ASSESSING AN AQUATIC ICON: A RANGE WIDE PRIORITY SETTING EXERCISE FOR THE GIANT OTTER *(Pteronura brasiliensis)*

Robert B. Wallace, Ariel Reinaga, Jessica Groenendijk, Caroline Leuchtenberger, Hauke Hoops, Leydi V. Auccacusi Choque, Guido Ayala, Mark Bowler, Miriam Marmontel, Fernanda Michalski, Oscar Mujica, Karen Pérez, Maribel Recharte, Marcelo Rheingantz, Indranee Roopsind, Fernando Trujillo, Galo Zapata Ríos, María del Pilar Becerra Cardona, Salvador Boher, Martín Buschiazzo, Jose L. Cartes, André Coelho, Benoit de Thoisy, Sebastian Di Martino, Nicole Duplaix, Guillermo Gil, Nelly Guerra, Hannah Heither, Danielle Lima, Joel Mendoza, Nuno Negrões, Robert Pickles, Juvenal Silva, Grazielle Soresini, Alvaro Soutullo, Victor Utreras B., Paul André Van Damme, Zelda van der Waal, Talía Zamboni, Veronica Zambrana.

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Abstract: This book represents the result of a Range-Wide Priority Setting (RWPS) Exercise applied to assess the distribution and conservation status of the giant otter (Pteronura brasiliensis) across its range. For this exercise, an in-person workshop was held in 2018 in Puerto Maldonado, Peru, bringing together a group of specialists to organize all available information on the species, currently dispersed across different sources, and translate it into a conservation strategy. One of the outcomes of this exercise is the definition of Giant Otter Priority Conservation Units (GOPCUs), considering threats, distribution, relative abundance, and other potentially important factors. Thus, the GOPCUs represent specific sites for long-term conservation investment in giant otters, as well as studies and population monitoring on behavior, reproduction, and distribution.

This giant otter RWPS book is organized into 17 chapters: an introduction chapter, then a chapter covering general knowledge about the species, followed by a chapter which presents the methodology applied. The next twelve chapters summarize information about giant otters and report on the exercise conducted for each of the countries of current and historical species occurrence, and the final two chapters address, respectively, the results, and the discussion, as well as recommendations related to the RWPS exercise. We hope that this RWPS document will guide the actions and strategies for giant otter conservation more efficiently and effectively among all key stakeholders involved.

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INTRODUCTION

Caroline Leuchtenberger

The giant otter (*Pteronura brasiliensis*) is an emblematic species of the tropical river ecosystems of South America. While many are fascinated by its complex and conspicuous behaviors and postures, others see it as a voracious predator and competitor for fish. However, the crucial role that the species plays in maintaining the balance of the aquatic ecosystem and as a sentinel of environmental health is undeniable.

Endemic to South America, the original distribution of the giant otter, limited to the east of the Andes mountain range, extended from northern Venezuela to Argentina. However, illegal hunting for the commercialization of its fur in the past led to the extinction of populations in large parts of its distribution, and many of these populations have not yet recovered. It is estimated that the current distribution of the species corresponds to only 60% of its historical range (Colodetti 2014).

Globally classified as Endangered on the IUCN Red List and listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the giant otter is considered extinct in Uruguay and Argentina, although there have been recent reports of solitary individuals, which may be new arrivals, in the latter country (Leuchtenberger *et al.* 2023). The species is also considered critically endangered in Ecuador and Paraguay, and Endangered in the other countries of its range (see each country chapter herein). Although commercial hunting no longer represents a significant threat to the giant otter, the reduction and degradation of its habitat, combined with emerging human activities, exacerbate the species' threats, which may lead to a 50% population decline over the next 25 years.

There are still many knowledge gaps, especially in areas of difficult access in the Amazon. Meanwhile, gold mining is advancing unchecked throughout the Amazon, hydroelectric projects are being implemented on the highland borders of the Paraguay and Amazon basins, and deforestation for pasture and soybean cultivation is expanding across the Pantanal wetland, the Cerrado, and various Amazonian areas, degrading and contaminating the ecosystem (Garrett *et al.* 2021; Colman *et al.* 2024). The climate crisis is no longer a future threat. Climate catastrophes, such as extreme droughts and fires (Marengo *et al.* 2021), are real threats that impact the survival of populations (Leuchtenberger *pers. obsv.*). The expansion of urban centres also threatens the species' health, by exposition to zoonotic pathogens, increasing the risk of new bioecological cycles and local population extinctions (Furtado *et al. in prep.*). Additionally, human conflict with the species seems to occur throughout almost its entire distribution (see each country chapter herein).

The assessment of the conservation status of populations across its extensive distribution range and the protection of source populations are essential steps to ensure its conservation. However, the species' occurrence is irregular across its wide

geographic range, and population estimates are limited to some regions. Moreover, due to its social organization, counting individuals does not represent the effective population size, as only the dominant pair reproduces within the group.

Despite the species' vulnerability and the emerging threat landscape, public policies that protect the giant otter are limited to a few countries within its range. National Conservation Plans that include the species are known only for a few countries in its current distribution, including Brazil and Colombia (Trujillo *et al.* 2008a, 2016). In Brazil, which holds the largest portion of the species' range, the giant otter is included in two conservation plans: the National Conservation Plan for Amazonian Aquatic Mammals and the National Conservation Plan for the Giant Otter, the latter being exclusive to the species. The Brazilian National Conservation Plan for the Giant Otter (Portaria ICMBIO n. 2901, 2024) was revised in 2023 and is now in its third cycle, with the general objective of "mitigating the impacts of the main threats to giant otter populations and their habitat in strategic areas within the Tocantins-Araguaia, Paraná, and Paraguay river basins for the species' conservation over the next five years."

Nevertheless, integrated and effective strategies are urgently needed to ensure the long-term protection and conservation of the giant otter. The Global Otter Conservation Strategy for the species (Leuchtenberger *et al.* 2018) recommends 15 priority actions, with the following main objectives:

1. To rebuild and maintain healthy populations of all otter species across all parts of each species' range as held before major human-induced declines.
2. To promote a global otter conservation community to achieve effective otter conservation and restoration through a "One Plan" approach, integrating interventions in the wild with captive populations, including a supportive legal and policy base, location-based habitat conservation, elimination of illegal trade, strategic research, education and outreach, collaborative capacity-building, and support from all sectors of society, including the local communities who share otter habitats.

Additionally, in 2022, during the II International Workshop on Giant Otters, held in Argentina, a group of 27 professionals from 16 institutions, representing eight countries, founded the International Giant Otter Alliance (IGOA). The mission of this Alliance is to act as an international collaborative group to communicate, share information, build capacities, and take action to promote and strengthen the conservation of the giant otter (IGOA 2022).

This book represents the result of a Range-Wide Priority Setting (RWPS) Exercise applied to assess the distribution and conservation status of the giant otter across its range. For this exercise, an in-person workshop was held in 2018 in Puerto Maldonado, Peru, bringing together a group of specialists to organize all available information on the species, currently dispersed across different sources, and translate it into a conservation strategy. One of the outcomes of this exercise is the establishment of

Giant Otter Priority Conservation Units (GOPCUs), considering threats, distribution, relative abundance, and other potentially important factors. Thus, the GOPCUs represent specific sites for long-term conservation investment in giant otters, as well as studies and population monitoring on behavior, reproduction, and distribution.

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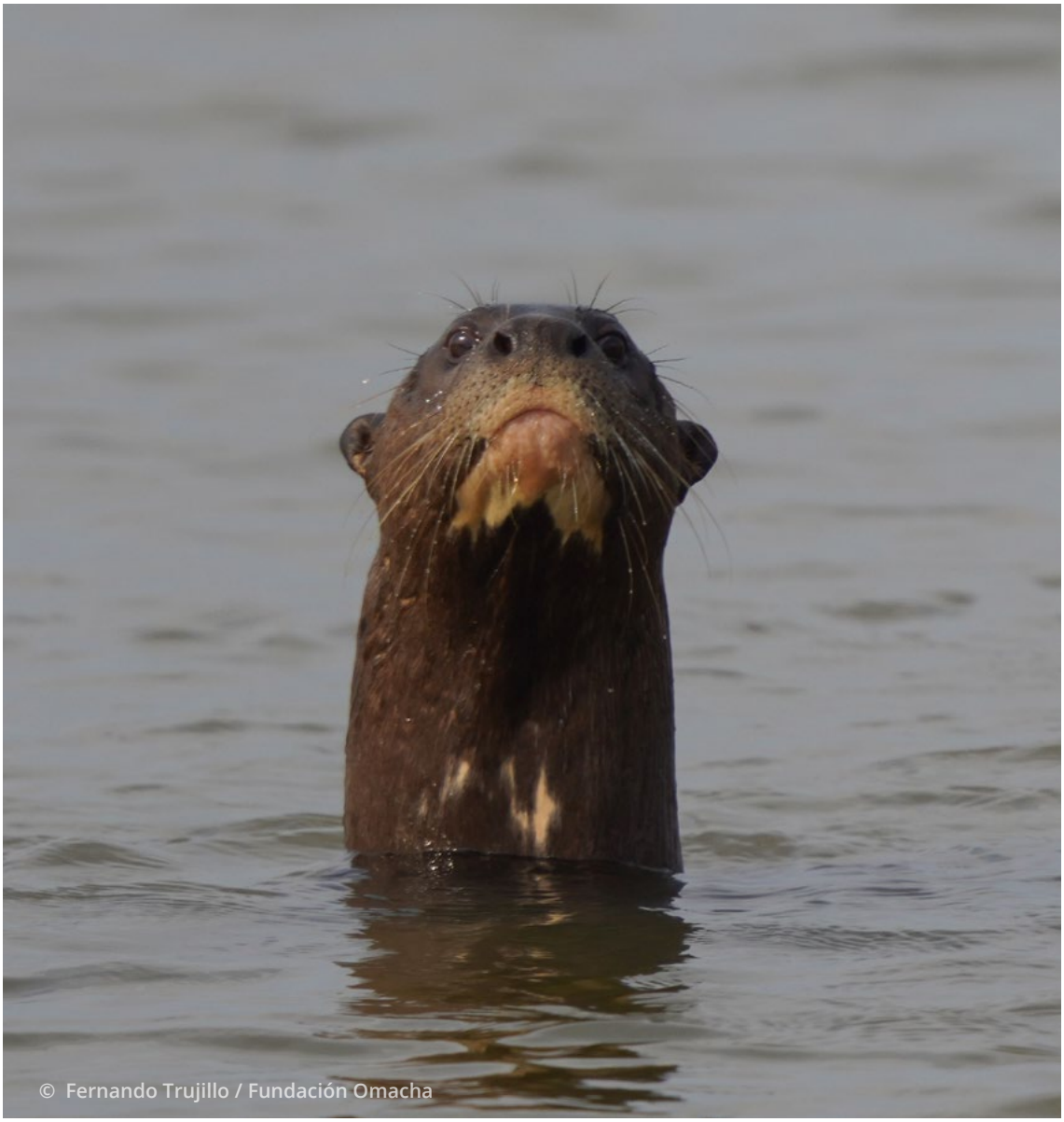

GIANT OTTER BIOLOGY, ECOLOGY AND BEHAVIOR

Leydi Auccacusi Choque, Oscar Mujica & Caroline Leuchtenberger

The giant otter (*Pteronura brasiliensis*) is a diurnal and gregarious mustelid, adapted to aquatic life, that lives in well-established social groups and defends a portion of its home range against conspecifics (Duplaix 1980). There is a general consensus about the biology and ecology of the giant otter, with studies to date conducted in seasonally flooded forests, occasionally flooded oxbow lakes, and semi-natural environments including irrigation canals.

MORPHOLOGY

The giant otter (*Pteronura brasiliensis*) is the largest, though not the heaviest, of the thirteen species of otter in the world (Schenck *et al.* 1999; Groenendijk *et al.* 2015). Unlike other otter species, sexual dimorphism in giant otters is not pronounced. The total body length of an adult male ranges from 1.5 to 1.8 m, although skins of adult male individuals up to 2.2 m to 2.4 m in length have been recorded (Cabrera & Yepes 1940; Duplaix 1980; Carter & Rosas 1997). Females are slightly smaller, measuring 1.5 to 1.7 m. Weight differences are slightly more marked, ranging from 23 to 32 kg for males and 22 to 26 kg for females (Duplaix 1980; Carter & Rosas 1997).

The color of the giant otter coat varies from reddish brown when dry to dark chocolate when wet. The coat is dense and velvety, and is composed mainly of short, soft, waterproof hairs, where the outer coat is approximately 8 mm thick, about twice the width of the undercoat (Foster-Turley *et al.* 1990). The lips, chin, throat and chest are usually marked with irregular creamy white spots, which vary from being completely absent to forming a large white area. These markings are present from birth and their size and shape are unique with a large variation among individuals, which facilitates individual identification (Duplaix 1980; Carter & Rosas 1997).

The limbs are short, flattened and end in large, fleshy feet with a well-developed membrane extending to the tips of the clawed toes, which they use for swimming, maneuvering and propelling themselves through the water. The tail is very muscular at the base and is dorsoventrally flattened towards the end like that of a beaver, measuring almost half the length of the body. They possess two sub-caudal anal scent glands that are used for temporal marking and may contract involuntarily if the animal feels threatened (Duplaix 1980).

The head is broad and flattened with very small rounded ears, and a blunt snout is supported by a long muscular neck. In addition, long and numerous whiskers protrude above the eyebrows, behind the eyes (supraciliary), behind the curve of the mouth and below the lower lips (Duplaix 1980; Carter & Rosas 1997). These whiskers are very sensitive and facilitate locating prey in turbid waters when vision is reduced (Duplaix 1980). Otters' nostrils and pinnae may be closed to prevent water entry when diving. Well-developed bones in the nasal chambers suggest a keen sense of smell at distances greater than 100 m (Duplaix 1980; Schenck & Staib 1998). Giant otters are almost exclusively diurnal and hunt primarily by sight. They are able to recognize observers at distances of 50 m (Duplaix 1980).

It is difficult to distinguish between male and female giant otters because there is no clear difference in head or body size. Therefore, one can only be sure of gender when the animals are observed out of the water and their genitalia are recognized during rest and grooming sessions: elongated nipples are generally observed in adult females, which may indicate that they have had cubs or are lactating. For males, the testicles are observed, with the scrotum being evident from one year of age (Staib 2005). Males also

display characteristic marking behavior, which can assist in sexing observed animals (Groenendijk *et al.* 2014).

HABITAT

The giant otter (*Pteronura brasiliensis*) inhabits tropical rainforests and mainly large rivers, streams, lakes and swamps (Duplaix 1980; Carter & Rosas 1997). Occasionally they may occur in agricultural canals, as well as where large dams are present (Carter & Rosas 1997). In forests that are seasonally flooded during the rainy season, giant otters prefer blackwater streams, so called because the water is dark brown with the presence of organic materials derived from decaying vegetation (Duplaix 1980). However, in other areas giant otters prefer whitewater oxbow lakes rather than associated rivers. These lakes are only occasionally flooded, and water depth is less variable with no current, and fish are abundant due to a higher concentration of nutrients, and therefore high primary production compared to blackwaters (Staib & Schenck 1994).

Giant otter habitat choice largely revolves around accessibility to suitable fishing sites throughout the year (Duplaix 1980). Giant otters prefer undisturbed water bodies with high quality and adequate vegetation cover, low and sloping banks, and easy access to forested streams or marshy areas, as well as abundant prey in relatively shallow water. Seasonality also affects the distribution and biomass of fish populations, and consequently it also affects the species habitat selectivity and home range size (Leuchtenberger *et al.* 2013).

DIET

Giant otters specialize in consuming a wide variety of fish in both deep and shallow water. Individuals consume between 3-4 kilograms of fish per day, representing between 10% and 15% of an otter's body weight. The average time of food in the digestive system is about three hours, indicating a high metabolic rate for this species (Carter *et al.* 1999; Groenendijk & Hajek 2006; Groenendijk *et al.* 2015). However, giant otters may opportunistically feed on turtles, alligators, snakes, freshwater crabs, small mammals, and waterfowl (Duplaix 1980; Groenendijk *et al.* 2001; Staib 2005; Groenendijk & Hajek 2006; Ribas *et al.* 2012; Leuchtenberger *et al.* 2020). In addition, foraging ecology depends on fish migration patterns and the success of fish capture depends on the organization and coordination of the social group during fishing (Duplaix 1980; Rosas *et al.* 1999; Groenendijk *et al.* 2015). Giant otter diet includes fish of the families Pimelodidae, Serrasalmidae, Curimatidae, Erythrinidae, Characidae, Anostomidae, Cichlidae and Loricariidae (Jácome-Negrete 2016). Giant otters usually search for fish during the daylight (Leuchtenberger *et al.* 2014a) under the marginal vegetation, using vision and sensitive vibrissae to find their preferred prey. In Madre de Dios oxbow lakes, giant otters feed on at least 21 different species of fish and selectively hunt prey, with a particular preference for two species, the black prochilodus (*Prochilodus caudifasciatus*) and the demon

eartheater (*Satanoperca jurupari*), although the precise reason for this preference over other species abundant such as piranhas is not yet clear (Groenendijk & Hajek 2006). In the Pantanal, the preferred prey of giant otter are *Hoplias* spp. trahira fish and "piranhas" (Serrasalmidae) (Leuchtenberger *et al.* 2020), and although they usually prefer mid- to large-sized fish, groups inhabiting poor and marginal habitats, such as the shallow and/or temporary lakes, consume small fishes and other alternative preys (Leuchtenberger *et al.* 2020).

Due to the piscivorous habit and active predatory behavior of the species, fishermen usually have a negative perception toward giant otters (Zucco & Tomas 2004; Rosas-Ribeiro *et al.* 2011), although the overlap between the otter's diet and the catch of fisheries is usually small (Leuchtenberger *et al.* 2020).

The giant otter's major predators are humans, black caiman (*Melanosuchus niger*), jaguar (*Panthera onca*) and occasionally anacondas (*Eunectes* spp.). Humans have significantly depleted otter populations through illegal hunting activities and increasing habitat loss (Antunes *et al.* 2016; Garbino *et al.* 2022). Black caimans are the main predators of otter pups (Jácome-Negrete 2016).

SOCIAL STRUCTURE

A typical giant otter population consists of highly social groups with well-established territories, which can vary during the dry and rainy season, and sexually mature dispersing animals known as solitaries. Giant otter groups are formed from two animals and can reach up to 16 individuals, and be composed of a monogamous dominant breeding pair and their offspring of several years, including non-breeding sub-adults (Duplaix 1980; Groenendijk 1998; Groenendijk *et al.* 2005; Staib, 2005; Groenendijk & Hajek 2006), although groups can also be composed by individuals with no genetic relationship (Ribas *et al.* 2016). Very rarely the group may be composed of two-family units traveling together (Duplaix 1980). Therefore, giant otter groups may temporarily coalesce around particularly abundant food sources when searching for suitable habitat (Groenendijk 1998).

A solitary or transient is usually a sub-adult that has left its family unit as it approaches sexual maturity (at two years of age) or an adult that has lost its mate. In both cases, there is no longer a link to an established resident group and the transient has adopted a nomadic way of life, migrating long distances of up to 252 km to find a mate and suitable habitat to establish its own territory (Schenck 1999).

The species is territorial and agonistic encounters between groups and between a group and a solitary otter are common (Ribas & Mourão 2004; Leuchtenberger *et al.* 2015) and can lead to mortal wounds (Foerster *et al.* 2022). To avoid these encounters, giant otters use a complex communication system of chemical signals and vocalizations (Leuchtenberger & Mourão 2009; Leuchtenberger *et al.* 2014b; Mumm *et al.* 2014).

Scent-marking at latrines and campsites takes place all day long (Leuchtenberger *et al*., 2014a) and is performed by the whole group using different postures (Leuchtenberger & Mourão 2009). Alpha males spend more time scent-marking to overmark the scent of other group members, which reinforces his dominant position for the other individuals of the group and for intruders (Leuchtenberger & Mourão 2009). Alpha females also overmark the scent of subordinate females within the group. In the Pantanal, the few cases in which a subordinate female over-marked scents of the dominant female occurred in a group where both (alpha and subordinate) were lactating (Leuchtenberger & Mourão 2009).

The vocal repertoire of giant otters is complex, presenting at least 15 different vocalizations (Leuchtenberger *et al.* 2014b) with variation between adults and neonates (Mumm *et al.* 2014), as expected for a social species.

HOME RANGE

Signs of presence of *P. brasiliensis* are quite visible, such as campsites, latrines and dens and, together with the visual identification of individuals and groups, have been the main source for most of the studies that have estimated home-range size. Giant otters maintain several resting sites, also called "campsites" within their home range, where otters clean the vegetation, and use it regularly for scent-marking, drying and resting. Campsites are small perennial patches of land, averaging 8.7 m long by 4.4 m wide and are clustered around feeding areas within territories. Large, shallow communal dens or burrows serve for sleeping or for raising pups and are commonly located under root systems or fallen trees with several escape exits (Carter & Rosas 1997; Groenendijk *et al.* 2005). Communal latrines are used by the whole group for defecation and can be located near dens and at campsites, or singly along the banks (Schenck 1999; Staib 2005; Groenendijk & Hajek 2006). Campsites are not necessarily associated with a den, whereas dens always have a nearby campsite. Therefore, camps probably have a role in territory demarcation (Groenendijk 1998, Leuchtenberger & Mourão 2009). Due to the difficulty in monitoring giant otter groups on a flooded landscape, data on the spatial ecology of the species has been restricted to observations made during the dry season, and most of these observations were reported as linear home ranges. In Suriname and Guyana, giant otters have large linear home ranges of 12 to 32 km of stream or river, including tributaries, or 20 km^2 of lake, that may overlap and encompass smaller territories centered around attractive feeding sites of 2 to 9.6 km of stream or 5 km^2 of lake (Laidler 1984; Groenendijk 1998). In the central Brazilian

Amazon at the Xixuaú Reserve, Roraima, the average home ranges of groups were estimated at approximately 8 km during the dry season (Evangelista & Rosas 2011a).

Telemetry tools have facilitated giant otter tracking during the wet season in the Pantanal (Leuchtenberger *et al.* 2013) and improved the accuracy of home-range size estimations and fidelity between seasons. The home range size of groups tracked with telemetry during the wet season (3.6–7.9 km²) were 4 to 59 times larger than during the dry season (0.1–2.3 km²) (Leuchtenberger *et al.* 2013). In seasonally flooded areas, some groups still maintain their dry-season territories during the wet season, increasing their territory sizes to marginal flooded areas, while others shift to flooded areas (Leuchtenberger *et al.* 2015), and home-range fidelity varies from 0% to 87% between dry and wet seasons (Leuchtenberger *et al.* 2013).

In Yasuní National Park, Ecuador, the home ranges of three giant otter groups in the Añangu, Tambococha, and Jatuncocha river-lagoon systems were estimated during the dry and rainy seasons. During the dry season, each section was traveled using a paddle-powered canoe at least 50 times to record the geographical location of each sign (latrines, campsites, dens, tracks) or direct observations, using a photographic catalog of the individual throat patterns of each group. For the rainy season, we calculated the area of flooded forest adjacent to the stretch of the river channel that was identified as the home range during low water. During the dry season, the Jatuncocha group had a home range of 2.75 km², Tambococha 0.59 km², and Añangu 0.45 km². Our estimates during the rainy season ranged between 1.98 and 19.55 km², which are notably larger than the estimates during the dry season. These differences did not appear to be related to the sizes of the giant otter groups, which had five individuals in Tambococha and six individuals in both Jatuncocha and Añangu (Utreras *et al.* 2005).

In southeastern Peru, giant otter home ranges usually encompass at least one oxbow lake, almost always several streams or swampy areas, and a stretch of river (Staib & Schenck 1994). However, it is possible for a group of *Pteronura brasiliensis* to permanently inhabit a lake, as long as it is no less than 6 km long and 200 m wide. A group lives in a stable range in both the rainy (October-April) and the dry season (May-September) (Groenendijk 1998). Two different groups have never been observed in the same range, nor has any interaction between two different social units been observed. Only transient giant otters may visit different ranges, but without joining resident and breeding groups (Staib 1993).

However, in the Pantanal groups overlap the limits of neighboring territories and agonistic encounters are common and the total territory extent of groups is positively correlated with group size in both dry and wet seasons (Leuchtenberger *et al.* 2015). The maintenance of territories throughout the seasons can positively affect the reproductive success of the alpha pairs, but it demands efforts in marking and defense (Leuchtenberger *et al.* 2015). Thus, newly formed small groups can increase their competitiveness by accepting non-kin helpers (Leuchtenberger & Mourão 2008).

MORTALITY AND COMPETITION

Little is known about the factors that contribute to giant otter mortality. Territoriality plays an important role in the spatial organization of groups and consequently increases intraspecific competition and reproductive success (Groenendijk *et al.* 2014; Leuchtenberger *et al.* 2015). In normal habitat conditions, cub mortality varies from 30% to 50% (Groenendijk *et al.* 2014; Leuchtenberger *pers. com.*), but extreme drought and fires might negatively affect cubs' survival and breeding rate of alpha pairs, as observed in the Pantanal (Leuchtenberger *in. prep.*). In Peru, Groenendijk and colleagues (2014) found the highest mortality rates for cubs and for dispersing age classes. Infanticide and cannibalism were also reported in the Pantanal (Mourão & Carvalho, 2001), which might be associated with sexual and territorial competition.

Studies of parasitism in giant otters in Peru found five different species of intestinal nematodes, including hookworms, and the presence of some insect larvae that burrow and develop under the skin of otters (Groenendijk 1998). In addition, diseases typical of domestic cats and dogs, such as parvovirus, distemper and rabies, can have serious repercussions on wild animal populations. Captive giant otter cubs have died from parvovirus and all mustelids are highly susceptible to canine distemper. People hunting with dogs travel long distances with the potential for contagion and infection of otter populations (Schenck 1999; Schenck & Staib 1995). Domestic diseases pose a potential threat to *Pteronura brasiliensis,* with high mortality in cubs (Groenendijk 1998). Giant otters may acquire some skin infections when solitary individuals are injured while traveling long distances in search of a new mate, where they may have confrontations with other groups of otters (Schenck 1999). In the Pantanal, a myiasis infection by *Cochliomyia hominivorax* larvae was found in a dead otter and may have deteriorated the health of the individual after intraspecific fights (Foerster *et al.* 2022).

With the exception of man, otters have few predators, with jaguar (*Panthera onca*), puma (*Puma concolor*), anaconda (*Eunectes murina*), caiman (*Caiman yacare*) and black caiman (*Melanosuchus niger*) the most significant. Although predation events are unlikely to be common, there are a few observations of caiman predation on cubs in the Pantanal (Schweizer 1992; Leuchtenberger, *pers. com*.) and two reported jaguar predation events, one of a solitary adult in the Balbina lake in the Central Amazon (Ramalheira *et al.* 2015), and another of a cub in the Pantanal (Leuchtenberger & Martin 2020). Duplaix (1980) also suggested that piranhas, stingray and electric eel could be alternative, though unlikely, causes of mortality, while Schenck & Staib (1992) considered white-lipped peccary as a possible, though rare, predator of cubs (Groenendijk 1998).

Competition with other animal species, such as Neotropical otters (*Lontra longicaudis*), river dolphins, fish and piscivorous birds, is probably minimal due to spatial separation, activity periods and differences in food preferences (Carter & Rosas 1997).

REPRODUCTION

Giant otters reach sexual maturity after 2.5 years (Groenendijk *et al.* 2014). Within a group, just the alpha pair breeds. Female and male giant otters show similar traits with respect to average reproductive lifespans (female 5.4 yrs., male 5.2 yrs.) and average cub productivity (female 6.9, male 6.7 cubs per lifetime); the longest reproductive life spans were 11 and 13 years respectively (Groenendijk *et al.* 2014).

The first reproductive season occurs at year 4, and adult females are receptive for 3 to 10 days within a 21-day estrus cycle (Groenendijk 1998; Groenendijk *et al.* 2014). Copulation takes place in the water and reproduction is possible throughout the year, although it usually occurs only once during the dry season when fish are especially abundant (Carter & Rosas 1997; Evangelista & Rosas 2011b). The alpha female of a group usually has one litter annually, although sometimes up to two litters per year have been reported (Vallejo & Pozo 2019).

Juveniles remain with the group for a relatively long period of time, as mortality among cubs and single individuals is high (Staib 1993; Groenendijk *et al.* 2014). Reproductive success is related to group size and habitat quality (Schenck 1999; Groenendijk & Hajek 2006).

Cubs remain with their parents until the next litter is born and likely remain with the family until the new cubs mature (Groenendijk *et al.* 2015). Each litter may have 1-6 cubs after a gestation period of 64-77 days (Wunnemann 1993), however, it is rare to see litters of more than four individuals in the wild (Duplaix 1980; Staib 2005; Groenendijk & Hajek 2006; Evangelista & Rosas 2011b; Groenendijk *et al.* 2015). Although rare, the presence of two lactating females belonging to the same group was observed in groups with bigger litters in the Amazon and Pantanal (Rosas & Mattos 2003; Leuchtenberger & Mourão 2009), which may also be related with the loss of dominance of the previous alpha mother (Davenport 2015).

Pups are cared for by both parents, as well as older siblings who may act as babysitters (Schenck 1999; Evangelista & Rosas 2011b), and remain inside the den for 2-4 weeks before being introduced to the water (Wunnemann 1993; Evangelista & Rosas 2011b). Pups open their eyes and are able to swim after one month, and at six weeks can be observed regularly playing near the den entrance (Carter & Rosas 1997; Evangelista & Rosas 2011b). In the wild, two-month-old cubs begin to ask noisily for fish because they cannot fish or travel with the family unit until they are 3-4 months old (Staib 1993). Cubs are weaned at nine months, and after 10 months they are indistinguishable from adults because they reach a larger size and develop fishing skills to catch their food. One-year-old juveniles begin to mark in the group camp and remain with the group until they reach sexual maturity (Carter & Rosas 1997), although a juvenile 10-month old female was observed dispersing from her natal group and joining a new group in the Pantanal (Leuchtenberger & Mourão 2008).


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METHODOLOGY FOR THE GIANT OTTER (*Pteronura brasiliensis*) RANGE WIDE PRIORITY SETTING EXERCISE

Robert B. Wallace & Ariel Reinaga

GENERAL APPROACH

The Wildlife Conservation Society developed the Range-Wide Priority Setting methodology to systematize scarce and often disparate data regarding the overall distribution of threatened wildlife species in order to make informed conservation management decisions (Sanderson *et al.* 2002). Conceptually, the Range-Wide Priority Setting (RWPS) methodology is an expert driven definition of where the most important conservation sites are for a given species, based on a spatially explicit analysis of systematized distributional data for the species. The methodology has been successfully used to systematize data and define conservation priorities for the following species: jaguar (*Panthera onca*: Sanderson *et al.* 2002; Marieb 2007), American crocodile (*Crocodylus acutus*: Thorbjarnarson *et al.* 2006), white-lipped peccary and lowland tapir (T*ayassu pecari* & *Tapirus terrestris*: Taber *et al.* 2009), Andean bear (*Tremarctos ornatus*: Wallace *et al.* 2014), and Andean condor (*Vultur gryphus:* Wallace *et al.* 2020) in Latin America, and a number of species in other parts of the world, including bison in North America (*Bison bison*: Sanderson *et al.* 2008), and eastern chimpanzees in Africa (*Pan troglodytes schweinfurthii*: Plumptre *et al.* 2010).

The basic conceptual steps to this methodology are as follows:

1. Systematize existing published information on the distribution of the target species focusing on distribution points and distinguishing between historical and more recent distribution records,
2. Request a community of experts to provide updated and/or unpublished information on the distribution of the target species in a spatially explicit manner,
3. Consult a community of experts on the diversity and relative importance of threats facing the target species across its distributional range,
4. Request experts to identify the most important Conservation Units or conservation stronghold polygons for the target species across its range based on a defined minimum population size,
5. Centralize information received from experts and provide spatially explicit first drafts of distribution (historical range & current range), threats and conservation units for the target species for subsequent expert review,
6. Bring together contributing experts to review and improve drafts of distribution (historical range & current range), threats and conservation units for the target species, finalize decisions about priority conservation units, and make decisions regarding priority conservation actions in the future,
7. Complete write-up and analysis of results for publication, distribution and use by decision-makers into the future.

