

History of Science and Conservation of The Jaguar (*Panthera Onca*) in Brazil

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ABSTRACT

The article discusses the history of scientific research and conservation efforts concerning the jaguar (*Panthera onca*) in its entire current range, focusing in its status in the Brazilian territory. It addresses the range, the ecology, the behavior and the survival strategies of the species. It also discusses human perceptions and reactions to its presence. The roles of hunters and scientists in the construction of current knowledge about the species are also presented. Lastly, all recorded conservation efforts concerning the species in the Brazilian territory, one of its major living areas, are discussed in detail.

Keywords: Jaguar; Science; Conservation; Environmental History.

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INTRODUCTION

Throughout history, the jaguar (*Panthera onca* - Linnaeus, 1758) has been the object of several types of representation, both iconographic and textual: indigenous myths, colonial chronicles, travelers' reports, backland exploration documents, hunters' tales, old and current popular folktales, fictional narratives, scientific articles and books aimed at the conservation of the species. The fear of this beast is one of the main characteristics of the Brazilian imagination about the fauna. Its deep sounding roar, which can be heard from afar, is terrifying, as reported by many travelers. In many stories the jaguar is portrayed as a sort of king of the forest, endowed with a tyrannical will. More recently, the jaguar has been the subject of rather extensive scientific research. Its behavior and life requirements are much better known today. This knowledge has been transmitted in different types of publications, both for specialists and for laymen.

This paper deals with the construction of scientific knowledge about the jaguar in Brazil. It is based on data and analysis produced by systematic field research and conservation biology projects. It also deals with the direct relationship between scientific research and conservation strategies of the jaguar. Our sources were scientific books and articles, master's dissertations and doctoral theses, websites of non-governmental organizations, conservation project reports, and interviews with researchers, practitioners, and activists.

The goals of the paper are to understand (i) how scientific research and conservation initiatives in Brazil over the last 40 years regarding the jaguar are linked and (ii) how researchers and activists are involved in the protection of jaguar populations from extinction.

The ambivalences of the representations of the jaguar make it both feared and admired. It is hunted because it inspires terror and preys domestic herds. Sport hunters value it as a trophy, despite the prohibition of its hunting. But it is also the object of aesthetic appreciation. Its ferocious aspect and efficiency as a predator impose respect. Scientists and conservation activists operate at the crossroads of the

tensions between humans and jaguars. They seek, through scientific knowledge, to turn fear and hatred into a desire for contemplation and other attitudes conducive to jaguar's protection. The fear and respect that the jaguar imposes, its beauty and its ferocity make it an object of admiration and knowledge, and combine to turn it into a highly relevant theme for environmental history.

JAGUAR: THE BEAST

The terror of becoming food, of being preyed upon by a beast of large teeth, sharp claws and tremendous strength, has inhabited the imagination of humans throughout history. The danger of being killed and devoured by beasts was real and in some contexts it still can be. Environments in which *Homo sapiens* emerged and evolved were also the home of large carnivores - efficient predators occupying the top of the food chain. Cultural evolution has led humans to the current status of "dominant animal," but the remaining predatory carnivores still impose respect and awaken the deepest fears of the human psyche.⁴

As forces of nature, great predators lived with humans, hunted them and occasionally were hunted by them. Their power needed to be kept at bay or neutralized. In different societies, totems, magical rituals, art, and hunting itself were, and sometimes still are, ways of relating to the great predators.⁵ In modern societies, science has taken them as objects of knowledge, studied their behavior and described their role in ecosystems. The continued existence of great carnivores has been defended by scientists, artists, nature admirers, amateur hunters, conservationists, and environmentalists, based on utilitarian (ecological and leisure services), aesthetic (beauty), and ethical (intrinsic value) arguments.⁶

⁴ On the terror of being devoured, see David Quammen, *Monster of God: the man-eating predator in the jungles of history and the mind* (New York: W. W. Norton & Company, 2003). On cultural evolution of *Homo sapiens* as a dominating species, see Paul R. Ehrlich and Anne H. Ehrlich, *The Dominant Animal: Human Evolution and the Environment* (Washington, D.C.: Island Press, 2008).

⁵ See Quammen, *Monster of God...*

⁶ Peter S. Alagona, *After the Grizzly: Endangered Species and the Politics of Place in California* (Berkeley: University of California Press, 2013); Thomas R. Dunlap, *Saving America's Wildlife: Ecology and the American Mind, 1850-1990* (New Jersey: Princeton University Press, 1988).

The jaguar is the largest carnivore found in the Brazilian territory. It lived in historical times from the southwestern United States to south-central Argentina. Currently, the distribution of viable jaguar populations ranges from northern Mexico to northern Argentina. Rare individuals have been monitored recently in the southwestern United States, but for over 50 years no reproductive population has been recorded in the country. The current range of the species is estimated at 8.75 million square kilometers, or 46% of its historical distribution. Approximately half of this range lies inside the Brazilian territory. Originally the species was present in all Brazilian biomes: Amazonia, the Pantanal (the great swampland), Cerrado (savanna), Caatinga (semiarid scrub forest), the Atlantic Forest, and the Pampa. The species' existence is strongly threatened in the Atlantic Forest and in the Caatinga; it is virtually extinct in the Pampa. Exceptionally jaguars have been sighted at altitudes up to 3,800 meters (outside Brazil), but they prefer low lying areas (below 2,000 meters). Unlike most felines, the jaguar feels comfortable in the water - it is an excellent swimmer and can capture prey efficiently in water.⁷

⁷ General information on the jaguar can be found in a relatively vast literature. Adriano Gambarini, Laís Duarte, Mario Haberfeld, Rogério Cunha de Paula, *Panthera onca: à sombra das florestas* (Vinhedo: Avis Brasilis Editora, 2016); José Luiz de Andrade Franco, História da *Panthera onca* no Brasil: entre o terror e a admiração (séculos XVI-XXI), In: José Luiz de Andrade Franco, Sandro Dutra e Silva, José Augusto Drummond, e Giovana Galvão Tavares (Orgs.). *História Ambiental II: territórios, fronteiras e biodiversidade* (Rio de Janeiro: Garamond, 2016); Leandro Silveira e Peter Crawshaw Jr., *Panthera onca*. In: Angelo B. Monteiro Machado, Gláucia Moreira Drummond, Adriano Pereira Paglia (eds), *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção – Volume II* (Belo Horizonte: Biodiversitas, 2008), pp. 793-794; Nélio Roberto dos Reis, Adriano Lúcio Peracchi, Maíra Nunes Fregonezi, Bruna Karla Rossaneis, *Mamíferos do Brasil: Guia de Identificação* (Rio de Janeiro: Technical Books, 2010); Luke Hunter, *Carnivores of the World* (New Jersey: Princeton University, 2011); Mel Sunquist & Fiona Sunquist, *Wild Cats of the World* (Chicago: University of Chicago, 2002); Tadeu Gomes de Oliveira, *Neotropical Cats: Ecology and Conservation* (São Luís: EDUFMA, 1994); Tadeu Gomes de Oliveira & Katia Cassaro, *Guia de campo dos felinos do Brasil* (São Paulo: Instituto Pró-Carnívoros, 2005); Leandro Silveira. Jaguar. In: Julie Scardina & Jeff Flocken (eds.), *Wildlife Heroes: 40 Leading Conservationists and the Animals They Are Committed to Saving* (Philadelphia: Running Press, 2012); Rafael Hoogesteijn & Edgardo Mondolfi, *El Jaguar: Tigre Americano* (Caracas: Armitano, 1992); Kevin L. Seymour, *Panthera onca - Mammalian Species*, nº 340 (October 26, 1989), pp. 1-9; Kristin Nowell & Peter Jackson, *Wild Cats: Status Survey and Conservation Action Plan* (IUCN, 1996); Ronaldo Gonçalves Morato, Beatriz de Mello Beisiegel, Emiliano Esterci Ramalho, Cláudia Bueno de Campos, Ricardo Luiz Pires Boulhosa, Avaliação do risco de extinção da onça-pintada, *Panthera onca* (Linnaeus, 1758), no Brasil, *Biodiversidade Brasileira*, 3(1) (2013), pp. 122-132, 2013; Alan Rabinowitz, *An Indomitable Beast: The Remarkable Journey of the Jaguar* (Washington, DC: Island Press, 2014); Alan Rabinowitz, *Jaguar: One Man's Struggle to Establish the World's First Jaguar Preserve* (Washington-DC, Island Press, 2000); Evaristo Eduardo de Miranda & Liana John, *Jaguar: O Rei das Américas* (São Paulo: Metalivros, 2010); Emil B. McCain, Jack L. Childs. Evidence of resident jaguars (*Panthera onca*) in the southwestern United States and the implications for conservation, *Journal of Mammalogy*, 89(1) (2008), p. 1-10; Panthera.org. *Jaguar Fact Sheet*. Available at: https://www.panthera.org/cms/sites/default/files/Panthera_FactSheets_Jaguar.pdf; Eric W. Sanderson, Kent H. Redford, Cheryl-Lesley B. Chetkiewicz, Rodrigo A. Medellín, Alan R. Rabinowitz, John G. Robinson, Andrew B. Taber, Planning to save a species: the jaguar as a model, *Conservation Biology*, 16(1) (2002) p. 58-72; Brian Miller, Richard Reading, Jim Strittholt, Carlos Carrol, Reed Noss, Michael Soulé, Oscar Sánchez, John Terborgh, Donald Brightsmith, Ted Cheeseman, David Foreman, Using focal species in the design of nature reserve networks, *Wild Earth*, 8 (1999), pp. 81-92; Rodrigo A. Medellín, Clementina Equihua, Cheryl L. B. Chetkiewicz, Peter Crawshaw Jr, Alan Rabinowitz, Kent H. Redford, John G. Robinson, Eric Sanderson, Andrew Taber (eds.), *El jaguar en el Nuevo Milenio* (México: Fondo de Cultura Económica / Instituto de Ecología: Universidad Autónoma do México/ Wildlife Conservation Society: 2002).

