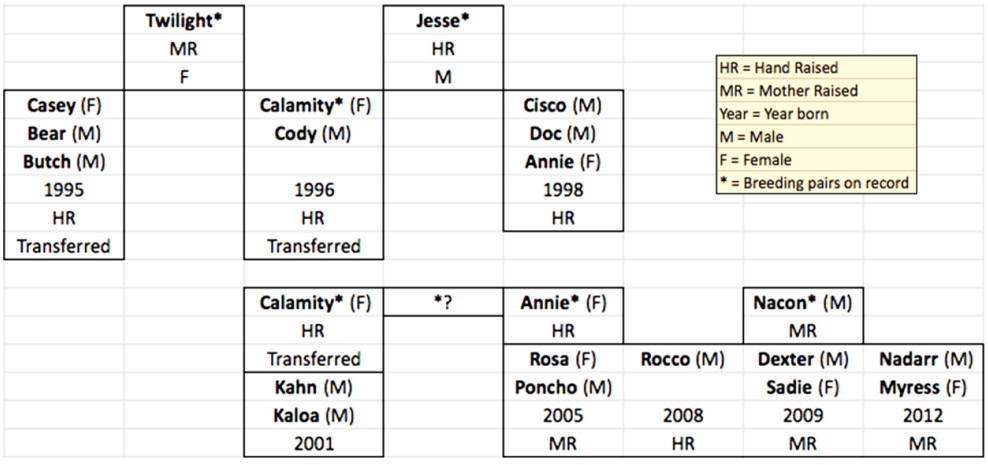


Image 4. EFBC Jaguar (*Panthera onca*) Family Tree, as of 2014

3.3. BREEDING

The following insights reflect the breeding protocol used by both re-known facilities aiding in the construction of this thesis (Project Survival's Cat Haven and Exotic Feline Breeding Compound - Feline Conservation Center). When developing a study on cub development, it is important to include the description of components such as breeding practices, feeding protocol, and rearing, as they all stand as intricate and essential aspects in the process of successfully breeding, producing, and raising cubs to adulthood. It was through the successful breeding and rearing of the cubs mentioned in this study, that an ethogram could be developed. A detailed description of feeding protocols employed by both facilities can be found in the appendices.

Breeding commences with the introduction of animals for the establishment of a new pair. The male and female should be housed in such a way that they are separate, but next to each other, enabling visual, olfactory, and auditory contact through such proximity. Keepers must provide close supervision and record any signs of aggression. When possible, house the pair in separate den areas, within the same enclosure, alternating access to the main cage for a period of at least two weeks. This time allocation, as well as individual behaviours and interactions observed in the animals, will vary amongst individuals. Should there be no significant signs of aggression, the keepers may move on to the next step of the process which involves introducing the pair to one another for short periods of time, under close supervision. Hoses should be accessible in order to ensure a hasty break up of a fight. In the case that there is no aggression, the pair may be left together for longer periods of time, however not overnight, for one to two weeks. These interactions should be observed for signs of aggression as well as courtship behaviour. Eventually, if there is still no aggression, they may be housed together more permanently. For pairs that have already been housed together previously, re-introductions must still be monitored and taken slowly, in order to ensure safe interactions. Signs of mating should be recorded in order to calculate possible due dates.

Should the female become pregnant, its advised that the pair be separated around two weeks previous to the expected due date. The female's diet should be incremented by 30-50% for the last stage of gestation as well as throughout lactation. Reintroduction of the male may be allowed if the female has not given birth by 14 days after the latest possible due date. During the week prior to the birth, as well as the close weeks following, access to the enclosure should be limited to only the keepers that normally are responsible for the cat. This is to ensure a comfortable and safe environment for the mother, and her cubs. It is generally advised that cubs be allowed to stay with the mother unless she shows signs to being an unfit mother, or the cubs show serious signs of distress. It is recommendable that handling of the cubs and/or physical examination should be reserved for when they reach eight weeks of age, at which point they may be sexed, weighed, vaccinated, etc. A detailed account on Jag3's 'birth log' can be found in the appendix (under the title "Annie's log"); the document describes the female jaguar's behaviour on the days coming up to her due date, and those following soon after. The document is an extract from the EFBC health chart records, on Jag3, 2005.

3.4. FEMALES IN LABOUR

Females in labour should be left to themselves, and the mother's den box should not be approached prior to the first two hours after hearing the last cub born in order not to startle her; otherwise, this could cause her contractions to stop abruptly or incentivize her to kill the cubs herself. If the female is not an apt mother and this is known, she must be separated as quickly as possible (without provoking stress onto her), in order to pull and tend to the new born cubs. If the female remains with the cubs and is taking care of them, leave them alone and ensure a safe and comfortable environment.

Cubs are generally born within fifteen minutes, to two hours from each other; any longer is an indication of complications. Signs of trouble include: an hour of intense straining without birth, ten minutes of intense straining with the cub visible in the birth canal or the mother walking around with the cub in the birth canal, ten minutes of fresh bleeding (several tea spoons) throughout or after the birth, sudden weakness, or an abrupt halt to labour with signs of distress, at which point it is necessary to intervene.

Should the cubs remain with their mother, average age weaning of jaguars is reached at five to six months of age. Cubs may be separated from their mother thirty days after they are weaned. If the cubs must be removed premature to their weaning, the female's diet should be limited to 50% of her usual intake, for two to three days, in order to induce the reduction of lactation. At that point the male may be reintroduced if desired. However, if cubs are pulled from the mother immediately after birth, a number of aspects should be accounted for.

Firstly, one must assure that the cub is successfully out of the amniotic sac. The amniotic sac may be removed by gently pulling it away, starting at the mouth and moving down the body. Mucous in the mouth and nose must be immediately aspirated using a syringe or an eye-dropper. Follow by rubbing the cub with a dry, soft towel in order to stimulate breathing. In the case that the cub is not breathing on its own, gently squeeze its chest from side to side and then from front to back. If it persists, place your mouth over its nose and blow gently, ensuring its mouth is uncovered. Blowing forcefully can rupture the lungs therefore this must be avoided, while leaving the mouth exposed helps to avoid this. Remove your mouth to allow the cub to breath and repeat until it begins to breathe on its own. Use a soft, dry towel to rub and warm up should the cub be cold or dry. Lastly, if the umbilical cord is longer than half an inch, tie it tightly with un-waxed dental floss and cut it below the tie. Place the cub in a warm, covered area; such as a towel-covered heating pad. Make sure the heating pad is on a 'low' setting and allow for areas of different amounts of towel layers so that the cub may move to a cooler area if desired. Keep inside a small, loosely covered carrier, in order to prevent drafts. Allow to settle in the carrier for around an hour before the first feeding.

It is highly important to remember never to feed a cold cub, making sure it is warm before feeding. Additionally, cubs must be stimulated before feeding to eliminate waste; this may be achieved by rubbing the anus repeatedly with a wet wipe, holding the tail away, until the cub expels all of its waste. It is normal for the first stool to be of a brown to orange, or yellowish colour. Bottles, nipples, measuring cups and all appliances used for cub feeding must be boiled previous to use.

3.5. POTENTIAL HAZARDS

A number of common problems or potential hazards should be closely watched for across the cub's early stages. Aspirating on the bottle is a common mishap when cubs are not bottle-fed in an appropriate position. The bottle should be tilted above the head, without forcing the cub to tilts its head too far back as this could lead to choking or formula gathering in the lungs. Should this occur, hold the cub in both hands, securing the head, and gently swing downwards in an arch. Softly pat the lung/rib area throughout, until breathing sounds clear once again. Keep the cub active and warm afterwards, and monitor closely for twenty-four hours. Constipation, diarrhoea, as well as abnormal stool colours should all be monitored. Greenish coloured stool may be an indication that the cub is eating too much, while white coloured stool generally indicates that the cub is not digesting the formula properly. If the stool is more of a grey colour, this may be an indication of pancreatic issues. Puss draining from the navel, swelling, the forming of abscesses, or red colouration, are all indications of an umbilical infection, which must also be watched out for. Eye discharge may be a sign of conjunctivitis, and may be treated by holding a warm, wet, washcloth over the eye until all the mucous is cleared and the eye is open. Terramycin may be used to treat both eyes, three to four times a day, for a period of two to three days. Should it persist, contact the responsible veterinarian. If the eyes are not opening or opening and closing again, and there is no discharge present, BNP or mycitracin ointment may be applied three to four times a day. Should this persist past twenty-four hours, however, the responsible veterinarian must be contacted.

3.6. MOTHER RAISED VERSUS HAND RAISED

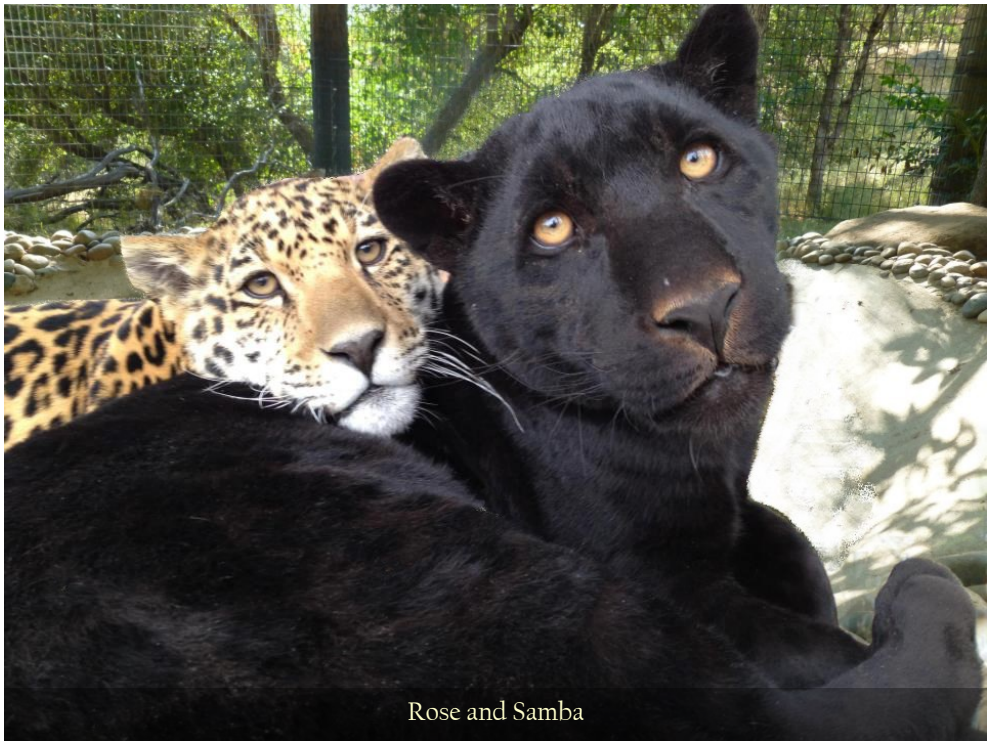
The question of whether pulling cubs born in captivity and subsequently hand raising (H.R.) them, versus allowing them to be mother raised (M.R.), remains under much dispute. Both methods pose their fair share of benefits, as well as downfalls - offering great virtue in certain aspects while lacking in others. Distinguishing which approach is more appropriate, and/or ethical, is a complex task; as well as which provides the greater benefits in terms of current and future conservation status. Lead conservationists, wildcat specialists, and organizations worldwide will differ on their view, and scarce conclusive results have been established so far. Recordings and research investigations up to now lack a focus or deeper examination into this area, and have not yet truly quantified this question. Furthermore, while there is a general protocol for appropriate cub raising, different facilities will vary in their management —even whilst employing the same approach (M.R. or H.R.)—, making it difficult to remove this human bias impact from the results.

Image 5. Mother (Jag3) with cubs (Jag 21 & Jag 22) at the EFBC, 2012

Image 6. Jag1-3, born via C-section, and thus hand-raised, at the EFBC, 1998

It is a question that would likely be answered most appropriately at an individual-specific level, as generalizations to the entire species may provide unprofitable results. Motherhood in wildcats, is not innate, but is learned. Moreover, if one believes in the concept of animals having personalities (which, anyone who has worked profusely with animals will not deny), this is another influencing factor, both on behaviour and reproduction (Tetley & O'Hara, 2012). Additionally, different species pose different particularities, varying in the degree to which they can be viably bred and raised in captivity. Cheetahs (*Acinonyx jubatus*), for example, are particularly problematic to breed in captivity, due to their high stress levels. Pallas cats (*Otocolobus manul*) have rarely been successfully hand raised and almost exclusively require their own mothers to raise them —this is not to say that all females end up being 'fit' mothers, however—. More ground has been covered though, in hand raising big cats, where there have been significantly more successful cases of hand raised cubs reaching adulthood. Establishing a mate and successfully breeding in the future however, is another concern.

Each of the branches outstretching from animal husbandry have taken years and years to define and delineate, for each individual species. Animals of different species, even those within the same family or genus, may vary tremendously across any given component of their husbandry. Having conservation as our ultimate goal, the ability to control a certain situation, or its development, is a critical factor. Control requires knowledge. Knowledge requires investigation; and so the cycle repeats itself.



Rose and Samba

In a captive, *controlled* situation, we would like to effectively manage systems such as reproduction, birth, and the raising of offspring - ensuring they themselves reach adulthood, and in turn form a part of this reproductive cycle, supplementing population numbers. As previously stated, in wildcats as in humans, motherhood is learned. Generally speaking, parental care will improve with the amount of litters a female gives birth to. This strengthens the conviction that to be a 'good' mother is something which is learned. Similarly, humans have also learned to provide better care for growing cubs as we gain further experience and expertise.