KEY DEFINITIONS OF THE GIANT OTTER RANGE WIDE PRIORITY SETTING EXERCISE

The key definitions used for the Giant Otter Range-Wide Priority Setting Methodology are as follows:

Locality Records

Localities where giant otters have been registered, distinguishing between records in the last 20 years and records previous to 2000, including supplementary information about dates, habitat type, and type of records (observation, dens, spraints etc.).

Potential Range or Historical Range

Areas (polygons) where giant otters are believed to have existed since 1900.

Areas of Knowledge

Areas (polygons) where experts are able to express informed opinion about either the presence or absence of giant otters.

Areas Without Knowledge

Areas (polygons) where experts are unable to express informed opinion about either the presence or absence of giant otters.

Proposed Current Distribution

Areas (polygons) where based on systematized distribution points and expert knowledge, experts believe the giant otter has occurred in the last 20 years.

Giant Otter Priority Conservation Units (GOPCU): Areas (polygons) considered important for the long-term conservation of the giant otter populations divided into three types:

- Type I – resident and stable giant otter population of >250 reproducing adults,
- Type II – resident and stable giant otter population of >50 reproducing adults.
- Type III – potential recovering population of < 50 reproducing adults.

The areas with and without knowledge about giant otter presence or absence, and the historical distribution of the giant otter allow us to focus exploratory research to fill in information gaps, as well as inform potential reintroductions. The current distribution map and the identification of Giant Otter Priority Conservation Units (GOPCUs) help us optimize financial resources and capacity to conserve the most important strongholds for the species.

Giant Otter Range Wide Priority Setting Pre-Workshop Methods

Giant otter data collected and systematized prior to the workshop came from two main sources: i) a literature review conducted by WCS prior to the workshop, and ii) the information solicited from the experts from different countries (see participant list). For the latter, using models previously designed for jaguars (*Panthera onca*; Sanderson *et al.* 2002), white-lipped peccaries (*Tayassu pecari*; Taber *et al.* 2009), lowland tapirs (*Tapirus terrestris*; Taber *et al.* 2009), Andean bears (Wallace *et al.* 2014), and Andean condors (Wallace *et al.* 2020), we developed three specific questionnaires for the giant otter (Appendices I-III):

- Questionnaire A: Giant otter localities in the last 20 years;
- Questionnaire B: Threats to the conservation of the giant otter across its distribution;
- Questionnaire C: Proposed Giant Otter Priority Conservation Units (GOPCUs).

Experts were encouraged to provide complete information about each giant otter observation point, including:

- Contributor's Name
- Country
- Department
- Name of Locality
- Watershed
- Date of first observation
- Date of last observation
- Longitude (Coord.X)
- Latitude (Coord.Y)
- Distance to nearest human settlement (km)
- Name of the nearest community
- Number of giant otters observed
- Estimated total number of giant otters observed
- Latrine, den or feeding site
- Habitat Type
- Land Use
- Additional notes (sex, age or status of observed specimens).

Similarly, experts were asked to draw polygons on maps of their country in GoogleEarth™ representing their knowledge regarding giant otters. The five types of polygon were:

- **Giant Otter Historical Distribution** - Areas within the historical distribution polygon in their country where experts know that giant otters have occurred since 1900;
- **Known Giant Otter Absence** - Areas within the historical distribution where the experts know that giant otters no longer occur;
- **Known Giant Otter Presence** – Areas within the historical distribution where the experts know that giant otters still occur, recognizing that the existence of one or

two isolated observation points does not necessarily equate to expert knowledge of a resident population;
- **Unknown Presence or Absence** – Areas within the historical distribution where the experts had no knowledge about giant otter presence or absence;
- **Giant Otter Priority Conservation Units** - Areas within their knowledge area which experts consider as giant otter population strongholds or Giant Otter Priority Conservation Units (GOPCUs).

As data came in from the experts we then processed this information into one overall giant otter GIS database. The data reception period closed in early May 2018. Respondents were invited to the Giant Otter Range-Wide Priority Setting workshop held between 23rd and 24th May 2018 in Puerto Maldonado, Peru. Workshop participation was based on a) budget constrictions, b) geographic coverage of giant otters across their range, c) participant availability, as well as d) the amount of data provided by each respondent. The Giant Otter Range-Wide Priority Setting Workshop immediately followed the International Giant Otter Symposium at the Madre de Dios University on the 22nd May 2018.

Giant Otter Range Wide Priority Setting Workshop Methods

The 2-day RWPS workshop in Puerto Maldonado had the following objectives:

- Update distributional knowledge of the giant otter across the range and analyze the connectivity of identified populations,
- Review, discuss and refine expert knowledge polygons for the giant otter and proposed Giant Otter Priority Conservation Units provided by participating experts,
- Evaluate the conservation status of the giant otter across the range through identifying Giant Otter Priority Conservation Units and analysis of habitat integrity,
- Determine priority conservation areas for the giant otter across the range,

The Puerto Maldonado workshop participants worked in six geographical groups to sequentially review and refine the giant otter range-wide priority setting exercise, including: i) historic distribution polygon; (ii) current distribution polygon; (iii) places (polygons) where collectively the experts had knowledge of the giant otter; (iv) places (polygons) where collectively the experts did not have knowledge of the giant otter; (v) most important threats to the giant otter in each geographic region; and (vi) proposed Giant Otter Priority Conservation Units. The working groups were: (1) Guyana; (2) Colombia and Ecuador; (3) Peru; (4) Bolivia; (5) Brazil; and (6) Argentina.

Using printed map material, digital versions in portable computers and the definitions detailed above, each group was asked to review the historical range draft maps, then the current distribution and knowledge maps, and finally the proposed Giant Otter Priority Conservation Units. Country groups were asked to work in the order requested and clearly mark changes on the printed satellite image maps, which included populations and thoroughfares to further help interpretation, as well as digital versions in kmz format (Google Earth™ 2018).

Each map prepared for the geographic working groups included the following cartographic information:

- Background satellite image (World Physical Map, ESRI 2020)
- Digital Elevation Model (World Wildlife Fund 2006)
- Rivers (Venticinque *et al.* 2016)
- Basins (BL5) (Lehner & Grill 2013; Venticinque *et al.* 2016)
- Political-administrative boundaries (RAISG 2021, Limits)
- Protected areas (RAISG 2021, Natural Protected Areas)
- Giant otter sighting points (from data systematization prior to the workshop)
- Workshop polygons on Historical Distribution, Known Giant Otter Absence, Known Giant Otter Presence, Unknown Presence or Absence, Giant Otter Priority Conservation Units (based on the combination of information from multiple experts received prior to the workshop).

Each geographic working group redrew the workshop polygons on the basis of discussions between specialists. The groups were also asked to revise and fill in the corresponding digital questionnaire forms (Appendices I-III), so that detailed data for each record and/or polygon could be included in the final Table of Attributes of the Geographic Information System. Each country group elected a secretary to record the decisions and progress of the working groups. Upon conclusion the geographic working groups reported back to each other, which was particularly important from the perspective of a number of transboundary areas.

Giant Otter Range Wide Priority Setting Post-Workshop Methods

Immediately after the workshop, each workshop map was photographed and using the ArcGIS (ESRI 2018) georeferencing technique we digitized each of the polygons for each country according to the corrections and proposals of the workshop participants. Finally, we drew each of the polygons with the ArcGIS editing technique (ESRI 2018). To ensure the coherence of the polygons, the ArcGIS topological correction technique (ESRI 2018) was used so that there are no overlaps between polygons.

We also consulted iNaturalist (https://www.inaturalist.org) and the Global Biodiversity Information Facility (https://www.gbif.org) and included additional distributional records for the giant otter, being careful to eliminate and duplicate records already captured through the pre-workshop literature review and expert consultation.

Experts from countries across the range who were not present at the workshop (French Guiana, Paraguay, Suriname, Uruguay, Venezuela) were consulted virtually using the same methodology. The post-workshop methodology also added a watershed criterion, and so each expert drawn polygon was adjusted to the overlapping Basin Level 5 (BL5) basin (Venticinque *et al.* 2016). The resulting maps show basin limits and not the original polygons. During the workshop, giant otter experts also defined the 500 m a.s.l. altitudinal contour as the maximum upper range for giant otter distribution. A Digital Elevation Model (DEM) was used to delimit the maximum altitude and eliminate the portions of river basins above this value.

Subsequently, we sent the watershed modified workshop polygons (Historical Distribution, Known Giant Otter Absence, Known Giant Otter Presence, Unknown Presence or Absence, Giant Otter Priority Conservation Units) to the participating giant otter experts. Finally, we sent the draft version of this document to all authors for comment and analysis, before revising this document according to responses from all 33 contributing authors.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN ARGENTINA

Guillermo Gil, Talía Zamboni & Sebastian Di Martino

LOCAL NAMES

Lobo gargantilla, Lobo grande, Nutria gigante, Lobo marino, Ariraí.

HISTORICAL AND CURRENT DISTRIBUTION

The historical distribution of the giant otter in Argentina (Figure 1-3) included the Paraná River and its main tributaries in Misiones: Iguazú River, Urugua-í streams, Aguaray Guazú, Paranay Guazú, Yabebirí, the Iberá wetlands in Corrientes, and other water bodies according to surveys (Santa Fe, Corrientes, Misiones, Chaco provinces and probably Entre Ríos Province), as well as the Uruguay River and its tributary Iraí stream and mouth of the Negro River, the Paraguay River and its tributary Inglés stream (Formosa province), and the San Francisco and Bermejo rivers (Chaco, Formosa, Jujuy and Salta provinces) (Parera & Parera 1991; Parera 1992, 1998; Beccaceci & Waller 2000; Giraudo & Povedano 2003; Massoia *et al.* 2006; Chebez & Gil 2008).

The giant otter was previously considered as possibly extinct in Argentina. However, from May to November, 2021 a solitary individual was registered in El Impenetrable National Park in Chaco (Leuchtenberger *et al.* 2021), along the Bermejo River (Figure 3), in June 2021, 125 km (in straight line) upstream, in the Formosa Nature Reserve (Figure 3), and in December 2021 in Buenos Aires province, more than 2,100 km downstream, being the southernmost record for a giant otter ever recorded (Leuchtenberger *et al.* 2023). Another solitary individual of unknown sex was recorded with a camera trap at Ibera National Park in September 2022 (Leuchtenberger *et al.* 2023), while another individual was sighted and photographed in October 2023 by locals in the Cerrito island, Chaco, where the Paraná and Paraguay rivers meet. The origin of these solitary animals remains uncertain, as the nearest known populations are located in northern Paraguay, more than 1000 km away if the animal followed the shortest distance by water. Previous to these records, the last observations in the country were made in 1985 in the lower Urugua-í stream and in the upper Iguazú River, with sightings in 1986 and 1988 and another sighting made in 2003 in Brazil 15 km from the border (Parera & Bosso 1991; Parera 1998; Chebez & Gil 2008). An observation made in 2010 suggested the occurrence of a giant otter in the Iguazú waterfalls (Valente 2016).

In the province of Corrientes sightings are mainly along the Paraná River (D'Orbigny 1998), with unconfirmed sightings up to the year 1993 (Becacecci & García Rams 1995), and Uruguay River. There are also unconfirmed records in the departments of Ituzaingó and Paso de los Libres (Chébez & Betonatti, 1994).

Within the Iberá wetlands, connected to the Paraná River through the Corrientes

River and to the Uruguay River through the Miriñay River, the most well-known evidence of the species presence is a skull (currently deposited in the Collection of the Natural Sciences Museum in La Plata) collected by Domingo Cabrera, a former local hunter and later park-ranger on April 19th, 1999. The finding was made on a sandbar on the island of Biombo (currently disappeared) in the Fernández lagoon. Other hunting records date back to 1942 or 1943 in the Misteriosa Lagoon, along with other sightings in 1987 in Sánchez creek, north of the town of Colonia Carlos Pellegrini, in mid-1985 in the Miriñay wetlands, and others mainly on the Paraná River and the vicinity of the Miriñay and Corrientes rivers (Figure 1; Parera, 1992). A solitary individual was recorded in four pictures of a camera trap near Laguna Iberá in September 2022 (Leuchtenberger *et al.* 2023).

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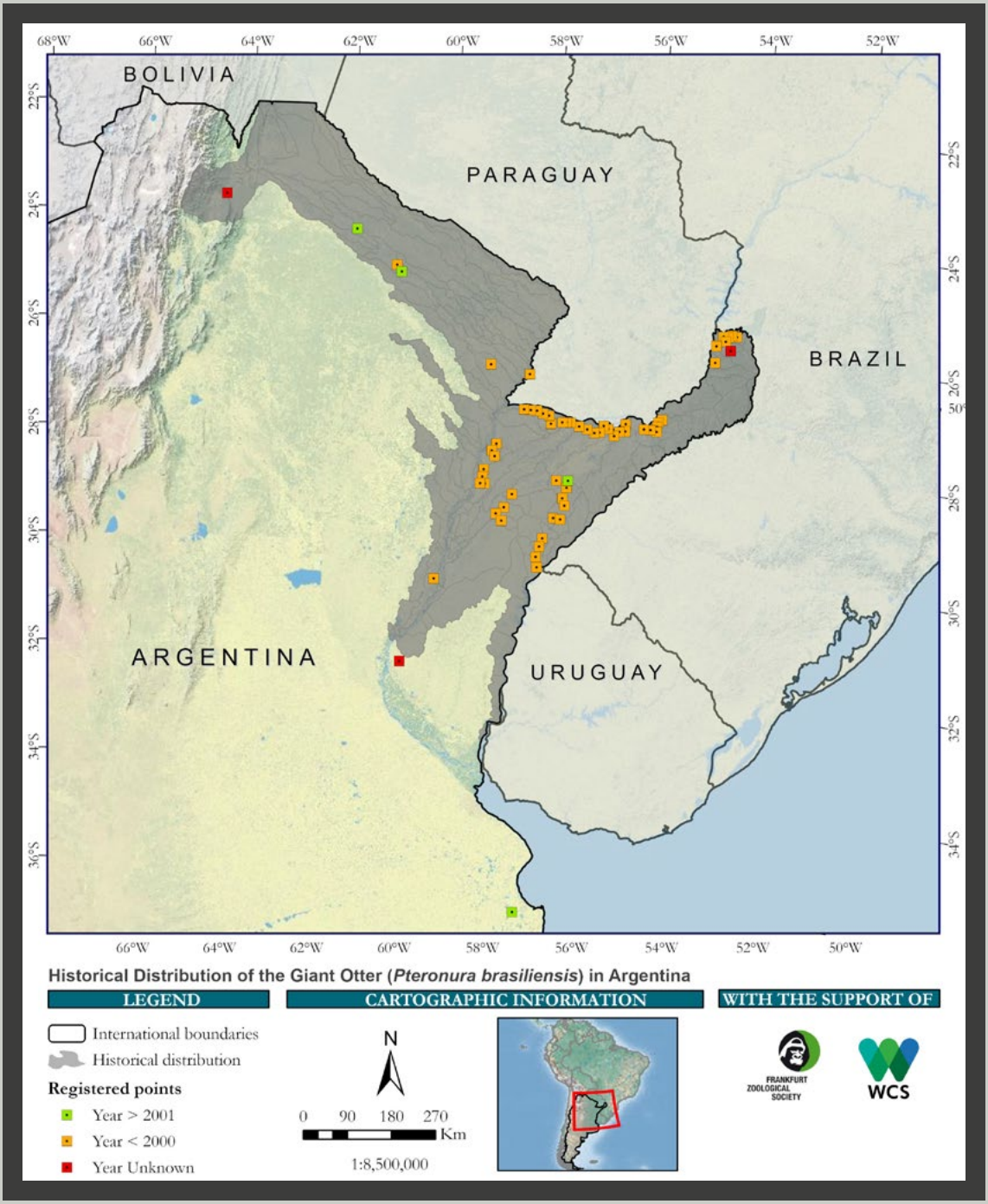


Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Argentina, from Parera (1992) and additional records.

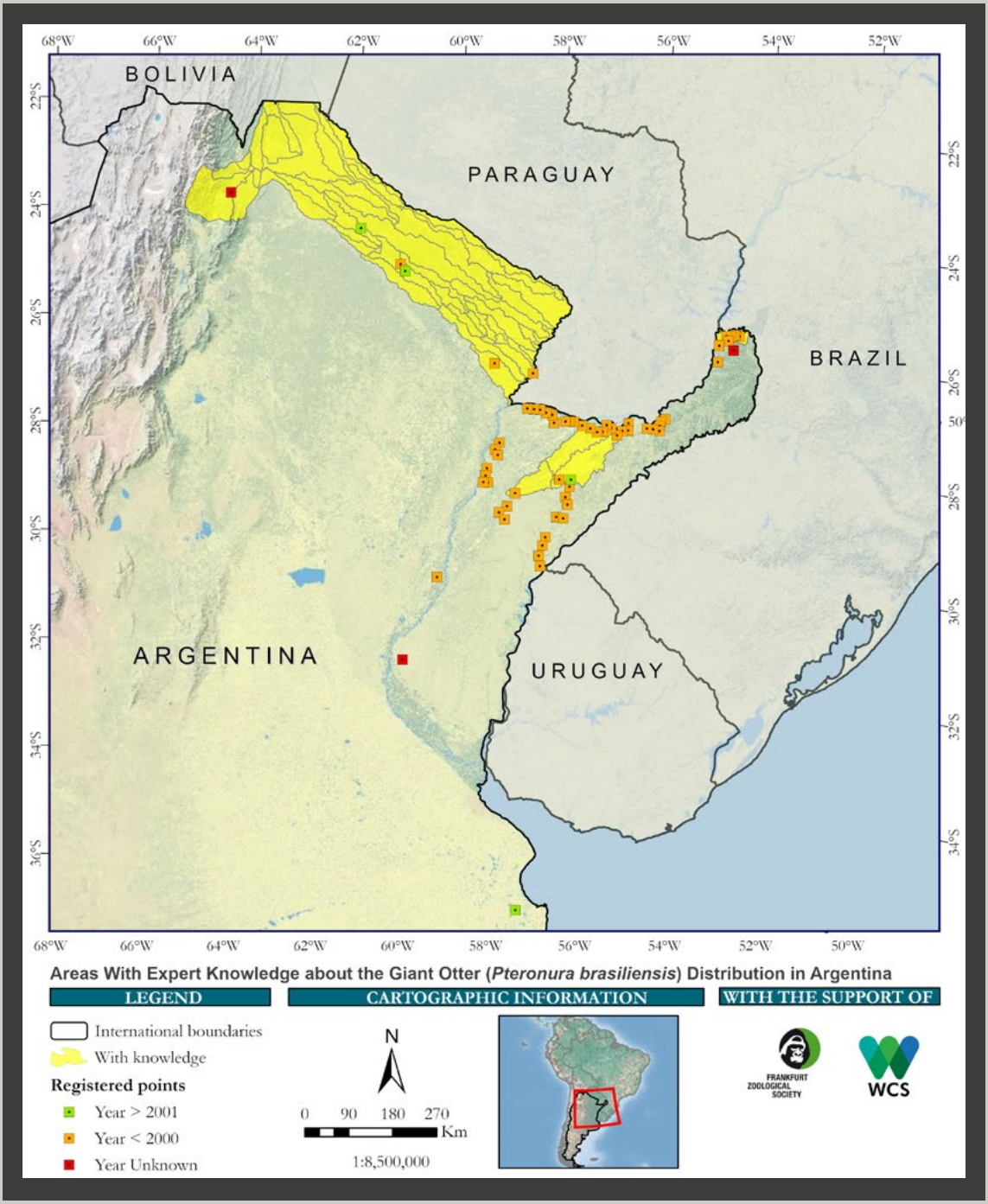


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Argentina.

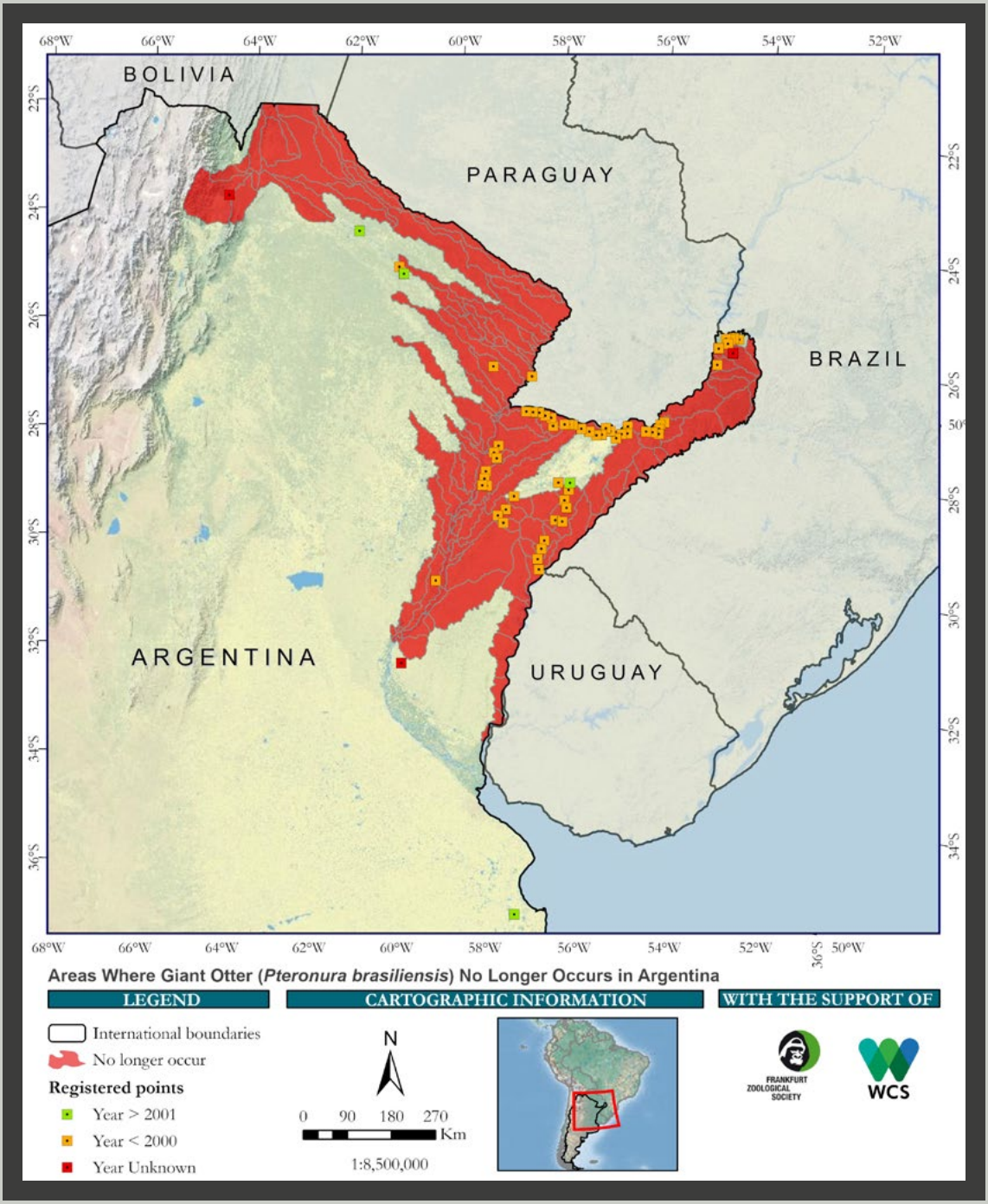
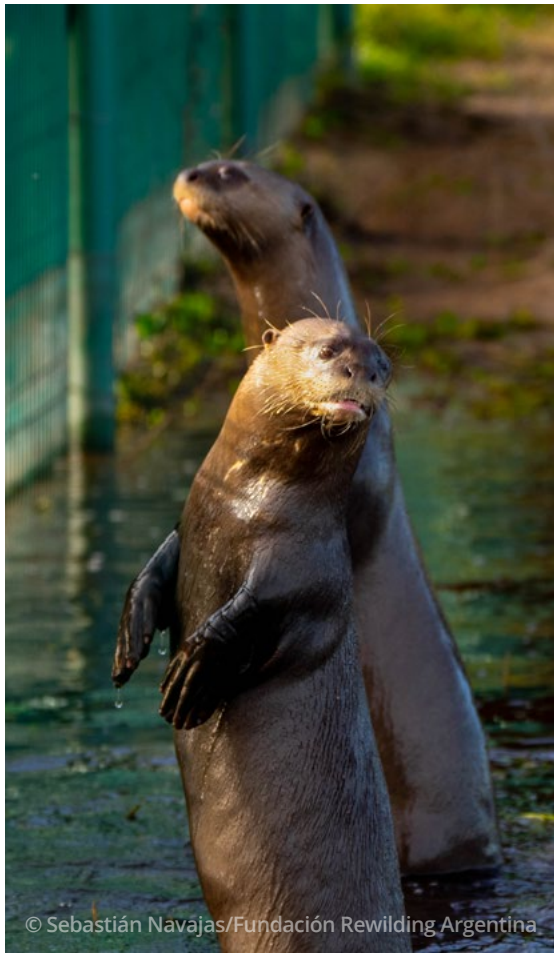


Figure 3. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Argentina.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Probably extinct at present, or with very low numbers. There are no past population studies in Argentina, only an analysis of the decline of groups to isolated individuals (Parera & Bosso 1991; Parera 1992, 1998).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HABITAT USE

Argentina lacks habitat use studies. Most historical records were made on large rivers (annual average flows of 2,830 m^3/s to 17,112 m^3/s) or their medium tributaries (56 to 1,824 m^3/s). There is only one record from 1999 for a lagoon that is part of a system of marshes, swamps and lagoons of 13,800 km^2. Most of the records are in the Selva Paranaense ecoregion, also known as the High Paraná Atlantic Forest, followed by the Paraná Delta, Yungas and Iberá Marshes ecoregions (Burkart *et al.* 1999).

THREATS

Oil industry

Oil development in Argentina began in 1922. There are no records of direct impacts to giant otters, although the Iguazú, Paraná and Uruguay rivers were and are subject to accidental oil spills. In 2001 in Brazil the Iguazú river suffered an oil spill of 4 million litres, but no impacts were detected in Argentine territory (misionesonline.net/2001/02/22/la-mancha-del-derrame-de-petrobras-en-brasil-esta-a-punto-de-ingresar-a-la-argentina/).

Hydroelectric development

There are some known cases of dams that seem to have affected negatively the occurrence of the species in Argentina. In 1990, the hydroelectric dam near the mouth of the Urugua-í stream began to operate, flooding 85 km^2. This artificial lake flooded the section of the stream where the species had several historical records, including reproductive family groups, and the last sighting (1985) in this

basin. This is the only case of a dam built in Argentine territory at the same time as the existence of the species. The dams installed on the Iguazú River in Brazil affect the daily and weekly flows of the river in Argentina (Garciarena 2009a, 2009b). An intake project on the Iguazú River to feed a hydroelectric dam in another basin (Urugua-í) was not successful.

On the Uruguay River there are two proposed dam projects (Garabí and Roncador, Corrientes) that would flood 800 and 1,300 km^2 respectively. This same river is already affected by the Itá dam upstream in Brazil, that was built in 2000 and flooded about 141 km^2. In 1979, the Salto Grande dam flooded 783 km^2 of the Entre Ríos Province and Uruguay River. On the Paraná River between 1989-1994, the Yacyretá dam flooded 1,200 km^2 in northern Corrientes, south of Misiones and Paraguay. In 2010, this flooded area increased to 1,600 km^2. There are also several projects for future implementation on the Paraná River: Corpus dam with a projected lake of 600 km^2 (Misiones Province and Paraguay), Paraná Medio (Pati-Chapetón dam) with a projected lake of 7,575 km^2 (Entre Ríos and Santa Fe Provinces) and Paraná Medio (Machuca Cué dam) with 1,720 km^2 to be flooded (Corrientes and Santa Fe Provinces).

Overfishing

Historically, fishing existed with an important internal market in the main cities along the Paraguay and Paraná rivers. In the mid-1990's factories were installed to export tens of thousands of tons. In 2002 a warning was issued about a 50% drop in the population of shad (*Prochilodus platensis*) in the mid-Paraná. In 2004, a 35,000-ton export record was reached, with an estimated total catch of 60,000 tons. Overfishing threatens all the fish fauna of the Paraná. Reductions in the quantity and quality of the surubi (*Pseudoplatystoma corruscans*) were also observed. In 2008, *Zungaro jahu* was evaluated as Vulnerable in the Plata basin, and *Hemisorubim platyrhynchos* Near Threatened due to overfishing, among other factors. For a stretch of the Paraná River, the siluriforms *Pseudoplatystoma corruscans*, P. *reticulatum*, *Oxydoras kneri* and *Pterodoras granulosus* are considered Vulnerable due to high levels of extraction (Cordiviola *et al.* 2009).

Water pollution

On the navigable Parana River, large cities and their industries have been present since the beginning of the country's development. It also crosses one of the most productive agricultural and livestock regions of Argentina. Studies on pollution were only carried out in the last decades, when the species was no longer present. There are three cellulosic plants on the river in Misiones, the oldest dating back to 1942. They are accused of dumping chlorine, sulfur and all the chemical residues left after the paper pulp is manufactured into the river. The waste dumped may have contained sulfite liquors, fine pulp, bleaching chemicals, sodium sulfides, mercaptans, carbonates and hydroxides, seine, clays, inks, waxes, fats, oils and fibers. Also, a high quantity of organic matter (54 kg BOD/Tn) and suspended solids (77 kg/tn). On the San Francisco River, the Ledesma sugar mill operated since 1830 dumping industrial waste from sugar and paper manufacturing into the river basin without any type of treatment.

Destruction of riparian habitat

The Paraná, Paraguay and Uruguay rivers were the first routes of penetration into Argentine territory and colonization at the beginning of European incursions (Gaboto in 1527; Ayolas & Cabrera in 1538; Jesuits in 1624). Puerto Iguazú, on the homonymous river, was founded in 1901, as the first outpost on its coasts, and today it has 82,000 inhabitants. It was not until the early 1970's that a colonization plan was developed (Cnia. Andresito, General Belgrano Department) that affected the coasts of the upper Iguazú River (above the waterfalls). The Urugua-í stream began its transformation in 1925 with the clearing and planting of pines on its lower course, and then flooded in 1990 by a hydroelectric dam. In Misiones, the coasts of the Paraná and Uruguay rivers and their main tributaries were profoundly modified (Izquierdo *et al.* 2008). The Iguazú River, the middle and upper basin of the Urugua-í stream, and a small section of the Uruguay River are within protected areas (Chebez & Hilgert 2003). The rest of the coasts of the Uruguay, San Francisco and Bermejo rivers also suffered modifications due to human settlements and agriculture. The city of S.S. de Jujuy on the San Francisco River and near the Bermejo River headwaters, had settlements since 1561 and is currently the capital of the province with 360,000 inhabitants. The Paraguay and Paraná rivers, possess big cities on higher ground, but has wide areas of dynamic floodable coasts, which are better preserved as they are not suitable for human settlements, although cattle ranching is common. The coastal structure of the Esteros del Iberá has been well preserved.

Direct killing

There are historical records of giant otter hunting since 1891 (Formosa), mainly for the fur trade. Between 1941 and 1960, 20 *Pteronura* skins were legally exported from Argentina, although there was also an illegal trade. It was also hunted for museum and private collections. Hunting data was collected by surveys in Corrientes and Misiones in the second half of the 20th century. Hunting probably affected the last specimens in Iguazú National Park (Giai 1976; Forcelli *et al.* 1985; Gruss & Waller 1988; Parera & Bosso 1991; Chebez 1994; Parera 1994, 1998; Chebez & Gil 2008; Gil *pers. obs*.).

Conflict with fishermen

Not detected as a threat, but perhaps isolated cases in the Paraná River (Parera *pers. comm.*).

Live capture

Not detected as a threat. Only two records of pups in the Paraná River in Misiones in 1944, and in Corrientes at the same time (Parera & Parera 1991; Chebez & Gil 2008).

Boat transit

Possibly a synergistic threat with other threats (Parera 1998).