Known in Brazil by the common names of “onça-pintada”, “onça-preta”, “jaguar”, “jaguaretê”, or “canguçu”, *Panthera onca* (its scientific name) belongs to the genus *Panthera*, together with the lion (*Panthera leo*), the tiger (*Panthera tigris*), and the leopard (*Panthera pardus*). The jaguar is the only panther in the Americas. The genus is different from the cougar (*Puma concolor*), which in Brazil is popularly called as “puma” or “suçuarana”. The coat of the jaguar varies from light yellow to brown, covered by spots that, on its back and sides, form rosettes with one or more spots inside. There are melanic specimens - known in Brazil as “onça-preta” [black jaguars]. Although they have a black coat, in the sunlight the spot and rosette pattern is easily visible. Its size varies from 1.10 to 2.41 meters (from head to tail) and its weight ranges from 35 to 158 kilograms. Males are larger and heavier than females.⁸

The jaguar is an opportunistic carnivore. More than 85 species have been recorded in their diet, which varies with prey density, and ease of capture. The main items on their menu are capybara, deer, peccary, sloths, and alligators. It avoids long pursuits, preferring ambushes, when it surprises prey. It has robust and strong constitution, with the most powerful bite among all felines, capable of crushing the hulls of turtles and tortoises. When it attacks large prey, instead of suffocating them, it jumps on their backs, dislocates their necks and, with a bite that penetrates the bones of the skull, kills the prey. As it has no predators, it occupies the top of the food chain. Conservation biologists look at the jaguar as a flagship species, as it is sensitive to environmental disturbances and therefore useful for monitoring habitat quality. Jaguars have low reproductive rates and are therefore especially sensitive to hunting pressure, changes in vegetation coverage, and availability of water and prey.⁹

BACKGROUND OF THE SCIENTIFIC KNOWLEDGE ON THE JAGUAR

During the first three quarters of the 20th century, knowledge about the jaguar in Brazil was produced mainly by hunters and disseminated through their reports. Jaguars were hunted for three reasons: for their pelts, as retaliation to their attacks on

⁸ Ibidem.

⁹ Ibidem.

livestock, and for sport. Some sport hunters left precious written testimonies of their encounters with jaguars. They admired the animal and were interested in its behavior, environment, and morphology. Francisco de Barros Júnior (1883-1969), in a classic hunting book, wrote that "my greatest concern was to kill a jaguar, since I thought that in order to be a complete hunter, it would be necessary to have killed at least one of these felines".¹⁰

His passion for sport hunting, wild nature and the jaguar brought Theodore Roosevelt (1858-1919), former president of the United States, to Brazil, in 1913.¹¹ He joined one of the expeditions of Brazil's premier backland explorer Cândido Mariano da Silva Rondon (1865-1958), crossing the Pantanal lands of the state of Mato Grosso all the way to the southwestern Amazon region. Roosevelt was well-known as an enthusiastic hunter, but he also sought to be a naturalist. According to him, his excursion with Rondon "was not intended a hunting trip, but a scientific expedition".¹² His observations about the two jaguars he hunted in the Pantanal - one killed by Roosevelt himself, and the other by his son Kermit - are of scientific relevance. He noted, above all, the adaptation of the animal to the environment, as we can see in the following passage: "Jaguars love the water. They drink greedily and swim freely. In this country they rambled through the night across the marshes and prowled along the edges of the ponds and bayous, catching the capybaras and the caymans [...]".¹³ In another section he states: "In this particular neighborhood the ordinary jaguar molested the cattle and horses hardly at all except now and then to kill calves. [...] There were plenty of capybaras and deer, and evidently the big spotted cats preferred the easier prey when it was available [...]".¹⁴

The legendary adventurer Sasha Siemel (1890-1970) left detailed accounts of his hunts. Born in Latvia, Siemel spent part of his life in the Pantanal. He became famous as the only white man able to hunt jaguars with a javelin - "zagaia", a spear of

¹⁰ Francisco de Barros Júnior, *Caçando e Pescando por todo o Brasil - 1ª Série - Brasil Sul* (São Paulo: Melhoramentos, s/d), p. 244. The date of the first publication of this rare book is 1945, by Troféu Press. Between 1945 and 1953 six volumes of this series were published, all of them by Barros Jr.

¹¹ Candice Millard, *River of Doubt: Theodore Roosevelt's darkest journey* (New York: Doubleday, 2005).

¹² Theodore Roosevelt, *Through the Brazilian Wilderness* (New York: Charles Scribners Sons, 1914), p. 26.

¹³ *Ibidem*, p. 82.

¹⁴ *Ibidem*, p. 83.

about 2 meters, with a support device at one end, which, propped on the ground, is directed at the chest of the jaguar when it lunges. In his book *Tigrero!*, published in 1953, he recounts how he learned to use the javelin with a native American guide, Joaquim Guató, and discusses his solitary jaguar hunts of.¹⁵ Siemel is the stereotype of the audacious hunter. He admired the jaguar, the "tiger" that risks its own life to hunt. Siemel's daily life, however, was more pragmatic and less glamorous. He was hired many times by farmers to eliminate jaguars that attacked cattle, with the help of ranch cowboys. He also was hired frequently as a guide for sport hunters. His usual weapon was the shotgun, not the javelin.¹⁶

The jaguar hunter who left the most important records for science was Brazilian Tony de Almeida (Antônio Eduardo d'Andrada Almeida). In 1976 he published *Jaguar Hunting in the Mato Grosso and Bolivia*.¹⁷ Born in São Paulo in 1935, he studied in England and became a hunter and guide. Between the late 1960s and the late 1980s he worked with hunting safaris for non-Brazilians. In addition to describing the behavior of jaguars, he systematically noted weight, size, and stomach contents of slaughtered animals. His book provided the most comprehensive information on the jaguar's biology and ecology in the years that elapsed before systematic field scientific research. His book was for a long time the main reference for scientists who studied the jaguar.¹⁸ Almeida went as far as comparing the behavior and diet of the jaguars in different biomes - the Cerrado, the Amazon Forest and the Pantanal:

The chief ingredients of the swamp jaguar's diet are caiman and capybara. These two animals only live in or near water, whence their abundance in the swamps. In the last hundred years, another important item has been added to the jaguar's menu in this region, namely cattle. All these animals are reasonably easy to stalk and kill.

In the plateau country and the Amazon forest, the jaguar's food consists chiefly of peccaries and tapirs, but he will eat any small animals that come his way,

¹⁵ Sasha Siemel, *Tigrero!* (New York: Prentice-Hall, 1953).

¹⁶ About this, see Felipe Sússekind, *O Rastro da Onça: Etnografia de um projeto de conservação em fazendas de gado do Pantanal* (Doctoral Dissertation in Anthropology, Museu Nacional do Rio de Janeiro, 2010); Cezar Benevides e Nanci Leonzo, *Miranda Estância: ingleses, peões e caçadores no Pantanal Mato-grossense* (Rio de Janeiro: FGV, 2001).

¹⁷ Tony de Almeida, *Jaguar Hunting in the Mato Grosso and Bolivia* (Long Beach: Safari, 1990). This is a revised and expanded reprint of the 1976 book.

¹⁸ About this, see Sússekind, *O Rastro da Onça...*; Benevides e Leonzo, *Miranda Estância...*; Peter G. Crawshaw Júnior, The history of carnivore research in Brazil, In: Ronaldo Gonçalves Morato et al (orgs.), *Manejo e conservação de carnívoros neotropicais* (São Paulo: Ibama, 2006).

such as armadillos, monkeys, pacas, agoutis, tinamous and other birds, turtles and their eggs, and even fish. The swamp jaguar will also eat smaller game, if it happens to practically fall into his lap, but he will certainly not waste time stalking it unless, of course, the jaguar is in bad health or in some other way handicapped.¹⁹

In the first half of the 20th century, the zoologist Rodolpho von Ihering (1883-1939) and the journalist, writer and conservationist Eurico Santos²⁰ (1883-1968), both Brazilians, produced the first scientific texts on the jaguar.²¹ They drew attention to its constitution and physical appearance, including variations. They also dealt with the animal's geographical distribution. However, they emphasized the characteristics and the ability of the jaguar as a predator. Ihering argued that:

The jaguar has all the qualities to dominate and, indeed, it reigns in the backlands. It climbs trees as easily as it crosses great rivers; there is no animal that can equal it in jumping in height and distance, and to all this the sagacity and ability of an highly skilled hunter is added. In general it is satisfied with wild pigs, capybaras or deer; but if that hunting is scarce and there is livestock in the region, cattle owners pay a lot of tribute [...].²²

Santos notes that the jaguar "is undoubtedly the most feared beast in the American continent, stronger, larger and more daring, a rival of lions and other exotic panthers".²³ He notes that its hunting is a grandiose spectacle: "Quiet hunting, to catch the victims by surprise ... Their walk is muffled, velvety, as if they walked on carpets [...]".²⁴ The jaguar walks guided by flair, lurks and "surprises animals in their dens and falls on them like lightning. It is often heard in the silence of the forests, late night, the distressed cry of an animal that struggles strangled and ferociously bled by the terrible butcher".²⁵

Ihering and Santos based much of their knowledge about the jaguar on information obtained from sport hunters. Therefore they allow considerable space in their writings for the descriptions of the hunt for the "cunning predator." Systematic

¹⁹ Almeida, *Jaguar Hunting* ..., p. 41.