It is true that a mother is a fitter candidate to raise her cubs than a human. Aspects such as feeding, the amount and composition of the milk, as well as the adequate age for weaning or detachment from the cubs, come naturally to her. For humans, however, deducing such details remains a work in progress. Certain behaviour in particular, such as ensuring the elimination of waste before feeding, come naturally to the mother, strengthening the mother-cub bond while soothing the cub; conversely, when performed manually by humans on cubs, this interaction may come across as aversive for the cub. Mothers possess a level of communication, sync, and understanding of their cubs far beyond our own —often reflected across cases of infanticide—, where mothers sense an inability in their cubs and thus eliminate it, following in suit with natural selection. In the wild, cubs may rely on their mothers for up to the first two years of their lives to teach them survival skills. However, it is important to recall that many of these survival skills are redundant in captivity, as skills such as hunting or avoiding predators are unnecessary amongst a confined, controlled environment. On the other hand, mothers also teach and condition socialization behaviours —this being the principle argument for allowing cubs to be mother raised—.

Despite the close ties humans may develop with wild animals, we lack the innate communication they share amongst one other. We may study behaviours and attempt to reproduce them, but it is unlikely it will ever be exactly the same as observed amongst wild species. Socialization skills are critical instruments for animal survival. Social cues indicate threats, opportunities to mate or establish alliances, neutral or passive behaviour, and contribute in the establishment of hierarchy. Mothers educate cubs on how to adequately interact with other individuals of their same species (as well as with those of others), and how to effectively interpret behavioural cues. Mothers both discipline and encourage cubs in a language they understand, and are innately aware of the level or forcefulness required to get the point across. Appropriate socialization skills will enable an animal to interact with other members of its same species later on in life, impacting its opportunity to find and establish a mate. All too often, cubs that have been hand raised become too imprinted upon the humans that raised them and thus lack the skills to interact appropriately with other individuals of their species, impeding them from establishing a mate, and thus reproducing. While such dilemmas can be handled using assisted reproductive techniques, such as *In Vitro* fertilization (IVF), or artificial insemination (A.I.), it is important to remember that these procedures are not only invasive but also highly expensive.

Some experts believe that mother raised cubs develop larger and faster, and end up being fitter due to the physical stimulation through interaction with their mothers and/or siblings. Concerns such as choking on the bottle or aspirating formula into the lungs are unlikely when left to be mother raised, but common concerns to be watched for when hand raising a cub. Cubs develop behavioural characteristics closer to those exhibited by their wild counter parts when mother raised as their engagement with humans is more limited.

It is important to clarify from an early stage what our ultimate goals for any given reproduction program are. In the case of hopeful future re-introductions, as little human interaction as possible must be ensured for the cubs/kittens, keeping them to as naturalized an environment as possible. Such programs will employ cub raising by their mothers, almost exclusively, maintaining little human contact and allowing the mother the opportunity to teach her offspring the skills required to thrive in the wild. Re-introduction programs, however, have not been as successful with wild cats as with many other mammalian species, particularly when considering big cats. While there have been successful re-introduction cases of smaller cats such as bobcats (*Lynx rufus*), or predominantly with the Iberian lynx (*Lynx pardinus*), the same cannot be said for big cat species; who subsequently learn that their food comes from humans, and in turn harass the people located in nearby rural villages, fuelling the conflict amongst the two as well as putting both animal and human lives in danger. This is why, generally speaking, a cat born in captivity will remain in captivity. While these animals would likely fail to survive in the wild, their reproduction and captive keeping is a means to ensure genetic diversity amongst the population as well as safeguard against the species extinction.

Samba & Rose in the tub

Keeping this concept in mind, we may re-shape our views on what is the most appropriate form of maintaining and handling these animals in captivity. If they are to remain in a captive environment, is it necessary —if at all appropriate—, to attempt to ensure behaviours strictly observed in the wild. This is important to a certain degree. One of our major reasons for maintaining captive populations is to study and gain knowledge on the species, in order to apply this knowledge when strategizing conservation plans for wild populations. Therefore, ensuring behaviours remain as "natural" as possible, allows us to understand the un-humanized nature of the animal, its development and behaviours, and giving us insights on elements of its survival. Furthermore, if we wish to use assisted reproductive techniques to enable genetic exchange between captive and wild populations, certain behavioural traits which may have a genetic basis, such as aggressiveness (for territoriality or mate possessiveness) are required.

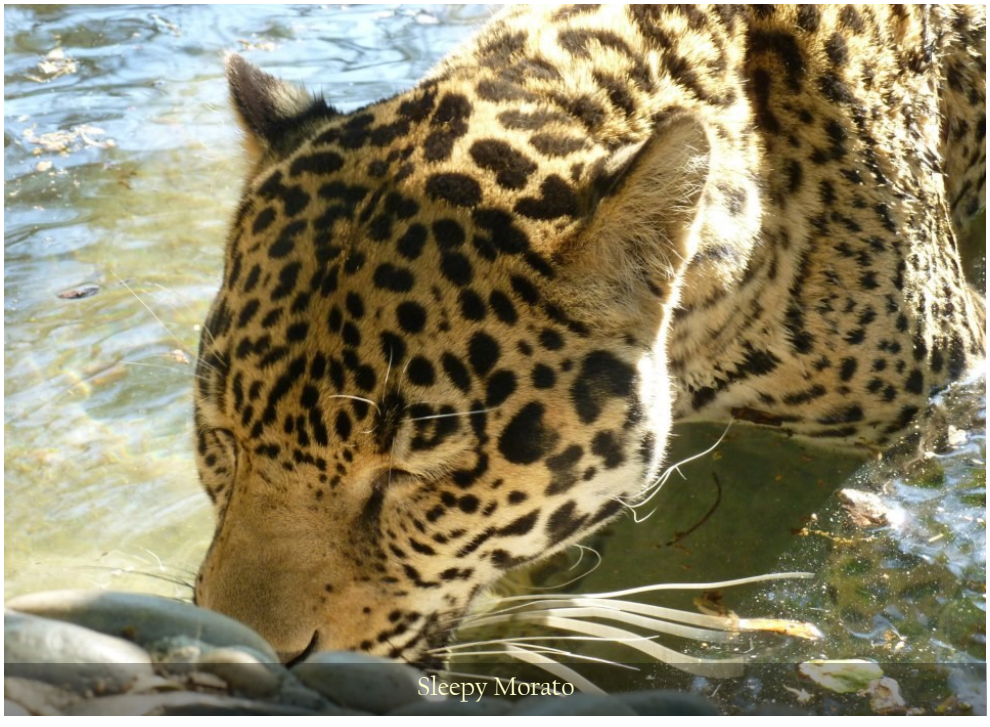
On the other hand, it is important to recall that captive environments often provoke an added stress onto animals —particularly those with a "wilder" or less domesticable nature—, which are not as desensitized to the strains of daily interactions with humans. This is why developing a closer relationship with the animals, allowing them to be comfortable in the presence of humans, is often preferable when raising species in captivity.

If these animals are bound to life in captivity, why not allow them to re-adjust to their current and permanent environment as opposed to attempting to maintain behaviours reserved for survival in the wild, but not as advantageous in captivity. Not only are mother raised captive cubs more prone to higher stress levels, but the mothers themselves also face mixed levels of stress whilst raising the cubs in a captive situation - not unlike in the wild where stressful environments are also experienced; however, this can lead to cases of infanticide. Hand raising cubs removes this risk. Hand raising also enables a greater control and/or vigilance over aspects of health, where medical check-ups and the recording of weight become much more accessible.

Cubs raised by humans create close bonds to their keepers and are likely to be much more comfortable around humans. While this may impede their socialization skills with other members of their species, it may facilitate reproduction in the sense that cats which remain more unfamiliar to humans oftentimes are too stressed to breed in a captive environment, or may end up killing their cubs should the pregnancy come to term; contrarily, cubs which were hand raised tend to be much more relaxed around humans making them more likely to feel safe and thus reproduce.

This has been observed in Clouded leopards (*Neofelis nebulosa*), which often are problematic when raising their cubs in captivity and thus they must be hand raised; despite this, they later show little signs of disturbance when later faced with the task of establishing a mate and reproducing.

An animal under less stress holds a higher quality of wellbeing, and consequently, is likely to reflect better health. Furthermore, experience has helped cat specialists develop methods by which to avoid cubs from imprinting too strongly onto humans - though this is not always entirely successful and will vary in success from facility to facility, cub to cub, as well as handler to handler. These cubs are likely to be much easier to manipulate and handle in the future, than cubs that have had more limited interactions with humans, enabling safer interactions —for both cat and human—, as well as higher accessibility of medical check-ups throughout their life time, and less stressful interactions. Still, hand raising cubs is highly time consuming and requires great dedication and discipline. It is a demanding commitment, which uses up resources and expenses, particularly when more than one cub must be cared for, and not many organizations have the means to carry out the task effectively. Many specialists will argue that it is better to leave cubs with their mother, not only because she is better equipped for the role but also from an ethical point of view. Numerous specialist organizations will hold that cubs should only be pulled under any of the following instances: cannibalism (unless there is any indication of the cubs being unviable), cub abandonment, if the female is caring for the cubs but one of the cubs is having difficulties suckling or has been clearly left aside or neglected (Vargas *et al*., 2006). The debate is therefore arduous. The main goal when breeding and raising captive populations is to find a balance between promoting natural behaviours, such as territoriality and social interactions, while ensuring a stress-free environment, which encourages copulatory behaviour (Vargas *et al*., 2007).



Sleepy Morato

3.7. THE ELABORATION OF THE ETHOGRAM

The ethogram described in the present research piece was elaborated by examining and standardising data recorded in the Health Charts of 16 jaguar cubs, pertaining to 2 captive facilities (Project Survival's Cat Haven, Dunlap, California, USA and the Exotic Feline Breeding Compound - Feline Conservation Centre, Rosamond, California, USA). The Health Charts included chart the data of cubs born in each of the facilities across 20 years, but only consider the first 10 weeks of the animal's life. The data was first recorded by the animals' principle care takers belonging to each of the aforementioned facilities, which stand as specialists in wildcat care and captive breeding. In both facilities, any and all behaviours, activities and events occurring within the observation period were recorded, predominantly surrounding behaviours related to feeding, excretion and interaction with their environment or other individuals. However, the way in which these behaviours and events are described varies, and scientific language is not employed.

Recordings were taken on a daily basis every two-four hours, across the first 10 weeks of each cub's life. Only behaviours that were observed during the time span of observation, which revolved around feeding and excretion periods, were annotated. The lengths of said behaviours ranged from a number of seconds to several minutes. When a behaviour was observed for the first time, this too was noted.

The raw data was recorded by to the 2 captive facilities (Project Survival's Cat Haven, Dunlap, California, USA and the Exotic Feline Breeding Compound - Feline Conservation Centre, Rosamond, California, USA) and has been analysed and categorised as secondary information by the present author. All behaviours recorded in the cub's health charts spanning across the first 10 weeks of their life were subsequently recorded and categorized within tables by the present author. The raw data often describes behaviours holding the same function and/or morphological form in a variation ways (non-standardised data collection). During the elaboration of the ethogram, such descriptions were analysed and standardised, grouping behaviours of the same nature, while distinguishing the morphological structure, as well as functioning behind it. Behaviours were classified across seven distinct categories: affiliative, agonistic, grooming, feeding, locomotor, elimination, and sensorial. Such instances of behaviour are believed to be reflections or practices of future behaviours essential to survival and social interaction.

4. RESULTS

4.1. BEHAVIOURAL TRAITS: A JAGUAR (*Panthera onca*) CUB ETHOGRAM (0-10 WEEKS)

The following behaviours have been observed and recorded across the health charts of cubs pertaining to Project Survival's Cat Haven and the Exotic Feline Breeding Compound - Feline Conservation Center (EFBC). Below are enlisted the array of behaviours observed, with full descriptions and complementary images. While the descriptive tables (for jaguars 1-16, tables 2-17 in the appendices) reflect observations denoted as they were originally recorded, the ethogram attempts to standardize these descriptions, providing a more accurate and concise description of each behavioural trait observed. For this reason, each behavioural trait is followed by a list of the terms and phrases which may have been employed in the original health charts in order to describe or refer to a particular behaviour.

SOCIAL

Affiliative

Play behaviour: has been observed as solitary, amongst siblings, as well as with other species. We adopt the definition of play offered by Bekoff & Byers (1981), as "any post-natal motor activity that appears to be purposeless, in which motor patterns from other contexts may often be used in modified forms and temporal sequencing." While play behaviour may appear 'purposeless' at the time, play behaviour is in fact quite instrumental in allowing the cub to develop motor skill coordination. It strengthens skills that will be vital in adulthood, intricate aspects to behaviours such as hunting, defense, or mating. Play may be solitary, where the cub carries out such mannerisms independently, or may be of a more social nature, where the cub interacts with another individual, be it conspecific —such as a sibling—, or in fact another species that maybe being raised alongside the cub's development. When the play behaviour is solitary, it falls within the category of Locomotor, whereas interactive play with another individual falls within Filial behaviours.

The following annotations all represent 'play' behaviour.

Playing with siblings: motor activity that appears to be purposeless, in which motor patterns from other contexts may often be used in modified forms and temporal sequencing, where the activity is of an interactive and responsive nature, with a sibling.

> **Found registered as the following within the descriptive tables**: *playpen with littermates, playing with littermates, played with brother, played with sister, played good with littermates.*

Image 7. Jags1,2&3 'Playing with siblings', at the EFBC, 1998

Playing with other species: motor activity that appears to be purposeless, in which motor patterns from other contexts may often be used in modified forms and temporal sequencing, where the activity is of an interactive and responsive nature, with an individual from a separate species.