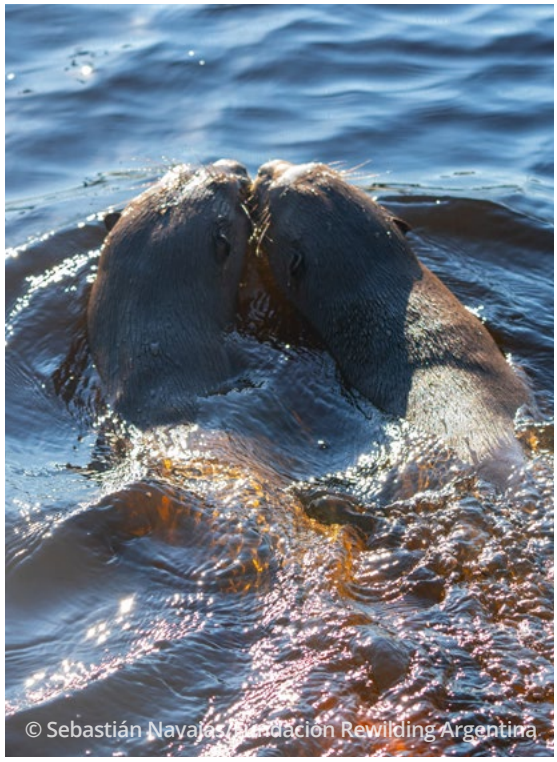
Other local threats

The abundance of domestic dogs in coastal human settlements was also raised as a possible synergistic threat (Parera 1998). In Esteros del Iberá the species is currently absent, but rice paddies extract water for irrigation from

the Trin y Fernández Lagoon, and a dam project (11,000 ha) on Ayuí Creek has the same purpose. In 2005, 24 km of embankments were built that affect the normal flow of water.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

If it is not already extinct, given the observed tendencies, the species is close to disappearing from Argentina. The solitary individual registered in 2021 could be a disperser from a family group most likely from Paraguay, although the existence of more individuals in Argentina is a possibility (Leuchtenberger *et al.* 2021).



KNOWLEDGE ABOUT THE SPECIES

There are few scientific data on this species in Argentina, and no medium- or long-term studies exist. Knowledge sources include the specimens collected (5 in the MACN of Urugua-í and Iguazú; 1 in the MLP of Iberá; www.gbif.org; Beccaceci & Waller 2000; Gil *pers. obs.*). The most detailed field observations were by the naturalist Andrés Giai between 1948 and 1950 in the Urugua-í and Aguaray Guazú streams on behavior, feeding and reproduction (Giai 1950, 1976). There are other specific data on behavior and reproduction in Urugua-í (Massoia 1976; Crespo 1982) and on the disappearance process along the main rivers of northeast Argentinian coast (Parera & Bosso 1991, 1992; Parera 1998), as well as complete compilations on the species (Massoia *et al.* 2006; Chebez & Gil 2008), and a phylogenetic study of the first fossil record of the species in Argentina (Prevosti & Ferrero 2008).

LEGAL STATUS

Argentina is a signatory to several international agreements: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits international trade in this species (National Decree No. 522/97; National Law No. 22,344); and the Convention on Biological Diversity, to promote the recovery of threatened species, among other things through the development and implementation of plans or other management strategies. The latter will adopt measures aimed at the recovery and rehabilitation of threatened species and their reintroduction into their natural habitats under appropriate conditions and adopts the National Strategy on Biological Diversity document (SAyDS Resolution No. 91/2003; National Law No. 24,375).

At the federal level, *Pteronura brasiliensis* is assigned the status of a Regionally Extinct species. It must be adequately protected to ensure its conservation and propagation. Hunting, capture, interprovincial transit, trade under federal jurisdiction and export of live specimens, products and by-products are prohibited. Feasibility studies and project proposals of initiatives that can cause transformations to the environment of wild fauna, have to previously consult the competent authorities regarding fauna (Resolution SAyDS Nº 513/07; National Decree Nº 666/97; National Law Nº 22.421; Di Martino *et al.* 2019). In the Misiones Province it is a Provincial Natural Monument, and has absolute protection from the authority (Provincial Law XVI-Nº 44, ex Nº 3,320; Provincial Law XVI-Nº 29, ex Nº 2,932). Hunting, and/or capture and commercialization, as well as possession of live or dead specimens, are prohibited in the Misiones Province (Provincial Decree Nº 2.874/1988; Law XVI-Nº 11, ex Decree Law 1.279/80).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

The protection of giant otters was one of the foundations for the creation of the Urugua-í Provincial Park (84,000 ha) in 1988 that protects the upper and middle basin of the stream (Forcelli *et al.* 1985; Chebez & Gil 1987), as well as the Urugua-í Private Wildlife Reserve (3,243 ha) in 1998 on the middle basin (Chebez & Gil 1987). It also served to justify the creation of the Provincial Parks Agrarian Engineer R. Cametti (136 ha) in 2000, Upper Iguassu Island Group (300 ha) in 2005, and the Ariraí Private Wildlife Refuge (180 ha) in 2004 (Chebez & Gil 1987; Rolón & Chebez 1998; FVSA in litt. 2004; Fundamentals of Bill D 24.421/04; Chebez 2005). Unfortunately, these areas were not enough to stop a process of extinction. The giant otter is also one of the reasons for the proposal of an interjurisdictional protected area in the Argentinean sector of the Iguazú River, from the mouth of the San Antonio stream to its confluence with the Paraná River (Fundamentals of the Draft Declaration 1281-D-2009).

The NGO Fundación Rewilding Argentina is in the initial stage of implementing the reintroduction project of the species in the Iberá Park (1,300,000 ha in Corrientes), as part of the Iberá species restoration project. Here, the threats that caused the disappearance of the species have been eliminated or controlled, and suitable habitat and food availability has been established. The project proposes the experimental reintroduction of the giant otter (Zamboni *et al.* 2018), thereby developing techniques that will allow the generation of self-sustaining populations in Argentina and other regions of South America in the future. In 2019 a female from Budapest Zoo (Hungry) and in 2020 a male from Givskud Zoo (Denmark) were obtained to form a breeding pair (CLT 2018; Di Martino et al. 2019). The animals are living in a prerelease enclosure in the core of the Iberá Park, and produced a first litter of three cubs in May 2021: one female and two males.

In 2022, a second male arrived from Parken Zoo (Sweden) and is in a second prerelease enclosure, with a female that arrived from the Biopark Doue La Fontaine, France, to produce a second reproductive pair, which had a first litter of four cubs. In 2022, the female from the first breeding pair died, and a new female from the Madrid Zoo was joined with the male. The female born in the first litter was transported in February 2023 to a prerelease enclosure in El Impenetrable National Park, where another reintroduction project was initiated by Fundación Rewilding Argentina. A third couple from the Halle Zoo in Germany was incorporated into the Iberá project in 2024 and a female from the Los Angeles Zoo recently joined the El Impenetrable project as a breeder. At the end of 2024 both reintroduction projects keep a total of 17 giant otters in prerelease pens.

RECOMMENDATIONS FOR FUTURE EFFORT

Research

Firstly, re-survey areas where the species may remain. If no signs of its presence are found, evaluate the possibilities of reintroduction including both, ecological and social factors. Also, coordinate with Paraguayan researchers and managers to survey connections with the Brazilian Pantanal, in order to determine the populations closest to the Argentine border and their possibility of dispersion (Parera 1998; Chebez & Gil 2008).

Conservation

The repopulation of the Iguaçu national parks area with the southern race was recommended (Coimbra-Filho 1972), as well as the Urugua-í stream (Chebez & Gil 2008).

The finding of a solitary animal in El Impenetrable National Park and Formosa Nature Reserve, reinforces the need to effectively protect these protected areas and their surroundings, as well as the Bermejo River that connects them.

The reintroduction project in Iberá could be used as a first experience to be implemented in other areas where the species used to live and with the potential to restore a self-sustaining population, for example, El Impenetrable National Park or Iguazú National Park (Figure 4).

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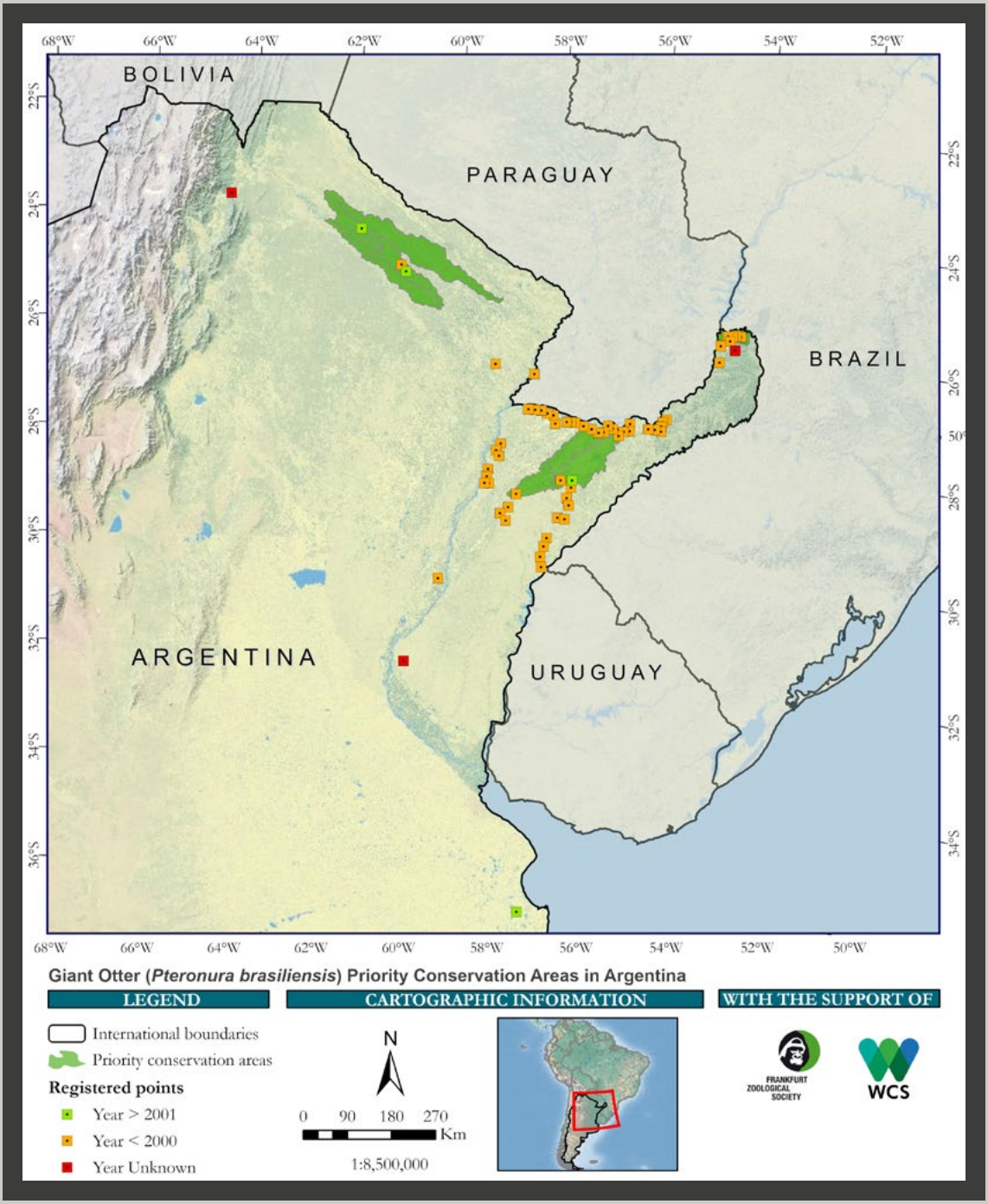

Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Argentina.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN BOLIVIA

Veronica Zambrana, Robert Wallace, Guido Ayala, Robert Pickles, María del Pilar Becerra Cardona, Nelly Guerra, Nuno Negrões & Paul André Van Damme

LOCAL NAMES

Londra, lobo de rio, nutria gigante.

HISTORICAL AND CURRENT DISTRIBUTION

The giant otter (*Pteronura brasiliensis*) was widely distributed below 350 m a.s.l. in the flood plains of the Bolivian Amazon (Figure 1), and was likely abundant in the Beni, Madre de Dios, Mamoré, Iténez (Guaporé) river basins, and in the Bolivian Pantanal in the Paraguay River basin (Van Damme *et al.* 2002; Ayala & Wallace 2009; Tarifa *et al.* 2010; Zambrana *et al.* 2010; Wallace *et al.* 2013; Ayala *et al.* 2015; ACEAA 2019a).

However, as a result of intensive hunting for the fur trade in the 1960's and 1970's, its populations were fragmented to the point of near extinction (Van Damme et al. 2002). By the 1980's, the giant otter was considered possibly extinct in the country (Marconi & Hanagarth 1985; Ribera 1990; Ergueta & Sarmiento 1992; Anderson 1993), but small populations survived in very remote areas that were difficult for hunters to reach, giving rise to the population that survives today.

Starting in the 1990s, several authors pointed out isolated and anecdotal observations of the species (FAN-WCS 1994; Carter & Rosas 1997; Gonzales 1997; Ten *et al.* 2001) reflecting a gradual recovery of populations in remote areas (Figure 2).

Since the 2000´s, research efforts also highlighted areas of absence for the giant otter, such as TIPNIS (Isiboro Secure National Park), and the Ichilo-Mamore, Beni, Yacuma and Itonama river basins (Figure 3). Nevertheless, there are isolated recent records in the Llanos de Moxos of the Beni Department, although it is not yet clear whether these represent records of resident populations or dispersing individuals. Concerningly, recent major expeditions to the Llanos de Moxos failed to register the presence of giant otter in the Great Tectonic Lakes of Exaltacion or the neighboring Iruyañez River (Grupo de Trabajo para los Llanos de Moxos & Wildlife Conservation Society 2022), the lakes of the Reyes and Santa Rosa del Yacuma municipality or the Yacuma River (Grupo de Trabajo para los Llanos de Moxos & Wildlife Conservation Society 2023), or the area further north in Santa Rosa dela Yacuma municipality including portions of the Benicito, Biata and Yata rivers (Grupo de Trabajo para los Llanos de Moxos & Wildlife Conservation Society 2024).

At present, giant otters remain a rare species in Bolivia. The current distribution of the species (Figure 3) includes parts of the Pando, Beni, La Paz, Santa Cruz, and Cochabamba departments, and it is found in the Southwest Amazon, Flooded Savannas, Chiquitano Dry Forest, and Cerrado ecoregions (Zambrana *et al.* 2010). Predictive distribution models developed for Bolivia indicate that the giant otter is mainly distributed in rivers located below 280 m a.s.l. (Zambrana & Crespo 2008), but

it has been found at 350 m a.s.l. (Ayala *et al.* 2015). Giant otters no longer occur around the city of Santa Cruz related to soya and livestock deforestation processes, as well as along the Maniqui River and southern Tarija Department (Figure 4).

The giant otter is predominantly distributed in three strongholds which are also considered as conservation priority areas for the species in Bolivia (Figure 5). Firstly, the Bolivian Pantanal (Paraguay River basin) has a population in permanent connection with a larger population in the Brazilian Pantanal. In Bolivia, the Pantanal population is probably separated from the Amazonian populations, although there may be a tenuous connection between Amazonian and Pantanal populations through Brazilian territory which is significantly perturbed by human activities. Secondly, in northeastern Bolivia, in the Iténez River basin, giant otters are widely distributed in most of the rivers that drain the Precambrian Shield. Apparently, it is less frequent in the rivers in the western portion of the basin, which originate in the alluvial plains of the Beni Department, although the species has been observed in the Blanco River, which flows along the edge of the Precambrian Shield. A third population is distributed in the northwestern Bolivian Amazon, in the white-water flood plains, and some clear-water tributaries, for example, the Manuripi River (ACEAA 2019a), within the Beni and Madre de Dios sub-basins (Ayala *et al.* 2015). This population is probably connected with giant otter populations in the southern Peruvian Amazon, in particular, in the Manu National Park, Bahuaja Sonene National Park and Tambopata National Reserve (Mendoza *et al.* 2017). Together this transboundary population represents a very important stronghold for the species (Ayala *et al.* 2015).

There are indications of a fourth population, which is little studied to date, and is probably a relic of a population that, according to local testimonies, once inhabited the clearwater tributaries and the floodplain lakes in the Mamoré River basin. In some tributaries of the upper basin of the Mamoré River (Ichilo, Isiboro, Sécure, and Chapare), the species was found in small numbers and remote areas, including the Isiboro Sécure National Park (Schaerlaekens 2005; Zambrana *et al.* 2010).


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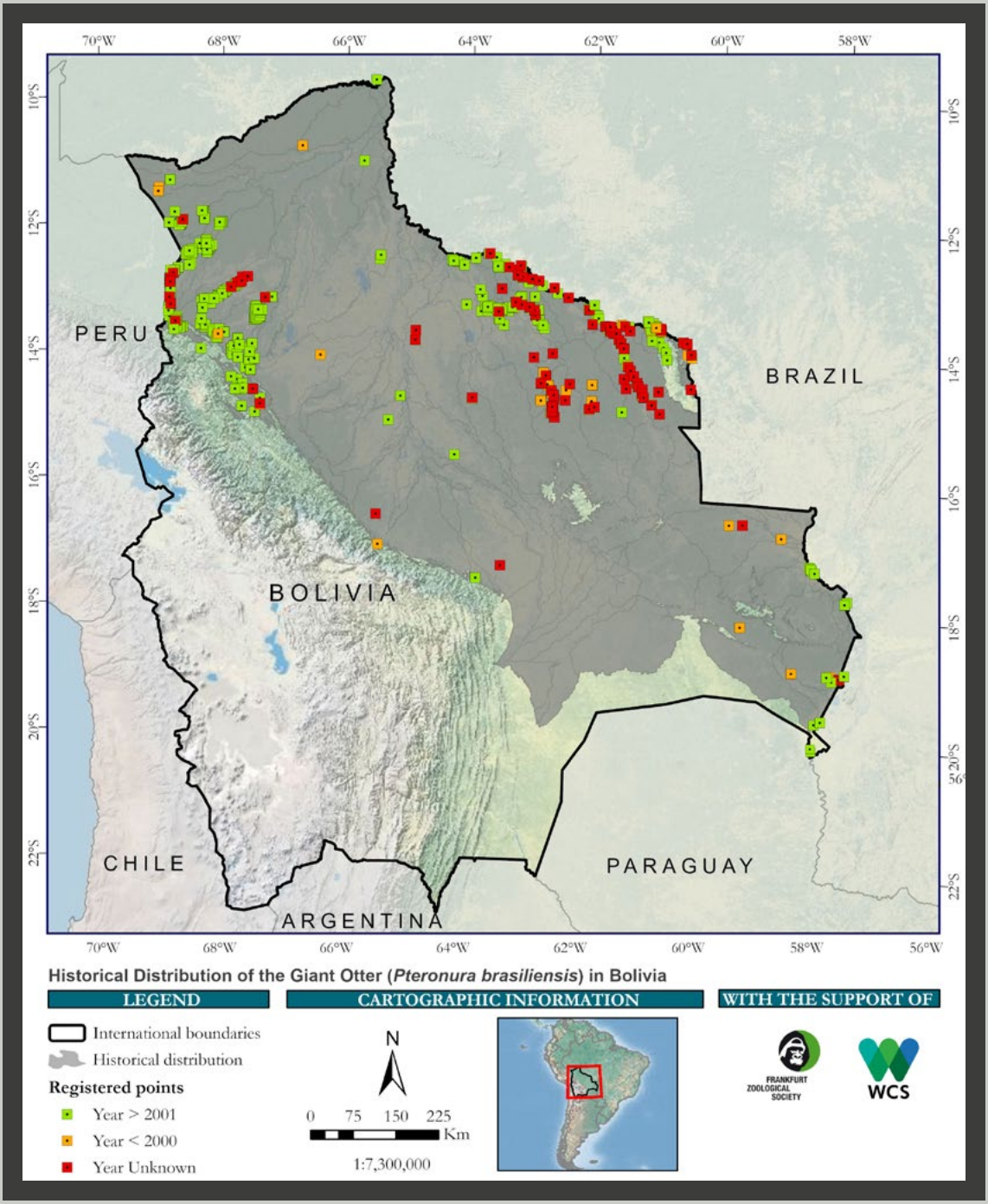

Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Bolivia.

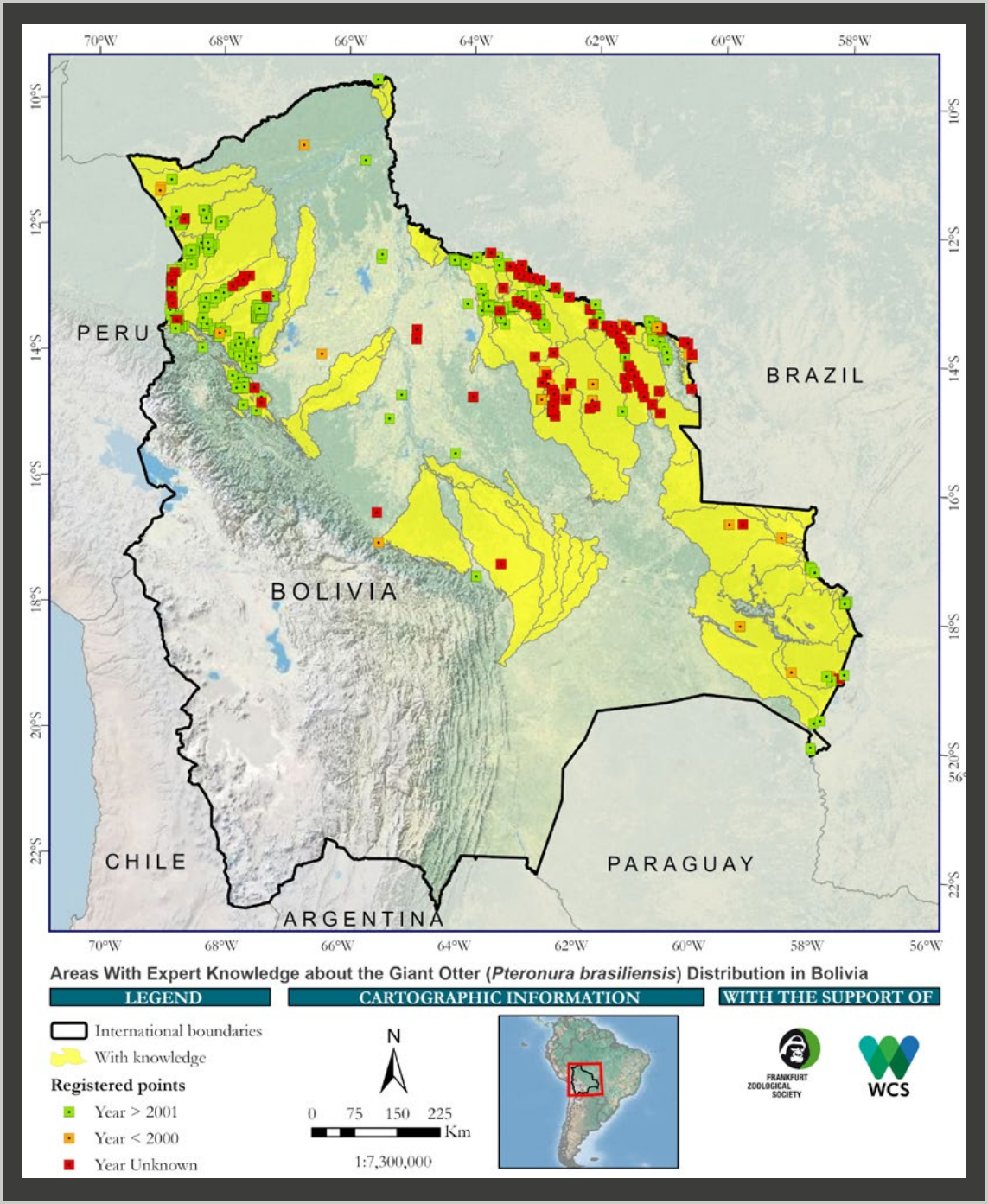

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Bolivia.

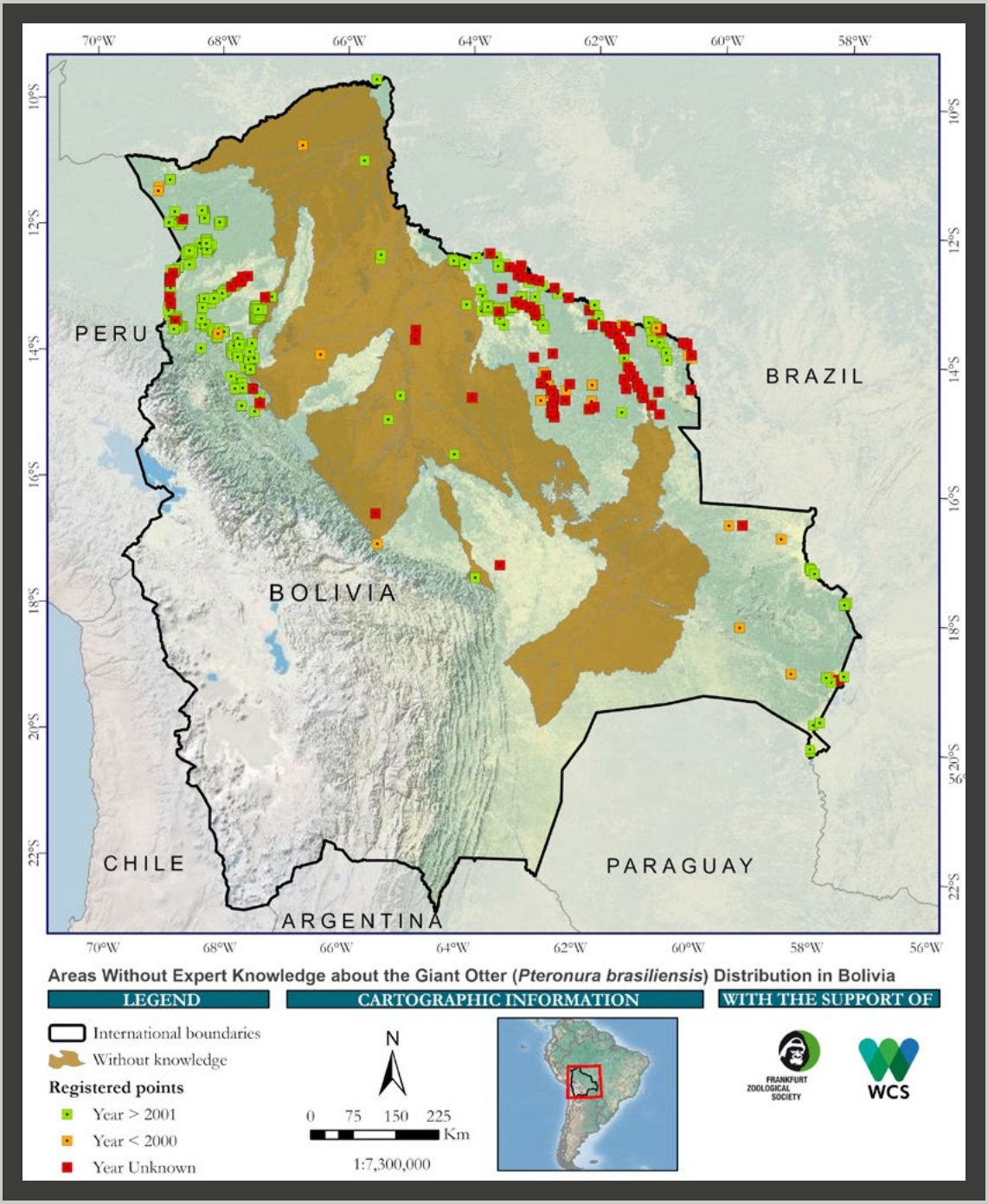

Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Bolivia.

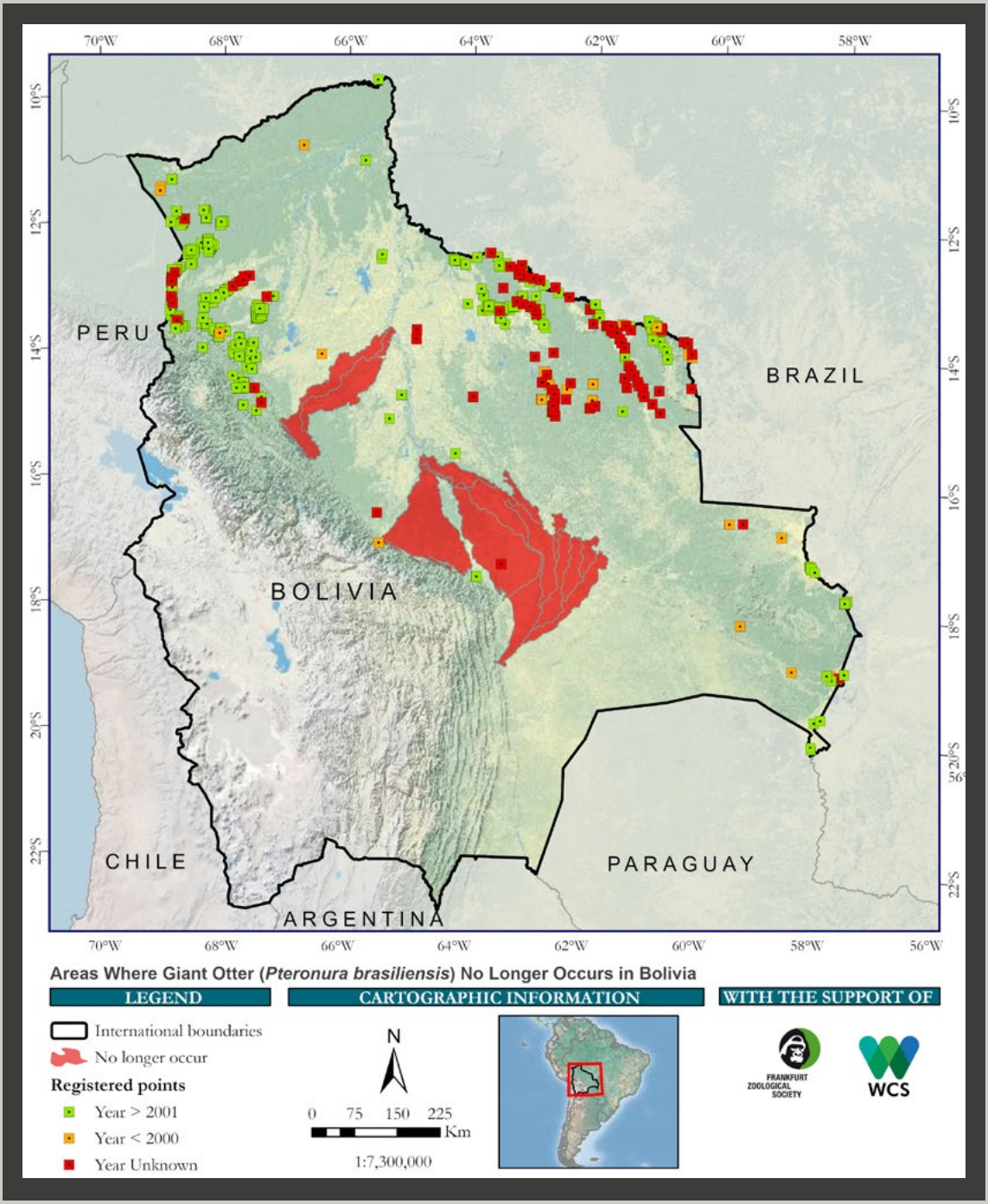

Figure 4. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Bolivia.