²⁰ Santos was one of the founders of the *Fundação Brasileira para a Conservação da Natureza* (FBCN), em 1958. About this non-governmental organization, see José Luiz de Andrade Franco e José Augusto Drummond, "Nature Protection: the FBCN and Conservation Initiatives in Brazil, 1958-1992", *HALAC*, 2 (2013), pp. 338-367. Santos wrote a long series of books on varied taxons of the Brazilian fauna, published during the 1930s, 1940s, and 1950s, and republished during the 1970s and 1980s, with the title of *Coleção Zoologia Brasileira*, edited by Editora Itatiaia.

²¹ Ver Rodolpho von Ihering, *Dicionário dos Animais do Brasil* (São Paulo: Difel, 2002), published originally in 1940; Eurico Santos, *Entre o Gambá e o Macaco* (Belo Horizonte: Itatiaia, 1984), originally published in 1945.

²² Ihering, *Dicionário...*, p. 360.

²³ Santos, *Entre o Gambá...*, p. 240.

²⁴ *Ibidem*, p. 243.

²⁵ *Ibidem*, p. 244.

and academic scientific research on the species in Brazil began only in the second half of the 1970s.

SCIENCE AND JAGUAR CONSERVATION

The first scientific field research on the jaguar in Brazil started in 1977. German zoologist George Beals Schaller, born in 1933, was the pioneering jaguar researcher. He grew up in the United States, where he became a recognized authority on wildlife research and conservation. When he came to Brazil to study the jaguar in its natural habitat, he was a well-known researcher – he had devoted much time to study gorillas, lions, and cheetahs in Africa, and tigers and snow leopards in Asia. His interest was scientific, but his research was interwoven with the concern for the conservation of the wild faunas of the areas that he studied.²⁶ Schaller emphasized his concern for the future of the jaguar, and proposed steps to prevent its extinction:

[...] the jaguar is already extinct or reduced to occasional stragglers over large parts of the Pantanal, in some areas because of systematic eradication by ranchers within the past twenty-five years. No species in which a female raises an average of only one cub every two years can stand such heavy attrition. Unless local attitudes change, only a large national park can save the Pantanal jaguar.

The ostensible reason for eliminating jaguars is that they kill cattle. And indeed they do, although the cats account for only a tiny percentage of those that die annually. In one Pantanal district the cattle population declined from 700,000 to 180,000 in six years, largely as a result of disease, drowning, and starvation, after severe annual floods submerged pastures for months. As a result of poor management on many ranches, only one cow in four or five raises her calf.²⁷

Schaller researched at the Acurizal Farm, located in the Pantanal, in the state of Mato Grosso. His research was part of a project of the New York Zoological Society - now Wildlife Conservation Society, WCS - in partnership with *Instituto Brasileiro de Desenvolvimento Florestal*, IBDF, Brazil's major environmental agency at the time. Peter Gransden Crawshaw Junior (Brazilian, 1952), a biologist and IBDF employee,

²⁶ About scientific research on the jaguar in Brazil, see: George B. Schaller, *A Naturalist and Other Beasts: Tales from a life in the field* (San Francisco: Sierra Club Books, 2007); Crawshaw Júnior, *The history of carnivore research in Brazil...*; Tadeu Gomes de Oliveira, *Research in terrestrial carnivora from Brazil...*; Rabinowitz, *An Indomitable Beast...*; Sússekind, *O Rastro da Onça...*; Silvio Marchini, *Onça-Pintada: 3 décadas de publicações científicas*, *O Eco*, December 21st 2010, <http://www.oeco.org.br/silvio-marchini/24666-onca-pintada-3-decadas-de-publicacoes->.

²⁷ Schaller, *A Naturalist and Other Beasts...*, p. 75. This book is based on published articles and books. The original publication date is at the end of each animal mentioned in the book. In the case of the jaguar, the date is 1980.

joined the project in January of 1978, as Schaller's research assistant. The IBDF intended to buy the farm and create a national park, which would include an adjacent protected area – the Caracará Biological Reserve. Together, they began capturing jaguars and placing collars with radio transmitters on them, in order to monitor their movements. They were assisted by the Englishman Richard Mason, a partner of Tony Almeida, and the “mateiro”(bush guide) Manuel Dantas and his five dogs trained for jaguar hunting.²⁸

In 1978, they captured two female jaguars, which received the first radio-collars for telemetry monitoring. However, the project was soon interrupted at this location, since the purchase of the farm by IBDF did not materialize, for political and administrative reasons. In addition, other two jaguars monitored by the project were slaughtered by farm employees.²⁹

Only in August 1980 the project would define a new research site – Miranda Estância Farm, located further south in the Pantanal, in the state of Mato Grosso. However, lacking motivation on account of the previous interruption, Schaller left the project in 1980, when he was invited by WWF to begin a survey of pandas in China. He was replaced by the American biologist Howard Quigley, who remained with Peter Crawshaw Jr. in the project until 1984. Between 1980 and 1984 seven jaguars were monitored.³⁰ Between 1977 and 2002 the jaguar researchers published a series of texts based on data generated between 1977 and 1984.³¹

²⁸ See Schaller, *A Naturalist and Other Beasts...*; Crawshaw Junior, *The history of carnivore research in Brazil...*; José Luiz de Andrade Franco. *História da Panthera onca no Brasil...*, p. 393-426. Interview with Peter Crawshaw Junior, by José Luiz de Andrade Franco, Fernanda Cornils Monteiro Benevides and Fernanda Pereira de Mesquita Nora (Brasília, 31 de outubro de 2016).

²⁹ Ibidem.

³⁰ Ibidem.

³¹ George B. Schaller & J. M. C. Vasconcelos, Jaguar predation on capybara. *Zeitschrift Säugetierk*, v. 43, p. 296-301, 1978; George B. Schaller & Peter Crawshaw Júnior, Movement patterns of jaguar. *Biotropica*, p. 161-168, 1980; George B. Schaller, Mammals and their biomass on a Brazilian ranch. *Arquivos de Zoologia*, v. 31, n. 1, p. 1-36, 1983; Peter Crawshaw Junior & Howard B. Quigley, *A ecologia do jaguar ou onça-pintada no Pantanal Mato-grossense. Estudos bioecológicos do Pantanal matogrossense – relatório final – parte I* (Brasília: IBDF, 1984); Howard B. Quigley & Peter Crawshaw Junior, Use of Ultralight Aircraft in Wildlife Radio Telemetry. *Wildlife Society Bulletin* (1973-2006), v. 17, n. 3, p. 330-334, 1989; Peter Crawshaw Junior & Howard B. Quigley, Jaguar spacing, activity and habitat use in a seasonally flooded environment in Brazil. *Journal of Zoology*, v. 223, n. 3, p. 357-370, 1991; Howard B. Quigley & Peter Crawshaw Junior, A conservation plan for the jaguar *Panthera onca* in the Pantanal region of Brazil. *Biological Conservation*, v. 61, n. 3, p. 149-157, 1992; Peter Crawshaw Junior, Recomendações para um modelo de pesquisa sobre felinos neotropicais. In: Claudio Valadares-Pádua & R. E. Bodmer (eds.), *Manejo e conservação de vida silvestre no Brasil* (Belém: Sociedade Civil Mamirauá, MCT-CNPq, 1997), p. 70-94; Peter Crawshaw Junior & Howard B. Quigley, Hábitos alimentarios del jaguar y el puma en el Pantanal, Brasil, con implicaciones para su manejo y conservación. In: Medellín et al (orgs), *El Jaguar en el Nuevo Milenio...*, p. 223-235; Peter Crawshaw Junior & Howard B. Quigley, Reprodución,

Results of this initial round of research focused mainly on jaguar ecology (feeding habits, home range, spatial distribution, activity patterns), based on the then recent model of radio-telemetry monitoring.³² Many of these early publications proposed conservation steps, including the notion of economically encouraged conservation - due to the strong conflicts involving jaguars and livestock farmers in the region:

Similarly to the species in most of its distribution, the future of the jaguar in the Pantanal is precarious, since its preservation comes into conflict with current cultural traditions and local economic interests. [...]

The data presented in this report reveal the jaguar's basic biological needs in the Pantanal. Based on these results, it is not only useless, but mistaken, to say that this species' predation on cattle is insignificant - this fact will always be a reason for persecution by some farmers. On the other hand, it is safe to say that livestock predation will be inversely proportional to the jaguar's natural prey density in an area, that is, the higher the number of peccaries, capybaras and deer, the lower the numbers of slaughtered cattle. [...]