Found registered as the following within the descriptive tables: *played with fishing cats, plays with dog, lots of play with volunteers*

Chase: running after another individual, either a conspecific or other.

Found registered as the following within the descriptive tables: *chasing littermates, runs after brother, chasing house cat*

Affection: showing fond interest or gentleness towards another individual.

Found registered as the following within the descriptive tables: *loving baby, wanting attention, likes to cuddle, affectionate, likes to have belly rubbed —mainly towards the primary care-giver—.*

Attention-seeking: vocalizations with the intention of receiving attention from a care-giving figure, often moving towards their general direction. The intention is confirmed when cub calms down, holds a relaxed stance, quieting vocalizations, once in contact with primary care-giver.

Found registered as the following within the descriptive tables: *runs to you, needing attention, yelling for attention, vocalizations, crying, likes to hear you talk.*

Image 8. Jag2, 'Attention-seeking', at the EFBC, 1998

Agonistic

Attack

Batting/swatting: forceful striking out with front paw, with the intention to hit/hurt/dissuade; may have claws out, or not.

Biting: holding onto, chewing, or grabbing things with the mouth

Found registered as the following within the descriptive tables: *biting, biting hard, biting rough, doesn't want to eat - just bite*

Non-nutritive chewing: grinding of the teeth on an object and/or individual.

Stalk: approaching an object/individual while maintaining body close to the ground, discretely drawing in on proximity, while attempting to go un-noticed.

Image 9. Jag1 'Stalking', at EFBC, 1998

Pounce: sudden jump towards a target, whilst within close proximity of reach.

Attack: swatting, biting, and/or lunging at another object or individual, with the intention to aggress. Attacking may be corresponded, or merely a one-sided warning.

Corresponded: aggressing another individual with the potential to respond.

Found registered as the following within the descriptive tables: *fighting, fight with sister, attacking brothers, beat up brother, harassing house cat, playful biting sister, rough play with sibling, ear biting sibling, little fight.*

Image 10. Jag1 & Jag3 'Corresponded Fighting', at the EFBC, 1998

One-sided: attacking an object unable to respond.

Found registered as the following within the descriptive tables: *getting mad at toys, beating up toy/attacking toy, temper tantrum.*

Wrestle: rolling whilst entangled with either a conspecific or other species; legs are usually off the ground, leaning on back or side; may be at the delivering or receiving end of attempting to forcefully hold down and restrain counterpart individual.

Found registered as the following within the descriptive tables: *wrestling with dog.*

Image 11. Jag4, 'Wrestling' with a 3-month old fishing cat (*Prionailurus viverrinus*), at the EFBC, 1996

Possessiveness

Object possessive: becomes physically aggressive and defensive over an object, keeping object close to itself, away from others – often using its body as a barrier between the object and the other individuals.

Found registered as the following within the descriptive tables: *doesn't like to share toys, doesn't like to share bowl with sister.*

Food possessive: becomes physically aggressive and defensive when around food. Will use vocalization to warn, often striking out with forelegs. The behaviour is considered whether or not it leads to physical aggression.

Found registered as the following within the descriptive tables: *aggressive with chicken legs, stealing sibling's food, steals chicken legs from littermates, very possessive over chicken leg, wanted to keep chicken all to herself, gave keeper smack when took bone (swat – anterior function).*

Threatening

Threat vocalizations: any of hissing, spitting, while baring teeth, or growling communicating an aggressive warning; if such vocalizations are ignored, the level of aggression tends to heighten.

Hiss: creating a harsh sibilant sound.

Spit: forcefully ejecting saliva from its mouth; the sound is built in the pallet of the mouth by pressing of the tongue.

Growl: a guttural sound, exposing teeth and formed in the throat.

Found registered as the following within the descriptive tables: *hissing and spitting, likes to hiss and bite, hissing fit, growling.*

Territoriality

Claw scratching: rhythmically scraping ground or object with its claws with the intention to scent mark (related to territoriality).

Found registered as the following within the descriptive tables: *scratching claws, using scratch posts, sharpens claws on carpet.*

Testing Strength: the animal is provoking irreparable damage onto its environment.

Found registered as the following within the descriptive tables: *wilder/wild, acting out – got disciplined, ripping up newspaper, being troublesome, getting into lots of trouble, tore up cage, brat.*

Independence

Dependence: less prone than siblings or conspecifics to venture out on own, or explore new places

Found registered as the following within the descriptive tables: *not as independent as brother.*

Explore: interest to investigate and move around new places.

Found registered as the following within the descriptive tables: *getting a little braver while outside.*

Antisocial: little to no interactions with conspecifics; limited filial interactions and more often agonistic if at all present.

Found registered as the following within the descriptive tables: *not socializing well with littermates.*

GROOMING

Self-grooming: rhythmically licking itself with the intention to clean itself; often follows feeding.

Found registered as the following within the descriptive tables: *licks back paws after feeding.*

Communal grooming: rhythmically licking another individual, with the intention to clean it, as well as establish a bond.

Found registered as the following within the descriptive tables: *cleaning sister, licks keeper after feeding, grooming keeper.*

FEEDING

Nursing: cub's mouth around nipple – either mother's or bottle, ingesting liquid (milk).

Found registered as the following within the descriptive tables: *nursing from mother, nursing on bottle, took bottle well, latched on - bit nipple*

Image 12. Jag16, 'Nursing', at Project Survival's Cat Haven, 2010

Sucking: draw air or liquid into the mouth through pursed lips, creating a partial vacuum. This behaviour in cubs mimics the instinctive behaviour observed in cubs of nursing on the mother's tit.

Found registered as the following within the descriptive tables: *trouble sucking, sucking his foot, sucking better, sucking right down, more interested in sucking, sucks hard then pulls off nipple quickly, grunts when sucks.*

Blow out: expelling air/liquid through pursed lips.

Found registered as the following within the descriptive tables: *tendency to blow out.*

Drink: taking liquid into the mouth and swallowing, using tongue to lap it up in the case when nursing is not required to obtain liquid.

Found registered as the following within the descriptive tables: *drank right down.*

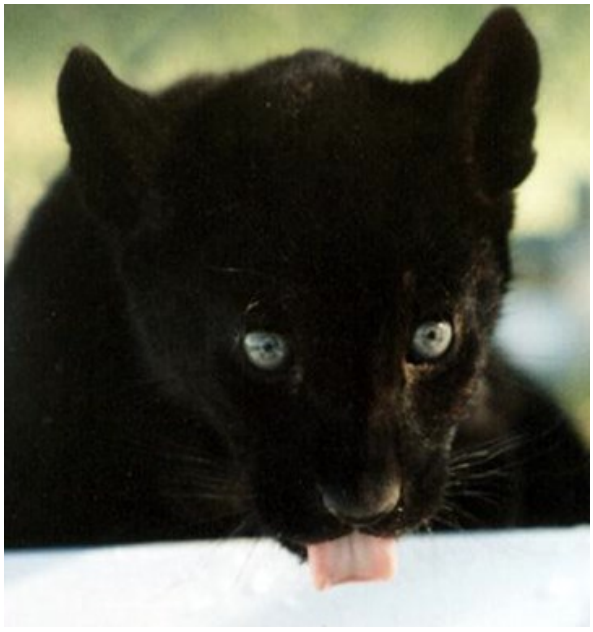


Image 13. Jag2 'Drinking', at EFBC, 1998

Nutritive-Chewing: using teeth to grind food and/or nutritive substance in order to break it down and consume it.

Crying for food: vocalizations, usually high-pitched crying, agitated, with the purpose of obtaining food, either of a solid or liquid form.

Found registered as the following within the descriptive tables: *crying for bottle, crying for food, wanted bottle.*

Finger-sucking: wrapping lips and tongue around human finger, generally primary care-takers, while rhythmically sucking.

Found registered as the following within the descriptive tables: *biting and sucking fingers, gets mad when not allowed suck finger.*

Nursing fixated: In the instance of hand-raised cubs, wants bottle more than solids; rejects solid food, refusing to eat it, searching for bottle.

Found registered as the following within the descriptive tables: *wanted bottle more than bowl.*

Burp: noisy release of air from the stomach, through an open mouth.

Found registered as the following within the descriptive tables: *still needs to be burped, burped, loud burps, big burps.*

Solids

Feeding: consuming solid food, taking it into the mouth, chewing it, and swallowing it once it is sufficiently broken down. Cubs may struggle on initial consumption of solids, and this process is thus followed and described, whether the cub be successful ('good'), or continues to struggle.

> **Found registered as the following within the descriptive tables**: *ate good/ ate very good, only, eating off keeper's fingers, ate from bowl with help, eats good from bowl, ate whole bowl, eating a lot, very interested in food, eating better.*

If a cub appears satisfied with a meal, eating with interest and haste, successfully manipulating and consuming the food, this is interpreted as an event, rather than the state of feeding, and has been described under any of the following; terms such as 'loved', 'good job', reflecting the cub's level of interest and intensity when approaching a new meal.

> **Found registered as the following within the descriptive tables**: *did good on chicken legs, loves horse meat, ate chicken leg – loved it, loved skinned chicken leg, eating chicken leg, loves turkey, good job stripping chicken legs, ate almost all meat off leg, loves eating out of bowl, no messing around at feeding.*

Contrarily, a cub may show signs of struggle when approaching a new meal, either not knowing how to consume it, or plainly not appetized by the meal. Turning its head away from the food, squirming, ignoring, or avoiding the food type are all signs of a lack of interest or appreciation for that specific food type, and have been mentioned under the following forms:

> **Found registered as the following within the descriptive tables**: *refused fresh turkey, makes faces at red meat, trouble eating chicken leg, refusing solids.*

Unsated hunger: cub expresses signs of irritability, such as light crying or whinging, heightened temper (aggression), and discomfort after feeding, as opposed to a quiet and passive composure, indicating the meal it has consumed has not sufficed to satisfy its hunger and wants to continue ingesting food. Attempts to direct itself towards food source.

> **Found registered as the following within the descriptive tables**: *ate his bowl and wanted more/hungry, would eat more, got mad when couldn't eat more, not satisfied after feeding - crying and biting, woke up hungry.*

Food ownership: significantly food motivated, the cub shows a keen interest in food, taking more than has been allowed to it, often delaying its consumption but holding on to it.

> **Found registered as the following within the descriptive tables**: *carrying food around, stole some of house cat's dry food, stole baby lynx's chicken leg.*

Teething: the growth of the cubs' milk teeth, often leading to discomfort and non-nutritive chewing. May sometimes a lost interest in food intake. The following descriptions refer to the by-products of teething:

- Drooling: dropping saliva uncontrollably from the mouth.

- Over-selective feeding: expressing more partiality to different foods, rejecting most of what is available to it. Electing to not eat over eating what has been offered to it.

> **Found registered as the following within the descriptive tables**: *teething bad – lots of chewing, slobbering, fussy – acting like teeth hurt/teething, lots of mouthing, drooling, fussy, wanted bottle but couldn't suck, fussy, struggle to get food down, chewing everything – teething.*

Stressed Feeding

Broken sucking: sucking with very frequent breaks, hesitating before taking the nipple or difficulties getting proper hold of it.

> **Found registered as the following within the descriptive tables**: *slow eater, frequent breaks, only couple of sucks at a time, then chews, chewing bottle nipple – forgot how to suck, refusing to suck bottle nipple.*

Refusing nipple: not taking nipple well, in such a way that the subsequent process of sucking would be impossible.

> **Found registered as the following within the descriptive tables**: *fighting nipple, biting nipple and cap, biting nipple, playing with bottle nipple, constant fight to feed, only using bottle as a pacifier, fighting bottle, yelling - clawing, not latching onto bottle, hungry but doesn't want bottle.*

Food disinterest: the cub is not interested in food consumption of any time; won't eat, won't maintain focus on food - whether it be solid or liquid. The act is not aggressive but merely a lack of attention drawn to the food source.

> **Found registered as the following within the descriptive tables**: *no attention span for eating, doesn't really want to eat, not as interested in food, left leg – wanted to go to sleep, fell asleep eating (too much play), refused to eat.*

Weaning: accustoming the cub to solid foods, as opposed to milk, coming from mother or bottle.

> **Found registered as the following within the descriptive tables**: *no more bottle, refusing bottle, eating solids off finger, started eating chicken, refused bowl.*

LOCOMOTOR

Active: physically energetic, moving around significantly.

Solitary Play: we adopt the definition of play offered by Bekoff & Byers (1981) and observed firsthand by the present author, as "any post-natal motor activity that appears to be purposeless, in which motor patterns from other contexts may often be used in modified forms and temporal sequencing". When the play behaviour is solitary, it falls within the category of Locomotor, whereas interactive play with another individual falls within Filial behaviours.

Including any of the following:

> **Found registered as the following within the descriptive tables**: *more interested in playing with his feet than feeding, too busy playing to eat, more interested in play than food, playful, lots of play, plays but tires quickly, played all day with short naps, getting more energy for play, wants to play throughout eating, playing with toys, constant play, likes playing with food bowl – can make it roll, playful with toy.*

Image 14. Jag3, 'Solitary Play', at the EFBC, 1998

Gait

Pulls self forward: uses front paws to drag itself forward, using one then the other, while hind paws are used to create friction, holding cub from moving backwards. Stomach is close to the ground, with an overall low stance.

Putting weight on hind legs: allowing more of the body's weight to fall on the cub's rear legs, suggesting it will soon be able to stand on them as the legs assimilate taking on the pressure of that weight.