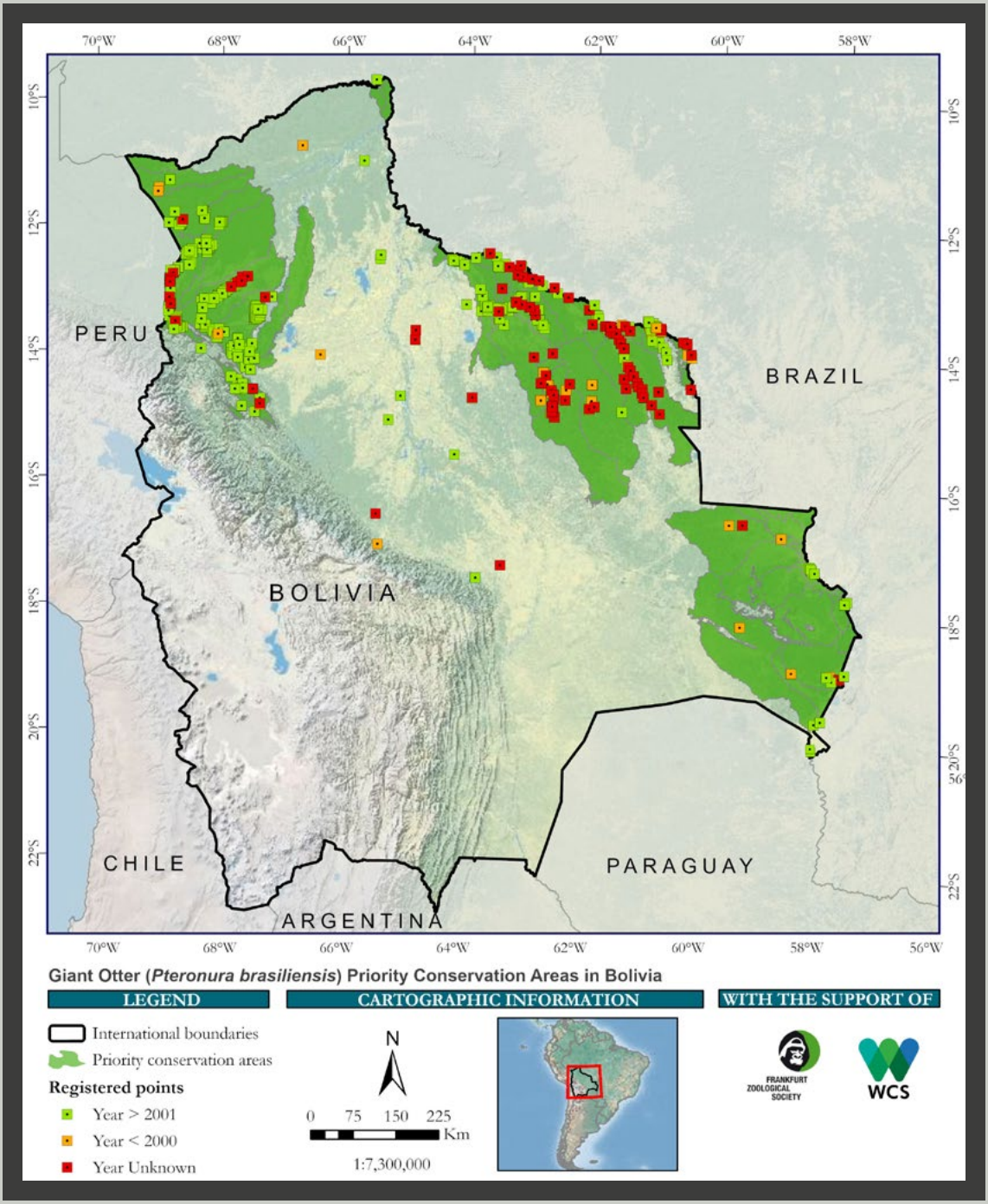

Figure 5. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Bolivia.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Van Damme and colleagues (2002) estimated that the total population of giant otters in Bolivia at the time of publication probably did not exceed 500 individuals. Recent studies (Zambrana 2008; Zambrana & Pickles 2008; Ayala & Wallace, 2009; Ayala *et al.* 2015; Becerra & Van Damme *in prep.*) provide a slightly more positive picture and show the first signs of recovery of Bolivian populations, with an estimate approaching 700 individuals.

The most important populations in the country are found in the middle and upper sub-basins of the Iténez River and smaller populations are found in the basins of the Madre de Dios, Beni, whereas the smallest populations were reported in the rivers draining the Bolivian Pantanal (Paraguay River basin). In the Mamoré River basin, the species has not recovered to date, except for the Isiboro River, where there are a few isolated records (Van Damme *et al.* 2002; Zambrana 2007).

The Iténez River sub-basin is the main stronghold for the giant otter populations in Bolivia (Gonzáles Jiménez 1997; Van Damme *et al.* 2001, 2002; Pickles 2013; Zambrana *et al.* 2013). It was recently shown that two of the largest giant otter populations within this sub-basin, respectively in the Noel Kempff National Park and in the Iténez Departmental Park, are connected by the 800 km Iténez-Guaporé transboundary corridor, making this population one of the largest and healthiest in South America (Zambrana *et al.* 2013).

Applying standardized methodologies for calculating relative abundances (for methodological details see Van Damme & Wallace 2005), a population of approximately 600 individuals were estimated for the Iténez River basin (Zambrana *et al.* 2013). Relative abundances were also calculated for all rivers studied in this sub-basin, in the San Martín River an abundance of 0.44 ind/km of river was estimated, in the Orince River an abundance of 0.81 ind/km, 0.18 ind/km in the San Joaquín River, 0.4 ind/km in the Blanco River, 0.25 ind/km in the Negro River, 0.73 ind/km in the Curichal stream, and 0.12 ind/km in the Iténez River. Other estimated abundances are: 0.29 ind/km of river in the Paraguá River (Van Damme *et al.* 2001), 0.11 ind/km in the upper basin of the Iténez River (Fraser *et al.* 1993) and 0.26 ind/km in the Negro River (Painter *et al.* 1994).

For the sub-basins of the Beni and Madre de Dios rivers, at the moment, the population recorded is 12 individuals for the Tahuamanu and Manuripi river systems (Zambrana 2006) and 167 individuals in the upper Madidi River and Tacana Indigenous Territory (Ayala *et al.* 2015). Studies are currently being carried out by ACEAA on otter populations in the Manuripi River basin that will update these data. Estimates of relative population abundances are: 0.02 ind/km for the Nareuda stream and 0.31 ind/km for Lake Bay (Zambrana 2006); 0.18 ind/km for the Madidi River (Ayala *et al.* 2015), 2.7 ind/km^2 in oxbow lakes across the mid and lower Madidi River basin (Ayala et al. 2015), and 0.069 ind/km for the Heath River (Identidad Madidi & SERNAP 2020). Giant otters have also been occasionally observed on the Tuichi, Hondo and Quiquibey rivers

and the Laguna Moa within the Tacana Indigenous Territory (CIPTA *unpubl. data*).

For the Paraguay River sub-basin in the Bolivian Pantanal, a population of approximately 50 individuals is estimated. Estimates of relative population abundances are: 0.02 ind/km for the Negro River (Pickles & Zambrana 2008); and for the Curiche Grande River basin, 0.24 ind/km for the San Antonio-Piraña sector, 0.37 ind/km for the Guaraná-Piraña sector, and 0.32 ind/km for the northern sector of Uberaba-Vista Hermosa (Becerra & Van Damme *in prep.*). Two incursions did not reveal the presence of giant otters in the Tucabaca and Aguas Calientes rivers, headwaters of the Bolivian Pantanal (Pickles & Van Damme *pers. obs.*).

The relative abundance data and the estimated population of giant otters reflects a process of recovery for the species in Bolivia, however, this information must be interpreted with care since they are estimates of adults, juveniles, and young. If only the effective population, or reproductive adult population, are considered, these estimates would be lower.

HABITAT USE

Water transparency, slow current, bank structure, habitat heterogeneity, and permanent fish supply were proposed as parameters that affect the suitability of natural habitat for giant otters (Van Damme *et al.* 2002). Recent studies (Zambrana 2008; Zambrana & Pickles 2008; Becerra & Van Damme *in prep.*) confirm the above and mention that currently most giant otter populations in Bolivia have been registered in the so-called clearwater rivers (*aguas claras*) that drain the Precambrian Shield. However, the species has also been recorded in different types of aquatic systems, such as whitewater rivers (mostly used as movement routes), streams, river tributaries, bays, swamps, floodplain lakes, and tectonic lakes, showing the diversity of habitats where the species is distributed in Bolivia.

All giant otter observations in Bolivia occur within three hydro-ecoregions; the Lowland Floodplain Hydro-ecoregion, the Brazilian Shield Hydro-ecoregion, and the Eastern Cordillera Hydro-ecoregion (Zambrana 2008). However, almost 90% of these observations were recorded in the "clear" floodplains of the Brazilian Shield Hydro-ecoregion, where the characteristic aquatic environments are the river-floodplain systems which are a set of meandering riverbeds with broad valleys and floodplains with numerous lagoons of fluvial or tectonic origin that are periodically flooded by the overflow of rivers (Navarro & Maldonado 2002). The most notable characteristics of these systems are their high transparency (Van Damme *et al.* 2001), slow current, an abundance of submerged and emerging macrophytes, presence of abrupt banks, high heterogeneity at the landscape level, and good food supply (Killeen & Schulenberg 1988; Van Damme *et al.* 2002; Zambrana 2007).

The remaining giant otter observations in Bolivia correspond to records in whitewater rivers originating in the Andes, where the species mostly uses the main river channel as movement routes and its clearer water tributaries for more permanent residence. The presence of banks and the high productivity of these systems offer favorable conditions for the species, but the large variations and flood pulses of these systems make them highly unpredictable, diminishing the areas available for den construction during the flood season. Historically, the multiple oxbow lakes in white water river-floodplains may have been the most important habitat for giant otter, offering a continuous and diverse food supply. This hypothesis is supported in the relative abundances along rivers versus oxbow lakes along the Madidi River (Ayala *et al.* 2015).

The absence of banks could be a problem in certain seasonally or permanently flooded areas in the Bolivian Pantanal and in tectonic lagoons, however, it was observed that in these areas giant otters use burrow dens where there is higher ground available, and possibly also use tree trunks as dens.

THREATS

Several characteristics of the giant otter make them a particularly vulnerable species to various threats. Their large size, and diurnal and gregarious behavior make them easy prey for hunters (Ojasti 1996). Giant otters are species with very specific habitat requirements and they are also very sensitive to human presence in their habitat. As predators at the top of the food chain, they are especially susceptible to bioaccumulation of mercury in their tissues. In addition to these innate characteristics, giant otters are threatened by increasing selective logging, and especially industrial and intensive agriculture activities along tropical forest rivers, as a result of human population growth, which is the main cause of natural system degradation, particularly in freshwater systems (Abell *et al.* 2008).

In Bolivia, giant otters face current threats that impact local populations and their habitats, and new, emerging or future threats that could have more serious effects on the long-term survival or recovery of the species. The following are the current threats to the species in Bolivia:

Conflicts with fishermen

The Bolivian Amazon lowlands are home to approximately 800 species of fish (Carvajal-Vallejos *et al.* 2015) and support diverse commercial and subsistence fisheries (Van Damme *et al.* 2011a). The annual volume of fish caught in the Bolivian Amazon is approximately 3,080 tons, but the fishery resource in the Bolivian Amazon is under-exploited and there is potential to increase fish production to approximately 12,000 t/year (Van Damme *et al*. 2011a). These data give us a guideline on the current level of interaction of fishermen with fishing grounds, and the potential increase of conflicts for the fishing resource between fishermen and giant otters that in the long term may lead to greater pressure on the species in Bolivia.

Structured interviews with local actors throughout the Bolivian Amazon indicate that most actors do not have problems with giant otters and do not consider them as harmful species or pests (ACEAA 2019b). However, information collected in the northern Amazon and in rivers bordering Brazil show that most fishermen report conflicts with the species and consider it detrimental to their fishing activities. This conflict is fueled by the fact that giant otters tend to consume prey out of the water in full view of the fishermen, making them an object of real or imaginary competition, and leading to the killing of entire family groups to secure fish stocks, especially when observed feeding in small ponds and lagoons.

Habitat degradation

The degradation of riparian habitat in Bolivia is mainly due to deforestation (Ibisch 2003; Killeen *et al.* 2007) and conversion to agricultural and livestock lands (Killeen *et al.* 2007), as well as colonization processes in remote areas. The degradation of aquatic systems is caused indirectly by the degradation of terrestrial habitat through the generation of changes in the hydrological cycle of rivers that in turn directly affect species such as giant otters and their prey (Van Damme *et al.* 2011c). Expanding human presence and associated threats such as

gold mining increase suspended solids from sediment mobilization and mercury contamination of the water (Roulet *et al.* 1999). Many riverine forests suffer annually from fires caused by poorly planned burning of pastures for livestock, causing resident giant otter groups to move to other areas, which endangers their cubs.

Another current threat in northern La Paz Department is the presence of the pirarucu (*Arapaima* sp.), a species that until seven years ago not registered in the Madidi River. Today the presence of this species is confirmed in several lagoons adjacent to the Madidi River. According to the last assessment of the giant otter population conducted in 2022 by WCS, it was found that in some lagoons where *Arapaima* are present there is no presence or traces of groups of giant otters, however, in lagoons where *Arapaima* were not registered groups of giant otters or their spore were registered (Ayala *et al. in prep.*).

Boat traffic

In the tropical forests of Bolivia, rivers represent the major navigation and connection routes between human populations. There are no recorded giant otter populations in wider and deeper rivers such as the Ichilo-Mamoré and Madera rivers where navigation is relatively more intense and larger boats are employed, and the impact of boat traffic on the species in these systems is unknown. In the smaller rivers where giant otters occur, the boats are usually smaller and the traffic is less intense, and giant otter groups adapt relatively well to the passage of these boats, but are more reluctant during the reproductive season. The greatest impact from boat traffic is poorly managed tourism in areas where giant otters are chased by boats to their dens so that they can be observed by tourists, generating great stress for the species and leading to the transfer of the young to other caves, placing them in danger.

Pollution of the aquatic environment

One of the main threats to giant otters is the pollution of the aquatic environment. The accumulation of methylmercury (MeHg) in fish is considered to be the most direct effect on the species. Mercury is easily transported through the water and the atmosphere, and bioaccumulated or biomagnified as methylmercury in migratory fish (Van Damme *et al.* 2002), which form an essential part of the giant otter diet.

The toxic effects of mercury on fish and humans have already been studied in different basins in Bolivia showing that the fish species that accumulate the highest concentrations are carnivores (Pouilly *et al.* 2012; Pouilly *et al.* 2013; Rejas 2016), which form a large portion of the giant otter diet. However, no specific studies have been carried out on mercury levels in otters and the real impact on the species is not known. However, the large amount of gold mining dredges in the northern Bolivian Amazon, mainly in the Beni River basin, have contaminated the waters and fish in that area (Maurice-Bougnoin *et al.* 2000), and we would expect that the effects of bioaccumulation will be strong on otter populations in that region, possibly affecting their health and/or their survival. Gold mining is also a major threat in the upper Madre de Dios River basin in Peru (Groenendijk *et al.* 2013;

Mendoza *et al.* 2017) and may affect the Bolivian giant otter populations in the lower stretches of this river. Historical gold exploitation in the upper Iténez and emergent gold exploitation in the middle Iténez River basin may also threaten the main stronghold for the species.

Pollution from chemical waste spills from oil activities, contamination with pesticides (insecticides, herbicides, fungicides, acaricides, etc.), and the spillage of various toxic chemicals, such as chlorine, phosphorus, arsenic, cyanide, lead, among others (Maurice-Bourgoin *et al.* 2000; Van Damme 2006; Van Damme *et al.* 2010a), also degrades the aquatic habitat quality where giant otters occur.


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Emerging and future threats for the species in Bolivia are:

Climate change

Although the effects of climate change in the Bolivian Amazon have only recently begun to be studied (IPCC 2001, 2007; Killeen 2007), modeling future scenarios gives us an idea of the magnitude of impact, not only at the regional level, but also at the global level (IPCC 2001, 2007; General Circulation Models (GCM); GCM models from IPCC-AR4 report; Cook & Vizy 2008). Broadly speaking, in the coming decades, global climate changes will affect water temperatures, precipitation levels, the hydrological regime and flooding patterns of rivers in the Bolivian Amazon (Sorribas *et al.* 2016; Feng *et al.* 2020).

The real impact of climate change on giant otter populations of Bolivia at the local level is not yet known, however, based on larger scale predicted climate change, a series of impacts at more local levels can be predicted that would seriously affect the survival of the species in the Bolivian Amazon: a) loss and degradation of available habitat for the species due to diminishing vegetation cover (Cook & Vizy 2008), release of carbon as a result of withering of Amazon forests which would lead to a tendency towards savannization (Killeen 2007), reductions in river flow (Xenopoulos *et al.* 2005) and desertification in certain areas; b) changes in the hydrological regime of rivers, in aquatic habitats and in the behavior of fauna and flora as a result of increased temperatures, general changes in precipitation patterns, increased occurrence of extreme events in precipitation, and changes in climate seasonality (Hare 2003; Allen *et al.* 2005; Van

Damme 2011c); c) a decrease in dissolved oxygen concentration, and an increase in pollutant toxicity (Ficke *et al.* 2007); and d) changes in the distribution patterns and boundaries (especially temperature-determined) of fish species (Feng *et al.* 2020), which would lead to changes in the distribution patterns of prey.

Construction of waterways

The Initiative for South American Regional Integration aims to promote the development of transport, energy, and communications infrastructure under a regional vision (Peru-Brazil-Bolivia), and envisages the construction of a series of hydropower plants in the Bolivian Amazon, as well as waterways, such as locks to facilitate navigation in the "*Madeira-Madre de Dios-Beni River Corridor*" (IIRSA 2010). In the future, the Iténez-Guaporé waterway is also planned, which will be essential to facilitate navigation between the Orinoco basin, the Amazon basin, and the La Plata basin (Van Damme 2011c). This axis has a total length of nearly 10,000 km, and is made up of the Madeira, Mamoré, Iténez (Guaporé), and Paraguay rivers in Bolivia (CAF 2010). Similarly, the current government of Bolivia is analyzing the feasibility of building the Ichilo-Mamore waterway, which will have a length of more than 1,400 km. The impact of these proposed mega-projects on the Bolivian Amazon is still unknown. However, the implementation of hydroelectric dams in the Brazilian Amazon has highlighted various environmental effects, mainly related to the disruption of the longitudinal connectivity of rivers, resulting in changes in hydrological and sedimentation patterns which indirectly affect the food chains and the structure of aquatic biological communities (Agostinho & Gomes 1997; Boudou *et al.* 2005; Oldani *et al.* 2007; Baigun *et al.* 2011; Van Damme 2011c; Forsberg *et al.* 2017; Latrubesse *et al.* 2017). Collectively, these effects may put too much pressure on already fragile giant otter populations and could easily lead to local, or even regional, extinctions.

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Hydroelectric dam construction

In Bolivia, to date, there are only a few hydroelectric dams built in some sub-Andean tributaries (Van Damme 2011c). Dams represent one of the most serious disruptions to river connectivity, creating changes in riparian communities, the river channel, and other bodies of water into which the river flows (Silk *et al.* 2004; Forsberg *et al.* 2017; Anderson *et al.* 2017). Impacts on lateral river connectivity would have more direct effects on riparian mammals, as they are strongly associated with riparian forests and floodplains. Although the actual impact of dams on giant otter populations at the regional level is unknown, at the local level one would expect associated impacts to be generated, including: the blocking of natural fish migration routes; changes in sediment transport levels and turbidity that affect otter hunting success; changes in nutrient transport affecting primary (and hence secondary) productivity in floodplains; changes in the morphology of streams and small tributaries that affect the life cycle and activities of the species; modification of water quality and flow patterns; loss of riparian forests; increased human activities around dams; and interruption of the natural connectivity of rivers. Although some cases in Brazil show that giant otters appear to adapt relatively well to the presence of dams (de Mattos *et al.* 2002), these adaptations should be considered only at the local level, and studies are required to document impacts at larger scales of population structure, as well as the connection between populations.

Hunting

The intentional hunting of giant otters is not a common activity in Bolivia since there is no direct demand for their skin. However, there are reports that occasionally inexperienced and/or experienced local hunters use giant otters as target practice, or kill them because of the fear they generate from being such large animals with prominent teeth. If these perceptions are not tempered by environmental education programs and public policies and enforcement strategies, they could pose a growing threat, especially to groups dispersing to enter new areas.


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PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

Although all the current and anticipated threats to the giant otter in Bolivia may restrict the recovery and recolonization of the species in Bolivia, it is important to highlight that the conservation status of the species in Bolivia is relatively stable. Giant otters were registered in almost 70% of habitat identified as potentially suitable for the species and population trends in some areas, such as the Iténez basin and northwestern Bolivia (Ayala *et al.* 2015), are positive.

Bolivia still has a large amount of quality habitat, and human population density in much of the Amazon is still very low, which has allowed giant otter populations to begin to recover in most of their range. The quantity of inaccessible habitat for hunters in the past has allowed relict groups to afford the processes of recovery of the species in Bolivia. If conflicts with fishermen do not increase and habitats continue to provide the necessary conditions for the species, the re-colonization process could continue to new areas where it has not yet been registered, such as the rivers and floodplain lakes of the Ichilo-Mamoré river basin, the headwaters of the Blanco River in the Iténez River basin, the main channel and oxbow lakes of the Madre de Dios River and the Orthon and Tahuamanu rivers of the Beni river basin. Likewise, current giant otter populations in Bolivia are located in relatively inaccessible areas, which could afford the re-colonization of the adjacent areas and the use of several rivers as corridors, for example, the populations in the Pantanal, the upper, middle, and lower Iténez River basin, and the Madidi and Heath rivers where giant otter populations have increased in recent years (Identidad Madidi & SERNAP 2020). A recent living proof of this recolonization capacity, occurred in 2021 when a giant otter was spotted for the first time since the 1980's in Argentina's Impenetrable National Park (Mongabay 2021).

However, there are a number of factors that may play against giant otters and inhibit its recovery in areas where it is already found, and/or prevent re-colonization to new areas that were part of its historical distribution, including: conflicts with fishermen and the innate characteristics of the species that make it easy to eliminate entire groups; high fragmentation levels of populations and isolation among them in certain areas; very low population densities of giant otters in the northern Amazon; and their high sensitivity to human presence.

KNOWLEDGE ABOUT THE SPECIES

Until 2002, Bolivia was considered as one of the countries with the least information available on giant otters, and data until then were collected using non-standardized methods (Van Damme *et al.* 2002). Several authors then developed standardized methodologies for the collection of real and comparable data on giant otter populations in South America (Groenendijk *et al.* 2005; Van Damme & Wallace 2005). As a result of these initiatives some giant otter conservation programs were born, and more interest was generated within the scientific community, which initiated a series of research activities in Bolivia.

From 2001 to the present, organizations such as Faunagua, WWF, WCS, and ACEAA have been collecting data on the distribution and population abundance, overcoming financial, logistical and time limitations, and applying and adjusting standardized methods developed by the IUCN Otter Specialist Group (Groenendijk *et al.* 2005; Van Damme *et al.* 2005). In addition, studies have been conducted on diet (Becerra 2006) and estimation of consumed prey size (Mallea 2008), conflicts with fishermen (Zambrana *unpubl. data*), habitat aptitude models (Zambrana & Crespo 2008) and population genetics (Pickles *et al.* 2009, 2011). This information has allowed us to understand the current patterns of distribution and population status of the species in almost 80% of its current range, and has yielded very interesting data regarding the genetics of the Bolivian populations, where it has been possible to confirm that 3 of the 4 phylo-groups of the species in South America are found in Bolivia (Pickles *et al.* 2011).

LEGAL STATUS

At present, despite the fact that giant otter populations are slowly recovering, populations remain isolated in their range, and habitat destruction along with conflicts with fishermen continue to threaten their recovery. Thus, since the first evaluation of their population status in 1996, the giant otter is considered Endangered in Bolivia (Zambrana *et al.* 2010).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Until 2004, conservation initiatives for giant otters were focused on the collection of basic data on the distribution and status of populations at a national scale, allowing us to assess the recovery of the species in Bolivia. This information (González Jiménez 1997; Van Damme *et al.* 2002) showed that many giant otter populations are not found within protected areas. This situation has led to the identification of areas of importance for their conservation through the design of habitat suitability models for the species (Zambrana & Crespo 2008), and the preliminary design of conservation strategies in the following protected areas: PNANMI Madidi, PNANMI Isiboro Sécure, RNVSA Manuripi, PNANMI Otuquis, PNANMI San Matías, PN Noel Kempff Mercado and PDANMI Iténez. Indigenous territories may also be important areas for the conservation of giant otters in Bolivia and across the Amazon. For example, giant otters have been registered in all three Tacana indigenous territories in northwestern Bolivia, and specific indigenous regulations exist to afford their protection (CIPTA 2008).

The most recent initiative aims to designate the giant otter as an emblematic species for the conservation of Bolivia's aquatic systems, which allows us to focus attention on the species and has strengthened communication strategies and environmental education campaigns. However, since 2011, studies on giant otter in Bolivia have decreased, highlighting the need for an update of the current situation that will allow more precise information to better direct future efforts to conserve the species in Bolivia.

RECOMMENDATIONS FOR FUTURE EFFORT

Although a large part of giant otter distribution in Bolivia has been sampled, it is now important to emphasize surveys in areas that function as corridors for the main populations, as well as areas of difficult access where there are unconfirmed reports from local inhabitants, as is the case for the Isiboro Sécure Indigenous Territory, as well as more remote tributaries of the Beni, Madre de Dios, Iténez and Madera river basins, and the Bolivian Pantanal.

It is also necessary to generate data on ecology, habitat use, social structure, migration, methylmercury bioaccumulation, diet, and population genetics, in conjunction with environmental education campaigns that support research processes and promote public awareness programs.

Considering the transboundary movements of giant otters and their occurrence in border areas, there is an urgent need to create habitat conservation corridors with neighboring countries where important giant otter populations reside, especially the upper Madre de Dios basin in Perú and the Iténez (or Guaporé) basin in Brazil.

The main threat to the species of conflicts with humans over fish resources can only be appeased if correct strategies for the use and conservation of the species are generated through activities such as ecotourism, which should be monitored and evaluated with great care and should also consider the participation of local people at all levels in the development of these activities. It is also urgent to elaborate a specific National Action Plan for the Conservation of the Giant Otter in Bolivia.

ACKNOWLEDGEMENTS

We thank all the organizations that for many years supported the surveys and conservation of the giant otter in Bolivia. Special thanks to WWF Bolivia for supporting the Londra Watch Program since 2004, and to WCS that leads efforts in northwestern Bolivia, as well as ACEAA for the current conservation initiatives in northern Bolivia. We thank the local authorities, park rangers from Manuripi National Amazon Wildlife Reserve, and guides of the Iténez Departmental Park and Madidi National Park and Natural Area of Integrated Management.

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CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN BRAZIL

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LOCAL NAMES

Ariranha, lontra gigante, lontra grande, onça d'água.

HISTORICAL AND CURRENT DISTRIBUTION

Giant otters are endemic to South America. Based on confirmed locations, the historical occurrence of the species in Brazil is presumed to have spanned the Amazon, Cerrado (central Brazilian savanna), Pantanal and Atlantic Forest biomes (Cheida *et al.* 2006), from southern Brazil to the extreme north (Foster-Turley *et al.* 1990; Carter & Rosas 1997; Rosas *et al.* 2008a; Colodetti 2014), excluding the semi-arid region of Caatinga (Tomas *et al.* 2000, 2015), below an elevation of 500m.a.s.l (Figure 1). Currently, there are no recent reports of giant otters in Minas Gerais, Rio de Janeiro, Santa Catarina and Rio Grande do Sul states (IBAMA 2001; Cherem *et al.* 2004; Rosas *et al.* 2008a), and only isolated records in northern Paraná (Braga *et al.* 1999; Rocha-Mendes *et al.* 2005). Giant otters can be considered extinct in the Atlantic Forest (Rodrigues *et al.* 2013; Silvestre 2016, Garbino *et al.*, 2022). Current giant otter distribution in Brazil is discontinuous, with stable populations restricted to the Amazon and Pantanal (Carter & Rosas 1997; Rosas *et al.* 2007a, 2008a; Tomas *et al.* 2015), and there is a population that persists in the Cerrado Ecorregion (Georgiadis *et al.* 2015; Leles *et al.*, 2022; Almeida, 2023) (Figure 1).

There are historical reports of giant otter presence for the São Lourenço (Rio Grande do Sul, Brazil) and São Francisco (Minas Gerais and northeastern Brazil) river basins (see Garbino *et al.* 2022) and Espírito Santo (Sooretama Biological Reserve – last reliable record dated 1964) (Travassos *et al.* 1964) (Figure 1). More or less in the last two decades some occurrences at the border of the distribution range of the species were reported in the Mearim-Grajaú interfluvium, in Maranhão (Silva Júnior 2001), and between Paraná and Mato Grosso do Sul states (Braga *et al.* 1999; Rocha-Mendes *et al.* 2005). Surveys along rivers inside the Ivinhema State Park and National Park of Ilha Grande in the border of the Paraná and Mato Grosso do Sul states did not find any vestige of the species (Silvestre 2016). Nevertheless, further efforts are needed to confirm the species occurrence for those areas.

According to Garbino and colleagues (2022), in the Brazilian Atlantic Forest the species formerly occupied an area of 909,257 km^2 and the forested rivers along the upper Paraná basin, in northern Argentina and southern Brazil were the last refugia of the species in this Biome (Garbino *et al.* 2022), where it is considered critically endangered (Rodrigues *et al.* 2018).

Based on confirmed giant otter localities, the group of giant otter experts participa-

ting in the Giant Otter Range-Wide Priority Setting Exercise confirmed the historical and current distribution of giant otters (Figure 2) and highlighted areas where the occurrence of the species was not confirmed (Figure 3). Currently, giant otters are widely distributed across the Amazon and have been recorded across diverse basins and rivers, including: (1) Solimões basin, in Japurá river/Amanã Lake (Lima 2009; Lasmar *et al.* 2013), and rivers Juami (Castelblanco-Martinez *et al.* 2006; Coelho *et al.* 2016), Javari (Carter & Rosas 1997; Melo *et al.* 2019), Juruá (Rosas-Ribeiro 2009; Lasmar *et al.* 2013), Jutaí, Purus (Rosas *et al.* 2003), Solimões, and Tefé (M. Marmontel *pers. obsv*.; Beltrán-Pedreros *et al.* 2008; Lasmar *et al.* 2013); (2) Urucu basin (Menegaldo *et al.* 2008; Santos & Mendes-Oliveira 2012); (3) Negro basin, in the Branco and Iruá (Ossa-Restrepo 2009; Rojas 2009; Pacca *et al.* 2016), Catrimani (Carter & Rosas 1997), Içana (Pimenta *et al*. 2018a), Jaú and Carabinani (Silva 2010), Jauaperi (Evangelista 2006), Parima (Carter & Rosas 1997), Pauini (Carter & Rosas 1997), Uraricoera (Colares 1990; Berardi 2015), and Unini rivers (Carter & Rosas 1997; Marmontel *pers. obsv.*), and tributaries of the Demeni river (Endo 2007); (4) Madeira basin, in the Alegre, Aripuanã (Ayres & Best 1979; Endo & Marinelli 2008), Canumã (Ayres & Best 1979), upper Guaporé (Avelar & Damasceno 2008), Jamari (Carter & Rosas 1997), Machado or Ji-Paraná (Damasceno 2007), Madeira (Castelblanco-Martinez *et al.* 2005), Mamoré (Avelar & Damasceno 2008), and Roosevelt rivers (Carter & Rosas 1997); (5) Tapajós basin, in the Bararati (M. Marmontel *pers. obsv*.), Juruena (Ayres & Best 1979; Dalponte 2009), Sangue (Ayres & Best 1979), Tapajós (Rosas *et al.* 2008a) and Teles-Pires rivers (Norris & Michalski 2009; Calaça *et al.* 2015; Calaça & de Melo 2017); (6) Uatumã basin, in Uatumã river/Balbina lake (Rosas *et al.* 2007a), Jatapu (Carter & Rosas 1997), and Capucapu rivers (Rosas *et al.* 2008a); (7) Curuá-Una basin (Carter & Rosas 1997); (8) Trombetas basin (Carter & Rosas 1997), in the Sapucuá lake tributaries (Loch *et al.* 2010); (9) Xingu basin, in the Bacaja and Xingu rivers (da Silva 2009); (10) Amazon estuary, in the Matapi and Jari rivers (Lima *et al. in prep.*); (11) the Atlantic coast under the influence of the Amazon estuary, in tributaries of the Amapari, Araguari, Cassiporé, Oiapoque, Tartarugal and Uaçá rivers (Silva *et al.* 2012; Oliveira *et al.* 2015; Lima *et al. in prep.*); and (12) on the Marajó island, in Benevides and Portel districts on the Camaraipe River (Siciliano *et al.* 2008).