Jaguar preservation could become more effective through some practical steps from part of the farmers, some of which are enumerated below:

- conservation of gallery and cape forests, which, as shown, constitute the most important environments for jaguars and their prey;
- reduction or prohibition of hunting of native species, including predators;
- prohibition of the use of dogs in the field, because they constitute a serious threat to a large part of the native fauna.

On the other hand, government entities could and should promote owners' interest in preserving parcels of their farms through fiscal incentives and partial tax exemptions, providing palpable benefits, in addition to conservationism through idealism.³³

Crawshaw returned to the US in 1985 to write his master's dissertation on the alligators of the Pantanal, at the University of Florida. Back in Brazil, he coordinated, between 1990 and 1995, the "Iguaçu Carnivorous Project", held in Brazil's Iguaçu National Park. This research resulted in his doctoral thesis, *Comparative Ecology of*

crescimento y dispersión del jaguar en la región del Pantanal de Brasil. In: Medellín et al (orgs), *El Jaguar en el Nuevo Milenio...*, p. 289-302. Howard B. Quigley, *Ecology and conservation of the jaguar (Panthera onca) in the Pantanal region, Mato Grosso do Sul, Brazil*. Doctoral Dissertation, University of Idaho, 1987. This dissertation was also based on data collected in Pantanal Mato-grossense.

³² For the history of the radio-telemetry model, see Peter Crawshaw Junior, *Recomendações para um modelo de pesquisa sobre felinos neotropicais*. In: Claudio Valadares-Padua & R. E. Bodmer (eds.), *Manejo e conservação...*, p. 70-94.

³³ Peter Crawshaw Junior & Howard B. Quigley, *A ecologia do jaguar ou onça-pintada no Pantanal Mato-grossense...*, p. 37.

Ocelot (*Felis pardalis*) and Jaguar (*Panthera onca*) in a Protected Subtropical Forest in Brazil and Argentina, defended at the University of Florida in 1995. During his activities in the Iguaçu National Park, Crawshaw trained a new generation of researchers focused on the study of carnivores. He founded, em 1994, the CENAP, *Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros* [National Center For Research and Conservation of Carnivorous Mammals], within IBAMA (*Instituto Brasileiro do Meio Ambiente*). As IBAMA was restructured in 2007, the CENAP was incorporated by ICMBio (*Instituto Chico Mendes de Conservação da Biodiversidade*). In 1996, CENAP contributed to the creation of the NGO *Instituto Pró-Carnívoros* [Pro-Carnivore Institute]. These two institutions brought together researchers interested in producing knowledge about carnivores and their conservation, including the jaguar.³⁴

Research on the jaguar also took place in other countries, especially since 1986. The North American zoologist Alan Rabinowitz (1953-2018), encouraged by Schaller, carried out important research and conservation work on the jaguar during the 1980s in Central America. This resulted in the creation, in 1986, of the Cockscomb Basin Wildlife Sanctuary, in Belize, the world's first reservation specifically designed to protect the jaguar. Before going to Belize, Rabinowitz underwent a quick training period in Brazil with Crawshaw and Quigley, learning to work with telemetry. Veterinarian Rafael Hoogesteijn and zoologist Edgardo Mondolfi, both Venezuelans, started researching the jaguar in the early 1980s, turning Venezuela into one of the countries that most contributed to the scientific literature on the jaguar. By the 1990s, Mexico, Argentina, Bolivia, Colombia, Costa Rica, Guatemala, Panama, Paraguay and Peru were hosting research projects focused on the jaguar.³⁵

As a result of increased research on the jaguar, in 1999 the WCS and the Instituto de Ecología of the Universidad Nacional Autónoma de México brought together 35 jaguar specialists in Cocoyoc Morelos - Mexico, including several

³⁴ Crawshaw & Quigley, *A ecologia do jaguar ou onça-pintada no Pantanal Mato-grossense...*; Franco, *História da Panthera onca no Brasi...*; Crawshaw Junior, *entrevista...*; Ronaldo Morato, *interview by José Luiz de Andrade Franco and Fernanda Cornils Monteiro Benevides (Atibaia-São Paulo, November 31st 2016)*.

³⁵ Rabinowitz, *An Indomitable Beast...*; Alan Rabinowitz; *Jaguar: One man's struggle to establish the world's first jaguar preserve* (Washington – D.C./Covelo, California: Island Press/Shearwater Books, 2000); Hoogesteijn & Mondolfi, *El Jaguar: Tigre Americano...*; Franco, *História da Panthera onca no Brasil...*

Brazilians. The goal was to present the "state of the art" of the knowledge about the species. Crawshaw, Julio Dalponte, Louise Emmons, Tadeu Gomes de Oliveira, Maria Renata Pereira Leite, Ronaldo Morato, Leandro Silveira, and Howard Quigley reported what was known about the jaguar in Brazilian territory. Brazilians formed the largest group of scientists present at the event. Other researchers were from Argentina, Belize, Bolivia, Paraguay, Guatemala, Colombia, Venezuela, Costa Rica, United States, Mexico, and Peru.³⁶

At the end of the workshop, later known as RWPS – Range Wide Priority-Setting, researchers reached a consensus about the geographical distribution and localization of core-populations of jaguars, or JCU - Jaguar Conservation Units. At this meeting a fundamental change of perspective occurred: from traditional conservation focused on specific populations to large-scale conservation, which takes into account the entire distribution of the species.³⁷

The book *El jaguar en el nuevo milênio*, resulting from this meeting, was published in 2002. It brought together 38 papers and still is the most complete compilation of data on the jaguar. 13 of these texts were written by Brazilian researchers. They deal with different themes associated with jaguar conservation: protected areas, reproductive techniques, capture techniques, feeding ecology, dispersion, conflicts with humans, evolution, and conservation genetics.³⁸ In the preface, Mexican ecologist Rodrigo A. Médellin highlights the purpose of the book:

The purpose of this book is to stimulate research, raise the level of discussion, and provide basic information that allows a robust process of informed, well-documented decision making, aiming at the welfare of the jaguar as a species. If readers find themselves compelled to work for the benefit of the jaguar and its habitat, each in its scope, from the lovers of natural history and animals to specialists and students in ecology and conservation biology, we will have reached our goal.³⁹

This quotation highlights the view that conservation should not be thought or conducted only by experts, but by all concerned with the survival of the species.

³⁶ Franco, *História da Panthera onca no Brasil...*; Marchini, "Onça-Pintada: 3 décadas de publicações científicas"....

³⁷ Kathy A. Zeller, Alan Rabinowitz, Roberto Salom-Perez, Howard Quigley, The Jaguar Corridor Initiative: A Range-Wide Conservation Strategy, In: Manuel Ruiz-Garcia & Joseph M. Shostell (eds), *Molecular population genetics, evolutionary biology and biological conservation of neotropical carnivores* (New York: Nova Science Publishers, 2013), pp. 629-658.

³⁸ Médellin et al (orgs.), *El Jaguar en el Nuevo Milenio...*

³⁹ Ibidem, p. 20.

Still concerning the results of the 1999 meeting, we must highlight the work of the Brazilian Eduardo Eizirik and his collaborators, whose genetic research with populations of jaguars were fundamental to conceive the large-scale conservation approach. Previously, based on morphological data, a classification was proposed that subdivided *Panthera onca* into eight subspecies.⁴⁰ However, Eizirik's research demonstrated that the previous classification had no genetic basis: he and his team found that there is a single species of *Panthera onca* throughout its entire range, without subspecies, indicating the need for connections between populations in order to maintain genetic flow.⁴¹

In 2006, WCS organized another workshop to address the same issues proposed in 1999. 110 researchers attended. The result was the proposition of a strategy to further expand the scope of large-scale conservation, incorporating corridor areas between the previously defined core areas. The program, established by the US based organization Panthera - founded by Alan Rabinowitz and by the billionaire North American conservationist Thomas S. Kaplan, and of which George Schaller is currently vice president - was named Jaguar Corridor Initiative (JCI). 14 countries of the American continent participate in it, including Brazil, and it is defined as a partnership between environmental NGOs, research institutions, local communities, and governments of the countries involved.⁴²

In Brazil, the methodology to define the priority areas proposed in these workshops led to the production of a *Plano de Ação Nacional para Conservação da Onça-Pintada* (PAN) [National Action Plan for Jaguar Conservation] (PAN Onça-Pintada, 2013). It included adaptations that considered, besides ecological aspects, the country's economic and socio-political factors.⁴³ PANs are conservation tools built by

⁴⁰For more details on research based on morphological data, see K. L. Seymour, *Panthera onca*, *Mammalian Species*, 340: 1-9, 1989.

⁴¹ Eduardo Eizirik, Jae-Heup Kim, Marilyn Menotti-Raymond, Peter Crawshaw Júnior, Stephen J. O'Brien, Warren E. Johnson, Phylogeography, population history and conservation genetics of jaguars (*Panthera onca*, *Mammalia*, *Felidae*), *Molecular Ecology*, v. 10 (2001), n. 1, p. 65-79; Warren E. Johnson, Eduardo Eizirik & Stephen J. O'Brien, Evolución y genética de poblaciones de jaguar: implicaciones para los esfuerzos futuros de conservación, In: Medellín, Equihua, Chetkiewicz, Crawshaw Júnior, Rabinowitz, Redford, Robinson, Sanderson, Taber (orgs), *El Jaguar en el Nuevo Milenio...*, pp. 551-600.