Crawling: moving slowly, close to the ground, putting most of its weight on its fore legs, pulling itself with these, while pushing hind paws off the ground, maintaining them at a mostly horizontal stance.

Walking: uses all four limbs to travel in any direction; leg movement is transverse.

> **Found registered as the following within the descriptive tables**: *mobile, "found reverse gear" - walks backwards.*

Running: the fastest gait, moving legs at a fast pace in such a manner that for an instance all feet are off the ground.

> **Found registered as the following within the descriptive tables**: likes *to run up until falls on face, tries to run - 3 skips, falls on face, ran around, wants to take off and go, getting around quicker.*

***Limping**: not a behaviour, but a condition recorded, limping refers to walking with difficulty, typically due to some sort of harm to the leg or foot.

Jumping: With mostly hind-leg propulsion, moving forward with forelegs leaving the ground first followed by the hind legs. Jumping may be vertical or horizontal (McDonnell. 2003).

> **Found registered as the following within the descriptive tables**: *starting to run and jump, prances and leaps, jumping/trotting while playing.*

Exploring: moving across an area inquisitively, with the purpose to familiarize itself with new areas, senses, and stimuli.

> **Found registered as the following within the descriptive tables**: *likes exploring, wondering around house, exploring, explores outside.*

Image 15. Jag16, 'Investigating', at Project Survival's Cat Haven, 2010

Climbing: using paws to pull self upward, mostly putting pressure on forelegs while ascending.

> Found registered as the following within the descriptive tables: *almost climbing out of playpen, climbing out of box, climbing cage, climbs up on couch by himself/herself, climbed into cage and put himself to sleep, climbing stairs, climbing on everything.*

Hunting behaviour

Carrying object in mouth: holding objects in mouth, navigating around with them.

> Found registered as the following within the descriptive tables: *carries toys around in mouth.*

Image 16. Jag3, 'Carrying object in mouth', at EFBC

Crouching down and hopping: simulation of the '**stalk and pounce**' motion, same mechanics but different function, where here the cub does not have an actual target, and is more practicing than aggressing or antagonizing.

Back-kick: kicking objects with hind legs, by quickly extending and retracting them.

Water-related

Jaguars are riverine animals, generally comfortable and/or drawn to the water. When initially exposed to water for purposes other than lapping small quantities however, jaguar cubs may react in a variety of ways, spanning from appreciation and curiosity to a more aversive approach.

- Loves showers and pool.

- Not as attracted to water as others.

Playing in water: splashing the water, whether submersed in it or not, with no particular purpose.

Swim: paddling through the water, maintaining head above the water.

Stretch: firm extension of the limbs, while often arching and extending the neck and back.

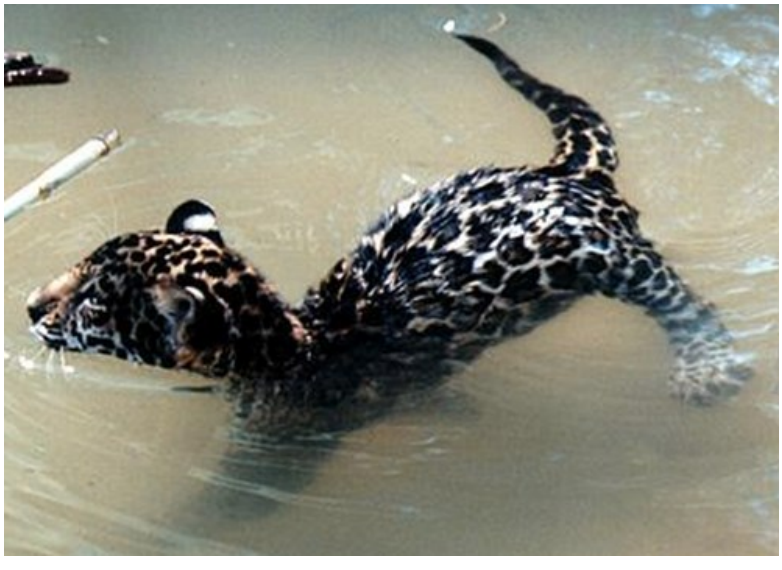


Image 17. Jag3, 'Swimming', at EFBC, 1998

ELIMINATION

Stool

Defecation: elimination of stool from the body through the anus.

Defecation may be aided or performed independently.

Stimulated defecation: During a cub's early stages, it relies significantly on its mother or pseudo-mother (primary care-taker) to stimulate it to defecate. The anus is rubbed repeatedly and rhythmically, with the tongue in the case of the mother, or a smooth, damp surface, (such as a wet wipe), in the case of a pseudo-mother.

> **Found registered as the following within the descriptive tables**: *stimulated to eliminate.*

Independent Defecation: the cub assumes a crouched or squatting position, lowering its pelvis and buttocks towards the ground, expelling waste without assistance or previous stimulation.

> **Found registered as the following within the descriptive tables**: *eliminated stool on own, stool in bed, stool all over cage.*

Incomplete defecation: the cub may or may not be aided to eliminate through stimulation, either way, it is pushing, often crouch when performing the task alone, but fails to expel any waste.

> **Found registered as the following within the descriptive tables**: tried *for stool - no go, tried for stool - got very mad.*

Refusing eliminatory stimulation: cub struggles to be released when being stimulated, very agitated, often released vocalizations of distress such as crying.

> **Found registered as the following within the descriptive tables**: *doesn't like being stimulated to eliminate, fights being stimulated.*

***Gassy**: not a behaviour, but a condition recorded, full of gas; hard or very round belly; signs of discomfort. Followed by possible disinterest in food or struggle to eliminate.

***Constipation**: not a behaviour, but a condition recorded, difficulty expelling stool, though it is formed and needs to be expelled.

> **Found registered as the following within the descriptive tables**: *refusing to eliminate but needs to.*

Pushing to defecate: contracting anal muscles, in the attempt to expel waste.

> **Found registered as the following within the descriptive tables**: *started to help push when stimulated.*

Urine

Urinate: discharging urine from the body.

Early on, urination may also require assisted stimulation, however is achieved independently considerably faster than defecation.

Stimulated to urinate: requires rubbing on the genital areas in order to discharge urine.

> **Found registered as the following within the descriptive tables**: *urinated when stimulated, still stimulated to urinate, stimulated to urinate by dog.*

Urinated alone: expelling urine independently, usually assuming a squatting position and subsequently release the urine.

> **Found registered as the following within the descriptive tables**: *urinated over big pile of newspapers, squatted and urinated on own, urinating mostly on own now, uses litter-box.*

Squatting: crouch down, lowering pelvis and buttocks towards the ground.

> **Found registered as the following within the descriptive tables**: *squatting to urinate with mild stimulation.*

SENSORIAL

Sight

Eye(s) opening: when the cub is born its eyes are closed, over the following week the eyes gradually begin to open, to different degrees, until eventually the eye lids of both eyes can open to the full extent of their capacity, and be held that way.

> **Found registered as the following within the descriptive tables**: *eyes ½ open, eyes partially open, eyes open, eyes closed first days, pupils visible.*

Tracking objects with eyes: following an object/individual as it moves with its eyes.

> **Found registered as the following within the descriptive tables**: *tracks larger objects with eyes, seeing better.*

Image 18. Jag10, 'Eyes opening', at Project Survival's Cat Haven, 2010

Hearing

Sound responsive: reacts and responds when hears sound, generally directing its ears, head, and/or body towards the source of sound.

> Found registered as the following within the descriptive tables: *comes to sound of keeper's voice, already responding to voice, comes when called, tracking sounds.*

Touch

Touch responsive: reacts and responds when entered in contact with, generally directing its head, and/or body towards the source of contact.

Smell

Flemen's response: open-mouth expression after sniffing of an object, animal, or particular scent (such as faeces or urine but not limited to); the lips are curled back exposing the teeth, usually with the neck stretched and head held high.

Responsive

Bright, Alert, and Responsive (BAR): aware of its surrounding, receptive and reactive to environmental stimuli, as well as individual with which it may be in interaction with.

Routine activity

Recognition: recognizes, responds and reacts when the name that has been assigned to the cub is exclaimed. (Found as "knows his/her name").

Image 19. Jag10, 'Flemen's Response', at Project Survival's Cat Haven, 2010

Communication

- Vocal ("Talkative"): very communicative, lots of vocalizations.
- Crying: long, repetitive, high pitched cries
- Scream: long but singular, loud, high pitched cry.
- Yelling: loud, sharp cry, communicating discomfort.
- Grunt: low, short, throaty sound.

5. DISCUSSION

This investigative work piece holds that captive breeding is an essential aspect of conservation efforts, in that it offers novel and vital information on the species, while simultaneously safeguarding population numbers. Captive conservation and breeding facilities offer a means by which researchers may study and understand the dynamics behind the survival skills of a species, their distinctive adaptations, intra-specific interactions, reproductive behaviours, knowledge on the different stages of their life cycles, as well as the weaknesses or threats they may be more prone to succumb to. An updated awareness of such information enables more appropriate and specialized constructions of conservation strategies, in order to better aid preservation, protection, and management of wild specimens. Moreover, the maintenance and reproductive control over captive populations allows for the possibility of genetic flow between in situ and ex situ populations, ensuring the upholding of healthy genetic diversity. Morato & Barnabe (2001) insist that it is imperative to therefore follow reproductive habits of both captive and wild jaguars, in order to follow their genealogy and preserve genetic variation. As the fragmentation and genetic isolation of jaguars in the wild has come to be as a result of human impacts primarily, it is therefore our responsibility to address both the immediate and long-term consequences, as well as prevent this calamity from continuing.

Furthermore, this information can subsequently be shared with the public, including the afflicted peoples sharing a space with such creatures, in order to ensure a deeper understanding of the species; their movement and behaviours, their ecological role, and their basic needs and subsequent responses to those needs —whether it be abundant access to food, sufficient cover, or genetically adequate mates—. By doing so, we attempt to induce a higher tolerance to the species, if not instigate a more empathetic approach to its survival. More significantly, the dissemination of such information, together with the formation of an initial cub-focused ethogram for this species, highlights the intrinsic value of the jaguar and its potential as a key species. Education is critical when it comes to conservation. Not only are we responsible for educating future generations on the imperative value of conservation, but also, it is important to work with and educate current generations in order to coax them into participating in conservation programs and following a more sustainable mindscape.

This thesis offers to communicate, from a scientific and well-researched standpoint, that the effectiveness of each method of cub-raising is case specific. This approach is supported by Tetley & O'Hara (2012), which argue that their lies a significant weight on individual differences, leading animals to vary in their responses to the captive environment. While motherhood is believed to be taught, in wild cats as in most mammalian species, the ability to appropriately nurture and care varies from individual to individual, as it does from keeper to keeper. Age, personality, environmental surroundings, and number of litters, all seem to be factors influencing motherhood — both in captivity and the wild—.

While big cat specialists believe motherhood to be something which is taught, rather than innate, it's aptitude seems to be impartial to whether the mother herself was mother or hand raised, at least when it comes to the captive jaguars dealt with across the two specialized facilities, responsible for donating their empirical knowledge and reports to this research work. While *Project Survival's Cat Haven* offers cases of hand-raised mothers with inadequate mothering instinct, the *EFBC* has recorded cases of both hand-raised mothers being capable and fit mothers for cub-raising, as well as mother-raised females that, conversely, were unfit or unresponsive mothers. Nonetheless, they do stress a distinct preference towards allowing cubs to be mother raised, as they believe this is more likely to lead to successful mate establishment in the future, through the education of social cues by the mother. However, having worked with both hand-raised and mother-raised jaguars, it is evident that having more socialized, hand-raised jaguars greatly facilitates the process of working with and maintaining them in captivity, as well as seems to reflect less stressful individuals. This enables smoother medical interactions, a more cooperative relationship between animal and keeper, and an animal more comfortable in the presence of humans —a significant element considering the animal is bound to a life with human interactions—. Individualized assessments of potential breeding mothers could be used to evaluate the reproductive failure of individuals, allowing for improvement on captive breeding by identifying compatible breeding pairs (Tetley & O'Hara, 2012).

Ideally, a healthy in-between, as suggested by Vargas *et al.*, (2006), would be aimed for, where keepers maintain a good, trusting relationship with the mother, and subsequently with her cubs. It has been observed in certain wildcat breeding facilities, such as The Cat Survival Trust in the UK, where snow leopard (*Uncia uncia*) mothers are left to raise their cubs, however, with regular human interactions; this is ensured by the previous establishment of an entirely trusting relationship between the mother and founder of the organization, Terri Moore, as well as the establishment of a preceding physically interactive relationship between the pair. It is important to remember however, that despite their relative closeness, big cats may vary greatly in their characters, behaviours, level of intelligence and trainability, as well as their approach to motherhood and response to a life in captivity. This is obviously driven by their instinct to survive, which inevitably forces different species to behave in different ways, according to their distinctive adaptations, size, and form. Whereas leopards (*Panthera pardus*) are more cautious, lacking the status of the biggest wild cats of their wide home range, having to fend from lions (*Pathera leo*) in Africa, and tigers (*Panthera tigris*) in Asia, jaguars find themselves being the top predators across their home range, and thus are 'more like bulldozers', rather than cautious creepers. These aspects seem to be apparent in the females' approach to motherhood when breeding big cats in captivity, where leopard mothers seem to be more protective and generally more likely to raise their cubs themselves (given the opportunity), than jaguar mothers in captivity, according to the lead cub care-taker at the EFBC, Sandra Masek. Furthermore, due to their sheer strength, captive jaguars are more likely to hurt their keepers (oftentimes unwillingly), than many other big cat species, such as leopards, snow leopards, or cheetahs for example, making it more difficult to maintain a hands-on relationship throughout their lives.