Giant otters were also registered in the ecotone between the Amazon Forest and Brazilian Cerrado (Araguaia-Tocantins hydrogeographic region) in the Araguaia, do Côco, Javaés, Javaezinho, and Tocantins rivers (Silveira & Almeida 2007; Georgiadis *et al.* 2015; Almeida 2023), as well as in the Mato Grosso State, in the north extension of the Sepotuba River and in the Guaporé and Corgão rivers (C. Leuchtenberger *pers. obs.*). Oliveira *et al.* (2007) reported the presence of the species in the Gurupi Biological Reserve in Maranhão state. Recently, Vieira and Oliveira (2020) confirmed the presence of the species in this Reserve. They also recorded the species in two other localities outside the Reserve. Along with the previous record by Prist *et al.* (2017) in the Sonhos River, a tributary of the Pindaré River, these findings enhance the understanding of the species's occurence in this border distribution range.

In the Pantanal biome within the hydrogeographic region of Paraguay River, the species seems to be widely distributed (Tomas *et al.* 2015), and was reported in se-

veral rivers and their tributaries, including the Abobral (Vargas & Marmontel 2007), Aquidauana (Tomas *et al.* 2000, 2015), Cuiabá (Camilo-Alves & Desbiez 2005; Tomas *et al.* 2015), Itiquira (Carter & Rosas 1997), Miranda (Tomas *et al.* 2000; Ribas 2004; Leuchtenberger & Mourão 2008; Tomas *et al.* 2015), Negro (Waldemarin & Barroeta 2004; Tomas *et al.* 2015), Piquiri/Correntes (Waldemarin *et al.* 2006; Carter & Rosas 1997; Tomas *et al.* 2015), Pixaim (Munn 2005), São Lourenço (Vendramin *et al.* 2007; Tomas *et al.* 2015), Salobra (Vargas & Marmontel 2007), Taquari (Zucco & Tomas 2004; Tomas *et al.* 2015), Touro Morto (C. Leuchtenberger *pers. obs.*), Prata (C. Leuchtenberger *pers. obs.*) and Vermelho rivers (Ribas 2004; Leuchtenberger 2008; Leuchtenberger & Mourão 2008; Tomas *et al.* 2015). There is also report in the Riozinho creek, in the northern Pantanal (Ribas 2004). Ribas *et al.* (2012) documented giant otters living in natural and artificial water bodies along the Estrada Parque Pantanal Road, a dirt road in southern Pantanal, and Porfirio *et al.* (2014) registered this species in the aquatic systems of the Serra do Amolar (Amolar Mountain Ridge).

Currently the species is considered extinct in the São Francisco, Paraná, and Uruguai river basins (Figure 4) and stronghold populations appear to be fragmented, highlighting priority areas (Figure 5) for the conservation of the species in Brazil. All these sites are under high risk of human pressure. The priority areas in the south, including the Pantanal, the Cerrado, and the southern border of the Amazon basin, are located in areas with high and accelerated human pressure, threatened by deforestation and habitat loss due to various land use purposes such as agricultural cultivation, mining, hydropower plans, and livestock farming (Alho *et al.* 2019; Garrett *et al.* 2021; Colman *et al.* 2024). The Pantanal population seems to present the lowest genetic diversity and the most fragile of the known phylogroups (Pickles *et al.* 2012). This population is probably connected with the Bolivian Pantanal population. The connectivity between the populations of the Pantanal and the Amazon, already naturally weakened by basin drainage, is potentially reduced due to the intense environmental degradation and habitat loss suffered by this transitional region between biomes. The genetic structure of the Cerrado population is unknown, but it may be an important route of dispersion among the Amazon and Pantanal populations. All conservation efforts should consider the protection of these stronghold populations and their connectivity.

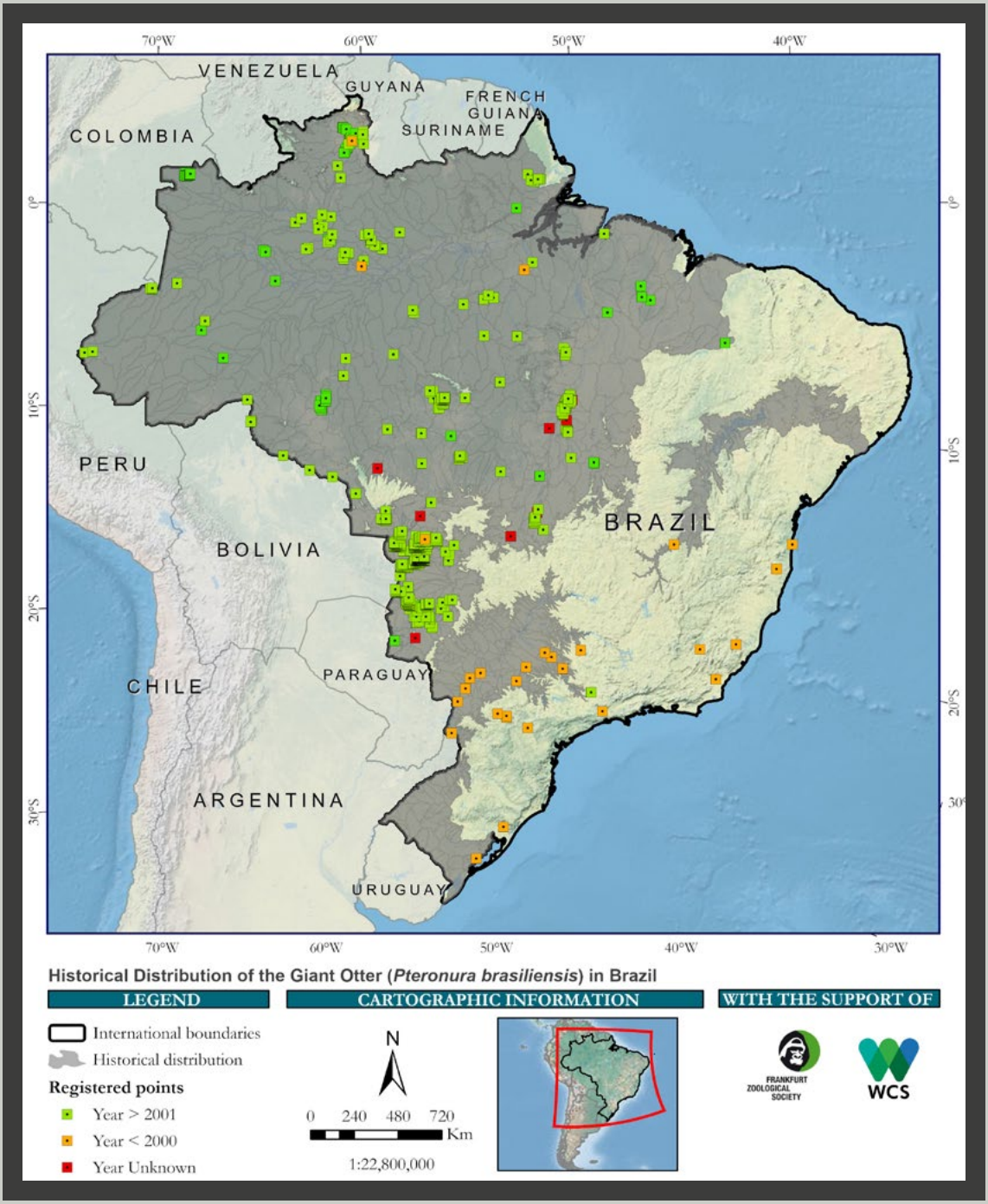

Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Brazil.

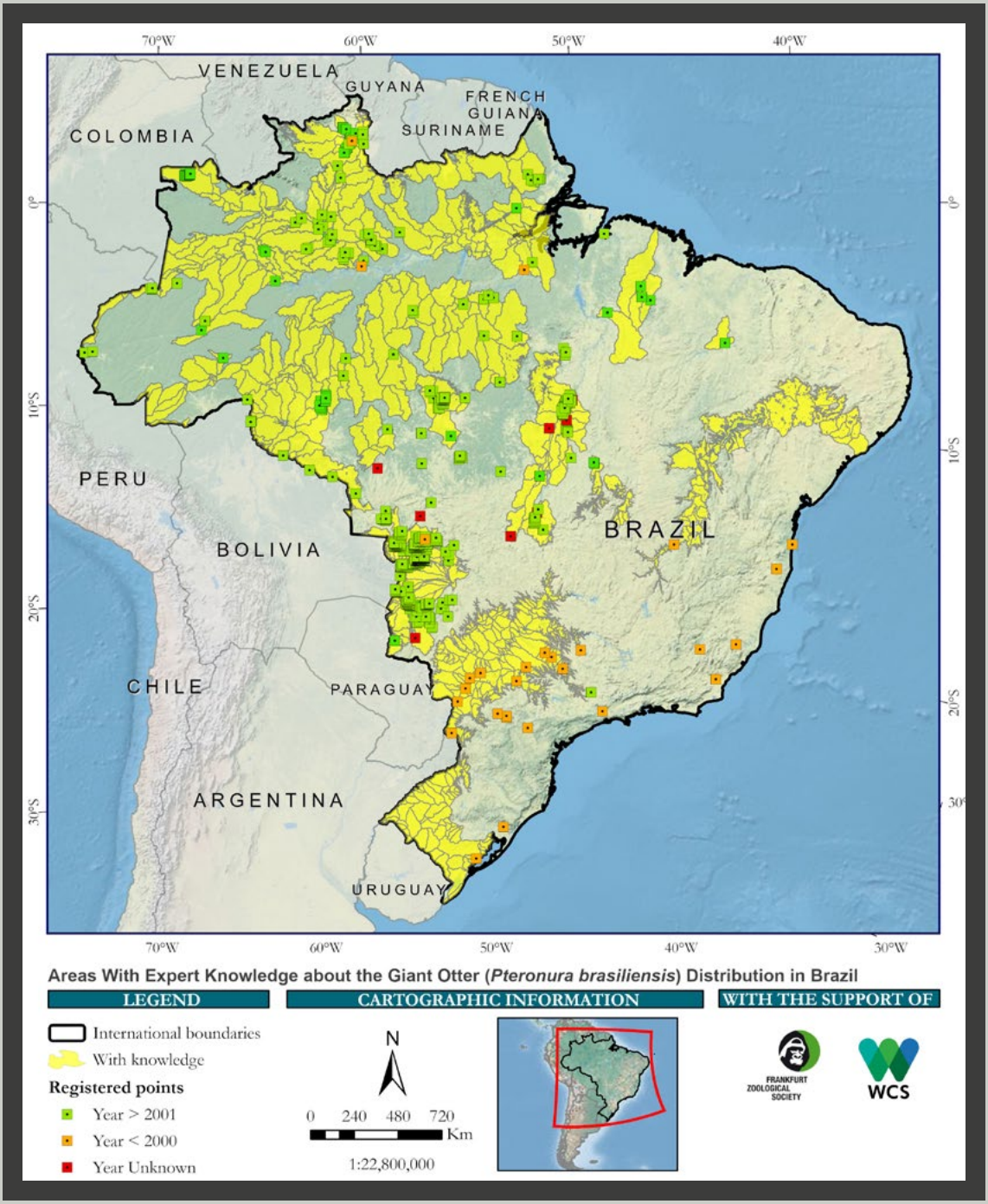

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Brazil.

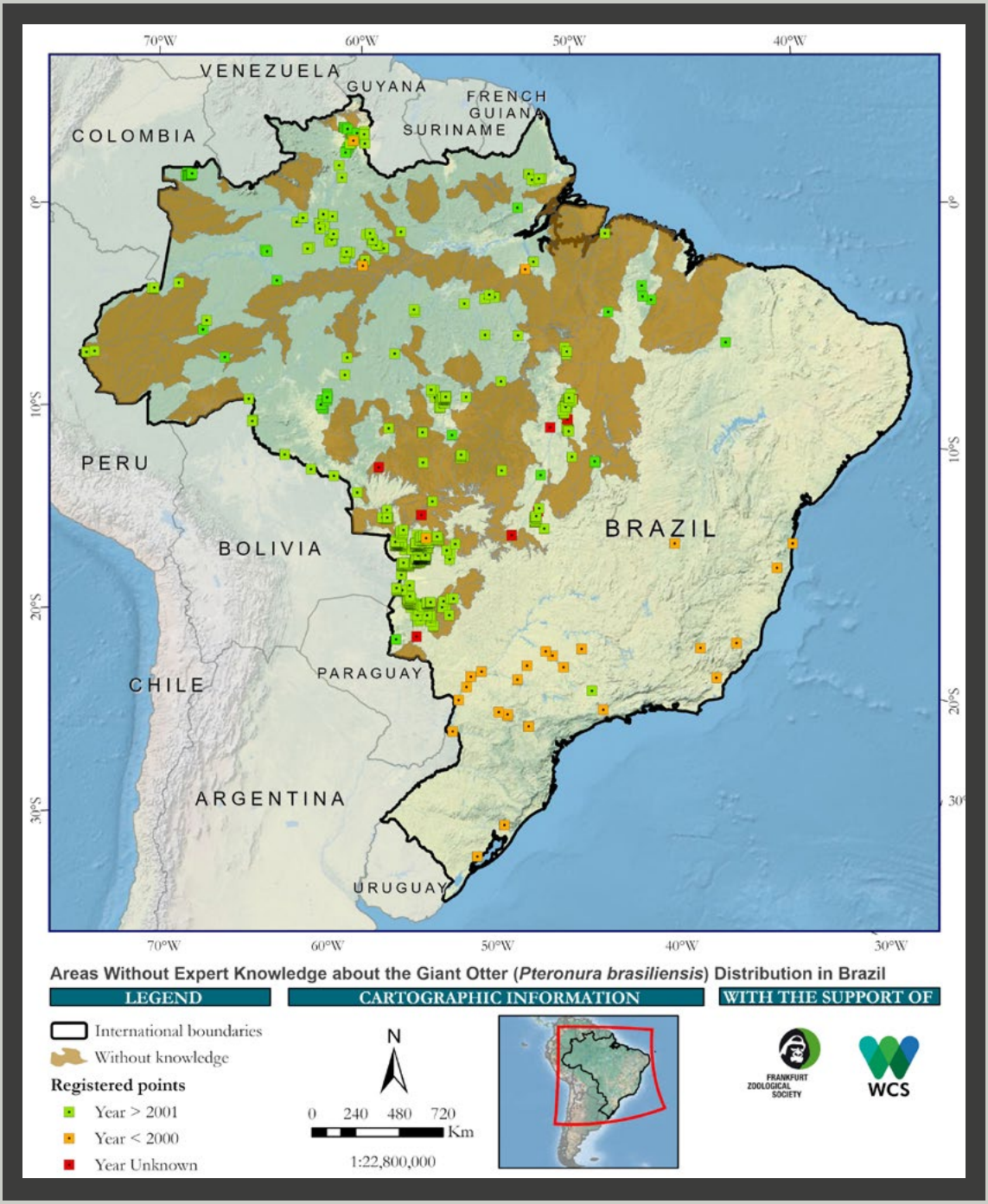

Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Brazil.

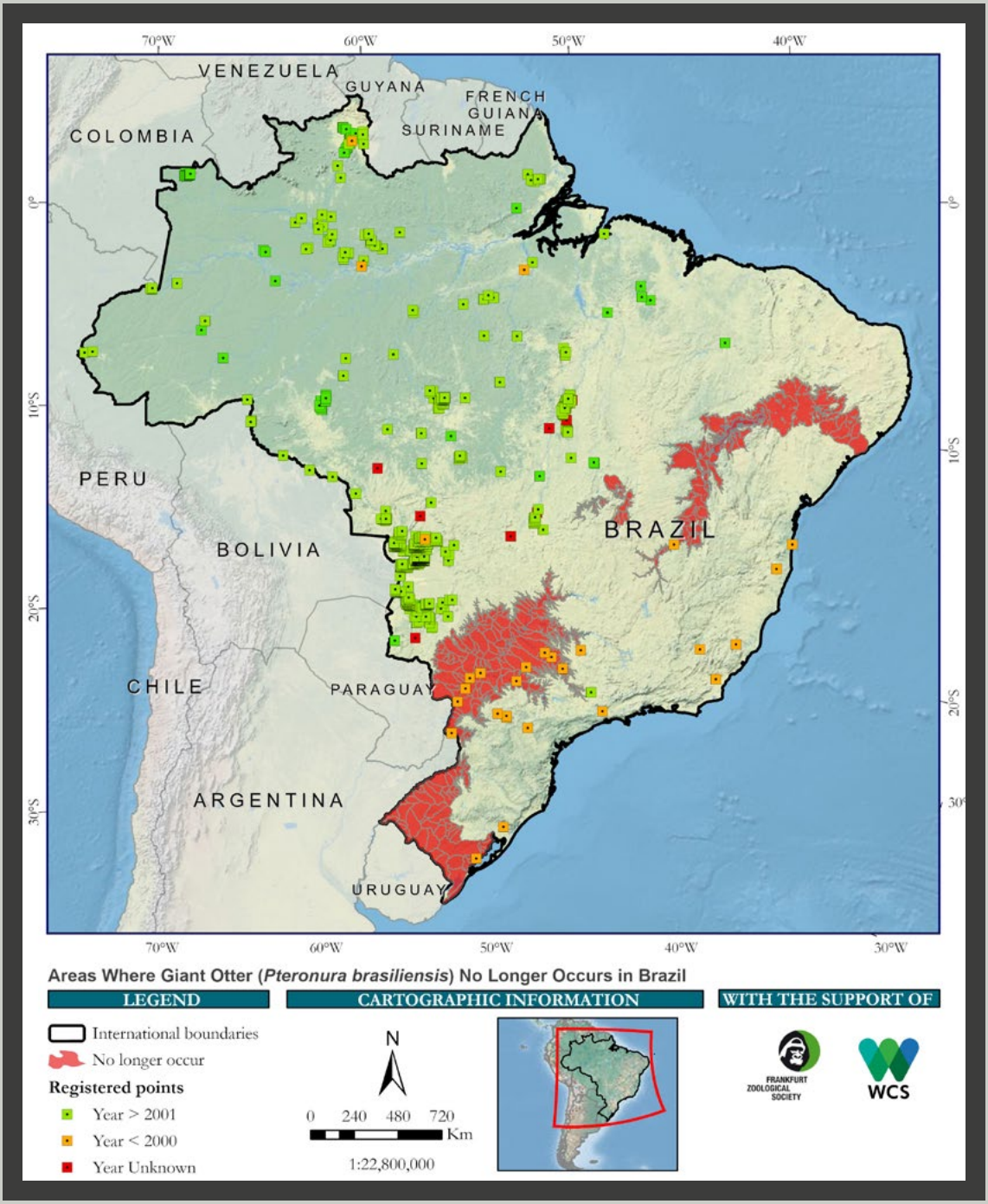

Figure 4. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Brazil.

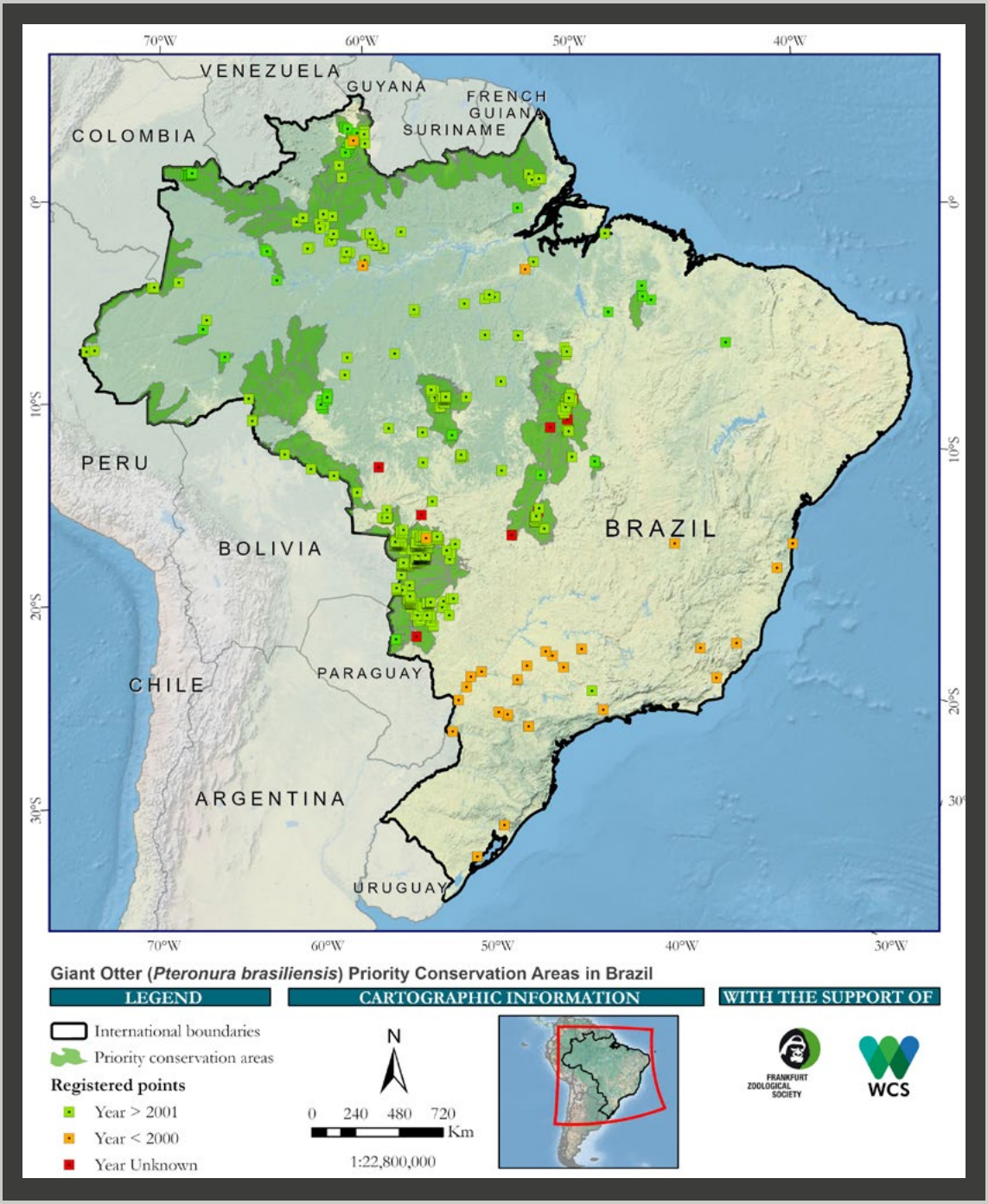

Figure 5. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Brazil.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

There is insufficient information to allow us to estimate a giant otter population size in Brazil. Surveys throughout the range lack a uniform methodological approach, and many estimates lack a temporal series. Recent population estimates are limited to some sites in the Pantanal and Amazon, where there are indications of populations in the recovery phase (Rosas *et al.* 2008a; Lima *et al.* 2013; Tomas *et al.* 2015). The total population suffered a drastic reduction between 1935 and 1980, mainly due to illegal hunting for the fur trade (Carter & Rosas 1997; Rosas 2004; Antunes *et al.* 2016; Pimenta *et al.* 2018; Schweizer 1992). In the 1980s, the giant otter population in its entire range was estimated to be between 1,000 and 3,000 individuals (Brecht-Munn & Munn 1988). However, Carter & Rosas (1997) suggested that this number was underestimated when compared to the estimate proposed by Schweizer (1992), of approximately 500 individuals for southern Pantanal in the same period. Surveys carried out in the Pantanal detected the species in different habitats and indicate that the population may reach around 4,000 individuals in this biome (Tomas *et al.* 2015). The species is believed to have expanded and reached densities close to carrying capacity in some water bodies in the southern Pantanal (Leuchtenberger & Mourão 2008; Ribas *et al.* 2012).

The Pantanal is an important area to conserve the giant otter and its habitat (Tomas *et al.* 2015). Although the species' population in this biome seems to be in a good condition (Tomas *et al.* 2015), it presents the lowest genetic diversity known for giant otters (Pickles *et al.* 2011). In addition, in 2019 and 2020 the Pantanal suffered from some of the biggest fires in recent years (Marengo *et al.* 2021). Four million hectares of forest and savanna habitat burned in 2020, and even though it was the worst in 60 years of regular annual burning in the region, warming trends and increasing anthropogenic activity suggest it may become more common (Libonati *et al.* 2020; Rodríguez Mega 2020). Coupled with the CoVid-19 pandemic, the impacts on habitat and wildlife have been overwhelming, but have yet to be assessed. Giant otter dens were burned and many animals may have died, from the fire, heat, or smoke inhalation. Destruction of vegetation and erosion of soils will further affect the riparian fringe where giant otters live, and those that survived may have a reduced prey base, as ash and charcoal resulting from the fires contaminate and poison the waters.

In the Brazilian Pantanal reported linear densities vary between 0.3 and 1 individual per km of river (Tomas *et al.* 2015). The first study about the species in the Pantanal was carried out along the Negro River by the naturalist Jorge Schweizer (1992) during the 1980s, when giant otters were rare in other areas such as the Paraguay and Vermelho rivers. At that time Schweizer reported one animal for every 1.5 km along the Negro River, despite hunting pressure. Forty years later, Leuchtenberger (2022) found a similar density of giant otters along the Negro River, reinforcing the idea that this population is an important stronghold for the species in this Biome. However,

Waldemarin & Barroeta (2004) found no established territory for giant otters in the area, and affirmed that the number of groups is highly variable between years, making population estimates impracticable. Between 2002 and 2007, 37 giant otter individuals were identified on the Rio Negro ranch, and between 2004 and 2005 nine individuals in the region of the Correntoso river (Waldemarin *et al.* 2006). On a cold July morning, Muanis (2008) reported 2 individuals/km along 20 km of the Correntoso River. Lower temperature days are ideal for population surveys, because animals are visible for longer periods while sunbathing on the riverside (Muanis 2008).

A stretch of 258 km of the Aquidauana and 82 km of the Miranda rivers revealed 30 giant otter groups (90 individuals), with an average group size of 3 ± 0.26 individuals (range 1 - 6), and an average of one group every 10.8 km of sampled river (Tomas *et al.* 2000). This is considerably higher than that reported for the same stretch of the Aquidauana River at the end of the 1960s (Schweizer 1992), suggesting a substantial population increase. Leuchtenberger (2008) monitored a stretch of 75.8 km of Miranda and Vermelho rivers in 2006-2007, finding 43 individuals in seven groups, with an average of six individuals per group (range 2 - 13).

Tomas *et al.* (2015) presented an update on the occurrence and estimates of the size of the population of giant otters in the Pantanal analyzing data from five river stretches (Tomas *et al.* 2000; Ribas 2004; Leuchtenberger *et al.* 2015), from July 2000 to November 2011. Their results revealed an average group size of 4.8 ± 0.57, and 13.3 ± 3.50 kilometers per group; the number of giant otters per kilometer (n = 0.54 ± 0.15) was considered intermediate if compared to the estimates reported in Suriname (2 individuals/km; Duplaix 1980), in Guyana (0.2 individual/km; Laidler 1984), and the Xixuaú Reserve, Brazil (1 individual/km; Evangelista & Rosas 2011a).

Similarly, efforts to estimate giant otter populations in the Brazilian Amazon are site-limited and may not reveal the real population size for this biome. In Balbina Lake (approximately 450 km^2), a total of 130 individuals were documented between 2001-2005, divided in 29 groups, averaging 4.14 animals per group (range 5 - 12) (Rosas *et al.* 2007). During a distribution survey around the Amanã Lake (Amanã Sustainable Development Reserve/Amazonas), giant otters were found in four of the 13 streams visited (Carvalho-Junior *et al.* 2004). Lima (2009) then monitored the area on a monthly basis, with seven groups (43 individuals) registered along five upstream tributaries of the lake by mid-2006, increasing to at least 75 individuals in 12 groups along eight tributaries by the end of 2008 (Lima *et al.* 2013). In the northern Brazilian Amazon, Oliveira *et al.* (2015) registered 0.6 giant otter direct detections per 100 km of waterway surveyed around sustainable use reserves in Amapá state.

Several population surveys have been conducted in Cantão State Park, located in the transition region between the Amazon and the Cerrado Ecoregion (Jácomo *et al.*, 2006; Cabral *et al.*, 2010a; Leles *et al.*, 2022; Almeida, 2023). Between August and September 2006, a giant otter census along the Araguaia, do Côco, Javaés, and Javaezinho rivers covered a total distance of 610.2 km and recorded 31 individuals (Jácomo *et al.*, 2006). Cabral *et al.* (2010a) documented 54 individuals in the Araguaia River above Bananal Island. Between 2010 and 2020, 168 giant otters were identified along 1,500 hectares of igapó flooded forest with oxbow lakes. The total number of adult-sized otters recorded in the studied area each year varied from 16 to 32 (mean = 23; SD = 6), distributed among 4 - 8 groups (Leles *et al.* 2022). Almeida (2023) surveyed an area of 285.39 km of rivers and 40 lakes, covering an extension of 15 km^2, in the Cantão State Park between 2019 and 2021. The author reported a total of 177 giant otters, with 171 distributed among 32 groups, and 33 cubs were born during the study period. Surveys conducted in the Araguaia Basin estimated a population size of over 200 individuals; however, the range of this survey was not reported (Duplaix & Savage, 2018).

HABITAT USE

Giant otters inhabit freshwater bodies, such as rivers, tributary streams, lakes and flooded areas adjacent to riparian forests (Duplaix 1980). In the Amazon region, the species apparently prefers clear- and black-water rivers, due to better transparency for visualization and capture of fish (Rosas *et al.* 1999), which is the main component of its diet. Giant otters

select their sites and refuges according to the physical characteristics of the environment, preferentially building their dens, campsites and resting sites at two meters from the water, on slopes below 45°, and avoiding using water bodies below 1-m depth (Lima *et al.* 2012).

Surprisingly, giant otters can colonize reservoirs of hydroelectric dams in the Amazon, as is the case for the Balbina dam (Rosas *et al.* 2007a). These authors emphasize that the use of reservoirs by giant otters is apparently related to their previous occurrence in the area, and also because of the absence of or reduced human presence, following the establishment of the artificial lakes. Stable giant otter populations may use the reservoirs year-round, including for breeding (Rosas *et al.* 2007). However, there is no consensus on the effects of habitat changes generated by the construction of hydroelectric dams on giant otter populations. While some studies argue that giant otters can inhabit hydroelectric dams (Rosas *et al.* 2007a; Calaça & de Melo 2017), others demonstrated that there is a mismatch between the proportional increase in giant otter population size and the newly available reservoir habitat area, suggesting that this is likely due to the low habitat quality and low fish prey productivity provided by this environment (Palmeirim *et al.* 2014; Michalski & Norris 2021; Raffo *et al.* 2022). Indeed, more studies evaluating populations pre- and post-dam filling are necessary to evaluate the effect of hydroelectric dams on giant otter populations.

The Cantão region is a complex ecotone, formed by the confluence of two large biomes, the Amazon forest and the Brazilian Cerrado. The abundance of lakes, combined with seasonal flooding, resembles the Pantanal biome, but creates a mosaic of unique ecosystems very particular to this region: inland waters (lakes and rivers), river islands, seasonal floodplains, and upland forests. Giant otters preferentially build dens on the edges of semi-deciduous forests located on higher grounds that hardly flood (Jácomo *et al.* 2006).

In the Brazilian Pantanal, vegetation is composed of extensive open areas of savanna, seasonally flooded natural grasslands, and gallery forests, and here giant otters are found in diverse aquatic habitats including rivers, seasonal, and perennial lakes or channels (Mourão & Carvalho 2001; Damasceno 2004; Ribas 2004; Muanis 2008). During the dry season (June-October) on the Negro River in the Pantanal, giant otters preferentially inhabit the rivers and channels (Waldemarin & Barroeta 2004). This is probably directly related to the abundance of river bluffs exposed during the dry season, allowing for groups to concentrate along the rivers. During the wet season (November-May), rivers and channels overflow into a large extension of adjacent gallery forests, and giant otters increase their home ranges into the flooded plain along the rivers (Leuchtenberger *et al.* 2013). The confluence of shallow streams and deeper rivers are important foraging areas for giant otters (Muanis 2008), because they concentrate fish such as trahira *Hoplias malabaricus* and piranha *Serrasalmus* spp., which are the giant otters' main prey in the Pantanal (Leuchtenberger *et al.* 2020).