⁴² For more details on the project, see the website of the organization *Panthera*, created in 2006: <https://www.panthera.org/initiative/jaguar-corridor-initiative>

⁴³ Rogério Cunha de Paula, Arnaud Desdizez, Sandra Cavalcanti (orgs.), *Plano de Ação Nacional para a conservação da onça-pintada* (Brasília: Instituto Chico Mendes de Conservação da Biodiversidade-ICMBio, 2013).

the collaboration between different institutional representatives (universities, governmental and non-governmental institutions) in order to establish priority goals and actions for the conservation of threatened species.⁴⁴ Regarding the Brazilian fauna, from 2004 to 2018, 58 PANs were issued for individual species (the jaguar PAN, the blue macaw PAN, for example) and for groups of species (the small cetacean PAN, the cervid PAN, the large felines PAN, for example).⁴⁵

In the case of the jaguar, its PAN defines six thematic lines: communication and education; public policy; research; habitat loss and fragmentation; hunting; conflicts. For each of them, actions were defined based on the intrinsic value of the species; on cultural aspects, because it is an emblematic species of the Brazilian fauna; on ecological considerations, as an essential component to maintain functional ecosystems⁴⁶; and on economic aspects, suggesting economic and fiscal incentives through ecotourism and initiatives that reduce conflicts between jaguars and humans.

More recently, there was a proposal to update this PAN in order to unify conservation strategies for the jaguar and the puma, since both species share certain ecological aspects, such as home range, diet, habitat use, as well as engaging in conflicts with humans. According to the biologist Rogério Cunha de Paula, coordinator of CENAP / ICMBio, "by working with the two the species at the same time it was possible to think about conservation actions in an integrated way, allowing the optimization of resources and efforts (..)".⁴⁷ More than 50 representatives of NGOs, government institutions, and scientists participated in the event held for the preparation of the "Plano de Ação Nacional para a Conservação dos Grandes Felinos" [National Action Plan for the Conservation of Large Felines] (the unified PAN), in the city of Atibaia, state of São Paulo, between December 5th and 8th, 2016. Currently, the

⁴⁴ PANs were defined as a conservation instrument through a Joint Ordinance 316, of the Ministry of the Environment and ICMBio, issued in August 2009.

⁴⁵ Data from Instituto Chico Mendes de Conservação da Biodiversidade website: <http://www.icmbio.gov.br/portal/faunabrasileira/planos-de-acao-nacional>

⁴⁶ Based on its ecological importance, the jaguar received several attributes: key species, indicator species, emblematic species, and umbrella species. In this regard, see: Brian Miller & Alan Rabinowitz, ¿ Por qué conservar al jaguar? In: Medellín, Equihua, Chetkiewicz, Crawshaw Júnior, Rabinowitz, Redford, Robinson, Sanderson, Taber (orgs), *El Jaguar en el Nuevo Milenio...*, p. 303-315, 2002; Brian Miller, Using focal species in the design of nature reserve networks, *Wild Earth*, v. 8, p. 81-92, 1999.

⁴⁷ Interview with WWF: "Plano prevê ações para conservação da onça-pintada e da onça-parda", disponível em: http://www.wwf.org.br/informacoes/sala_de_imprensa/?uNewsID=55503

unified plan is in the final stages of preparation. De Paula coordinated the jaguar PAN until 2016 and is responsible for the large felines PAN.⁴⁸

Brazil remains the leading country in the number of publications on the jaguar, a fact that stems from the fact that pioneering research on the animal was conducted in Brazil. The expressive and growing number of professionals dedicated to research and conservation of the jaguar in Brazil has made a series of projects possible. These researchers and operators of conservation projects have enjoyed continued support by national and international institutions, such as CENAP/ICMBio, Instituto Pró-Carnívoros, Instituto Onça-Pintada - IOP, Instituto de Pesquisas Ecológicas - IPÊ, Fundação O Boticário de Proteção à Natureza, Instituto de Desenvolvimento Sustentável Mamirauá, WWF-Brazil, WCS, and Panthera Foundation.⁴⁹

The jaguar projects aim to integrate scientific knowledge about *Panthera onca* with conservation actions. They apply the concepts of key species, umbrella species, indicator species, and flag species. These concepts are based on the notion that the jaguar plays a key role in ecosystems. The jaguar is a top predator of the food chain;⁵⁰ in order for it to survive, components located below (especially its prey) need to continue to exist so that the jaguar can meet its requirements. Therefore, preserving the jaguar requires preserving the food chain that sustains it.

A number of more recent studies on the jaguar have added new knowledge of great importance to its conservation. Soil scientist and zootechnician Sandra Cavalcanti and biologist Fernando Azevedo, former field assistants of Peter Crawshaw in Iguazu National Park, and now associated with Instituto Pró-Carnívoros, chose the Pantanal to conduct field research for their respective doctoral dissertations on the jaguar. Their main scientific reference was the pioneering study of Crawshaw and Quigley at the Estância Miranda. Cavalcanti returned to the Estância Miranda area in 2000 and made pioneering use of GPS technology in telemetry. Cavalcanti and

⁴⁸ Gambarini, Duarte, Haberfeld, Cunha de Paula, *Panthera onca: à sombra das florestas...*

⁴⁹ Gambarini, Duarte, Haberfeld, Cunha de Paula, *Panthera onca: à sombra das florestas...*; Franco, *História da Panthera onca no Brasil...*; Crawshaw Junior, entrevista...; Morato, entrevista...

⁵⁰ A *Panthera onca* does not have natural predators in the food chain. It preys on other animals that are below in this chain.

Marianne Soisalo published an important article that included the first jaguar population estimate made by combining telemetry techniques and GPS, allowing the comparison of different methods.⁵¹ Results suggested that the widely used MMDM (Mean Maximum Distance Moved) method overestimated population density, which in terms of management could place the population of jaguars at risk by delaying the establishment of protection initiatives.

Fernando Azevedo started his research in 2003, in two farms, São Francisco e São Bento, target of two projects that he coordinated: Gadonça e Onça Pantaneira. The purpose was to study the jaguar's ecology, focusing on the issue of cattle predation.⁵² One of the texts resulting from his dissertation, entitled "Evaluation of Potential Factors Predisposing Livestock to Predation by Jaguars", found that there is a low risk of cattle mortality due to predation by jaguars, disputing findings of earlier studies. Among several management implications, Azevedo's research suggested that efforts to reduce livestock mortality would be more efficient by focusing on causes unrelated to predation, which could be more easily controlled.⁵³

Biologists Leandro Silveira and Anah Jácomo founded, in 2002, the Instituto Onça-Pintada / Jaguar Conservation Fund. They conducted jaguar research and conservation projects in several Brazilian biomes: Araguaia river (Cerrado and Amazonia biomes); Cantão State Park (Amazonia); Emas National Park, Uruçuí-Una Ecological Station, and Nascentes do Rio Parnaíba National Park (Cerrado); Serra da Capivara and Serra das Confusões National Parks (Caatinga); Serra do Mar State Park and Carlos Botelho State Park (Atlantic Forest); and Caiman Ecological Refuge and Barranco Alto Farm (Pantanal).⁵⁴ Research lines included monitoring of jaguar populations and their prey, as well as management programs to solve conflicts

⁵¹ Marianne K. Soisalo, Sandra M. C. Cavalcanti. Estimating the density of a jaguar population in the Brazilian Pantanal using camera-traps and capture–recapture sampling in combination with GPS radio-telemetry. *Biological Conservation*, 129 (4) (2006), p. 487-496.

⁵² Ver Sússekind, *O Rastro da Onça...*; Sandra Maria Cintra Cavalcanti, *Predator-prey relationships and spatial ecology of jaguars in the southern Pantanal, Brazil: implications for conservation and management* (Doctoral dissertation in Wildlife Biology. Utah State University, 2008); Fernando Cesar Cascelli de Azevedo, *Predation patterns of jaguars (Panthera onca) in a seasonally flooded forest in the southern region of Pantanal, Brazil* (Doctoral dissertation in Natural Resources, University of Idaho, 2006).

⁵³ Fernando Cesar Cascelli de Azevedo, Dennis L. Murray. Evaluation of potential factors predisposing livestock to predation by jaguars. *Journal of Wildlife Management*, 71 (7) (2007), p. 2,379-2,386.

⁵⁴ About IOP, see website <http://www.jaguar.org.br/pt/index.html> e Leandro Silveira. *Jaguar...*

between ranchers and jaguars. Their results seek to define strategies for jaguar conservation, inspired by actions contained in the aforementioned jaguar PAN.