Extracts from both Project Survival's Cat Haven and the EFBC cub health charts, as well as the elaboration of a jaguar cub ethogram, give us further insights on the value of each method of rearing, as well as enlighten us regarding aspects of jaguar cub behaviour and development. The EFBC, a specialized feline breeding center, holds that allowing cubs to be mother-raised is preferable when conservation goals are more orientated towards breeding. Experienced staff members affirm that mother-raised cubs are generally larger and healthier than hand-raised cubs, and tend to adapt better to captive breeding as adults as well as their interaction with conspecifics. However, this is not often a plausible scenario, and lies very much in the hands of the mother herself. A similar stance is taken at Project Survival's Cat Haven, though all of the cubs born at their facility have been hand raised due to the two main breeding females neglecting their cubs. There is a significant upside to this however, where hand raised cubs display signs of being much better adjusted to a life in captivity. They are more comfortable around their keepers, easier to manage, and indicate lower signs of stressful behaviour, which has positive impacts on successful reproduction (females displaying heightened signs of stress will often kill their young in captive environments).

This is equally a reflection of the animal's behaviour swaying from its' natural instinct and therefore the final goal of the breeding program will also have an implication on the approach to hand vs mother raising. New mothers are watched particularly closely, as there is little way to know whether they will be fit mothers or not. In the case of the EFBC, one of their primary breeding females 'Twilight' (JagA), produced four litters.

During her first pregnancy, Twilight was subdued for a C-section once she had surpassed her latest due date by over ten days. Three cubs were retrieved stillborn, with one being particularly large and deformed, possibly blocking the birth canal. Upon her second pregnancy, the mother – who was mother-raised herself, was closely observed and was given Oxytocin on her due date in order to induce labour. This was unsuccessful and thus, another C-section was performed.

Three healthy cubs were retrieved and survived after 1.5 hours of CPR (Jag6, Jag7, Jag8). These cubs were subsequently hand-raised. From this point on, the rest of Twilight's (JagA) births were managed through C-sections and hand raising cubs. She gave birth to one cub on her own, but demonstrated no interest in caring for it; therefore, this cub was also hand-raised. It is interesting to note that one of Twilight's (JagA) daughters (Jag3), who has remained at the EFBC throughout her lifetime, standing as another leading breeder, has given birth to four litters unassisted; three of which, she has raised herself.

The ethogram elaborates on an array of behaviours, attitudes, and developments that can be observed amongst jaguar cubs, throughout their initial development, not only acting as a useful aid and basis of comparison for other facilities hand rearing cubs, but also giving us insights on the origins of certain behaviours critical for future survival. Play behaviour, could (and should) be examined at a closer level, exploring attitudes, analysing skill, and dissecting which behaviours reflect the origins of essential behaviours, such as fighting, hunting, or reproduction.

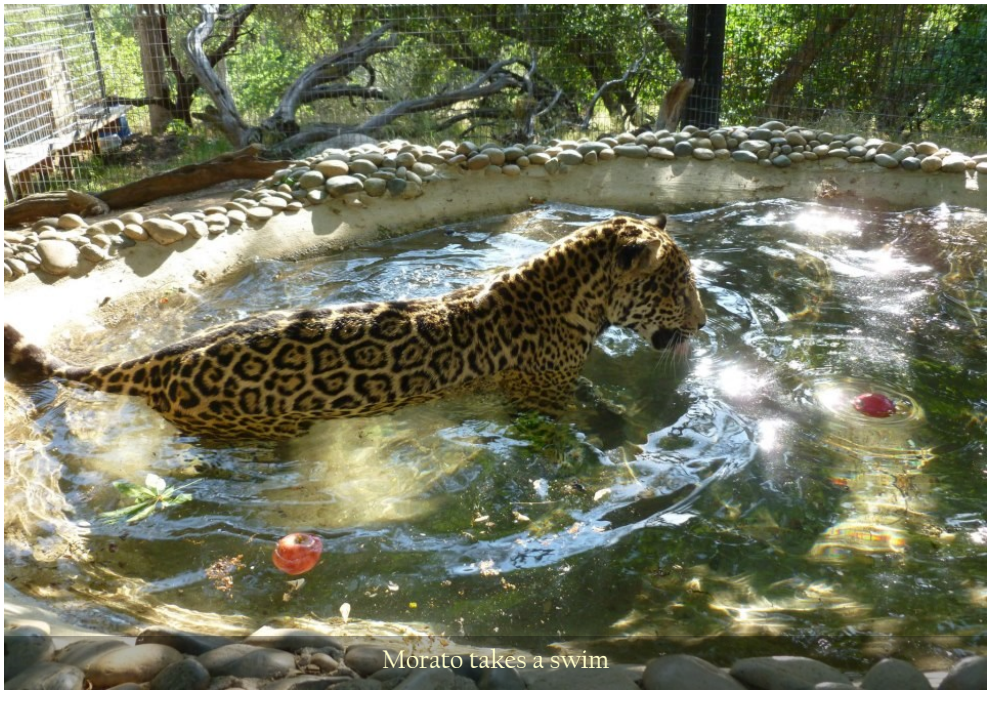
For example, often cubs playfully stalk and pounce up on their keepers, siblings, or other pen mates. While the act seems purposeless at the time, and falls under our conception of 'play', within the category of 'affiliative' or 'locomotor' depending on the nature of play, this same action in years to follow will display similar mechanics, but a greatly different function. Bekoff (2001) holds that when individuals play they tend to use action patterns that can be seen in other contexts, such as predatory behaviour, anti-predatory behaviour, and mating. Play is a means of practice, in order to develop skill, and later in the animal's life, the function of the previously described behaviour will instead be to 'hunt' —a behaviour crucial to a top predator's survival—.

Play is also a central component when raising animals in captivity. Animals must be stimulated both physically and emotionally in the form of behavioural or environmental enrichment, in order to satisfy their well-being. Play is a huge part of this and keepers/key stakeholders from both aforementioned facilities hold this as a central element to satisfying the quality of life for the cats under their care, for all stages of the animal's life. Unfortunately, as the data used to construct the current ethogram was obtained from a secondary source, the author was not able to deepen the development of this topic, at a first-hand level.

Extracting information from the cub charts, and thus forth the ethogram, has provided rich information regarding jaguar cub rate of both behavioural and physical development, offering guidance on first time occurrences of significant milestones. Furthermore, the data presented is unique, in that it offers detailed information at a qualitative level, on an unprecedented amount of cubs (sixteen individuals). Jaguar cubs' teeth come in at around fifteen days, showing signs of teething at about three weeks. At about six weeks they develop a stronger bite. Here lies an important difference between a lesson that would be taught by the cub's mother, and the one subsequently enforced by the cub's human handler: hand-raised cubs should not be allowed to use their teeth and/or claws on humans.

This lesson must be instilled from a young age, so as to avoid undesirable habits when they are older. Cubs must therefore not be provoked in a manner that could solicit such behaviour. When cubs start biting, an unpleasant noise can be made so as to dissuade them. They become conditioned to realize that this sound represents a punishment and reflects a response to a disadvantageous behaviour. Should the cub persist, strengthening its bite, a quick flick on the nose with a finger should discourage this behaviour. Mother's will often respond to roughhousing cubs with quick nips in sensitive areas, in order to communicate inadequate or intolerable social behaviours. Cubs must be communicated to in a language they understand, with clear and constant cues for greater efficiency. Light swats to the rear end may be delivered when play with humans takes on a more aggressive nature, and a chew-toy is given as a substitute. When toys become too damaged they must be removed in order to avoid ingestion of harmful pieces. Balls, pinecones, and scented boxes are all good toys. Other cubs/animals are good play companions too. Play encourages the development of motor skills, as well as social skills, and is an important part of cub development that must be equally tended to. It is through play that cubs learn how to control and coordinate both their muscles and senses.

Most of the cubs were born with their eyes partially open, (50-75%) and started tracking larger objects at about three weeks of age. After one week, jaguar cubs show signs of tracking sounds. Towards the end of their first week they reflect signs of play, though this is of a more solitary than interactive nature. At two-three weeks, play behaviours start to extend towards other individuals, whether it be their siblings, other animals, or keepers. Aggressive play behaviour has been observed as of two weeks of age. Instances of grooming are expressed after the first week; this can be self-grooming or often occasions where the cub licks and grooms the keeper or its siblings. Exploration is a highly important behaviour for young predators, as they will spend most of their adult lives exercising this very behaviour for the purpose of survival. In the adult stage of their lives, exploring will lead them to finding food, mates, and cover. Cubs will be seen exploring at about two weeks old, moving across an area inquisitively, with the purpose to familiarize themselves with new areas, senses, and stimuli. Cubs begin to run at about three weeks; this is soon followed by jumping, and subsequently, concrete climbing at about four weeks. Cubs attempt to climb from as early as one week of age but do so unskillfully, without successfully managing to ascend. Solid foods, as opposed to pure formula, are offered at six weeks, with cubs handling chicken legs well at eight weeks. Some cubs take a couple weeks longer to adjust to this stage, and can take up to ten weeks to start managing solids successfully. At about four weeks, cubs may begin to eliminate well-formed stool without stimulation, but often will need assistance for up to eight to ten weeks. The Flemen's Response, has been recorded to be seen as early as four weeks of age, a behaviour distinctive in wild cats and few other genera. One male (Jag15) was recorded to have sprayed at fifteen weeks.



Morato takes a swim

6. CONCLUSION

Six main behavioural categories were distinguished across the behaviours issued by jaguar cubs aged 0-10 weeks. These include social, which comprises both affiliative and agonistic, grooming, feeding, locomotor, elimination, and sensorial. While the behaviours observed stand as the foundation to future principal and essential behaviours observed in adult jaguars, sexual behaviours were not quite evident yet at this stage.

Among the category of affiliative behaviours, four distinct behavioural traits were observed; most of these related to the cub seeking nurture by a maternal figure however. Agonistic behaviours were much more prevailing, with a total of sixteen behavioural traits distinguished. This suggests a greater need, and therefore emphasis, put on agonistic behaviours in jaguar survival. Agonistic behaviours varied in motivation, spanning from instances of attack or defence, demonstrations of territoriality, possessiveness, and preludes to hunting behaviours. The lack of affiliative behaviours compared to agonistic ones offers insight on behavioural patterns essential for jaguar survival throughout their independent adult phase. It supports the notion that, while adult jaguars may have limited interactions with conspecifics, the species is primarily solitary, and employs avoidance as part of its survival strategy.

The behavioural category of feeding included seventeen different behaviours, which transformed as the cubs aged and moved from liquids to solids. Elimination depicted eight separate behaviours, which also demonstrated a metamorphosis of behaviours, moving from immediate post-natal behaviours to behaviours that will prevail throughout adulthood. Twelve key behaviours were distinguished within the category of sensorial behaviours, though it is likely that through deeper study, more would be recognized. Within the category denominated as locomotor, sixteen behaviours were documented. 'Play' held a significant role, reflecting the development of basic skills necessary for future survival, ranging from areas of reproduction, hunting, and defence. This too, is an area that requires deeper, and individualized study, as it reflects the gradual acquirement of skills and behaviours distinctive to the species.

The construction of an ethogram not only supports the research and information on captive jaguar breeding provided within this research piece, but also stands as a helpful tool offering a manual for other captive facilities breeding jaguars.

The thesis overall gives insights on what to expect along the first 10 weeks of a cub's development, with a comprehensive description of behaviours or complications to expect, practical and detailed information on breeding practices, feeding protocol, and a dive into the debate and pros and cons of hand vs mother raising cubs, as well as the impacts this may lead to in the animal's future. The piece synthesizes the full range of current information available on jaguars, and hopes to educate the public and draw a new light on this majestic and inconspicuous species.

Rosie posey in the tub

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Internet Resources

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APPENDICES

Feeding

Extracted from Project Survival's Cat Haven's feeding protocol:

First Feeding:

Zoo Matrix 33/40 (33% protein and 40%fat) or 42/25 formula:

Mix 3 parts pedialyte to 1 part powdered formula (¾ C pedialyte: ¼ C 33/40).

Newborn cubs require feeding every three hours, including through the night, for up to their first three nights, depending on the cub's food intake and willingness to nurse. The cub should be stimulated at every feeding to eliminate waste. Should the weight and food intake be satisfactory, the cub may be allowed to sleep for six hours on the third night.

Day 2: Mix formula 2 parts bottled water with 1 part 33/40 or 42/25. Feed the cub every three hours.

Day 5: Feed the cub every four hours and allow it to sleep six hours at night.

Day 10: Begin adding di-calcium phosphate to formula. 1/16 -1/8 tsp. di-cal : 1 C water : ½ C 33/40

Feed the cub every four hours and allow it to sleep six-seven hours at night if intake is sufficient.

2 weeks:

At this point, the cub requires feeding every four hours, allowing sleep for six-seven hours at night. Begin working up to eight hours at night. Should the weather be adequate and warm during the day, the cubs may be allowed to play in a larger carrier, without the heating pad during the day, as well as in a smaller carrier at night without the heating pad.

3 weeks:

Begin adding ½ a jar of turkey or chicken baby food to the formula mid-week. ½ jar baby food : 1/16 -1/8 tsp. di-cal : 1 C water : ½ C 33/40

Make sure not to use 'Gerber' brand baby food, as the added onion and garlic powder can be lethal to cubs. Feed the cub every four hours and allow to sleep eight hours at night (feeding five times a day).

4-4½ weeks:

Add one full jar of baby food to one cup prepared formula, feeding every five hours (four feedings daily).