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THREATS

Giant otters were overhunted for the fur trade, and this was the major anthropogenic activity that impacted populations during the 20th century (Carter & Rosas 1997; Campos-Silva *et al.* 2017; Antunes *et al.* 2016; Pimenta *et al.* 2018b; Garbino *et al.* 2022). The giant otter was among the most hunted mammal species in the Amazonas State, which registered an export of 7,510 furs between 1950 and 1965 (Carvalho 1967). Official national export statistics indicate that 40,663 giant otter furs were traded between 1960 and 1967 (Ayres & Best 1979; Best 1984), and for a period of just five years (1960 - 1964) 11,530 were exported from the Amazon region. Those furs originated from the states of Rondônia (149), Roraima (432), Amapá (1,718), Acre (1,729), Amazonas (1,874), Maranhão (2,084), and Pará (3,544) (Carvalho 1967). In Pantanal, 12,390 giant otter fur were exported between 1960 and 1969, approximately 24.4% of the national production for the same period (Harris *et al.* 2005). The official statistics are most likely an underestimation of the actual hunting pressure suffered by the species. Quantitative information about wildlife trade is generally imprecise, contradictory, and difficult to obtain (Smith 1980). However, Antunes *et al.* (2016) presented the first historical account of the scale and impacts of this trade in the Amazon basin and showed that whereas aquatic species suffered basin-wide population collapse, terrestrial species did not. Similarly, Pimenta *et al.* (2018b) analyzed how biological traits of aquatic and terrestrial species faced market forces, revealing different levels of resilience past the international fur trade period. Pelt trade was also the major factor for the species' disappearance by the late 1940s in the Brazilian Atlantic Forest (Garbino *et al.* 2022).

Even with hunting bans, established after the Brazilian Wildlife Protection Law of 1967, hunting remained a small-scale economic activity, particularly in remote areas, where law enforcement is largely inefficient (Carter & Rosas 1997; Rosas *et al.* 2003; Marmontel & Calvimontes 2004; Lima 2009; Rosas-Ribeiro 2009). Apparently, a trade market for giant otter fur no longer exists (Rosas *et al.* 2003), and the remaining kills are associated with resource use conflicts or the inclination of some local dwellers to display the animal's fur as house adornments.

The conflict for resource use between fishermen and giant otters is currently the major cause of deaths (Rosas *et al.* 2003; Marmontel & Calvimontes 2004; Zucco & Tomas 2004; Alves 2006; Lima 2009; Rosas-Ribeiro 2009; Vargas 2009; Cabral *et al.* 2017). The first conflict events were documented in Mato Grosso do Sul State on the Miranda and Aquidauana rivers of the Pantanal (Tomas *et al.* 2000), where both riparian dwellers and professional fishermen perceive the increasing giant otter population as a competitor for fish resources. At the limit between Corumbá and Ladário municipalities, conflicts between fishermen and giant otters are caused by alleged competition for fish resources (predation), damage caused to fishing equipment, and the disturbance caused by the presence of giant otter groups, which make fishing momentarily unfeasible (Zucco & Tomas 2004). In Miranda, professional fishermen accuse giant otters of stealing bait from fishing hooks (Vargas & Marmontel 2007; Vargas 2009).

Similarly, conflicts between fishermen and giant otters were registered in the Brazilian Amazon; for example, in the Uacari Sustainable Development Reserve, Amazonas, 21 giant otters were killed between 2006 and 2009 (Rosas-Ribeiro 2009). More recently, in 2011, riverine residents around the Amapá National Forest, in Amapá State, also reported that giant otters were killed as a result of fear, anger or retaliation during fishing activities (Michalski *et al.* 2012). Giant otters in the Amanã Sustainable Development Reserve are blamed for damaging nylon fishing nets (0.3 - 0.4 mm) used by local fishermen to capture small fishes like jaraqui (*Semaprochilodus* sp.), pacu (*Mylossoma* sp.) and matrinxã (*Brycon* sp.), with two otters killed around the Amanã Lake area between 2006 and 2009 (Lima 2009; Lima *et al.* 2014). Two other deaths were caused by accidental entanglement in stronger polyamide stake nets (210/24 and 210/36), used for capturing larger fish like tambaqui (*Colossoma macropomum*) (Lima 2009). Conflicts with fishing activities were also documented for the mid-Solimões (Lasmar *et al.* 2013) and lower Purus rivers (Rosas *et al.* 2003). There, fishermen claimed that giant otters steal stored fishes, even from inside their canoes. Inhabitants of the region also declared that giant otters remove entangled fishes from their nets and momentarily interfere with the pirarucu (*Arapaima gigas*) fishing (Rosas *et al*. 2003). Cabral *et al.* (2017) reported conflicts in two protected areas in the Uatumã River. Michalski *et al.* (2012) reported conflicts between riverine residents and giant otters around sustainable protected areas, as well as rural wage-earners' negative attitudes in relation to the same species in forested areas across Amapá State (Michalski *et al.* 2020). Accidents with giant otters were reported in 2020 in the Sepotuba River, Mato Grosso State, in an area transitioning between the Pantanal and the Amazon (tangaraemfoco.com.br/2020/07/06/biologa-fala-sobre-motivos-de-ataques-de-ariranhas-em-rio-de-tangara-e-cuidados-para-evitar-mais-acidentes.html). In Corumbá, Mato Grosso do Sul State, in the Southern Pantanal, a group of giant otters chased swimmers during a swimming championship in the Paraguay River. However, security boats successfully prevented attacks by interrupting the movement of the group towards the swimmers. Both situations reinforce the likelihood of negative responses from giant otters towards humans due to territorial defense, and may led to increasing conflicts.

The intentional capture of giant otter cubs for trade or keeping as pets is another threat to the species (Schweizer 1992; Carter & Rosas 1997). Besides removing future reproductive individuals from the wild population, captivity reduces the chances of survival if the animals are returned to their natural habitat (Vargas 2007). As a consequence of increased giant otter encounters, some local dwellers living by the Amanã Lake became interested in capturing and maintaining cubs as pets (Lima & Marmontel, 2011; Lima *et al.* 2014). This practice has also been documented in other sites in Amazonas (Cabral *et al.* 2017; Marmontel *pers. obs.*), Pará (Batalhão de Polícia Ambiental do Pará 2009; Ibama 2010), Mato Grosso (C. Leuchtenberger *pers. obsv.*) and Amapá states (Lima *et al.* i*n prep*.; F. Michalski p*ers. obsv.*).

Wildlife tourism for observing giant otters is an incipient industry in Brazil. According to Tomas *et al*. (2015), the high probability of observing the species in the Pantanal points to a considerable potential for tourism. In addition, giant otters are considered charismatic and are a potential flagship species to promote conservation (Stevens *et al.* 2011). However, tourism was identified as a potential threat to the species during the workshop "*Ações de pesquisa e conservação com relação ao estudo de ariranhas* (Pteronura brasiliensis) *no Brasil*" (Vargas 2007), and the activity should be pursued cautiously (Tomas *et al.* 2015).

There are records of poorly organized tourism in the Miranda (Mato Grosso do Sul State) region, where professional fishermen act as nature guides to earn extra income, taking tourists to visit giant otter territories (Tomas *et al.* 2015). An even more invasive approach has been practiced for over 15 years on the Pixaim River in Mato Grosso State. There, a group of giant otters is regularly fed by local guides to increase the chances for tourists to observe and photograph the animals (Munn 2005). This business has been maintained without monitoring its consequences on the behavior and dynamics of the group.

Currently the use of food to attract giant otters to the boat with tourists is a common tourism activity in the Northern Pantanal, which sometimes results in the retaliation of habituated otters (C. Leuchtenberger *pers. obs.)*. Considering that badly managed tourism is endangering the species in this biome, since 2019 the Giant Otter Project (giantotterproject.org) has been monitoring the impact of tourism on giant otters in Porto Jofre (northern Pantanal) and at the Barranco Alto Lodge (southern Pantanal). The team is also conducting workshops with tourism guides presenting best practices to attain a more sustainable experience with giant otters. The goal is to establish a long-term tourism based on giant otter observations, while assessing the impact of human activities on the species, and thereby allowing the adoption of more efficient conservation strategies.

Habitat loss and fragmentation is a major threat to giant otters. The species proved to be sensitive to forest loss in a highly fragmented region of 7,295 km^2 in the southern Amazon, where giant otters were unlikely to be present in forest patches <100 ha and had a probability of occurrence of >80% in >1,000 ha forest patches (Michalski & Peres 2005). Coupled with habitat loss, the conversion of gallery forests into annual crops disrupts watercourses (Lima 2009), and is one of the most pressing threats for the species in the Amazon, where river margins are subjected to intensive shifting cultivation (Carter & Rosas 1997). In Pantanal, a den's entrance was affected by fire, resulting in its abandonment by the resident couple (M. Marmontel, *pers. obsv.*). In Tocantins River, Maranhão State, ten giant otters were recorded leaving their den when major fires came close (S. Almeida *pers. comm.* 2020, Universidade Federal do Rio Grande do Norte).

Water body contamination by agricultural pesticides may also affect the species. The lowland Pantanal is particularly susceptible to this kind of pollution (Vargas 2009), constantly draining and concentrating the runoff chemicals from the surrounding plateaus, where extensive agriculture plays a major

role. The Pantanal has great propensity for chemical contamination due to the concentration of pesticides found upstream from flooded areas (Oliveira 2009). Similar situations may occur in other basins as well, for example, the Tapajós basin.

Apparently, mining activities along Pantanal's border are also affecting the floodplains. On the Bento Gomes and Cuiabá rivers (Mato Grosso State) and the Paraguay River (Mato Grosso do Sul State), 88.8% of the samples obtained from liver and muscular tissues of fishes showed detectable levels of mercury (Vieira & Alho 2004), with 27.5% containing mercury levels above the maximum concentration allowed for human consumption. The necropsy of two giant otters found dead on the Negro River in the Pantanal showed mercury levels below the critical limit known to cause deaths of otters (Dias Fonseca *et al.* 2005). Soresini *et al.* (2020) measured the total mercury concentration in giant otter fur samples (n = 19) from southern Brazilian Pantanal. The mercury concentrations found (7.15 ± 3.41 $\mu g \cdot g^{-1}$ dry weight) were above the upper limit found in fur samples of otter species not exposed to contamination sources (range from 1 to 5 $\mu g \cdot g^{-1}$), which indicates that mercury may be a threat for giant otters in the southern Pantanal (Soresini *et al.* 2020). For the Tapajós basin, as well as other areas in the Brazilian Amazon contaminated by mercury, Uryu *et al.* (2001) concluded that some omnivorous and piscivorous fishes already are, or soon will be contaminated, posing a threat to giant otters through the consumption of contaminated prey. However, a larger sample is required to support a conclusion about the health of the giant otter population in Brazilian Amazon and Pantanal.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

As result of former intensive hunting pressure, Brazilian giant otter populations have been in check for nearly four decades. The tendency of population growth and territorial expansion is now placing the species in a conflict path with the increasing riverine human population who are facing decreasing fish stocks. The opening and paving of roads, like the BR-163 (Cuiabá-Santarém) and the BR-319 (Manaus-Porto Velho) threaten to intensify habitat change by the increase in vehicle transit and migration rates, promoting the establishment of new settlements, further increasing the human population at the region, land speculation, pollution and deforestation (Ferrante & Fearnside 2020).

Deforestation in 2020 in the Brazilian Amazon was estimated at 11,088 km^2, the highest in 12 years (Silva Junior *et al.* 2021). The Native Vegetation Protection Law of 2012, which replaced the original Forest Code of 1934 (Federal Decree # 23793) impacted giant otter conservation in Brazil, for example, by excluding intermittent springs from areas of Permanent Protection, reducing the native vegetation buffer along streams, and loosening requirements to restore native vegetation. These measures will likely lead to reductions in vegetation corridors, and expansions in cultivation and cattle grazing areas, hence promoting soil degradation (Brancalion *et al.* 2016), and consequently affecting the riparian zones occupied by giant otters.

The Pantanal floodplain is directly impacted by the land use practices in the highlands of the Paraguay Basin. Considering that the agricultural area is expected to increase in the Upper Paraguay Basin in the coming decades, the sediments and pesticides that will reach the floodplain by 2050 may increase between 223% and 460% and between 7.4% and 11.2%, respectively, depending on the economic scenario adopted (de Oliveira Roque *et al.* 2021).

The past government's plan to promote economic growth entailed a large-scale change in environmental policy (Capelari 2020). Under that scheme, large infrastructure projects in the Amazon and in the Pantanal, such as dams, waterways and highways were promoted, law bills legalized the grabbing of public lands, and all categories of protected areas were considered for mining, monoculture plantations (and the use of pesticides banned elsewhere), cattle ranching and the use of water resources to generate electricity (Latrubesse *et al.* 2017; Ferrante & Fearnside 2019, 2020; Araújo 2020; Capelari 2020; Silva Junior *et al.* 2021, Ikeda-Castrillon, *et al.* 2021). The current government has adopted a more environmental-oriented approach.

Finally, climate change may lead to unpredictable changes in the species distribution by altering the seasonal pattern of flooding and dry periods in the Pantanal and the Amazon (Silva Junior *et al.* 2021). The increase in the number of forest fires in the Amazon in 2019 (Capelari 2020) has undoubtedly affected giant otter habitat, albeit no scientific record has been possible due to the CoVid-19 pandemic that prevented scientists from going to the

field. In the Pantanal, devastating fires and the intense drought have directly impacted the survival and reproduction rates of giant otters (Leuchtenberger *et al.* in prep.). Giant otter distribution into the future will be subject to the abovementioned factors, and in the worst-case scenario will be restricted to marginal areas close to the river headwaters, far away from the increasingly disturbed main river channels.


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KNOWLEDGE ABOUT THE SPECIES

Studies of giant otters in Brazil focused on several themes including occurence/ distribution (Carter & Rosas 1997; Braga *et al.* 1999; Tomas *et al.* 2000, 2003, 2015; Rodrigues *et al.* 2002; Rosas *et al.* 2003; Carvalho-Junior *et al.* 2004; Ribas 2004; Zucco & Tomas 2004; Castelblanco-Martinez *et al.* 2005, 2006; Alves 2006; Evangelista 2006; Jácomo *et al.* 2006; Oliveira *et al.* 2007; Semedo *et al.* 2007a; Silveira & Almeida 2007; Avelar & Damasceno 2008; Lima *et al.* 2008; Rosas *et al.* 2008a; Lima 2009; Ossa-Restrepo 2009; Rojas 2009; Vargas 2009; Rosas-Ribeiro *et al.* 2010; Ribas *et al.* 2012; Berardi 2015; Georgiadis *et al.* 2015; Oliveira *et al.* 2015; Pacca *et al.* 2016; Silvestre 2016; Prist *et al.* 2017; Pimenta *et al.* 2018a; Melo *et al.* 2019; Schweizer 1992), habitat use (de Mattos *et al.* 2002, 2004; Waldemarin 2002; Damasceno 2004; Ribas 2004; Waldemarin & Barroeta 2004; Camilo-Alves & Desbiez 2005; Castelblanco-Martinez *et al.* 2005, 2006; Jácomo *et al.* 2006; Rosas *et al.* 2006; Waldemarin *et al.* 2006; Damasceno 2007; de Mattos *et al.* 2007; Rodrigues *et al.* 2007; Rosas *et al.* 2007a, 2007b; Semedo *et al.* 2007b; Silveira & Almeida 2007; Vendramin *et al.* 2007; Dias *et al.* 2008; Muanis 2008; Leuchtenberger & Mourão 2009; Lima 2009; Ossa-Restrepo 2009; Rojas 2009; Vargas 2009; Bozzetti *et al.* 2010; Cabral *et al.* 2010a; Muanis & Oliveira 2011; Leuchtenberger *et al.* 2013; Palmeirim *et al.* 2014; Oliveira *et al.* 2015; Calaça & de Melo 2017; Pimenta *et al.* 2018a; Damasceno *et al.* 2021b: Leles *et al.* 2022; Schweizer 1992), diet (Benetton *et al.* 1990; Carter *et al.* 1999; Rosas *et al.* 1999; Zuanon *et al.* 2002; Damasceno *et al.* 2003, 2021a; Muanis & Waldemarin 2003; Chupel *et al.* 2004; Damasceno 2004; Pacheco *et al.* 2004; Waldemarin & Barroeta 2004; Damasceno 2007; Pacheco & Shiraiwa 2007; Semedo & Dias 2008; Ossa-Restrepo 2009; Cabral *et al.* 2010b; Colodetti *et al.* 2010; Silva 2010; Muanis & Oliveira 2011; Ribas *et al.* 2012; Leuchtenberger *et al.* 2020a), behavior (Salvo-Souza & Best 1982; Lacerda 2000; Mourão & Carvalho 2001; Damasceno & Shiraiwa 2003; Machado & Rosas 2003; Rosas & de Mattos 2003; Damasceno 2004; Evangelista 2004, 2006; Louzada-Silva 2004; Machado 2004; Ribas & Mourão 2004; Waldemarin & Barroeta 2004; 2006; Castilho & Menezes

2006; de Mattos *et al.* 2006; Winter 2006; Chupel & Shiraiwa 2007; Rosas *et al.* 2007; Leuchtenberger 2008; Leuchtenberger & Mourão 2008, 2009; Traad 2008; Rosas *et al.* 2009a; Lazzarini *et al.* 2011; Bezerra *et al.* 2011; Evangelista & Rosas 2011a; Leuchtenberger *et al.* 2013, 2014a, 2014b, 2015, 2016a, 2016b; Ramalheira *et al.* 2021; Schweizer 2022), conflicts and coexistence (Cook *et al.* 2022), reproduction (Louzada-Silva & Sartori 1998; Rosas *et al.* 2004; Cabral *et al.* 2005; Borges *et al.* 2006; Evangelista & Rosas 2011b), current and potential threats (Rosas *et al.* 2003; Marmontel & Calvimontes 2004; Zucco & Tomas 2004; Alves 2006; Lima 2009; Rosas-Ribeiro 2009; Vargas 2009; Fonseca & Marmontel 2011; Rosas-Ribeiro *et al.* 2011; Michalski *et al.* 2012; Lasmar *et al.* 2013; Calaça *et al.* 2015; Melo *et al.* 2019; Soresini *et al.* 2020; Garbino *et al.* 2022), field monitoring techniques (Rosas 2003; Silveira *et al.* 2011; Leuchtenberger *et al.* 2014a), latrines as a food resource for vertebrates (Leuchtenberger *et al.* 2012; Togura *et al.* 2014), management in captivity (Louzada-Silva *et al.* 1998; Reis *et al.* 1997; Juarez *et al.* 2000; Barros *et al.* 2002; Louzada-Silva 2004; Rosas *et al.* 2006; Traad 2008; Rosas *et al.* 2009b), clinical aspects (Freitas & Lent 1949; Marsicano et al. 1986; Colares & Best 1991; Carter et *al.* 1999; Farias *et al.* 1999; Cavalcanti *et al.* 2002; Rocha *et al.* 2005; Roza & Azevedo 2006; Rosas *et al.* 2008b; Amorim *et al.* 2014; Amaral & Rosas 2020; Pinto *et al.* 2023; Ribeiro *et al.* 2023), parasites (Soresini *et al.* 2023; Barros-Battesti *et al.* 2024), anatomical characteristics (Machado *et al.* 2002a, 2002b, 2002c, 2002d; Oliveira *et al.* 2011), toxicological analysis (Rosas & Lehti 1992; Dias Fonseca *et al.* 2005; Ceccatto 2010; Soresini *et al.* 2020), age estimation (Oliveira *et al.* 2007), genetics (Franco de Sá *et al.* 2007; Garcia *et al.* 2007; Ribas *et al.* 2011; Ribas *et al.* 2016; Soresini 2019; Fonseca-da-Silva 2021), fossil records (Cartelle & Hirooka 2005; Perini *et al.* 2009), potential for tourism (Tomas *et al.* 2000; Mourão & Ribas 2004; Silva & Rosas 2008; Baptistella 2020), and outreach and communication for species conservation (Louzada-Silva *et al.* 1998; Salleti 2006; Nascimento Júnior *et al.* 2007; Leuchtenberger *et al.* 2020b).

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LEGAL STATUS

In Brazil the giant otter was classified as Endangered in 1989. The International Union for Conservation of Nature classification changed to Vulnerable according to the A4c criteria (Carter & Rosas 1997; Fundação Biodiversitas 2003). Brazilian federal legislation for wildlife conservation recognized the giant otter as a species threatened with extinction (Portaria IBAMA nº 1.552, 19th December 1989; IBAMA 2001; Instrução Normativa MMA nº 003, 26th May 2003). Currently, the species is classified as Vulnerable to extinction (A3cd) in Brazil (Rodrigues *et al.* 2018).

The giant otter is included in state lists of threatened species, based on local particularities, under distinct categories: "Regionally Extinct" in Rio Grande do Sul (Marques *et al.* 2002; Estado do Rio Grande do Sul Decreto Estadual n° 51.797, 8th September 2014), Minas Gerais (Deliberação Normativa COPAM nº 147, 30th April 2010) and Espírito Santo states (Passamani & Mendes 2007), "Probably Extinct" in Rio de Janeiro State (Bergallo *et al.* 2000), "Vulnerable" in Pará (Estado do Pará Resolução n° 54, 24th October 2007), "Critically Endangered" in Paraná (Mikich & Bérnils 2004; Estado do Paraná Decreto nº 7.264, 1st June 2010) and "Endangered" in São Paulo (Estado de São Paulo Decreto nº 53.494, 2nd October 2008; Bressan *et al.* 2009; Estado de São Paulo Decreto nº 60.133, 7th February 2014).

According to an evaluation carried out by biome, the species was classified as Critically Endangered in the Atlantic Forest, as Endangered in the Pantanal, and Data Deficient in the Amazon and Cerrado (Rodrigues *et al.* 2018).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Several initiatives were taken to raise awareness and sensitize the human population living in areas which overlap with giant otter territories. In general, these efforts are carried out by researchers when visiting study areas. In 2009 a partnership between Frankfurt Zoological Society/Peru and the Mamirauá Sustainable Development Institute/Amazonas printed the first "*Zé, a ariranha*" (translated and adapted from the original version "*Pepe, el lobo de río*"). This educational tool was aimed at riverine populations living by the Amanã Lake (Amazonas), where an expansion of giant otter groups, and an increase in anthropogenic interference were registered (Lima 2009). The first edition was re-issued in 2011, and distributed as part of an educational kit to the schools participating in the congress of the Brazilian Society for the Progress of Science.

Nascimento Júnior *et al.* (2007) elaborated a didactic-pedagogical game focusing on the giant otter, for use by school teachers when lecturing about ecology and environmental awareness. The game, called "O ludo da Ariranha", includes themes like the species' territorial behavior, reproduction, parental care, as well as the anthropogenic activities that contribute to the species' extinction, guiding the players to think about giant otter conservation. Vargas and Marmontel (2007) carried out workshops to train tourism guides, with the objective of reducing impacts over giant otter populations during boat tours on Miranda river. The effort was extended to reach the visiting public, through a series of lectures about the vulnerability of the species. The "*Associação dos Amigos para a Proteção ao*

Peixe-Boi da Amazônia (AMPA)/Amazonas" (Friend's Association for the Protection of the Amazonian Manatee) works to stimulate discussions for the conservation of aquatic mammals, like the giant otter, through sensitizing workshops, humanitarian education for riverine populations, school lectures, environmental conservation campaigns and exhibits (Associação Amigos do Peixe-boi 2011).

Carvalho-Junior *et al.* (2014) installed a research base in southern Pantanal, to support the development of community-based conservation tourism, with the giant otter as the focus species. This initiative engaged both the local community and Brazilian and foreign eco-volunteers to collect biological and behavioral data, and promoted cultural appreciation, stimulating the adaptation of family lodges to tourism in communities around Aquidauana (Mato Grosso do Sul State).

The Giant Otter Project (Projeto Ariranhas – giantotterproject.org) has been conducting long-term population monitoring in the Brazilian Pantanal for over a decade. Since 2019, it has established three control areas in Brazil, two in the Pantanal (Rio Negro and Porto Jofre locality) and one in the Cerrado (Tocantins and Araguaia basins). Alongside population monitoring, the team conducts educational outreach with the local community and tourists, and provides training for tourism professionals to adhere to best practices guidelines for observing the species. At the time of this writing, the Giant Otter Project has already catalogued 412 giant otters and trained 342 tourism professionals along the three study areas. Educational material is free available at the project's website (giantotterproject.org/material/), as well as the "*Best Practices Guide to Giant Otter Observation*" (projetoariranhas.org/wp-content/uploads/2022/08/guia_boas_praticas.pdf) and on social media (instagram.com/projetoariranhas/). In 2021 the "*Giant Otter Coloring Book*" (Projeto Ariranhas 2021) and the childrens' story book "*Gaspar goes fishing*" (Leuchtenberger 2021) were published. "*Gaspar goes fishing*" is written in two languages (Portuguese and English) and brings as a central theme the feeding of giant otters and its negative consequences for the species, as well as curiosities about the species and interactive activities. The book is distributed to local schools in Brazil.

In Tocantins, the State Environmental Agency established the Giant Otter Monitoring Program (Pro Ariranha) in the Cantão State Park (Portaria 70/2022), which aims to develop long-term activities to contribute towards the conservation of the species in this protected area. The Program comprises 17 actions that include management, monitoring, employee training and scientific research activities.

In November 2022, as a result of the 2nd International Giant Otter Congress, based in Ituzaingó, Argentina, a group of experts and other stakeholders founded the International Giant Otter Alliance (IGOA). The purpose of the IGOA is to work as an international collaborative group to communicate, share information, train and act to promote and strengthen the conservation of the giant otter.

Research initiatives developed during the last twenty years focused on the recommendations of the "*Plano de Ação para os Mamíferos Aquáticos do Brasil*" (Action Plan for the Brazilian Aquatic Mammals, IBAMA 2001), Executive Summary to the National Action Plan for the Conservation of the Giant Otter (ICMBio 2011), Executive Sum-

mary to the Action Plan for the Amazonian Aquatic Mammals (ICMBio 2019) regarding the priority actions for the conservation of the giant otter in Brazil. This included monitoring the main populations and changes on their habitats, with long term studies coordinated by C. Leuchtenberger (Mato Grosso and Mato Grosso do Sul), F. Michalski (Amapá), G. Georgiadis (Tocantins), G. Mourão (Mato Grosso and Mato Grosso do Sul), M. Marmontel (Amapá and Amazonas), O. Carvalho-Junior (Mato Grosso do Sul); the accomplishment of molecular studies in order to validate the existence of subspecies (Garcia *et al.* 2007); long term studies on potential threats to the species, particularly focusing the effects of hydroelectric dams' reservoirs on populations (Rosas & de Mattos 2003; Rosas *et al.* 2007a), and the phenomenon of biomagnifications of mercury in the ecosystem (Uryu *et al.* 2001; Dias Fonseca *et al.* 2005; Cecatto 2010); the study of giant otter populations inside parks and reserves (Ribas 2004; Rosas *et al.* 2007a, 2007b; Lima 2009; Ossa-Restrepo 2009; Rojas 2009; Rosas-Ribeiro 2009; Silva 2010) seeking out to verify the efficacy of conservation measurements; as well as conducting demographical and biological studies (coordinated by C. Leuchtenberger, G. Georgiadis, G. Mourão, M. Marmontel).

From the results obtained during the workshop "*Ações de pesquisa e conservação com relação ao estudo de ariranhas* (Pteronura brasiliensis) *no Brasil*" (Vargas 2007), the following strategies were defined, from which some were already implemented: intensify efforts for distributional surveys in Amazonia, in transition areas (Silveira & Almeida 2007) and the known limits of the species distribution (Lima *et al.* 2008); increase the sample size and the evaluation of the perceptions of fishermen about the species to attain a better diagnostic of the conflicts (Rosas-Ribeiro 2009); studies evaluating the fish availability and seasonality of fish consumption by giant otters (Silva 2009); the use of radio-telemetry as a research tool in ecological studies (Silveira *et al.* 2011); identify the sites where giant otters are used as a tourist attraction, and create standardized methods to evaluate the impact of this activity, and norms to inhibit damages on natural populations; environmental education of fishermen and riverine populations, aiming to educate about the ecological importance of giant otters (e.g. Associação Amigos do Peixe-boi 2011); campaigns of environmental education in zoos and the involvement of the media to reverse the negative perception about the species.

The third cycle of the Brazilian Action Plan for the Giant Otter was planned in 2022 and had the general objective of "mitigate the impacts of the main threats to giant otter populations and their habitat in strategic areas within the Tocantins-Araguaia, Paraná, and Paraguay hydrographic regions for species conservation over the next 5 years". To do so, 25 actions distributed in four goals are to be executed: "reduction of conflicts between humans and giant otters", "formulation of strategies and mitigation of the impacts of habitat loss and degradation of giant otters due to human actions and climate change"; "increase and maintenance of the viability of isolated or remnant giant otter populations"; "assessment of the sanitary risk from contaminants and diseases in giant otter populations". The species is also included in the Brazilian Action Plan for the Conservation of Amazon Aquatic Mammals (ICMBio Portaria nº 19, 16th Januray 2019).

RECOMMENDATIONS FOR FUTURE EFFORT

The most pressing needs for future efforts for giant otter conservation are:

1. Assess human-giant otter conflicts, and promote human-giant otter coexistence, especially related to fisheries;
2. Promote long-term monitoring of giant otter populations within environmental plans of hydroelectric projects and other man-made structures;
3. Expand the knowledge about giant otter's health, through investigation of pathogen, zoonotic disease and general pollution effects on giant otter populations;
4. Assess the impact of recent droughts and fires on the Pantanal population;
5. Evaluate the effect of the reduction of permanent protection areas, proposed in the Native Vegetation Protection Law, on giant otter populations;
6. Monitor the impacts of tourism activities that promote giant river otters as focal species and help introduce best practices guidelines in areas with potential for ecotourism (e.g., Pantanal);
7. Increase coordinated group efforts to produce data on genetics and demographics;
8. Conduct range wide population estimation;
9. Conduct modelling exercises for distribution and ground truthing the results, with special focus on the "blind spots" for the occurrence of giant otters (e.g., Espírito Santo, Paraná, and Maranhão states);
10. Incorporate climate change, extreme events and disease into modelling scenarios;
11. Coordinate and combine in situ and ex situ initiatives into a one-conservation approach;
12. Establish environmental education in communities that coexist with the species;
13. Strengthen the research groups currently working with giant otters, maintaining close cooperation with the regional aquatic mammal rescue networks.
14. Establish public awareness programs, and active collaboration with local agencies and communities.

ACKNOWLEDGEMENTS

We thank all the organizations, authorities, researchers, park rangers, guides and local communities that for many years supported the surveys and conservation of the giant otter in Brazil.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN COLOMBIA

Fernando Trujillo & Karen Pérez

LOCAL NAMES

Lobo Perro de agua (Cuenca del Orinoco), lobo de río, nutria gigante, lobón (Amazonas), *tabú/täu* (Piaroa), *yéu, yeó* (Puinave), *bojonawi* (Guahibo), *iñehui* (Yucuna), *ñewi* (Curripaco), *javi* (Carijona), *jiayavi* (Cubeo –Vaupés River), *timí* (Macuna - Apaporis River), *eriayábua* (Tanimuca - Apaporis River) (Rodríguez-Mahecha *et al.* 1995; Botello 2009).

HISTORICAL AND CURRENT DISTRIBUTION

Giant otters were distributed over a wide area that covers about 60% of Colombia (Figure 1), including the Orinoco river basin (Arauca, Casanare, Ele, Lipa, Cravo Sur, Cusiana, Pautó, Meta, Manacacías, Bita, Tillavá, Planas, Vichada, Duda, Guayabero, Guaviare, and Inirida tributaries) and the Amazon basin (Putumayo, Caucayá, Caquetá, Cahuinarí, Apaporis, Miritíi-Paraná, and Vaupés tributaries) (Beltrán e*t al.* 1994; Botello 2000; Trujillo *et al.*, 2006, 2010, 2015, 2016; Ferrer *et al.* 2009a). After the fur hunting era, giant otter populations were extremely reduced or completely absent near large population centers such as Leticia, Puerto Carreño, Inírida and Florencia. However, more recently some populations have been recovering and observations are more frequent at some sites. Giant otters are found up to 500 m a.s.l. (Alberico *et al.* 2000), however, recent surveys at the base of the Andes suggest that it is found below 300 m a.s.l., perhaps due to historical hunting pressure.