At Caiman Ecological Refuge, the part of Miranda Estância which belongs to the businessman and conservationist Roberto Klabin, there is the Projeto Onçafari [Project Jaguar-Safari]. It promotes jaguar conservation by stimulating ecotourism in Pantanal. This implies making jaguars get used to photographic safari vehicles. They remain totally wild, but do not perceive the vehicles as a threat and do not hide when they approach. Tourists can witness the animals' behavior and photograph them. The project was devised by Mário Haberfeld, a former racing driver currently involved in ecotourism and nature conservation, and by Simon Bellingham, a South African photographic safari guide. Rogério Cunha de Paula, from CENAP/ICMBio and from Pró-Carnívoros, is also involved in the project.⁵⁵

More than 80 jaguars were identified by this project; 13 were monitored with radio-collars. Researchers reported behaviors that previously were difficult to track - such as parental care. They noticed that mothers, once used to safari vehicles, teach the behavior to their cubs. This caused jaguar sightings to increase from 21 percent of visitors in the third year of the project to 58 percent in the fifth year. In addition, neighboring farmers showed interest in adopting the project's model, since they saw that profit obtained from tourist activity significantly outweighs damage caused by cattle predation by jaguars.⁵⁶

Biologist Emiliano Esterici Ramalho researched, for his masters and doctoral studies, the behavior of jaguars in the Amazonian floodplain, at the Mamirauá Sustainable Development Reserve.⁵⁷ He found that jaguars do not leave wet areas during the flood season, a behavior associated with the availability of prey throughout the year: sloths and monkeys during floods, and alligators, alligator eggs, and wild pigs

⁵⁵ About the Miranda Estância farm and its division in 1984, see Benevides and Leonzo, *Miranda Estância...* About the Projeto Onçafari, see <http://www.projetooncafari.com.br/pt-BR/>

⁵⁶ Gambarini, Duarte, Haberfeld, Cunha de Paula, *Panthera onca: à sombra das florestas...*

⁵⁷ See Emiliano Esterici Ramalho, *Uso do Habitat e Dieta da onça-pintada (Panthera onca) em uma área de várzea do médio rio Solimões* (Master's Thesis in Ecology. Instituto Nacional de Pesquisas da Amazônia - INPA. 2006); Emiliano Esterici Ramalho, *Ecologia e Conservação da onça-pintada nas Florestas Alagáveis da Reserva Mamirauá* (Doctoral Dissertation in Wildlife Ecology and Conservation. University of Florida, 2012).

during the dry period.⁵⁸ During the floods, jaguars are usually found high up in the trees, especially *apuí* specimens, where they even breed and care for the young. This finding contributed to a new economic niche to be explored, since the project also aims to promote ecotourism. Using boats during the flood season, it is easier for visitors to locate and visualize the jaguars monitored by radio-collars. Linked to both the Mamirauá Institute and Pró-Carnívoros, Ramalho continues to research the jaguar's ecology in the forests of the Amazon region, as coordinator of Project Iauaretê.⁵⁹

Pró-Carnívoros develops several *Panthera onca* conservation projects. Two current projects deserve to be mentioned: (i) “Amigos da Onça: Grandes Predadores e Sociobiodiversidade na Caatinga” [Friends of the Jaguar: Great Predators and Sociobiodiversity in the Caatinga], coordinated by the biologist Claudia Bueno de Campos; and (ii) “Ecologia e Conservação da Onça-pintada no Parque Nacional do Iguaçu” [Ecology and Conservation of the Jaguar at the Iguaçu National Park], coordinated by the veterinarian Ronaldo Gonçalves Morato, director of CENAP/ICMBio, by the biologists Jorge Pegoraro and Apolônio Nelson Rodrigues, from ICMBio, and by the biologist Marina Xavier da Silva.⁶⁰

The Caatinga project is conducted in five municipalities located in the North of the state of Bahia, in a region called Boqueirão da Onça (“Nook of the Jaguar”). This area has great relevance for the conservation of Caatinga biodiversity and thus the project is involved in a proposal to create a mosaic of protected areas.⁶¹ In August 2017, project researchers captured the first jaguar and started to monitor it by GPS.

⁵⁸ See Emiliano Esterci Ramalho & William Ernest Magnusson. Uso do habitat por onça-pintada (*Panthera onca*) no entorno de lagos de várzea, Reserva de Desenvolvimento Sustentável de Mamirauá, AM, Brasil. *Uakari*, 4(2) (2008), p. 33-39.

⁵⁹ Emiliano Esterci Ramalho, interview by José Luiz de Andrade Franco, at the Mamirauá Sustainable Development Reserve - Amazonas (May 19th, 2013). About Project Iauaretê, see Instituto de Desenvolvimento Sustentável Mamirauá, *O Macaqueiro*, Ano XIII, nº 57 (January/February 2013).

⁶⁰ See Pró-Carnívoros website <http://www.procarcarnivoros.org.br/2009/>

Pró-Carnívoros team has, as associates, a wide net of *Panthera onca* researchers, amongst which: Ronaldo Gonçalves Morato, Rose Lilian Gasparini Morato, Cláudia Bueno Campos, Dênis A. Sana, Eduardo Eizirik, Taianna Haag, Emiliano Esterci Ramalho, Sandra Maria Cintra Cavalcanti, Fernando Cesar Cascelli de Azevedo, Henrique Villas Boas Concione, Ricardo Luiz Pires Boulhosa, Joares May, Marina Xavier da Silva, Rogério Cunha de Paula, Silvio Marchini, Tadeu G. de Oliveira, Cynthia Elisa Widmer de Azevedo, Julio César Dalponte, Valéria Amorim Conforti, Alexandre Vogliotti, Fernanda Michalski, Kátia Ferraz, Míriam Lúcia Lages Perilli and Fernando Lima. Fauna photographer Adriano Gambarini is also part of the team.

⁶¹ See Daniele Bragança, Governador da Bahia diz sim para Boqueirão da Onça, *O Eco*, 26 de julho de 2017: <http://www.oeco.org.br/noticias/governador-da-bahia-diz-sim-para-boqueirao-da-onca/>

The data to be generated should guide conservation strategies in the critically endangered Caatinga biome, contribute to the resolution of conflicts between humans and jaguars, and identify the impacts caused by the installation of wind farms.⁶²

The project at Iguazu National Park began in the 1990s. It derives from Peter Crawshaw Jr.'s pioneering studies conducted between 1990 and 1995. Until 1994, the project monitored 21 ocelots, seven jaguars, and individuals of other species, such as coatis, wild dogs, jaguarundis, and maracajá cats. In addition to information on the ecology and conservation of these species, it trained researchers and managers. The CENAP, created in 1994, also arose from the work developed at Iguazu National Park. CENAP kept its headquarters at park until 1996.

Despite its success, the project was discontinued for ten years, due to financial constraints. It was resumed in 2009, with the name of *Carnívoros do Iguazu* (Carnivores of Iguazu) thanks to a partnership between public and private institutions. Currently, it monitors jaguar populations in the Iguazu National Park and surrounding areas. The information obtained contributes not only to park management, but also to support actions aimed at interconnecting stretches of the Atlantic Forest biome, a requirement for the establishment of viable jaguar populations. A study conducted by the project team showed that Atlantic Forest fragmentation in the ecoregion of Alto Paraná caused the loss of genetic diversity in the remaining populations of jaguars, which were restricted to poorly connected protected areas.⁶³ The loss of connectivity among populations is one of the major challenges to species conservation and has important implications for management, especially regarding the need to form networks of protected areas and to adopt large-scale conservation approaches.

Recently, in April 2018, was launched the project *Onças do Iguazu* (Jaguar's of Iguazu), an institutional initiative of Iguazu National Park, to continue the work

⁶² Instituto Pró_Carnívoros, *Programa Amigos da Onça captura a primeira onça-pintada no estado da Bahia*, September 19th, 2017: <http://procarnivoros.org.br/index.php/programa-amigos-da-onca-captura-primeira-onca-pintada-no-estado-da-bahia/>;

See Morato, Beisiegel, Ramalho, Campos, Bουλhosa, *Avaliação do risco de extinção...*

⁶³ Taiana Haag, A. S. Santos, Dênis A. Sana, Ronaldo Morato, Laury Cullen Jr, Peter Crawshaw Jr, Carlos de Ângelo, Mario S. Di Bitetti, F. M. Salzano and Eduardo Eizirik, The effect of habitat fragmentation on the genetic structure of a top predator: loss of diversity and high differentiation among remnant populations of Atlantic Forest jaguars. In: *Molecular Ecology*, 19(22) (2010), p. 4,906-4,921.

initiated by Crawshaw in 1990. The project is coordinated by Ivan Baptiston and Yara Barros, and count with the partnership of many experimented researchers: Peter Crawshaw Júnior, Ronaldo Morato, Rogério Cunha de Paula, Kátia Ferraz, Sílvio Marchini, Gediendson Araújo, Edilson Esteves, and Rosana Nauderer.⁶⁴ Together with WWF Brasil, the project *Onças do Iguaçu* published a guide of peaceful coexistence between humans and jaguars, which also deals with other predators such as puma and ocelot.⁶⁵

Also active in the Atlantic Forest biome, the Instituto de Pesquisas Ecológicas (IPÊ) maintains, since 2004, the project *Detetives Ecológicos* [Ecological Detectives]. It generates field data on population size, genetic conservation status, and dispersal patterns of large mammals at Morro do Diabo State Park and forested remains of the Pontal do Paranapanema region (both located in the far west of the state of São Paulo, with a history of land conflict and intense forest degradation). Researchers Laury Cullen Jr and Fernando Lima work with the jaguar. The project also works with three other species: puma (*Puma concolor*), ocelot (*Leopardo pardalis*), and tapir (*Tapirus terrestris*).⁶⁶ These species are called "landscape detectives" because they indicate "how to plan and manage reservations and large interconnected ecoregions, since their survival depends on maintaining ecologically healthy environments".⁶⁷