8 weeks:

At this point, most species are weaned onto Nebraska canine or feline diet and boiled chicken. In the case of both facilities contributing to this research work-piece, the latter was employed.

Administer first FEL-O-VAX LK III vaccine.

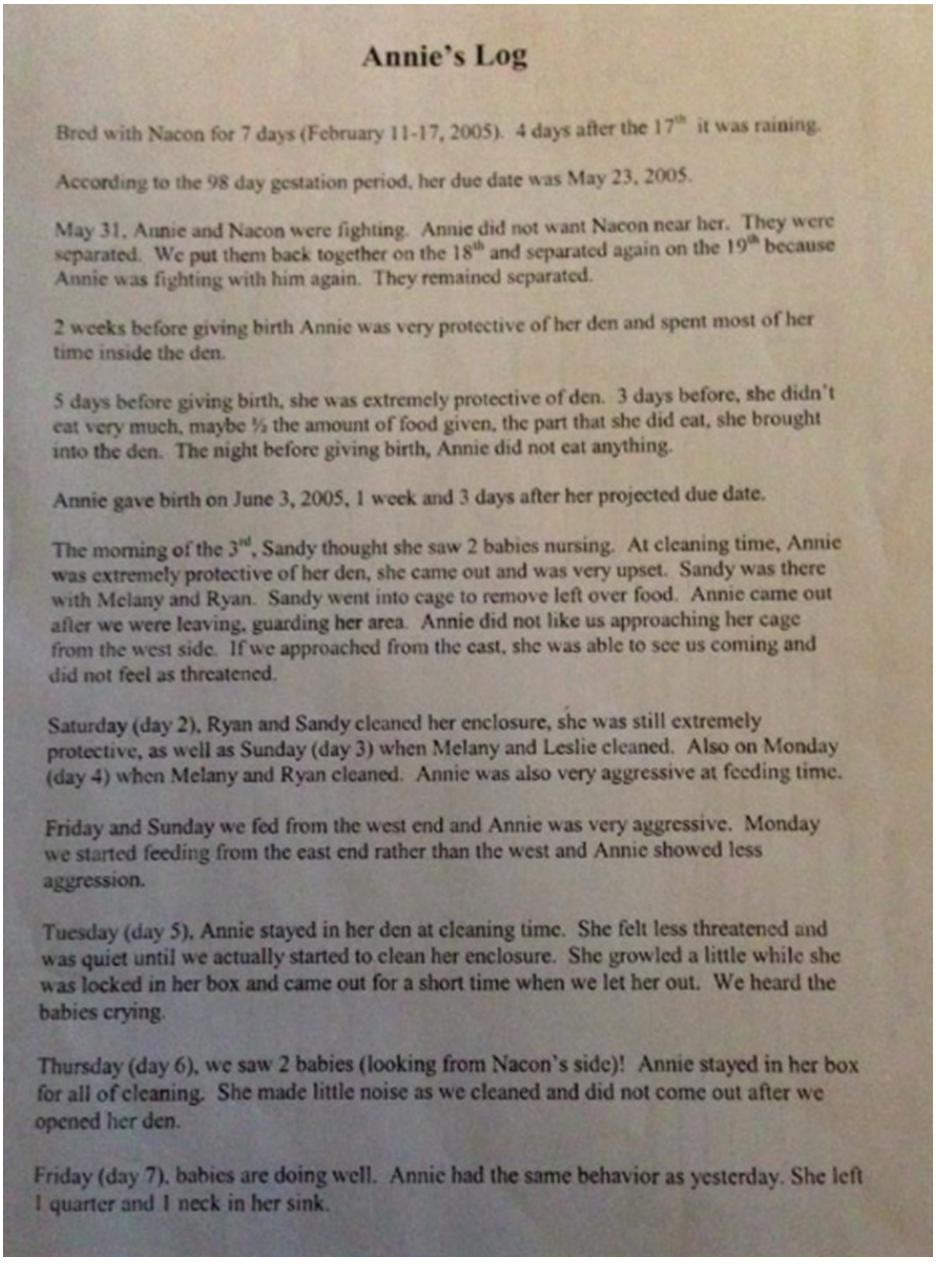
12 weeks:

Administer second FEL-O-VAX LK III vaccine.

16 weeks:

Administer third FEL-O-VAX LK III vaccine, followed by yearly boosters.

Annie's Log (birth log)



Annie's Log

Bred with Nacon for 7 days (February 11-17, 2005). 4 days after the 17th it was raining.

According to the 98 day gestation period, her due date was May 23, 2005.

May 31, Annie and Nacon were fighting. Annie did not want Nacon near her. They were separated. We put them back together on the 18th and separated again on the 19th because Annie was fighting with him again. They remained separated.

2 weeks before giving birth Annie was very protective of her den and spent most of her time inside the den.

5 days before giving birth, she was extremely protective of den. 3 days before, she didn't eat very much, maybe ½ the amount of food given, the part that she did eat, she brought into the den. The night before giving birth, Annie did not eat anything.

Annie gave birth on June 3, 2005, 1 week and 3 days after her projected due date.

The morning of the 3rd, Sandy thought she saw 2 babies nursing. At cleaning time, Annie was extremely protective of her den, she came out and was very upset. Sandy was there with Melany and Ryan. Sandy went into cage to remove left over food. Annie came out after we were leaving, guarding her area. Annie did not like us approaching her cage from the west side. If we approached from the east, she was able to see us coming and did not feel as threatened.

Saturday (day 2), Ryan and Sandy cleaned her enclosure, she was still extremely protective, as well as Sunday (day 3) when Melany and Leslie cleaned. Also on Monday (day 4) when Melany and Ryan cleaned. Annie was also very aggressive at feeding time.

Friday and Sunday we fed from the west end and Annie was very aggressive. Monday we started feeding from the east end rather than the west and Annie showed less aggression.

Tuesday (day 5), Annie stayed in her den at cleaning time. She felt less threatened and was quiet until we actually started to clean her enclosure. She growled a little while she was locked in her box and came out for a short time when we let her out. We heard the babies crying.

Thursday (day 6), we saw 2 babies (looking from Nacon's side)! Annie stayed in her box for all of cleaning. She made little noise as we cleaned and did not come out after we opened her den.

Friday (day 7), babies are doing well. Annie had the same behavior as yesterday. She left 1 quarter and 1 neck in her sink.

From the EFBC health chart records, on Jag3, 2005.

Behaviour Defined		Behavioural Categories - Jag1						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	playing with littermates	temper		Trouble sucking Tendency to blow out Ate very good Big burps sucking his foot slow eater, frequent breaks	Active more interested in playing with his feet than feeding wants to take off and go 1/2 hr. Playing	Tried for stool - no go Tried for stool - got very mad	Not as loud or well toned as other 2 cubs Eyes 1/2 open very responsive Bright, Alert, Responsive (BAR)
	1	play with littermates	getting mad at toys		drank right down ate good			
	2	affectionate				likes exploring lots of play	never urinates in bed Tried for stool - no go	Bright, Alert, Responsive
	3				drank right down fussy - acting like teeth hurt doesn't really want to eat	very playful		Bright, Alert, Responsive
	4				Hungry Only eating off keeper's fingers crying for bottle wanted bottle more than bowl chewing bottle nipple - forgot how to suck fussy	lots of play plays but tires quickly very active getting more energy for play	Tried for stool - no go gassy, no stool	Bright, Alert, Responsive crying
	5				Hungry	played all day with short naps		
	6				ate whole bowl ate his and brothers food crying for bottle	too busy playing to eat very active went outside, runs in grass	Tried for stool - no go Tried for stool - got very mad stool on own	Bright, Alert, Responsive crying
	7				Eating a lot	outside - took off very active	Tried for stool - got very mad Tried for stool - no go small stool, then he left running	Bright, Alert, Responsive
	8	playing with littermates			hand fed		Tried for stool - no go	Bright, Alert, Responsive
	9				did good on chicken legs loves horse meat	not as attracted to water as others	lays in litter box while urinating Tried for stool - no go	Bright, Alert, Responsive
	10					no time to eat only play	stimulated to eliminate	Bright, Alert, Responsive left outside overnight

Behaviour Defined		Behavioural Categories - Jag2						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	affectionate likes to hear you talk			ate right down ate great loud burps	walking good 1/2 hour playtime	Tried for stool - no go Tried for stool - got very mad	good muscle tone eyes partly open BAR
	1	play pen with littermates			lots of sucking/chewing on hand	very playful	stool in bed gassy stimulated to eliminate	BAR
	2		beating up toy		ate right down	playing exploring starting to run	Tried for stool - no go stool in bed	BAR
	3	chasing littermates	biting and swatting at everything		ate his bowl and wanted more	very playful more interested in play than food prances and leaps		BAR
	4	lots of play with volunteers			ate some chicken off keeper's finger loves turkey eats good from bowl	lots of play all day	eliminated stool on own Tried for stool - no go	BAR
	5		little fight attacking everything		Trouble sucking ate from bowl wanted bottle no attention span for eating eating better	not as active plays little, then wants to sleep played hard, worked self out more playful		BAR
	6				ate good crying for bottle wanted bottle but couldn't suck ate bowl	playful, with naps	stool on own	BAR lots of screaming yelling
	7				Refused fresh turkey	went outside, took off on own playing not as active as littermates	Tried for stool - no go stimulated to eliminate	Bar
	8	playing with littermates				limping running Playing	Tried for stool - no go	Bar
	9				eating chicken leg carrying food around	playing more interested in play than food		Bar
	10	very affectionate	wilder			wants to play		BAR left outside overnight

Behaviour Defined		Behavioural Categories - Jag3						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	playing with littermates	hissing and spitting likes to hiss and bite		sucking right down sucking toys foot ate good		doesn't like being stimulated to eliminate tried for stool - no go	BAR loud cries loud, strong, grunts lots of yelling
	1				ate good	very playful	refusing to eliminate but needs to stool in bed tried for stool - no go	BAR
	2		attacking brothers attacking toy			almost climbing out of playpen exploring lots of play	stool in bed tried for stool - no go	BAR yelling
	3	runs after brother playing with volunteers	attacking everything doesn't want to eat, just bite biting brother's tail		fussy at eating chewing on bottle nipple	lots of play playing hard, then sleep wanting to play more than eat	tried for stool - no go urinated alone	BAR
	4	affectionate	fighting		eats turkey off keeper's finger drank water from bowl chewing on bottle nipple	very active and playful wants to play thoughout eating		BAR
	5				eating solids off finger makes faces at red meat ate good from bowl	just wants to play active but little appetite playing but tired quickly	tried for stool - no go	BAR
	6				not very hungry refusing solids cried for bottle	active all day with frequent naps very active	tried for stool - no go	BAR
	7		acting out - got disciplined ripping up newspaper		no more bottle not too hungry ate good from bowl still crying for bottle	very active	tried for stool - no go	BAR
	8	playing with littermates chasing house cat	harrassing house cat		hand fed		stimulated to eliminate stool tried for stool - no go	BAR
	9		steals chicken legs from littermates		hand fed good job stripping chicken legs ate horse meat hungry, would eat more	very active loves showers and pool	tried for stool - no go stimulated to eliminate	BAR
	10	very affectionate	being troublesome aggressive with chicken legs gave keeper smack when took bone			playing with new box toy thinks bigger cage is great uses sink to swim in	stimulated to eliminate stool on own	BAR left outside overnight

Behaviour Defined		Behavioural Categories - Jag4						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0				biting & sucking fingers took bottle well grunts when sucks lots of chewing and biting gets mad when not allowed suck finger	Very strong active comes right to you when you speak to her playful	tried for stool - no go	BAR v. responsive to sound & touch eyes partially open R. Eye open, L. eye 2/3 eyes open talkative
	1		temper tantrum		refusing bottle (tummy bloated) got mad when couldn't eat more not satisfied after feeding - crying & biting hungry baby drinks bottle right down	active, on the go very active climbing out of box	tried for stool - no go really mad while being stimulated gassy	BAR yelling when hears keeper's voice talkative lots of grunts
	2				got mad - wanted more to eat	playful very active	lots of trouble forming stool tried for stool - no go gassy	BAR
	3	very affectionate loving baby				very active playful climbing cage wondering around house exploring	tried for stool - no go gassy	BAR
	4				ate good teething bad - lots of chewing, slobbering only couple suck at a time, then chews	very active likes to explore very playful starting to run and jump getting around quicker	tried for stool - no go	BAR
	5	playing a lot with volunteers			didnt really want bottle more chewing than sucking	likes to run up until falls on face playful	tried for stool - no go	BAR
	6	played with fishing cats	wild		mainly chewed & pulled at nipple *maybe time to start weaning spat out turkey, ran away	loves to run and play brat! Won't eat, no stool - just play!	tried for stool but got very mad	BAR Flemen's Response
	7		chasing all the house cats		ate whole bowl, licking it clean refused bottle ate good	constant play	stool on her own	BAR
	8		getting very mouthy getting into lots of trouble		ate chicken leg - loved it	lots of play exploring yard lots of energy	stool on her own	BAR
	9		attacking toy		ate good	more interested in play than food		BAR
	10		tore up cage -wild		ate good	very playful		BAR