The reduction of the geographic distribution of giant otters in Colombia is directly related to active demographic and colonization processes, the consolidation of urban centers and the spread of human influence. This is particularly severe throughout the Andean foothills and around the departmental capitals in the Orinoco and Amazon. This demographic pressure has increased the deterioration of water bodies due to deforestation and pollution, and the depletion of the fishery resource.

Knowledge of giant otters in Colombia is concentrated in relatively few areas in the Orinoco and Amazon (Figure 2), especially the Amazonas, Arauca, Bita, Caquetá, Cuduyarí, Meta and Orinoco rivers, and corresponds to the intermittent presence of research groups or initiatives by autonomous regional government corporations.

Nevertheless, the information gaps for the species are also geographically extensive (Figure 3) due to the difficulties of terrestrial access to some regions, especially in the Caquetá, Guainía, Putumayo and Vaupés departments. The strategy to increase knowledge about giant otters in these

remote areas would be to invest in training and monitoring in protected areas and indigenous reserves.

In general, giant otter populations do not occur in the foothills of the Orinoco in the Arauca, Casanare and Meta departments. In the Orinoco, the species inhabits water bodies associated with gallery and riparian forests, and as altitude increases in the piedmont the absence of populations of the species becomes evident. This may be due to two main phenomena. First, there may be a competitive exclusion with the river otter (*Lontra longicaudis*: Moraes *et al.* 2021). River otters have smaller space requirements than giant otters and prefer smaller water bodies where they can optimize foraging strategies to obtain food efficiently. Secondly, as altitude increases in these areas, both water bodies and fish fauna decrease in size, favoring the presence of the smaller river otter and excluding giant otter populations. Therefore, these foothills are not considered as ideal habitat for giant otter survival (Alviz & Pérez-Albarracín 2019).

Giant otter populations are no longer present in the Amazonian foothills in the Caquetá and Putumayo departments (Figure 4). These ecosystems are severely altered due one of the highest deforestation rates in the country.

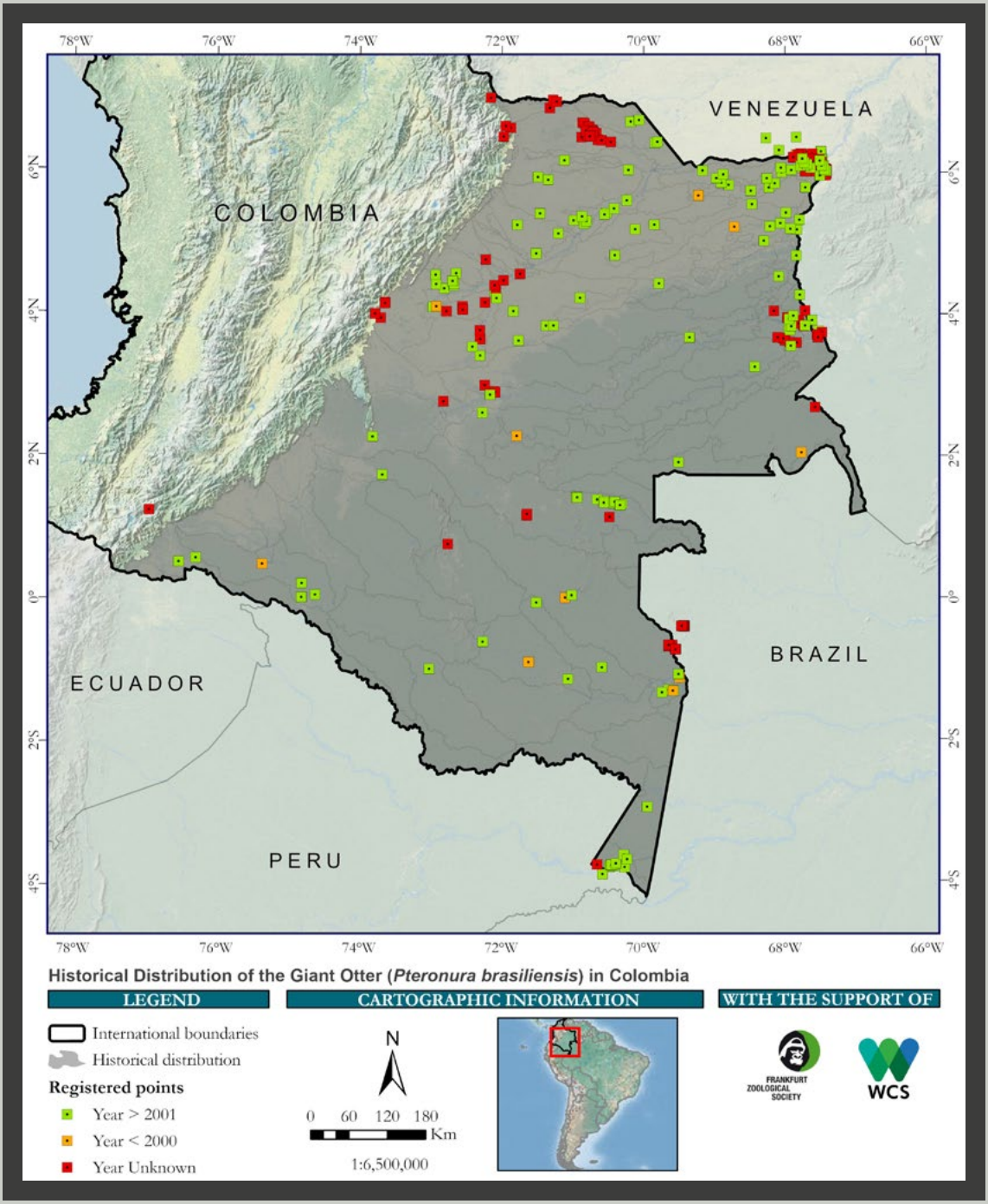


Figure 1. Historical giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Colombia.

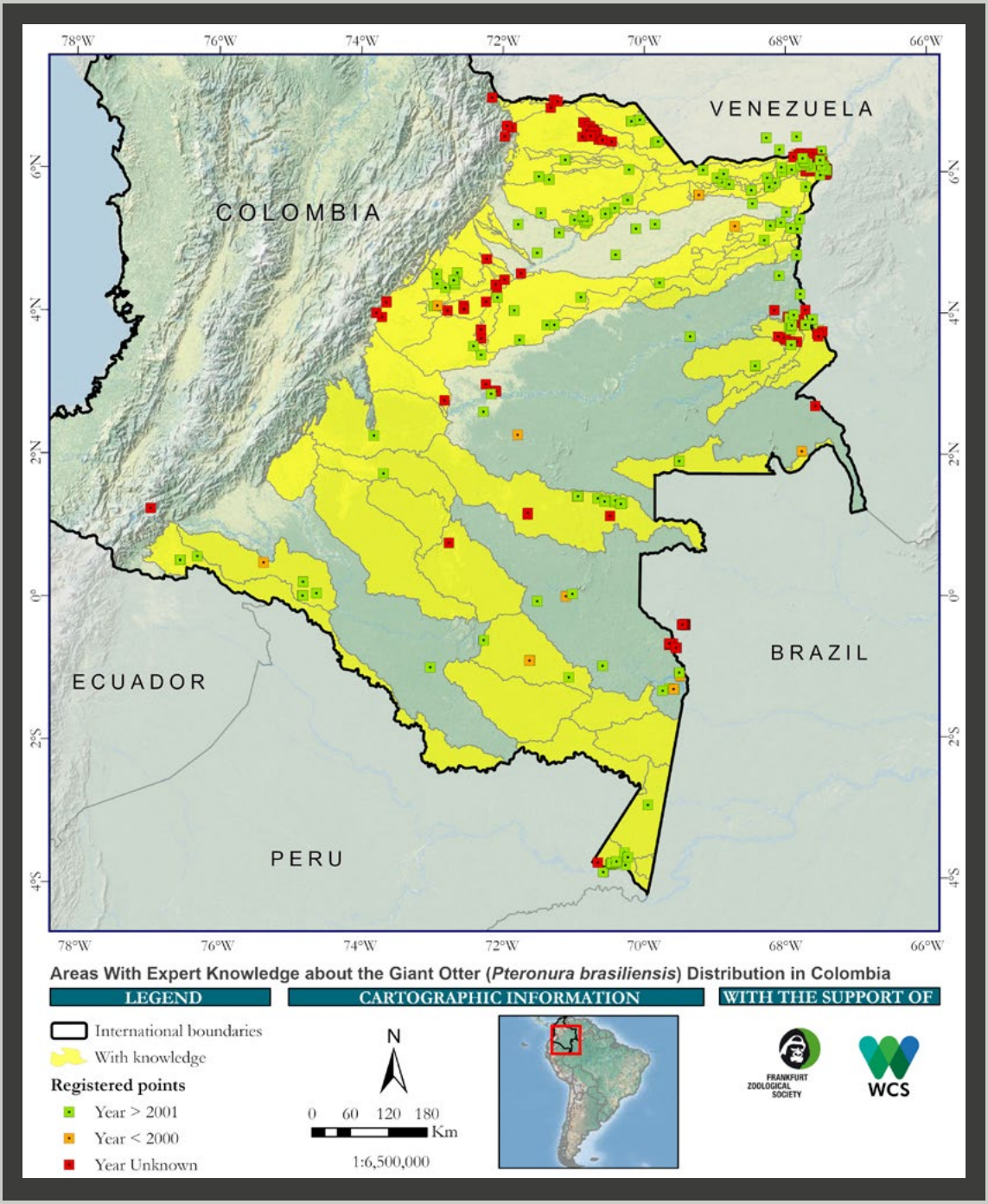


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Colombia.

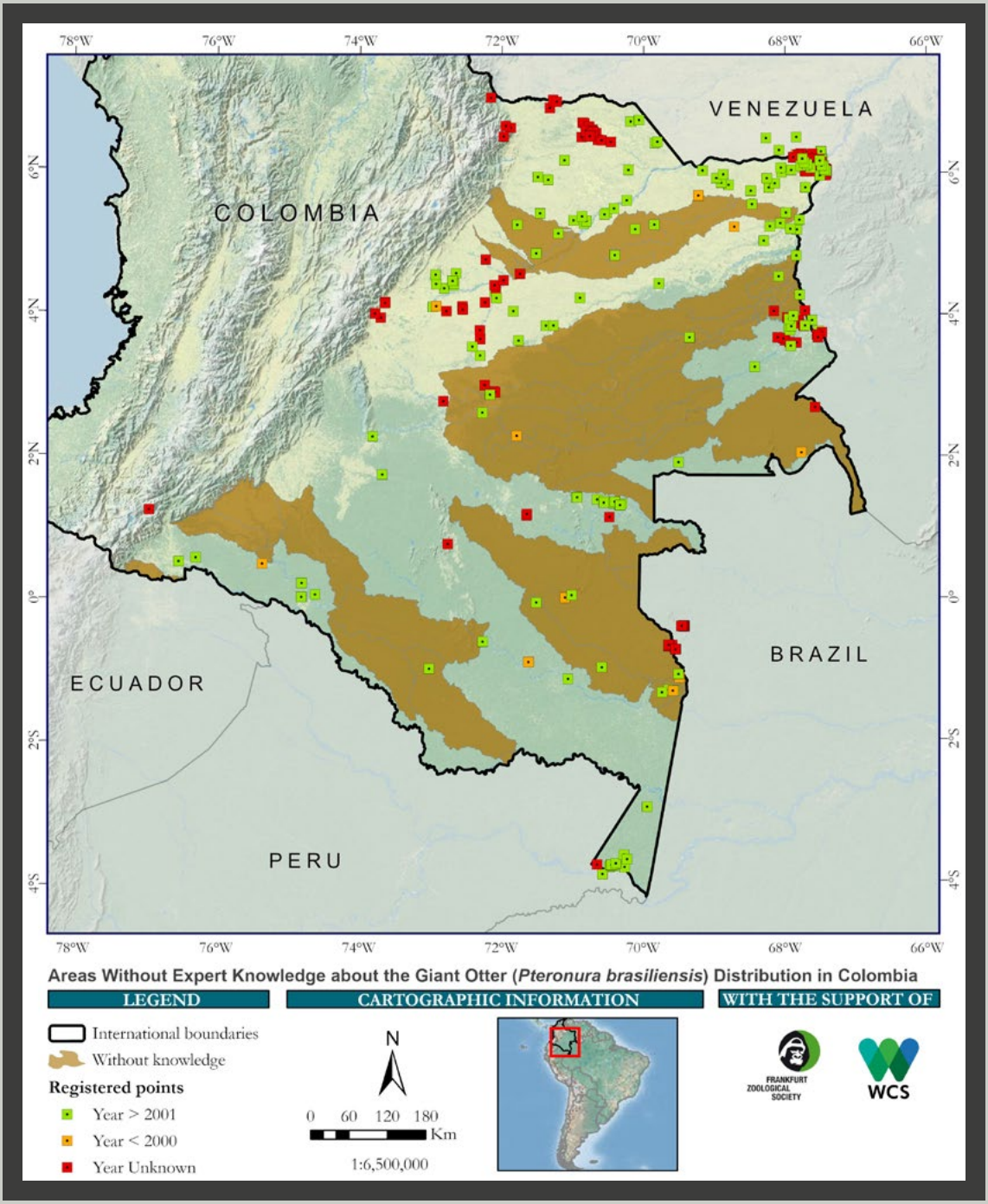


Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Colombia.

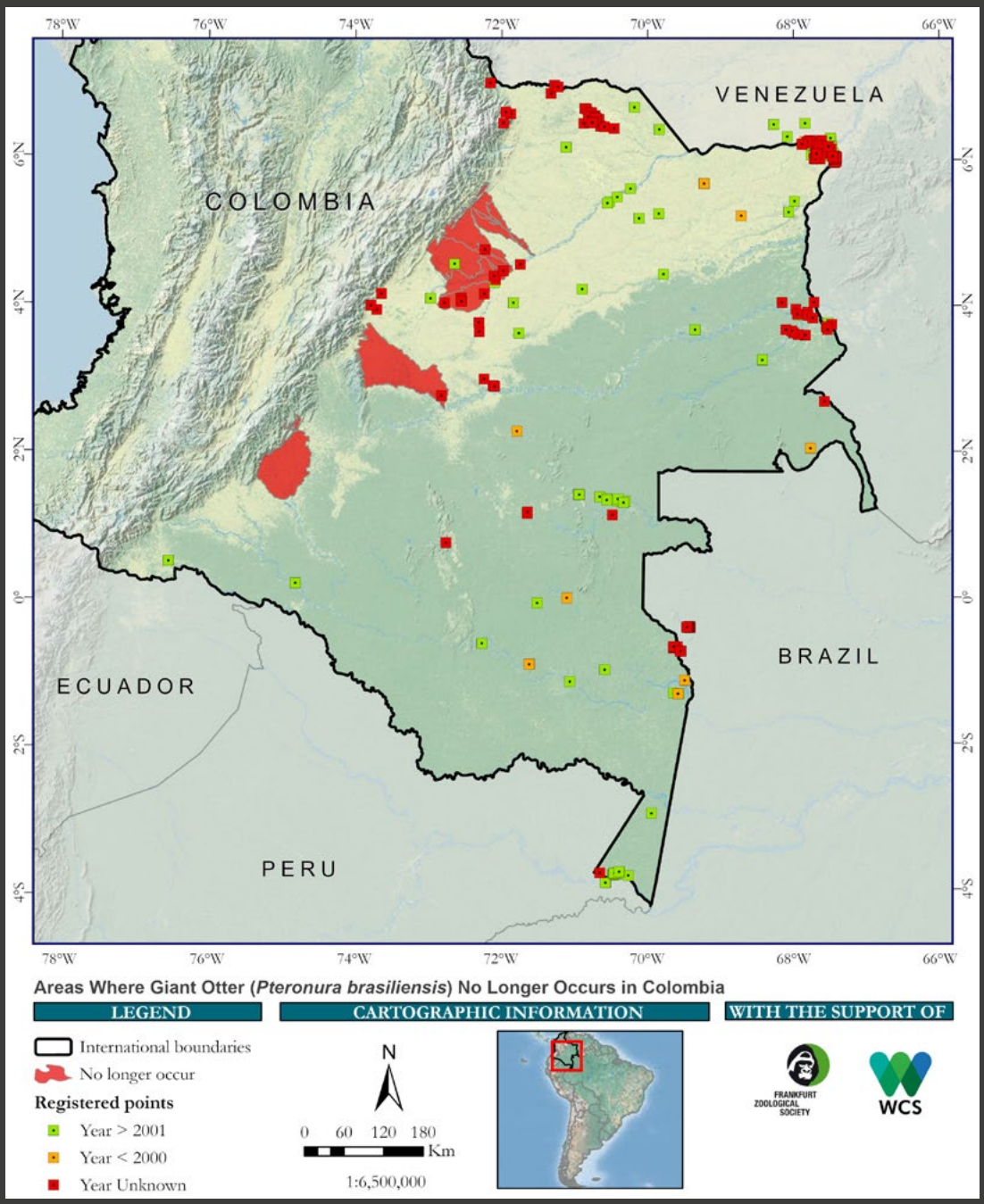


Figure 4. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Colombia.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Due to the scarcity of giant otter population density studies in Colombia, and the methodological differences between the few studies carried out to date, we present available information including reference relative abundance values (Table 1). These values do not allow comparisons to evaluate density patterns for the different basins studied. The values are reported as the number of individuals and/or groups encountered per kilometer traveled, and density of sign evidence such as campsites, footprints and latrines, among others.

Table 1. Giant otter relative abundance and sign density in Colombia

Geographic Area	Rivers	Distance Surveyed (km)	No. Individuals	Groups	Sign Density (Ind./km)	Source
Orinoco						
Tuparro	Tomo	1,750	163	30	ND	Defler 1983, 1986
Vichada	Bita	105	39	7	0.9	Valbuena 1999
Vichada	Orinoco, Bita	60	20	5	ND	Carrasquilla 2002
Vichada	Meta, Orinoco, Bita	75	36	19	ND	Velasco 2004
Vichada	Orinoco, Bita, Meta	75	32	11	0.9*	Díaz 2008
Vichada	Orinoco, Caño Negro, Caño San José	691	30	5	0.77	Garrote *et al.* 2020
Vichada	Bita (Ramsar site)	135	18	4	0.13	Omacha 2020
Arauca	Arauca, Ele, Lipa, Cravo Norte	177.1	26	4	0.14	Franco *et al.* 2015
Casanare	Meta		10	2	ND	Díaz & Sarmiento 2002
Guaínia	Inírida, Guaviare	217.8	36	8	ND	Suárez 2009
Amazon						
Caquetá	Caquetá and tributaries	350	8	3	ND	Beltrán *et al.* 1994
Caquetá	Meta	45	3	2		Martínez 1998
Vaupés	Cuduyarí	125	9	2	0.14	Cañón *et al.* 2015
Apaporis	Apaporis	30	25	4	0.8	Botello 2000

***Relative abundance calculated as individuals/hour on the Orinoco river**

HABITAT USE

In the Colombian Orinoco, giant otter presence is reported in tributaries and lagoons especially during the high-water season (June-August), and near the confluences and in the main rivers during the low water season (January-April). At low water, groups burrow in dens in the lower sections of streams and canals, moving in the early morning hours to the main rivers, where they stay most of the day, with temporary resting places and burrows on islands in the middle of the channel. In the late afternoon, they return to the streams to spend the night. In the high-water season, groups have territories of up to 3 linear km along the river. At low water the areas of movement are more extensive, possibly due to the dispersion of fish in lagoons and small tributaries, travelling several km by land to access isolated fishing spots during this period (Carrasquilla & Trujillo 2004; Velasco 2004; Díaz 2008; Trujillo & Mosquera 2018). Many studies report giant otters as more associated with black water river systems, however in the Orinoco River on the Colombian-Venezuelan border and the Meta River, they are found in white waters with high rainfall and sedimentary load, with latrines and burrows in rocky areas of the Guyanese Shield (Carrasquilla & Trujillo 2004; Velasco 2004; Trujillo *et al.* 2006, 2016).

During 2018-2019 activity patterns of giant otters in the Orinoco River (Vichada) were evaluated using circular kernel density estimations, revealing a diurnal activity pattern (Alvarez *et al.* 2020), coinciding with that previously described for the species (Leuchtenberger *et al.* 2013). However, differences in the hours of greatest use of latrines by each group: midday in the lagoon, afternoon on island/rock and throughout the day and night for shore latrines. These differences seem to be influenced by the availability and behavior of fish in each habitat and by human disturbance levels (Alvarez *et al.* 2020).

In the transition zone between the Orinoco and the Amazon, in the Estrella Fluvial de Inírida and Puinawai NNP, giant otters are reported mainly in lagoon and small tributary zones, with seasonal movements similar to those previously reported (Muñoz & Repiso 2001; Ferrer *et al.* 2009; Suárez 2009). For the Caquetá River region, giant otters are frequent in tributaries, lagoons and the flooded forest, with marked seasonal movements. Overfishing in the upper basin, at sites such as the Miritί Parana, has apparently driven the species to move downstream, and is now present at popular community fishing, generating some conflicts with fishermen (Matapi *et al.* 2008).

In the department of Arauca (2014-2018), the hyper-seasonality of flooded savannas may be favoring the dispersal of otter family groups among the main water bodies in response to fluctuations in water levels and resource availability (Alviz & Pérez-Albarracin 2019). The flooded savannas may function as transit areas in the wet season to favor connectivity between family groups and displacements in search of higher areas for refuge.

THREATS

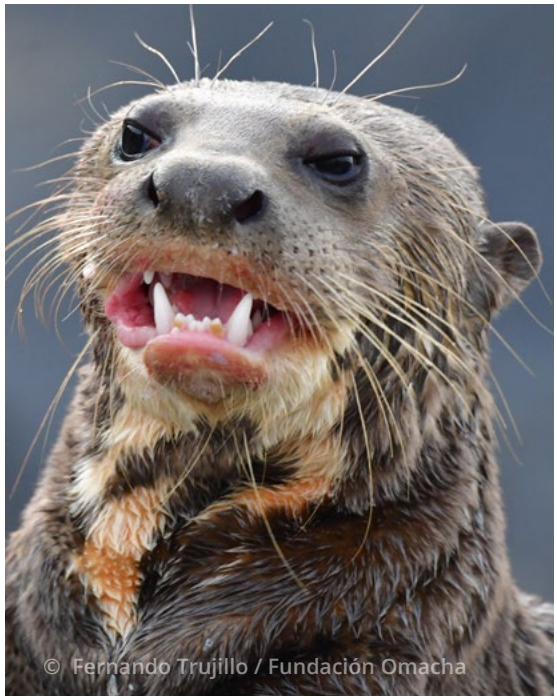
Pteronura suffered strong hunting pressure in the late 1950's and early 1960's due to the fur trade for international markets. Statistics are neither reliable nor robust, since there was movement of skins in border areas and the declaration of these was not rigorous (Medem 1968; Donadio 1978). Since hunting was banned, giant otter populations have slowly recovered in some geographic areas, generating the perception in local communities that their numbers are increasing significantly. The increase in otters, added to the overexploitation of the fishing resource, has generated conflicts with fishermen who consider otters as competitors and sometimes choose to kill them, and request Regional Corporations (CARs) to reduce their numbers (Díaz & Sánchez 2002; Garrote 2005; Trujillo *et al.* 2006). Evaluations of this problem in the Miritί Parana zone (Caquetá tributary) and in the Estrella Fluvial de Inírida, found that giant otter densities are not as high as reported by the communities and that the overlap in diet does not include many of the commercial fish species (Matapi *et al.* 2008; Suárez 2009). In these conflict areas, a reduction in large catfish stocks, leads to a shift in the focus of the fishery towards smaller catfish and cichlids that were previously only used by coastal communities. These studies were carried out in concert with local communities, and concluded that the increase in the population of otters is not the main factor in the reduction of fish catches, rather the main causes seem to be the increase in the demand for fish in urban centers, and the lack of fishing management plans (Trujillo *et al.* 2008a; Valderrama *et al.* 2010). In the Upper Putumayo, park rangers report conflicts between arawana fishermen (*Osteoglossum bicirrhosum*) and giant otters in the tri-border area between Peru, Colombia, and Ecuador.

The degree of conflict with fishing varies according to the type of river system, as well as human population density, with greater conflict when numerous human communities are found in low productivity systems, such as small black water rivers. There is less hostility to the presence of otters in larger rivers (over 1000 m^3/s), as well as among populations with traditional and non-commercial fishing and consumption. An important factor that accentuates this conflict is the loss of traditional management and self-regulation of fishing by communities in strategic areas for fish (lagoons, streams, flood systems, torrents). The conflicts between otter and fishermen must be understood from the need of the communities to address the problem of overfishing, the carrying capacity of the systems and the use of the resource, so it is important to consider cultural aspects of fishing systems and beliefs about fish consumption in research activities (Botello 2009).

In addition, the illegal sale and possession of *Pteronura* offspring as pets, which are generally killed because of their increasing aggressiveness as they grow, has been reported (Díaz & Sánchez 2002; Trujillo *et al*. 2008; Portocarrero-Aya *et al.* 2009). Sometimes these individuals are seized and enter into rehabilitation processes, either in situ or at zoos (Gómez *et al.* 1999; Morales-Betancourt & Trujillo 2010). Currently, the Omacha Foundation, in partnership with Regional

Corporations, are adjusting international protocols to efficiently manage seizures and releases if appropriate.

A latent threat to the species, are high mercury levels in the Amazon and Orinoco basin. Carnivorous fish such as catfish, some characids and cichlids, and other scavengers such as *Calophysus macropterus* have high mercury levels (Trujillo *et al.* 2008b, 2010a; Cubillo-Moreno 2009).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PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

The predicted distribution of *Pteronura* in the future is linked to prey availability, which will also be strongly influenced by commercial fishing patterns. This is expected to increase conflicts with fishermen due to the perception that giant otters compete for fish, especially in the Vaupés River, in the middle Caquetá basin, the upper Putumayo river on the border between Colombia, Peru and Ecuador (La Paya, Güepi and Cuyabeno), and the Meta River between Cravo Sur and Paz de Ariporo, and between Juriepe and Puerto Carreño. In the tri-national zone, this problem is being addressed through a WWF project to strengthen protected areas and governance. A critical aspect in Colombia is the human colonization at the base of the Andes on the western limit of giant otter distribution, which is reducing distribution and fragmenting populations.

The implementation of large monocultures and forest plantations in the Orinoco is drying up extensive areas of wetlands (Andrade *et al.* 2009; Trujillo *et al.* 2010b), threatening to fragment and even destroy critical habitats for the otters, and forcing them to move to other areas.

The effect of climate change on the distribution of giant otters has not yet been addressed in Colombia, but it will presumably alter flood pulses, fish dispersal patterns (Hansen & Hiller 2008), and in turn otter movement patterns and distribution. Recent climate modeling shows unoptimistic scenarios for several rivers in the Colombian Orinoquia, with flow reductions of more than 30% in the next 10 years because of reduced rainfall, prolonged and more extreme droughts, and agro-industrial water harvesting for crops (Paredes-Trejo *et al.* 2023).

KNOWLEDGE ABOUT THE SPECIES

Giant otters have been relatively well studied in the Puerto Carreño area, between the Meta, Bita and Orinoco rivers, in aspects such as habitat use, diet, genetics and abundance (Valbuena 1999; Carrasquilla 2002; Gómez 2004; Velasco 2004; Díaz 2008; Alvarez *et al.* 2020). As part of this research, a reference collection of hard fish structures was created, as well as a catalog of identified giant otter individuals, and the rehabilitation and release of three specimens (Trujillo *et al.* 2008; Portocarrero-Aya *et al.* 2009). In the El Tuparro Biosphere Reserve the first published studies were carried out (Defler 1983, 1986).

In the Estrella Fluvial de Inírida area (Velasco 2005; Garrote 2006; Suárez 2009) studies focused on habitat use, diet and evaluation of conflicts with fishermen. In the Amazon, specific evaluations on the Caquetá, Apaporis, Putumayo and Amazonas rivers (Beltrán *et al.* 1994; Martínez 1998; Botello 2000, 2009; Matapi *et al.* 2008), are short-term. However, between 2008-2009 The *Fauna Acuática Amenazada de la Amazonía* (FACUAM) evaluated the conservation status of otters, dolphins, caimans, manatees and *Podocnemis* turtles in four regions of the Amazon: the Amazon River, Caquetá River, and the upper and lower Putumayo (Bermúdez-Romero *et al.* 2010), from which specific recommendations for their conservation emerged (Trujillo *et al.* 2010c; Valderrama *et al.* 2010).

In 1999, the Zoological Foundation of Cali initiated a program on the reproductive behavior and biology of the giant otter, consolidating it into a successful initiative with the birth of young in captivity (Sykes-Gatz 2004; Corredor-Londoño & Tigreros-Muñoz 2005). Recently, the University of the Andes and the Omacha Foundation started a genetic evaluation program of *Pteronura brasiliensis* and *Lontra longicaudis* in Colombia (Correa 2010). In this study, two haplotypes were shared between Colombia and Brazil and 14 new haplotypes were only reported in Colombia. High levels of diversity were detected at the haplotype level and low levels of genetic diversity at the nucleotide level, which is a similar pattern for other endangered species.

LEGAL STATUS

In Colombia giant otters are categorized as Endangered (EN) according to the IUCN A2acd criteria and qualifiers (Trujillo *et al.* 2006). It was legally protected through Resolution 574 of 1969 which prohibited its hunting. This measure was later strengthened with Resolution 848 of 1973, which is still in force. All Colombian fauna species are protected by Resolution 1608 of 1978, and in the 2000 Criminal Code, when actions against threatened species were criminalized (Law 599). Giant otters are listed as an Endangered species in Colombia in the 2024 resolution 0126.

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Giant otters occur in 13 protected areas, covering 9,819,240 ha (Table 2), and representing 12.41% of the entire distribution area in the Amazon and Orinoco.

Table 2. Protected areas with giant otter populations (*Pteronura brasiliensis*) in Colombia

Protected area	Area (ha)	Estimated population
Amazon		
PNN La Paya	422,000	1,750
PNN Amacayacu	293,500	105
PNN Cahuinari	575,500	60
PNN Chibiriquete	2,783,000	75
PNN Río Pure	999,880	75
PNN Yaigojé-Apaporis	1,060,603	691
PNN Tinigua	208,000	135
RNN Nukak	855,000	177.1
RNN Puinawai	1,092,500	
Orinoco		
PNN Tuparro	548,000	350
PNN Sierra La Macarena	629,280	45
DRMI Mata de la Urama	20,134	125
DNMI Cinaruco	331,843	30
Total	**9,819,240**	

Additionally, some Regional Corporations (CARs), which depend on the Ministry of Environment, Housing and Territorial Development (MAVDT) have identified this species as a priority and included them in regional action plans. Corpoamazonía created an alliance with several organizations (Fundación Omacha, Natura, Sinchi) and produced an Action Plan for the Conservation of Threatened Aquatic Fauna: Otters, Manatees, Caimans, Dolphins, Turtles (Trujillo *et al.* 2008a). Based on this plan, a two-year consultation process with local communities was carried out to promote the implementation of conservation agreements and reduce fishing conflicts (Bermúdez-Romero *et al.* 2010; Valderrama *et al.* 2010). Similarly, in the El Tuparro Biosphere Reserve, Orinoco, a management plan for threatened species (manatees, dolphins, otters, jaguars, and turtles) was designed and implemented to mitigate threats (Trujillo *et al.* 2008b).

Additionally, three Ramsar sites have been designated for giant otter conservation. The first is the Orinoco/Amazon interface zone known as the Inírida River Star, with

256,000 ha. The second is the Tarapoto wetlands, in the Amazonian area bordering Peru, with 44,600 ha. Finally, the largest Ramsar site in Colombia is the Bita River in the Orinoco, with 824,000 ha. In 2022 these three Ramsar sites were designated as Other Effective Conservation Mechanisms (OECM) through local governance exercises.