In 2010, IPÊ expanded its research efforts to Iguaçu National Park, through a partnership with other institutions, such as CENAP.⁶⁸ The goal is to implement population management for landscape integration from ecological corridors. In 2016, a study published in *Scientific Reports*, involving the cooperation of 14 research groups from Brazil, Argentina, and Paraguay, presented pertinent results. The jaguar lost extensive habitat in the Atlantic Forest, which extends over 1.7 million km² in Brazil, Argentina and Paraguay. 85 percent of the Atlantic Forest has been erased. Of the

⁶⁴ See Projeto Onças do Iguaçu, *Boletim 001, A voz da onça de maio de 2018*, available at: https://issuu.com/agencia_fog/docs/oncasdoiguacu_boletim_001_maior18?fbclid=IwAR2-Yn9wCrJYyyAjSITEnxTCix-w5qDHGAh2GmQXYoKEHTmPFYhrm4EXGk

⁶⁵ Yara Barros, Carlos R. Brocardo, Thiago Reginato, Sílvio Marchini, Sandra Cavalcanti, Rogério Cunha de Paula, Ricardo Boulhosa, Ricardo Luciano, *Onças do Iguaçu: Guia de Convivência* (Brasília: Projeto Onças do Iguaçu/WWF Brasil, 2018), available at: https://d3nehc6yl9qzo4.cloudfront.net/downloads/guia_oncasiguacu_v12.pdf

⁶⁶ See IPÊ website <http://www.ipe.org.br/projetos/pontal-do-paranapanema/75-detetives-ecologicos> and IPÊ activities report from 2012, available at: <http://www.ipe.org.br/docs/2017/relatorios/relatorio-anual-2012.pdf>

⁶⁷ Laury Cullen Jr, Kauê Cachuba, Denis A. Sana e Alessandra Ferreira Dales Nava, As onças-pintadas como detetives da paisagem no corredor do Alto Paraná, Brasil. In: *Natureza e Conservação*, 3 (1) (2005), p. 43-58.

⁶⁸ See IPÊ's 2010 activity report, available at: http://www.ipe.org.br/docs/artigo_completo/822/relatorioipe2010.pdf

remaining 15 percent, only 7 percent are in good condition. The remaining jaguar populations survive in approximately 3 percent of their original territory in the biome. The estimated current jaguar population is less than 300 individuals throughout the entire biome.

The authors sustain that three remaining Atlantic Forest nuclei are fundamentally important for long-term survival of the jaguar: in Brazil, the upper Paraná-Paranapanema river (in the states of São Paulo, Paraná, and Mato Grosso do Sul) and the coastal slopes of the Serra do Mar (in São Paulo); and, in Argentina, the “Corredor Verde”, in the province of Misiones.⁶⁹ According to Fernando Lima, “the distinguishing aspect of this research effort is that it brought together so many institutions and people willing to share data and contribute, resulting in ... the most complete diagnosis of the species in a biome”.⁷⁰ The findings of this research became the basis for jaguar conservation strategies in Brazil, Argentina, and Paraguay. Results guided actions implemented by IPÊ, such as the restoration of 1,200 hectares of Atlantic Forest (by means of 2.3 million trees planted until 2016) in the Pontal de Paranapanema. This is currently the largest reforested corridor in Brazil. It connects two protected areas: the Morro do Diabo State Park and Mico-Leão- Preto Ecological Station.⁷¹

IBAMA and CENAP/ICMBio are responsible for two initiatives dedicated to the recovery or holding of animals seized from illegal animal trafficking: NEX (No Extinction), located at the Preto Velho Farm, in the municipality of Corumbá de Goiás (state of Goiás), located 80 kilometers from Brasília, and the zoo of the Centro de Instrução de Guerra na Selva (CIGS), a military unit located in the city of Manaus

⁶⁹ See Agustin Paviolo, Carlos De Ângelo, Kátia M Ferraz, Ronaldo G. Morato, Júlia Martinez Pardo, Ana C. Srebek-Araujo, Beatriz de Mello Beisiegel, Fernando Lima, Denis Sana, Marina Xavier da Silva, Myriam C. Velazquez, Laury Cullen, Peter Crawshaw Jr, Maria Luisa S. P. Jorge, Pedro M. Galetti, Mário S. Di Bitetti, Rogério Cunha de Paula, Eduardo Eizirik, T. Mitchell Aide, Paula Cruz, Miriam LL Perilli, Andriara S. M. C. Souza, Verónica Quiroga, Eduardo Nakano, Fredy Ramírez Pinto, Sixto Fernández, Sebastian Costa, Edsel A. Moraes Jr and Fernando Azevedo, A biodiversity hotspot losing its top predator: The challenge of jaguar conservation in the Atlantic Forest of South America. *Scientific Reports*, 6 (37147) (2016).

⁷⁰ Relatório de atividades de 2016 do IPÊ, p. 12, available at: https://issuu.com/institutoipe/docs/relato_rio_ipe_2016

⁷¹ *Ibidem*, p. 25.

(state of Amazonas). The two institutions operate also in captive breeding, environmental education and partnerships focused on scientific research.⁷²

NEX, in partnership with researchers from the group “Brasília é o Bicho”, has participated in the project “Monitoramento de onças-pintadas na natureza” [Monitoring jaguars in nature]. Since 2013, it monitors a free jaguar, a male named Xangô, a regular visitor of NEX grounds.⁷³ Data on this animal’s movement were used in an important article entitled “Space Use and Movement of a Neotropical Top Predator: The Endangered Jaguar”, published in *Plos One*.⁷⁴ This article used data generated by the monitoring of 44 jaguars in Brazil and Argentina. It revealed that the species has a larger home range than previous studies had indicated. Research was conducted by Ronaldo Morato and 29 scientists from 16 institutions. It is an example of how cooperation between scientists and conservation practitioners has produced new knowledge about the species throughout its entire home range.⁷⁵

Research on the jaguar belongs mostly to the burgeoning scientific field of conservation biology. Results corroborate the main findings of this field - (i) the need for a comprehensive and integrated planning of conservation strategies; (ii) the importance of management actions aimed at the preservation and restoration of wild environments; (iii) combating the destruction and fragmentation of habitats; and (iv)

⁷² Interviews by José Luiz de Andrade Franco with Cristina Gianni, presidente of NEX, at the Preto Velho farm, municipality of Corumbá de Goiás – state of Goiás, on August 24th, 2012; and with Lieutenant Renato Lopes, veterinarian of the zoo in the Centro de Instrução de Guerra na Selva, CIGS, Manaus – state of Amazonas, May 23rd, 2013..

⁷³ José Luiz Franco, Fernanda Pereira de Mesquita Nora and Marcelo Ismar Santana. No Extinction (NEX) - the story of a scientific conservation refuge and its role in biodiversity conservation. In: *Sustentabilidade em Debate*, 8 (2017), p.158-184.

⁷⁴ Ver Ronaldo G. Morato, Jared A. Stabach, Chris H. Fleming, Justin M. Calabrese, Rogério C. De Paula, Kátia M. P. M. Ferraz, Daniel L. Z. Kantek, Selma S. Miyazaki, Thadeu D. C. Pereira, Gediendson R. Araújo, Agustin Paviolo, Carlos De Ângelo, Mário S. Di Bitetti, Paula Cruz, Fernando Lima, Laury Cullen, Denis A. Sana, Emiliano E. Ramalho, Marina M. Carvalho, Fábio H. S. Soares, Barbara Zimbres, Marina X. Silva, Marcela D. F. Moraes, Alexandre Vogliotti, Joares A. May Jr., Mário Haberfeld, Lilian Rampim, Leonardo Sartorello, Milton C. Ribeiro, Peter Leimgruber, Space Use and Movement of a Neotropical Top Predator: The Endangered Jaguar, *Plos One*, 11(12) (2016).
<http://journals.plos.org/plosone/article?id=10.1371/journal.plosone.0168176>

⁷⁵ The 17 institutions are: Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros (CENAP) /Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio); Conservation Ecology Center/Smithsonian Conservation Biology Institute/, National Zoological Park; Instituto Pro-Carnívoros; Universidade de São Paulo (USP), Estação Ecológica Taiamã/, ICMBio; Departamento de Medicina Veterinária da Universidade Federal de Viçosa (UFV); Instituto de Biología Subtropical, Universidad Nacional de Misiones e CONICET (Argentina); Instituto de Pesquisas Ecológicas (IPÊ); Laboratório de Ecologia Espacial e Conservação, Instituto de Biociências, Universidade Estadual de São Paulo (UNESP); Programa de Pós-graduação em Ecologia, Universidade Federal do Rio Grande do Sul (UFRGS); Instituto de Desenvolvimento Sustentável Mamirauá; Instituto de Defesa e Preservação dos Felídeos Brasileiros; Programa de Pós Graduação em Zoologia, Instituto de Ciências Biológicas, Universidade de Brasília (UnB); Projeto Carnívoros do Iguacu (ICMBio); Universidade Federal da Integração Latino-Americana (UNILA); Projeto Onçafari.

ensuring connectivity. Large carnivores and top-chain predators, including the jaguar, play a key role in the understanding of how ecosystems work and in the development of strategies for biodiversity conservation. They are indispensable components of healthy ecosystems.

CONCLUSION

The jaguar, although feared, is admired by many people who want to see it, get to know its habitat, and understand its way of life. It is a charismatic species that draws attention to itself and to the natural environment in which it lives. Conservation projects seek to develop strategies, such as ecotourism and environmental education, that allow for a more harmonious coexistence between human populations and jaguars in order to change the perception of the animal from fear to admiration. To maintain viable populations, the jaguar must cease to be viewed as a wicked beast and be valued as a respected species - or even as an income-generating alternative, through ecotourism.