Behaviour Defined		Behavioural Categories - Jag5						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	wanting attention likes to cuddle			Refusing to suck bottle nipple mouths nipple sucking better falling asleep while feeding fussy eating sucking on nipple but no drinking lots of mouthing, drooling ate good	active and strong strong bite very active playing walks pretty good put in playpen for excersize	tried for stool - no go	BAR eyes open yelling
	1		temper not socializing well with littermate				Tried for stool - got very mad	BAR
	2		temper tantrum		fighting bottle, yelling clawing	almost climbing out of playpen exploring very active walks around house yelling		BAR
	3	lots of play - runs to you	attacking toy temper tantrum rough play, attacks brother constantly		very hungry	very active, all over house very playful	Tried for stool - got very mad	BAR
	4		lots of "no's" stalks brother, then pounces on him		fighting nipple crying for food	very active and playful climbs up on couch by himself climbed into big cage & put himself to bed more interested in play than food climbing up on things	tried for stool - no go stool by himself urinated over big pile of newspapers	BAR Flemen's Response
	5	affectionate	wild! Running around attacking all		teething - fussy biting nipple and cap fussy with bottle	more interested in play than food	tried for stool - no go	BAR
	6				wants bottle more than solids ate from bowl with help ate from bowl - no help	more interested in play than food		BAR
	7				ate well from bowl ate chicken leg - loved it	lots of play all day	tried for stool - no go	BAR
	8		not as independent as brother		didnt touch food just played with chicken leg	lots of play and trouble	tried for stool - no go stool by himself	BAR
	9		being troublesome		finally ate food outside	playing well		BAR
	10					explores outside	stool all over cage	BAR

Behaviour Defined		Behavioural Categories - Jag6						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0		little hissing		hungry baby	active and playful		BAR
	1	played with brother	beat up brother		drank bottle right down	playful		BAR
	2	affectionate			ate good biting nipple fussy	playful	tried for stool - no go	BAR yelling
	3	playing great with littermates	biting beating up brothers tantrum, biting clawing		chewing nipple ate good hungry fussy, struggle to get food down ate great	playful "found reverse gear" - walks backwards		BAR
	4		tantrum, biting clawing attacking everything temper		ate good once got started ate great	very playful more interested in play than food running all around	tried for stool - no go stool on own	BAR
	5		wild		ate good only using bottle as pacifier	lots of play more interested in play than food	stool on own tried for stool - no go	BAR
	6		biting hard		ate good fussy	very playful running all around more interested in play than food	tried for stool - no go	BAR
	7		very possesive over chicken leg		refused bottle just sucked on nipple hungry for meat loved skinned chicken leg	lots of play very active		BAR crying
	8		wanted to keep chicken leg all to herself		ate good	very playful		BAR
	9		biting everything rough		ate good didn't want bottle loves chicken legs	lots of play more interested in play than food too active - into everything		BAR
	10	Transferred						

Behaviour Defined		Behavioural Categories - Jag7						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0		hissing		crying for food	active	started for stool on own, then stimulated	BAR good responses
	1		temper		fussy ate right down	very playful wanting to run around	tried for stool - no go	BAR great lungs - strong yelping
	2	likes to have belly rubbed played good with littermates			ate real good hungry constant fight to feed very fussy - teething	lots of play very active		BAR loud!
	3	playing great with littermates lots of tummy rubs	chewing on keeper's hand biting and chewing on keeper's hand beating up toys, littermates temper	cleaning sister	ate great biting nipple hungry fussy eating	very playful tries to run - 3 skips, falls on face	stool on own	BAR
	4	affectionate	doesn't like to share toys		ate good got fussy eating	playful ran around jumps	stool on own	BAR
	5		wild		fighting bottle eating good again then nipple tore, upset loves eating out of bowl	very playful climbing very active		BAR yelling
	6	very affectionate	attacking littermates stealing sister's food ripping up things		ate real good wanted bottle	very playful running around		BAR
	7				hungry refused bottle and bowl crying for food	walkling around whinging lots of play		BAR
	8	needing affection	does'nt like to share bowl with sister fight with sister		ate chicken leg ate good	lots of play		BAR
	9				wanted more chicken legs	lots of play climbing on everything too active just wanted to play		BAR
	10	Transferred						

Behaviour Defined		Behavioural Categories - Jag8						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0				doesn't want to eat playing with bottle nipple	active and strong putting weight on hind legs	urinated in bed	BAR good responses
	1				hungry fussy - just wanted to suck ate good	playing		BAR
	2	likes ears scratched			ate good didn't really want to eat ate great	lots of play climbing side of cage	tried for stool - no go	BAR
	3				ate great no messing around at feeding	playful climbing very active		BAR good responses
	4				ate good fell asleep eating (too much play)	playful running around house	formed stool on own	BAR
	5	very affectionate			ate good	lots of play climbing all over very active explorative		BAR
	6		starting to bite hand troublesome		ate good ate great refused bowl chewing nipple	playful running all over the place more interested in play than food		BAR
	7				refused bottle eating better woke up hungry	lots of play not as active		BAR
	8				refusing solids cries for bottle	more interested in play than food		BAR
	9				fussy chewing on nipple refusing solids	very playful		BAR
	10							

Behaviour Defined		Behavioural Categories - Jag9						
		Filial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	yelling for attention	temper tantrums		sucks hard then pulls off nipple quickly lots of mouthing nipple woke up crying for bottle	strong baby active playful	tried for stool - no go	BAR already repsonding to voice vocal eyes 2/3 open
	1		hissying fit temper tantrum			lots of play getting very playful now	tried for stool - no go	BAR
	2		hitting and chewing everything			more interested in play than food exploring lots of play	tried for stool - no go	BAR eyes open
	3	playing with house cat			fussy	lots of play lots of exploring more interested in play than bottle	tried for stool - no go	BAR
	4				fussy with bottle - teething chewing everything - teething crying for bottle	playful active	used litterbox to urinate	BAR
	5				stole some of house cat's dry cat food	lots of play	uses litterbox	BAR
	6		getting a little braver while outside			lots of play climbing up on couch	tried for stool - no go	BAR
	7	playing a lot with volunteers			got bowl - ate right down stole baby lynx's chicken leg trouble eating chicken leg	more interested in play than food	stool on own trouble forming stool, even when stim. fights being stimulated	BAR
	8		getting wilder		ate almost all meat off leg ate bowl & stole some of baby lynx's		large amount of stool on own gassy	BAR
	9				left leg - wanted to go sleep		large stool by himself	BAR
	10		brat			likes playing with food bowl - can make it roll	stool on own	BAR

Behaviour Defined		Behavioural Categories - Jag10						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	vocalizations		self-grooming	Nursing on bottle finger-sucking	mobile crawling playful with toy	urinated when stimulated	eyes 1/2 open L eye open, R eye 3/4 open comes when called
	1		playful biting sister		Nursing on bottle	Found/played with objects		
	2				fussy with food	jumping/trotting while playing		
	3	played with sister						Tracks larger objects with eyes
	4		rough play with sister wrestling with dog scratching claws			stretch after naptime	squatted and urinated on own	
	5				very interested in food not latching onto bottle			Flemen's Response
	6					climbs over play pen alone pulls self up onto couch		
	7							
	8				fussy	playful		
	9		uses scratch posts				urinating mostly on own now	
	10							

Behaviour Defined		Behavioural Categories - Jag11						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	vocalizations		self-grooming	Nursing on bottle	mobile	urinated when stimulated	tracking sounds
				licks back paws after feeding	finger-sucking	crawling		L eye open, R eye 3/4 open
				licks keeper after feeding		playful with toy		
	1	played with brother	playful biting brother		fussy	very playful		
	2		batting brother		hungry but doesnt want bottle			
					fussy			
	3	played with brother			fussy	very playful		
						jumping/trotting while playing		
	4		rough play with brother		fussy	playful		
	5				finger-sucking			Flemen's Response
	6					climbs over play pen alone		
						pulls self up onto couch		
	7							
	8							
	9		using scratching posts		not interested in food	very playful	urinating on own	
			growling and hissing					
	10				hungry!			

Behaviour Defined		Behavioural Categories - Jag12						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	vocalizations	hissing	self-grooming	Nursing on bottle	mobile		eyes open
			spitting	licks keeper	finger-sucking			
					latched on, bit nipple			
	1					jerking head movements		tracking loud sounds
	2							
	3							
	4							
	5							
	6						still stimulated to urinate	
	7				not interested in bottle	pulls self up onto couch	still stimulated to urinate	
					still needs to be burped		urinating on own	
	8						still stimulated for stool	
	9	Transferred						
	10							

Behaviour Defined		Behavioural Categories - Jag13						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	crying	hiss		nursing from mother	pulling self forward	stool on own	eyes open
		vocal			burped	crawling		
					finger-sucking			
	1	possibly sucking on siblings genitals		self-grooming		playing with toys		tracking sound
	2	played with sister		self-grooming	acting hungry	playing with toys	urinated on own	
	3				not as interested in food	very palyful and active		pupils visible
	4	plays with sister				very playful		
						exploring		
	5				acting hungry	crouching down and hopping	urinated on own	knows her name
	6		wrestling with dog		not interested in food	climbing and jumping		
	7				not interested in food	very palyful and active		
	8		ear biting with sister				urinated on own	
	9				started eating chicken	playing in water	urinating on own now	
	10							

Behaviour Defined		Behavioural Categories - Jag14						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	crying vocal			nursing from mother burped finger-sucking	pulling self forward crawling	urinated on own	eyes closed first days eyes opened
	1	possibly sucking on siblings genitals		self-grooming		playing with toys		tracking sound
	2	played with sister		self-grooming	acting hungry	playing with toys	urinated on own	
	3			grooming keeper	fussy, not interested in food	very playful and active		comes to sound of keeper's voice
	4	plays with sister			fussy, not interested in food	climbs on furniture		
	5				acting hungry	hopping while playing carries toys around in mouth	urinated on own	knows her name
	6		wrestling with dog		refused to eat	climbing and jumping		
	7				not interested in food			
	8		ear biting with sister possibly biting sister				urinated on own	
	9				started eating chicken	very playful	urinating on own now	
	10							

Behaviour Defined		Behavioural Categories - Jag15						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0	licking keeper			nursing from mother Nursing on bottle			eyes completly open tracking sounds
	1	licking keeper		self-grooming licking paws	fussy	crawling	stimulated to urinate by dog pushing when stimulated	tracking sounds very well
	2					playing with toys and back feet		
	3				more interested in sucking	walking/exploring climbing stairs	stimulated to urinate by dog	seeing better
	4							
	5		chewing on box			playing		
	6							Flemen's response
	7							
	8							
	9							
	10				started eating chicken			
								* Sprayed at 13 weeks

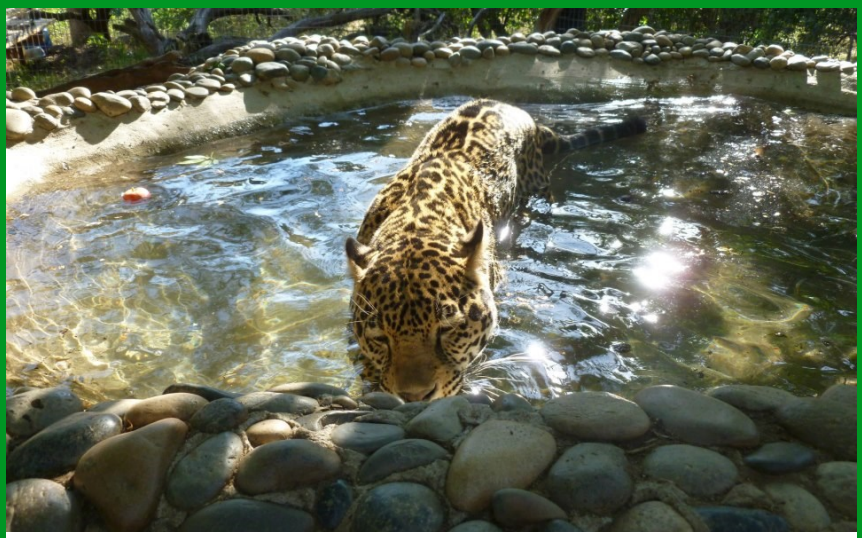
Behaviour Defined		Behavioural Categories - Jag16						
		Fillial	Agonistic	Grooming	Feeding	Locomotor	Elimination	Sensorial
Week	0				nursing from mother Nursing on bottle			eyes completly open
	1			starting to lick/groom paws	fussy			
	2	plays with brother	sharpening claws on carpet	grooming feet	finger-sucking	playing with toys	started to help push when stimulated	
	3	very vocal plays with dog	sharpens claws on carpet	grooming keeper		walking for 30 min. Intervals pulls self up on couch kicking toys with hind legs		starting to see better responds/comes when called
	4				no interest in bottle	jumping/pouncing trying to run stalking		
	5						squatting to urinate with mild stimulation	
	6							
	7						urinating on own	
	8							
	9							
	10							