With the growing threats posed by habitat destruction and persecution, especially by farmers and rural populations in defense of their livestock, or moved by the terror that the jaguar still imposes, science has been the main tool for the conservation of species. It has become a science for conservation, as it advances in the production of knowledge related to ecology, behavior, and genetics, and develops strategies of environmental education, incentives to ecotourism, and resolution of conflicts. In this way, contemporary science has been contributing to increase knowledge about the jaguar, and for Brazilian society to develop the care and love necessary to guarantee the survival of this magnificent member of the native fauna.

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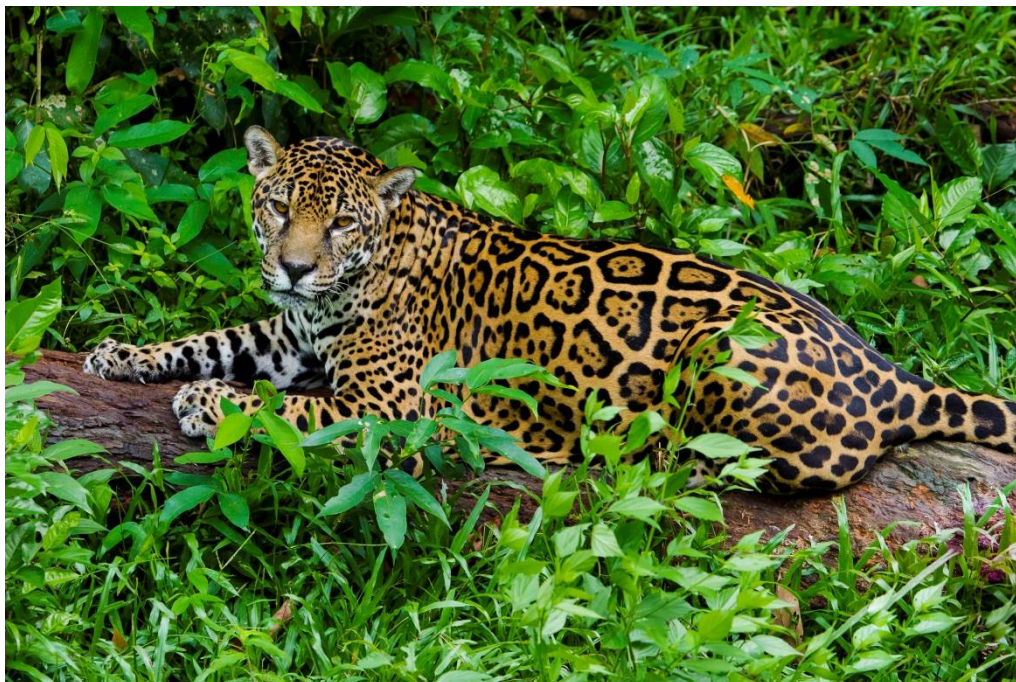
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ANNEX

Panthera onca, jaguar, at the zoo of the Centro de Instrução de Guerra na Selva (CIGS), Manaus, state of Amazonas.



Photograph: Marcelo Ismar Santana

Date: May 23rd, 2013

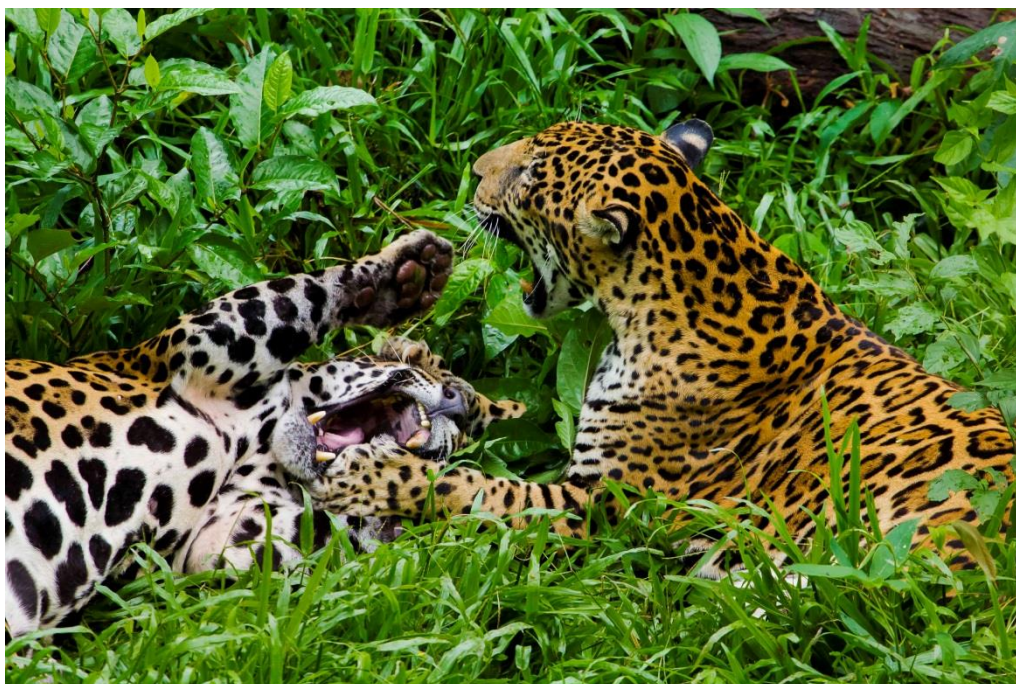
Panthera onca, jaguar, melanic specimen, hosted at the conservationist refuge No Extinction (NEX), at Corumbá de Goiás - state of Goiás..



Photograph: Marcelo Ismar Santana

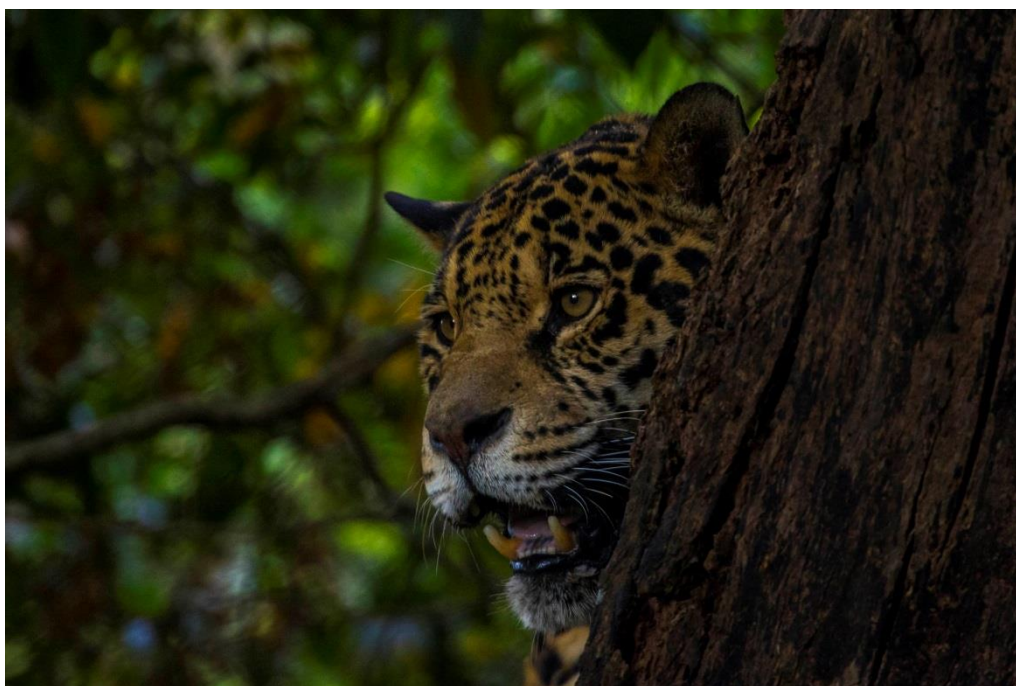
Date: August 24th, 2012

Panthera onca, jaguar, couple in the heat season, at the zoo of the Centro de Instrução de Guerra na Selva (CIGS), Manaus, state of Amazonas.



Photograph: Marcelo Ismar Santana
Date: May 23rd, 2013

Panthera onca, jaguar, at the conservationist refuge No Extinction (NEX), at Corumbá de Goiás - state of Goiás.



Photograph: Marcelo Ismar Santana
Date: August 24th de 2012

Historia de la Ciencia y de la Conservación del Jaguar (*Panthera Onca*) en Brasil

RESUMEN

El objetivo del estudio es analizar la historia de la investigación científica y los esfuerzos de conservación relacionados con el jaguar (*Panthera onca*) en toda su gama actual, centrándose en su estado en el territorio brasileño. Aborda el rango, la ecología, el comportamiento y las estrategias de supervivencia de la especie. El estudio también analiza las percepciones y reacciones humanas ante su presencia y presenta los roles de los cazadores y científicos en la construcción del conocimiento actual sobre la especie. En resumen, todos los esfuerzos de conservación registrados con respecto a las especies en el territorio brasileño, una de sus principales áreas de vida, se discuten en detalle.

Palabras clave: Jaguar; Ciência; Conservación; Historial Ambiental.

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