Species holding report for: Panthera onca / Jaguar							
Institution	Male	Female	Other	Group M.	Group F.	Group O.	Total
All 145 Institutions, 5 Regions	178	208	4	0	0	0	390
Species : Panthera onca / Jaguar							
All 145 Institutions, 5 Regions	178	208	4	0	0	0	390
Region: Africa 1 Institutions, Male: 1, Female: 1, Other: 0							
LORY PARK / Lory Park Zoo & Owl Sanctuary	1	1	0	0	0	0	2
Region: Asia 18 Institutions, Male: 35, Female: 33, Other: 1							
AL AIN / Al Ain Zoo	1	4	0	0	0	0	5
ALBUSTAN / Al Bustan Zoological Center	1	3	0	0	0	0	4
ALMA-ATA / Almaty State Zoo of Kazakhstan	1	1	1	0	0	0	3
BAYRAMOGL / Faruk Yalcin Zoo (Hayvanlar Alemi & Botanik Bahcesi)	1	1	0	0	0	0	2
CHIANGMAI / Chiangmai Zoological Garden	0	2	0	0	0	0	2
COLOMBO / Department of National Zoological Gardens	5	2	0	0	0	0	7
HYDERABAD / Nehru Zoological Park	7	3	0	0	0	0	10
KHAOKHEOW / Khao Kheow Open Zoo	3	5	0	0	0	0	8
KOBE PARK / Kobe Oji Zoo	1	1	0	0	0	0	2
MADRAS / Arignar Anna Zool. Park, Chennai	2	1	0	0	0	0	3
MYSORE / Sri Chamarajendra Zoo (Mysore Zoo)	2	1	0	0	0	0	3
NAGOYA / Nagoya Higashiyama Zoo	1	1	0	0	0	0	2
OSAKA / Osaka Municipal Tennoji Zool. Gdns.	1	1	0	0	0	0	2
SEOUL / Seoul Zoo	2	2	0	0	0	0	4
SINGAPORE / Singapore Zoological Gardens	2	1	0	0	0	0	3
TAIPEI / Taipei Zoo	1	2	0	0	0	0	3
TBILISI / Tbilisi Zoo	4	1	0	0	0	0	5
YOKOHAMA / Nogeyama Zoological Gardens of Yokohama	0	1	0	0	0	0	1
Region: Europe 55 Institutions, Male: 50, Female: 69, Other: 2							
AMSTERDAM / Artis Zoo	0	1	0	0	0	0	1
ANTWERP / Zoo of Antwerp	0	2	0	0	0	0	2
ATTICAZOO / Attica Zoological Park S.A.	1	2	0	0	0	0	3
BARCELONA / Parc Zoologic de Barcelona	1	1	0	0	0	0	2
BEAUVAL / Zoo Parc de Beauval	1	1	0	0	0	0	2
BERLIN TP / Tierpark Berlin-Friedrichsfelde GmbH	1	2	0	0	0	0	3
BOJNICE / Zoologicka zahrada Bojnice	0	1	0	0	0	0	1
BRATISLAV / Zoologicka Zahrada Bratislava	1	1	0	0	0	0	2
BROXBOURN / Paradise Wildlife Park	1	0	0	0	0	0	1

CABARCENO / Parque de la Naturaleza de Cabarceno	3	4	0	0	0	0	7
CHESTER / North of England Zoological Society	1	2	0	0	0	0	3
COULANGE / Parc Zoologique d'Amneville	1	1	0	0	0	0	2
DARTMOOR / Dartmoor Zoological Park	1	0	0	0	0	0	1
DORTMUND / Zoo Dortmund	1	1	0	0	0	0	2
EDINBURGH / Edinburgh Zoo - Scottish National Zoo	1	1	0	0	0	0	2
ESKILSTUN / Parken Zoo i Eskilstuna AB	1	2	0	0	0	0	3
HALLE / Zoologischer Garten Halle GmbH	1	1	0	0	0	0	2
HEADCORN / Wildlife Heritage Foundation	1	1	0	0	0	0	2
HODONIN Z / Zoologická zahrada Hodonín	2	2	0	0	0	0	4
KAZAN / Kazan Zoological & Botanical Garden	1	1	0	0	0	0	2
KISKUTLIG / Xantus János Állatkert Kht.	0	1	0	0	0	0	1
KRAKOW / Park i Ogrod Zoologiczny w Krakowie	1	3	0	0	0	0	4
KREFELD / Zoo Krefeld GmbH	2	1	0	0	0	0	3
LA PALMYR / Parc Zoologique de La Palmyre	1	1	0	0	0	0	2
LA TESTE / Zooland-Park	0	2	0	0	0	0	2
LES SABLE / Zoo des Sables d'Olonne	0	0	1	0	0	0	1
LISBON / Jardim Zoologico / Lisbon Zoo	1	0	0	0	0	0	1
MINSK ZOO / Minskij Zoopark (Minsk Zoo)	0	1	0	0	0	0	1
MOSCOW / Moscow Zoological Park	0	1	0	0	0	0	1
NESLES / Le Parc des Felins	2	1	0	0	0	0	3
NIKOLAEV / Nikolaev Zoo of Nikolaev-City Council	2	1	0	0	0	0	3
NOVOSIBRK / Novosibirsk Zoological Park	2	2	0	0	0	0	4
NYIREGYHA / Nyíregyházi Állatpark Nonprofit KFT (Sosto Zoo)	1	1	0	0	0	0	2
OLOMOUC / Zoologicka zahrada Olomouc	1	1	0	0	0	0	2
OPOLE / Ogrod Zoologiczny Opole	0	1	0	0	0	0	1
OSIJEK / Zoo Osijek/UNIKOMza Komun Gospodarstvo	1	1	0	0	0	0	2
PARIS JP / Menagerie du Jardin des Plantes (MNHN)	1	0	0	0	0	0	1
PESSAC / Parc Zool. De Bordeaux-Pessac	1	0	0	0	0	0	1
PISTOIA / Societa Zoologica Di Pistoia S.R.L	2	1	0	0	0	0	3
PLAISANCE / African Safari	1	2	0	0	0	0	3
ROSTOCK / Rostock Zoologischer Garten	2	1	0	0	0	0	3
RUSHDEN / Ravensden Zoo Ltd. (extinct Dec 1999)	0	1	0	0	0	0	1
SAARBRUCK / Zoologischer Garten Saarbruecken	1	2	1	0	0	0	4
SALZBURG / Salzburg Zoo Hellbrunn	1	1	0	0	0	0	2
SKAERUPZO / Skaerup Mini Zoo	1	3	0	0	0	0	4
SO LAKES / South Lakes Wild Animal Park	1	1	0	0	0	0	2
SOFIAZOO / Sofia Zoological Gardens	1	2	0	0	0	0	3
SZEGED / Szeged Zoo	1	1	0	0	0	0	2
TERRA NAT / Terra Natura S.A.	0	1	0	0	0	0	1

VIENNA / Schönbrunner Tiergarten GmbH	0	2	0	0	0	0	2
WARSAW / Miejski Ogrod Zoologiczny Warsaw	1	1	0	0	0	0	2
WIGHT ZOO / Isle of Wight Zoo	0	2	0	0	0	0	2
WINGHAMBP / Wingham Wildlife Park	1	1	0	0	0	0	2
YARMOUTH / Thrigby Hall Wildlife Gardens	0	1	0	0	0	0	1
ZAGREB / Zagreb Zoo / Zooloski vrt Zagreb	1	1	0	0	0	0	2
Region: North America 59 Institutions, Male: 69, Female: 76, Other: 1							
ABILENE / Abilene Zoological Gardens	1	0	0	0	0	0	1
AKRON / Akron Zoological Park	1	2	0	0	0	0	3
ALDERGROV / Greater Vancouver Zoo	1	0	0	0	0	0	1
ALEXANDRI / Alexandria Zoological Park	1	1	0	0	0	0	2
ARDASTRA / Ardastra Gardens & Conserv. Centre	0	1	0	0	0	0	1
AUDUBON / Audubon Zoo	1	1	0	0	0	0	2
BATONROUG / BREC'sBaton Rouge Zoo	1	0	0	0	0	0	1
BOWMANVIL / Bowmanville Zoological Park	1	0	0	0	0	0	1
BREVARD / Brevard Zoo	2	1	0	0	0	0	3
CHATTANOG / Chattanooga Zoo at Warner Park	2	0	0	0	0	0	2
COAL VAL / Niabi Zoo	1	0	0	0	0	0	1
DALLAS WA / Dallas World Aquarium	1	2	0	0	0	0	3
DREHER PA / Palm Beach Zoo at Dreher Park	1	3	0	0	0	0	4
ERIE / Erie Zoological Gardens	1	0	0	0	0	0	1
EVANSVLLE / Mesker Park Zoo	1	1	0	0	0	0	2
GARDENCTY / Lee Richardson Zoo	0	3	0	0	0	0	3
GRANBY / Zoo de Granby	0	1	0	0	0	0	1
GUADALJR / Guadalajara Zoo	2	1	0	0	0	0	3
GUAT CITY / Zoologico Nacional La Aurora	3	9	1	0	0	0	13
HATTIESBG / Hattiesburg Zoo	1	0	0	0	0	0	1
JACKSONVL / Jacksonville Zoo and Gardens	2	3	0	0	0	0	5
LITTLEROC / Little Rock Zoological Gardens	1	1	0	0	0	0	2
LORO PUEB / Parque Loro Puebla	1	2	0	0	0	0	3
LOSANGELE / Los Angeles Zoo & Botanical Gardens	2	0	0	0	0	0	2
LOUISVILL / Louisville Zoological Garden	2	0	0	0	0	0	2
LUFKIN / Ellen Trout Zoo	1	1	0	0	0	0	2
MAMELLES / Parc des Mamelles	2	0	0	0	0	0	2
METROZOO / Zoo Miami	1	2	0	0	0	0	3
MILWAUKEE / Milwaukee County Zoological Gardens	3	1	0	0	0	0	4
MONCTON / Magnetic Hill Zoo	1	1	0	0	0	0	2
MONROE / Louisiana Purchase Gardens & Zoo	0	1	0	0	0	0	1
MONTGOMRY / Montgomery Zoo	1	4	0	0	0	0	5

NORRISTOW / Elmwood Park Zoo	0	2	0	0	0	0	2
OKLAHOMA / Oklahoma City Zoological Park	1	1	0	0	0	0	2
OMAHA / Omaha's Henry Doorly Zoo	2	0	0	0	0	0	2
ORONO / Jungle Cat World Wildlife Park Inc.	1	0	0	0	0	0	1
PALM DES / The Living Desert	1	1	0	0	0	0	2
PHILADELP / Philadelphia Zoo	1	1	0	0	0	0	2
PHOENIX / Phoenix Zoo	1	1	0	0	0	0	2
PUEBLA / Africam Safari (Africam, S. A.)	1	3	0	0	0	0	4
RIO GRAND / Albuquerque Biological Park	1	0	0	0	0	0	1
ROSAMOND / Exotic Feline Breeding Compound Inc.	5	2	0	0	0	0	7
SACRAMNTO / Sacramento Zoo	1	1	0	0	0	0	2
SALISBURY / Salisbury Zoological Park	0	2	0	0	0	0	2
SAN ANTON / San Antonio Zoological Gardens & Aquar	0	1	0	0	0	0	1
SANDIEGOZ / San Diego Zoo	1	1	0	0	0	0	2
SANJOSECA / Happy Hollow Zoo	0	1	0	0	0	0	1
SANJOSECR / Zoologico Nacional Simon Bolivar	3	3	0	0	0	0	6
SEATTLE / Woodland Park Zoo	2	3	0	0	0	0	5
SEDGWICK / Sedgwick County Zoo	1	1	0	0	0	0	2
ST LOUIS / Saint Louis Zoological Park	1	1	0	0	0	0	2
STONEHAM / Zoo New England, Stone Zoo	1	1	0	0	0	0	2
TORONTO / Toronto Zoo	1	1	0	0	0	0	2
TUCSON / Reid Park Zoo	0	2	0	0	0	0	2
TULSA / Tulsa Zoo	1	1	0	0	0	0	2
W ORANGE / Turtle Back Zoo	0	2	0	0	0	0	2
WACO / Cameron Park Zoo	1	1	0	0	0	0	2
WATERTNSD / Bramble Park Zoo	1	1	0	0	0	0	2
WILD WRLD / Wildlife World Zoo	2	0	0	0	0	0	2
Region: South America 12 Institutions, Male: 23, Female: 29, Other: 0							
BARRANQUL / Barranquilla Zoo	1	2	0	0	0	0	3
BOGOTA / Parque Zoologico Jaime Duque - Bogota	2	1	0	0	0	0	3
BUENOSAIR / Jardin Zoologico de Cuidad Buenos Aires	1	1	0	0	0	0	2
BUIN ZOO / Parque Zoológico Buin Zoo	2	1	0	0	0	0	3
CALI / Fundacion Zoologica de Cali	0	3	0	0	0	0	3
COLOMSANT / Fundacion Zoologico Santacruz	4	4	0	0	0	0	8
MACOURIA / Zoo de Guyane	3	2	0	0	0	0	5
MEDELLIN / Parque Zoologico Santa Fe	1	5	0	0	0	0	6
PERU CERH / Parque Zoologico Huachipa	4	6	0	0	0	0	10
PISCILAGO / Parque Recreativo y Zool. Piscilago	2	2	0	0	0	0	4
SANTIAGOZ / Zool.Nacional Parque Metro De Santiago	1	1	0	0	0	0	2
SAO PAULO / Fundacao Parque Zoologico de Sao Paulo	2	1	0	0	0	0	3



Six main behavioural categories were identified in jaguar cubs aged between 0 to 10 weeks. These include social (which comprises both affiliative and agonistic behaviours), grooming, feeding, locomotor, elimination and sensorial. The observed behaviours provide insights on those that are essential to the jaguars' future adult survival. Sexual behaviours were not yet evident at this stage. A broader selection of agonistic behaviours were recorded compared to affiliative ones, suggesting that behaviours of this nature have a greater weight and influence on jaguar survival.

Play behaviour is central to cub development, allowing for the advancement and polishing of vital skills, surrounding reproduction, hunting and defences. Deeper research into this specific area promises great value.

Hand raising versus allowing cubs to be raised by their mothers, does not seem to influence the cubs' ability to care for their own cubs in the future, though it can affect other areas of the animal's physical and social development. Allowing cubs to be mother raised will conserve the animals' natural behaviours. However, when conservation and captive reproductive programs stand as the priority, it is debatable that hand raising jaguar cubs may encourage behaviours more suited to that of a context of a life in captivity.

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