In 2015, the Ministry of Environment, Housing and Territorial Development in association with the Omacha Foundation completed a National Action Plan for the conservation of the aquatic mammals of Colombia (Trujillo *et al.* 2015), which included in situ and ex situ conservation recommendations for giant otters. Later, with the same Ministry, an Action Plan was designed for both otter species present in Colombia (*Pteronura brasiliensis* & *Lontra longicaudis*) (Trujillo *et al.* 2016). The Aquatic Mammals Action Plan (2020-2030) was recently updated for Colombia, with specific recommendations were made for giant otters (Trujillo *et al.* 2020).

Given the relative lack of knowledge about veterinary management of otters in the country, and the recent seizures linked to illegal trafficking, a Giant Otter Rehabilitation Protocol (Peña *et al.* 2019) was designed and printed in an alliance between Fundación Omacha and the Cali Zoo.

Within the framework of the design and implementation of the Bita Ramsar site management plan in 2019-2020, agreements were signed with fishermen, the forestry sector and ranchers for the conservation of threatened focal species such as giant otters (*Pteronura brasiliensis*), river dolphins (*Inia geoffrensis)*, tapirs (*Tapirus terrestris)*, jaguars (*Panthera onca*), peacock bass (*Cichla* sp), and *Podocnemis* turtle species. The Ramsar agreements were signed and endorsed by the Colombian Ministry of the Environment for 255,000 ha and included environmental education and monitoring processes. Infographics and dissemination material were designed, which was reinforced by a general dissemination book on otters in the Orinoco basin (Trujillo & Mosquera 2018).

Twelve geographic areas distributed in the Orinoquia and Amazonia were prioritized for giant otter conservation in Colombia (Table 3 & Figure 5).

Table 2. Protected areas with giant otter populations (*Pteronura brasiliensis*) in Colombia

	Protected area
Orinoquia	
1	Bita/Meta/Orinoco
2	DNMI Cinaruco
3	Lipa/Cravo Norte
4	Humedales de Paz de Ariporo
5	PNN Serranía de La Macarena
6	PNN El Tuparro
Transición Amazonas/Orinoco	
7	Sitio Ramsar Estrella Fluvial de Inírida
Amazonas	
8	PNN Chiribiquete
9	Río Cuduyarí
10	PNN La Paya
11	PNN Cahuinarí
12	Sitio Ramsar Tarapoto

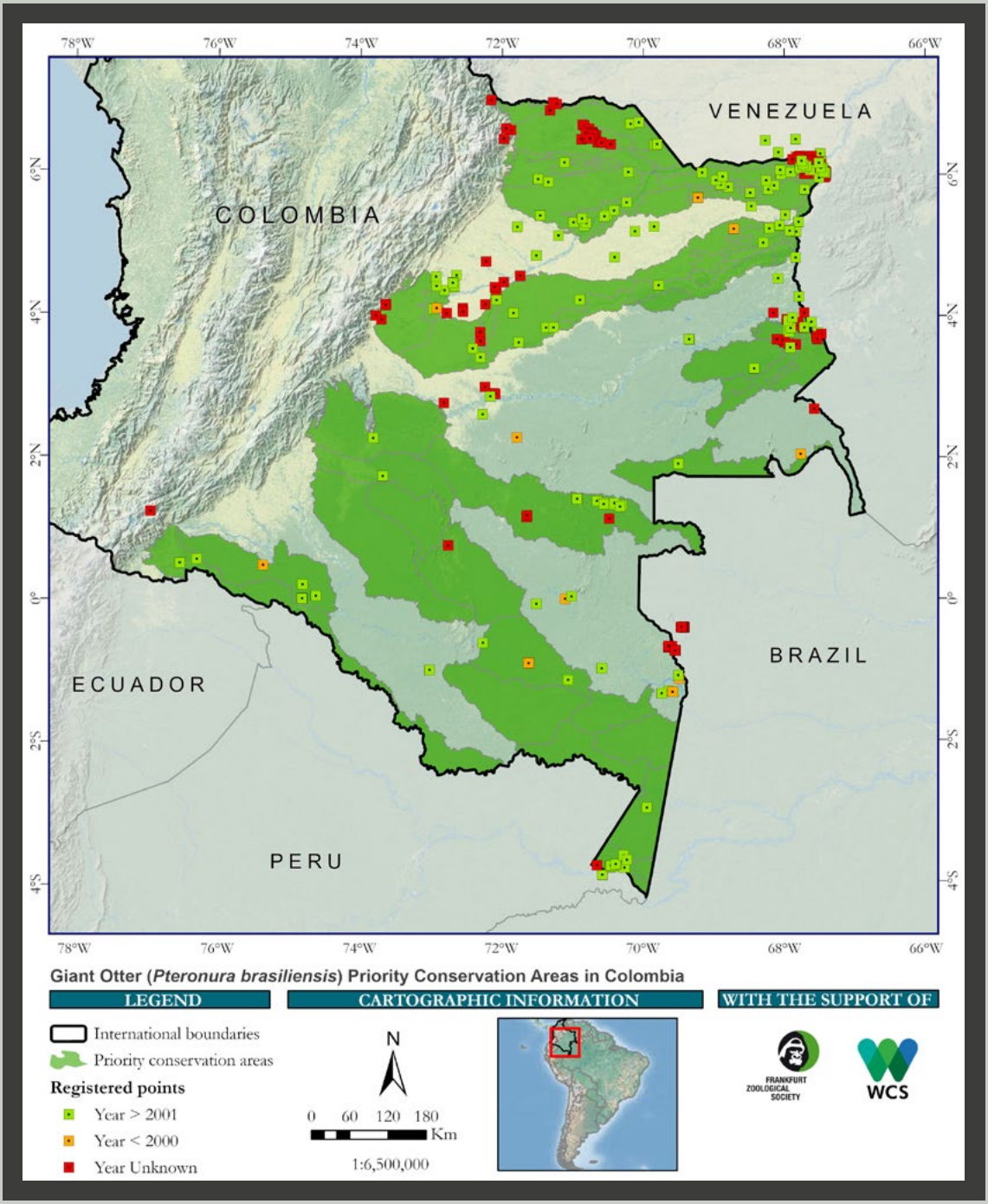

Figure 5. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Colombia.

The expert identified priority conservation areas for giant otters reflect the overall conservation status of the forests, natural grasslands and associated water bodies. In the Orinoco, the Arauca Department is one of the areas with the greatest conservation potential for the giant otter. The Cravo Norte, Casanare, Lipa and Ele river basins are composed of gallery and riparian forests that support reproductive activities, resting and refuge sites, where pressures on giant otter populations are related to retaliation hunting (Alviz & Pérez-Albarracín 2019). The Cinaruco National Integrated Management District in Cravo Norte is part of this giant otter priority conservation area.

Another giant otter priority conservation area is in Vichada within the Bita, Tuparro and Vichada river basins. In the Bita River since 2017, sustainable development and biodiversity protection activities have strengthened through the establishment of Natural Reserves of the Civil Society, Conservation Agreements and complementary strategies, such as the establishment of nurseries and the strengthening of beekeeping processes (FOB 2021). More recently, the Bita was designated as the largest Ramsar site in the country, and as an example of management of a large wetland, where the conservation of several threatened species, including the giant otter, has been prioritized (Suárez *et al.* 2021). The El Tuparro National Park is one of the largest protected areas in Colombia and is home to a high diversity of threatened, vulnerable and ecologically important species for the Orinoco. These conservation jurisdictions have favored the protection of giant otter populations throughout the Department.

In the Amazon/Orinoco transitional zone, the Estrella Fluvial de Inírida Ramsar site is one of the sites where giant otter populations are being monitored with the participation of local communities.

In the Amazon, the Serranías de Chiribiquete National Park is undoubtedly one of the best options for the conservation of this species. This is the largest protected area in Colombia, exceeding four million hectares, with a very low level of human presence and in very good conservation condition. The indigenous communities on the Cuduyarí River (Vaupés Department) have an otter management plan endorsed by the Corporación para el Desarrollo Sostenible del Norte y Oriente Amazónico. In the La Paya and Cahuinarí National Parks, giant otters are considered in the management plans and authorities are willing to implement monitoring processes. Finally, the Tarapoto Ramsar site has a permanent presence of researchers, as well coordinated conservation work with the indigenous communities.

RECOMMENDATIONS FOR FUTURE EFFORT

Research

- Identify geographic regions with conflicts between fisheries and otters and evaluate levels of competition through diet analysis.
- Assess the impact of monocultures, forest plantations, wetland drainage, hydrocarbon exploration and exploitation, and deforestation on giant otter distribution and habitat use.

- Evaluate the impact of water stress in rivers of the Orinoquia on giant otter distribution to produce a model that generates early warnings on known *Pteronura* populations.
- Strengthen the *Pteronura* phylogeographic and genetic evaluation research program in Colombia.
- Consolidate a *Pteronura* research program, standardizing sampling techniques for distribution, habitat use, abundance, diet, and genetic sampling.
- Conduct studies on trophic ecology to describe competition and predation relationships.
- Evaluate the direct and indirect effects of the progressive human colonization from the Andes on the distribution and abundance of the species in Colombia.
- Establish priority habitats and populations for conservation using comparative density studies.
- Create a reference collection and database on hard structures (vertebrae, mandibular processes, spines, otoliths, scales) of fishes of the Amazon and Orinoco so as to evaluate otter diet, and provide information with which to combat fishing competition as a main direct threat.

Conservation

- Continue with agreements with local communities for the conservation of aquatic fauna in the Amazon and begin a similar process in the Orinoco.
- Generate management and release protocols for confiscated otters.
- Support Regional Corporations (CARs) in the implementation of priority conservation actions (national and regional plans) for giant otters.
- Evaluate and strengthen the Cali Zoo *ex situ* conservation program and generate similar standards for other sites holding the species in captivity.

Education and Communication

- Integrate the conservation of otters and their habitat into environmental education programs (PRAES) in the Amazon and Orinoco regions.
- Carry out actions that discourage the capture of otters as pets.
- Promote the designation of special management areas for aquatic fauna at the community level, such as fish reproduction areas, as part of the consultation process with the communities.

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ACKNOWLEDGEMENTS

We would like to express our gratitude to the Ministry of Environment of Colombia, specifically to the Directorate of Forests, Biodiversity and Ecosystem Services. We thank Fundacion Omacha and Fundacion Orinoquia Biodiversa (FOB) for all the support through the years towards the research and conservation efforts with giant otters in Colombia. We would also like to thank Corporinoquia, WWF Colombia, the Cali Zoo, the Barcelona Zoo, the Institute of Conservation Biology (IBICO) of Spain, and especially Germán Garrote for leading the giant otter research process in Vichada.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN ECUADOR

Victor Utreras B. & Galo Zapata Ríos

LOCAL NAMES

Lobo de río, nutria gigante, nutria (Spanish). Indigenous languages: yafaje, saráro (Cofán); k^{w}ahe ya'o (Siona-Secoya); ñeñe ompode (Waorani), pishna, jatun pishna (Kichwa); umpude (Waorani); wankanim (Shuar – Achuar) (Zapata Ríos 2000; Tirira 2004).

HISTORICAL AND CURRENT DISTRIBUTION

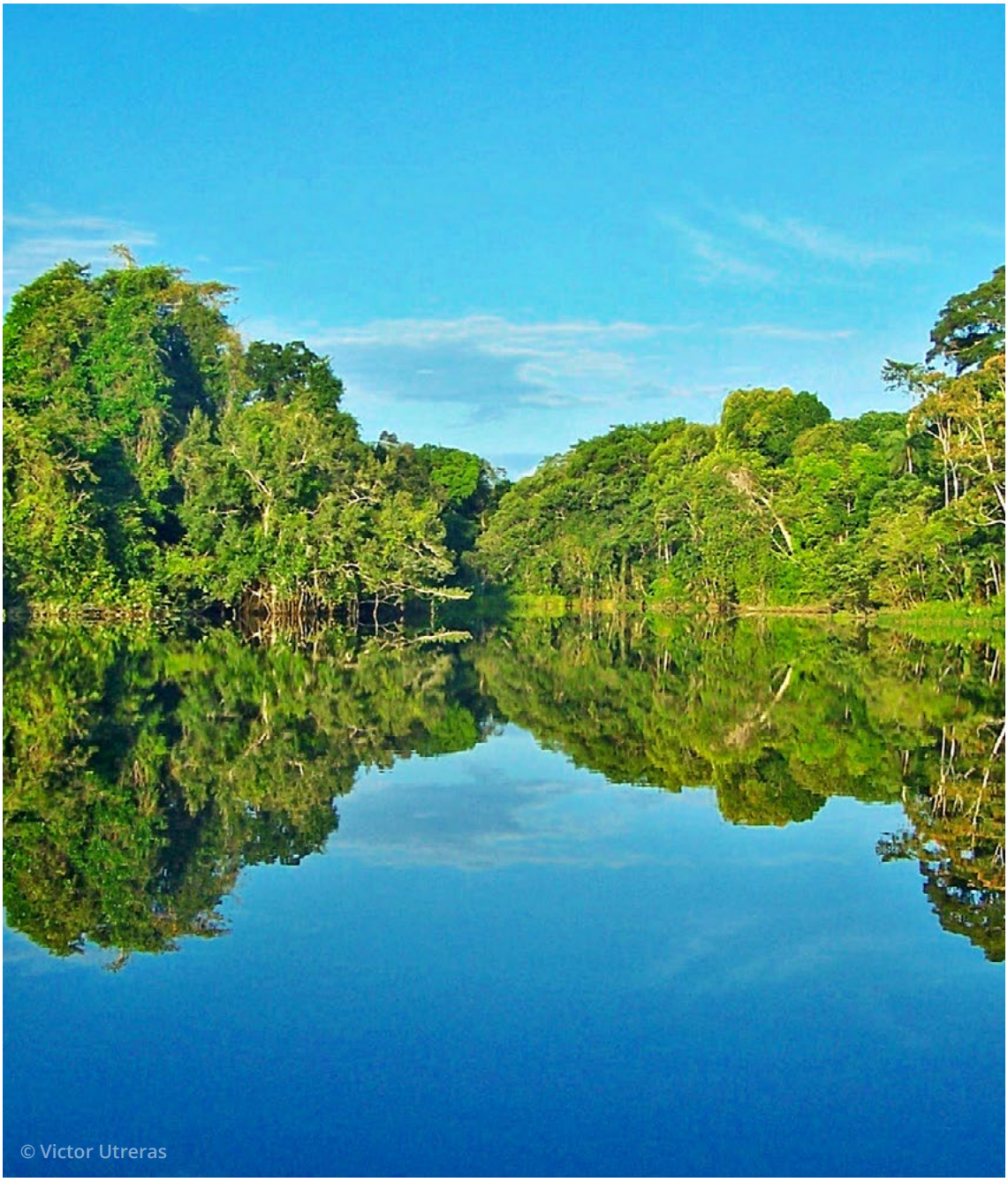
Historically, giant otters were widely distributed along the main rivers, tributaries and lake systems of the Ecuadorian Amazon, up to 500 m a.s.l. (Utreras & Jorgenson 2003). The most important region for the species was probably the northern Ecuadorian Amazon, where complex lake and river systems and large seasonally flooded areas are found (Utreras & Jorgenson 2003; Figure 1).

The current distribution of the giant otter in Ecuador encompasses less than 40% of the historical distribution range. Currently, they occur in some large rivers, tributaries and lake systems below 300 m a.s.l. (Utreras *et al.* 2013). In the northeastern Amazon, between the Putumayo and Napo rivers, they occur along the Güeppí, Cuyabeno, Aguas Negras, Sábalo, Juanillas, Lagartococha rivers and lake systems, the Cocaya River, and tributaries of the Aguarico River. They also occur in the Pilchicocha, Garzacocha, Challuacocha and Pañacocha lake systems along the northern margin of the Napo River. The current distribution in this region, suggests a recovery process of populations after being almost exterminated due to intensive hunting during the international pelt trade activities of the 20th century. During the 1990's, we obtained only 14 records of giant otters in this region, nine solitary individuals and five family groups. In contrast, during the last ten years, we have recorded the species on 28 different occasions, including seven solitary individuals and 21 established family groups (Figure 1).

South of the Napo River, most records are in the Añangu lake system, and the Tiputini, Tivacuno, Yasuní (including the Jatuncocha and Tambococha lake systems), Nashiño, Shiripuno, Cononaco, and Curaray rivers. In the Tigre River basin, the species occur in the Pindoyacu and Conambo rivers. In the lower Pastaza River basin, the species occur in the Capahuari, Ishpingo and Bobonaza rivers, and in the Morona and Zamora river basins (Utreras & Araya 2002; Utreras & Jorgenson 2003; Utreras & Tirira 2011; Utreras *et al.* 2013; Tirira 2017; Figure 1).

The areas with expert knowledge about giant otter populations includes all of the river basins of the Ecuadorian Amazon, below 500 m (Figure 2). There

is a small area, of approximately 4,472 km^2, along the lower slopes of the Andes and the westernmost limit of the species distribution in the western Napo River basin, where we lack both current and historic information for the giant otter (Figure 3). Based on current records of the species in the Ecuadorian Amazon, and the conservation status of its habitats, we identified a large section of the Ecuadorian Amazon as a priority area for the long-term conservation of the giant otter (Figure 4).



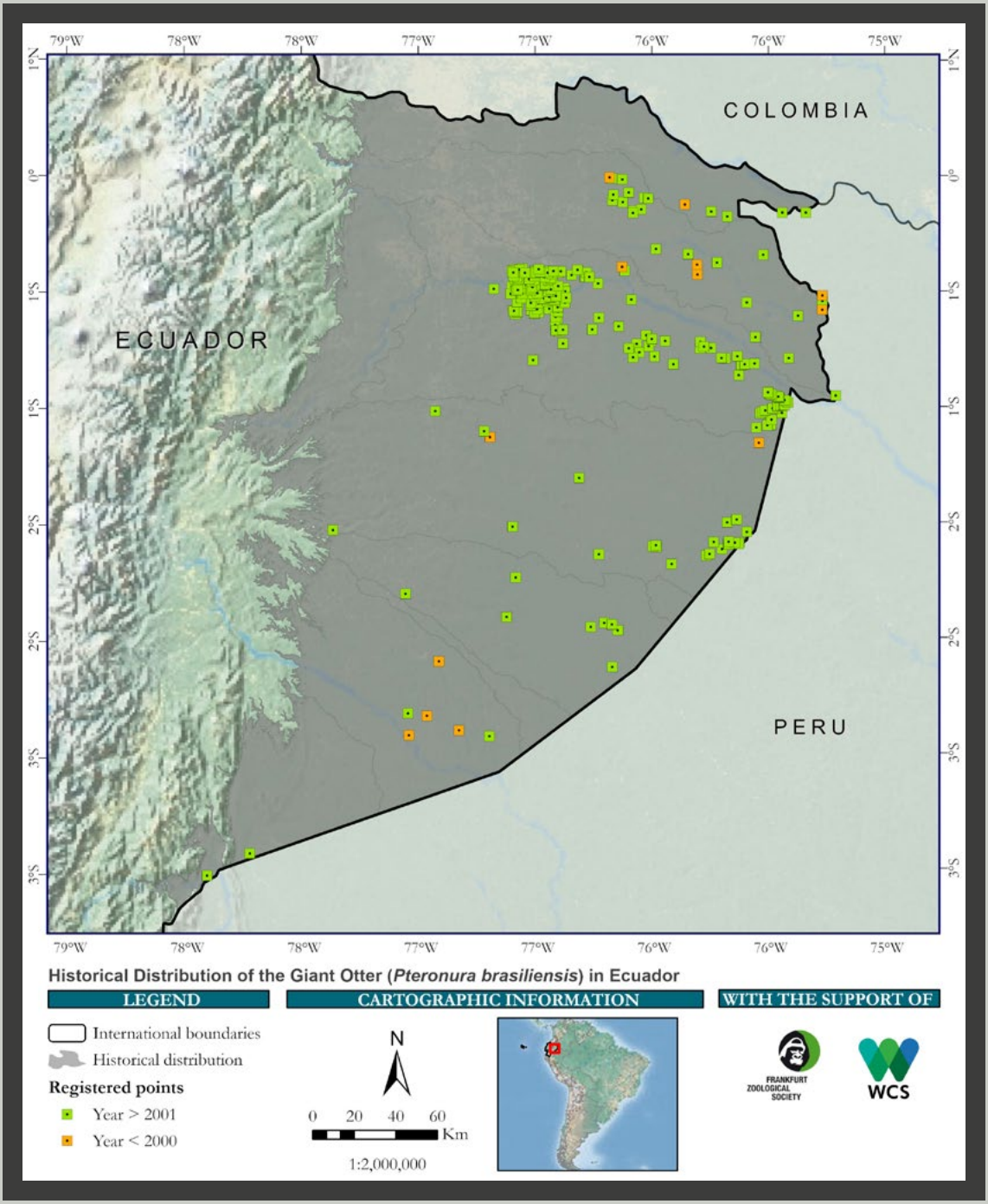


Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Ecuador.

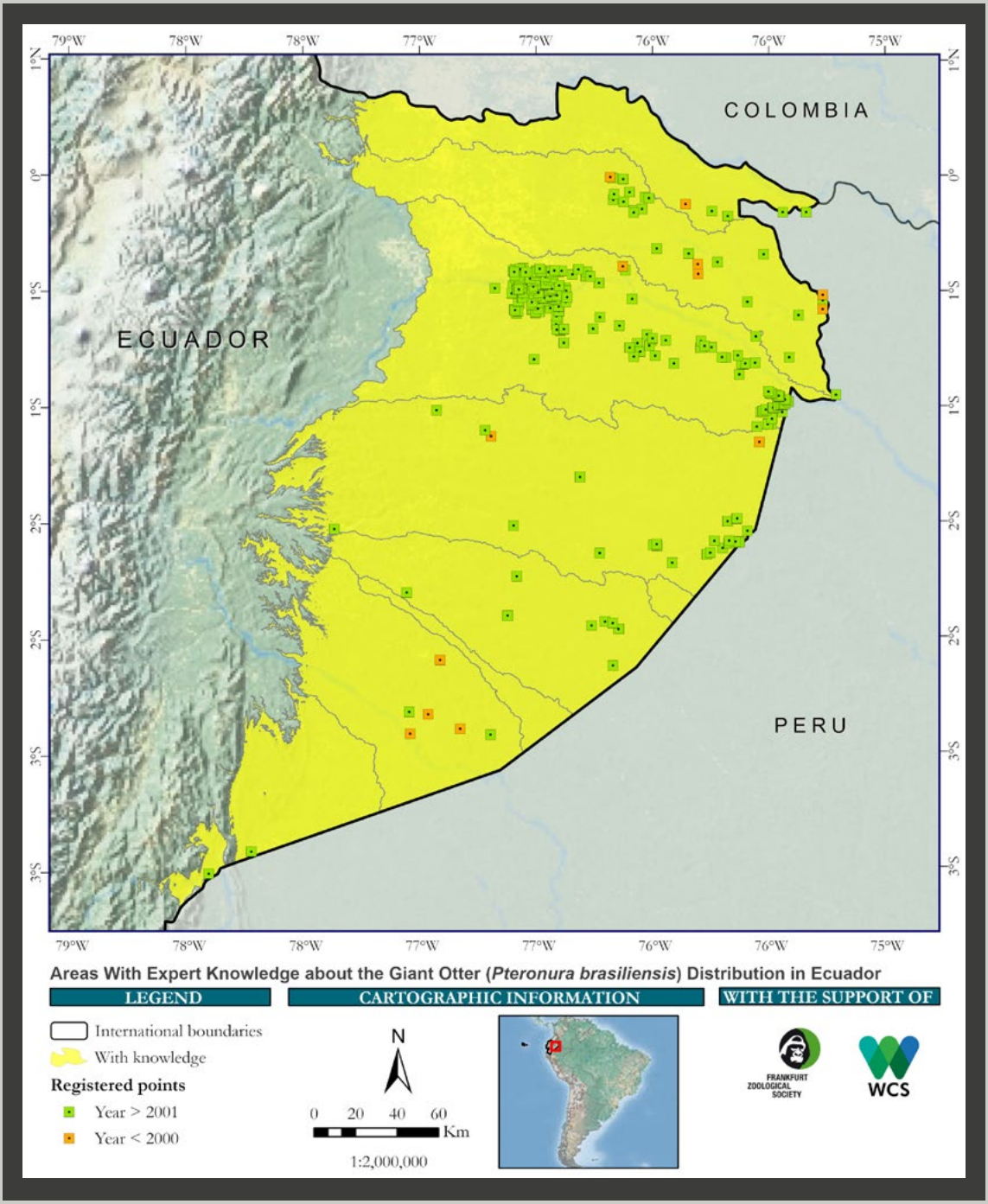


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Ecuador.

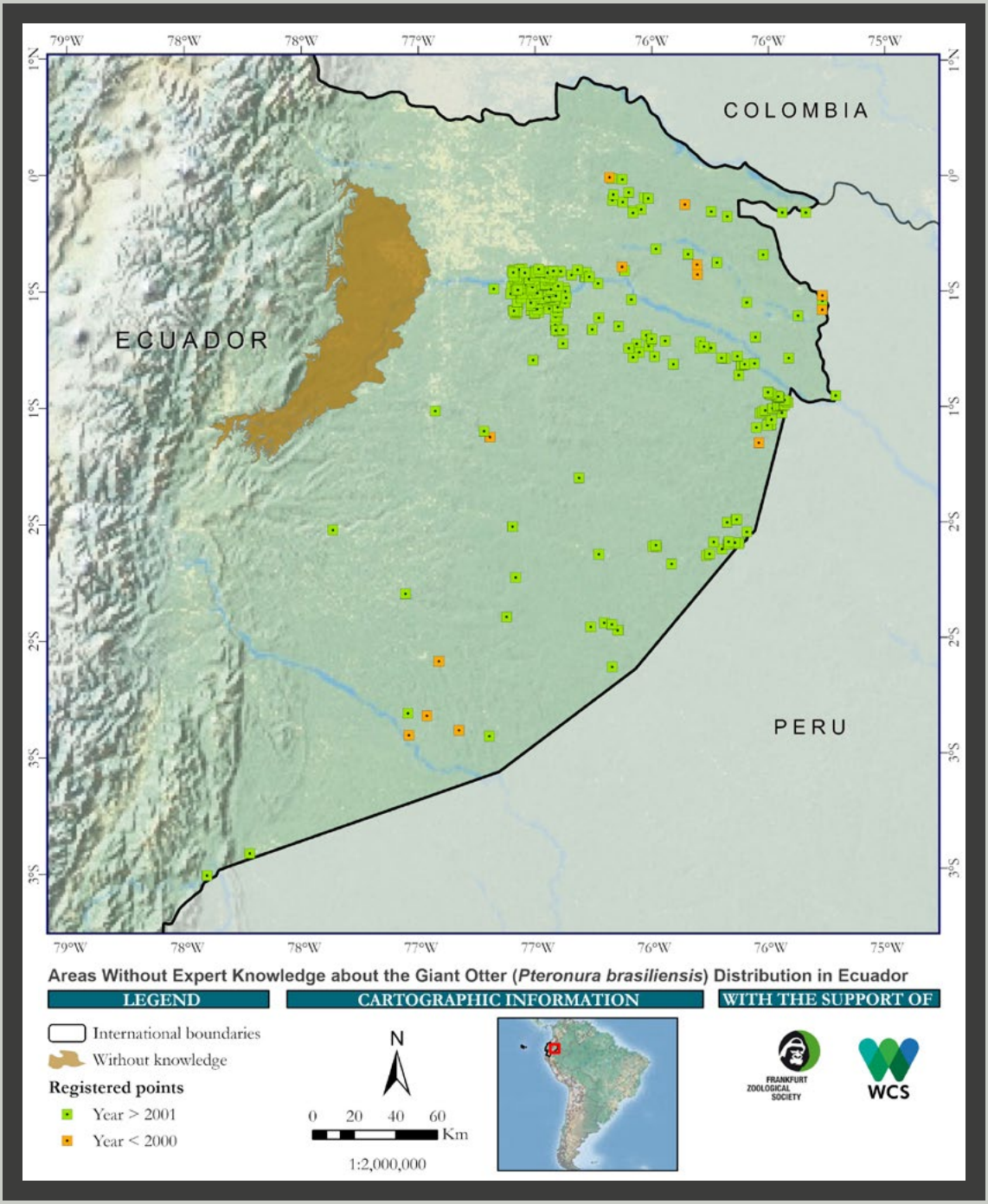


Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Ecuador.

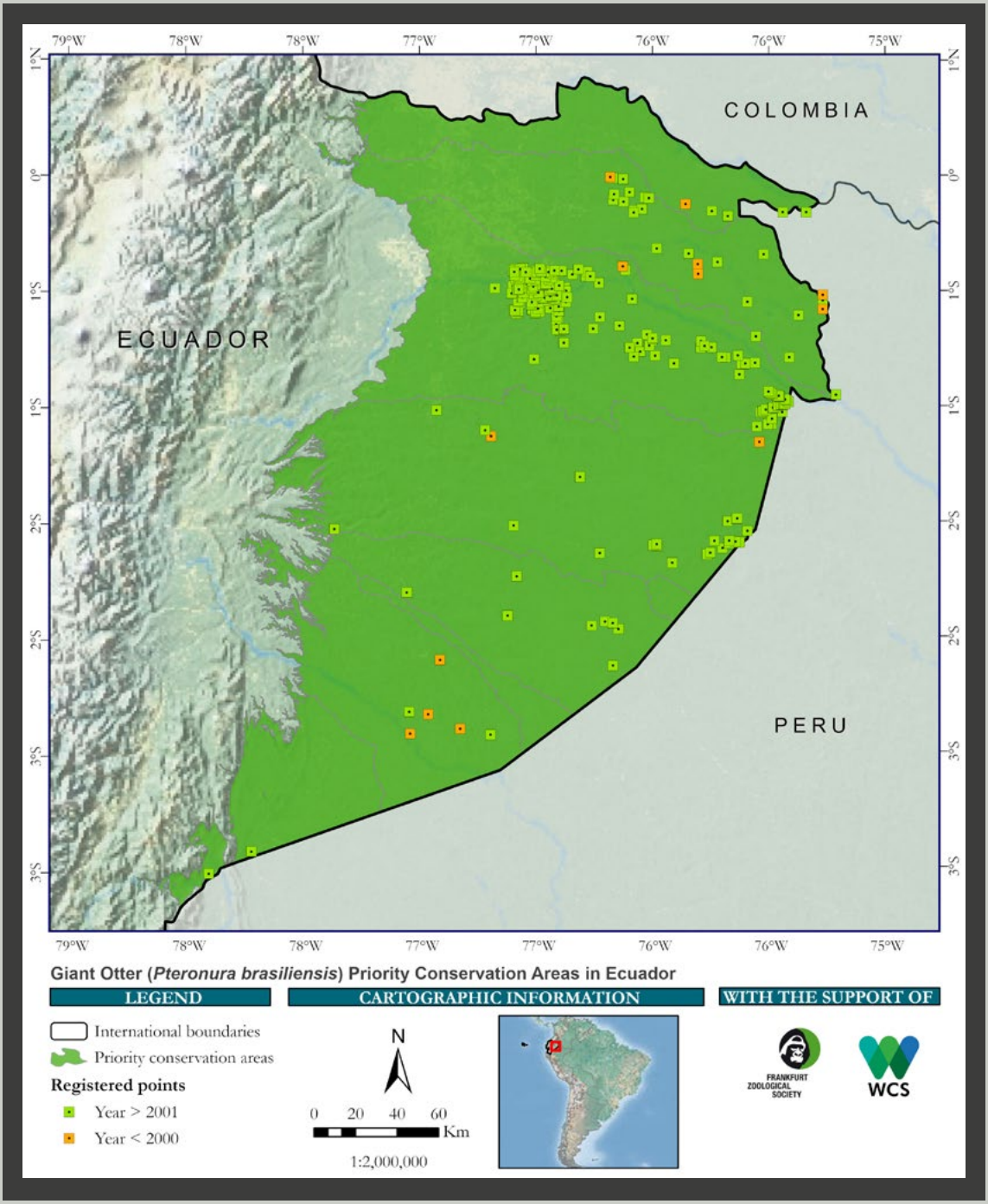


Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Ecuador.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

The only abundance estimation comes from a survey carried out in the northeast of Yasuní National Park in 2001 (Utreras 2001a). The 319 km survey along the Tiputini, Tivacuno, and Yasuní rivers, registered a total of 32 giant otter individuals (six family groups and two solitary individuals). A more recent survey was carried out in the Lagartococha River and lake system, along the eastern limits of the Reserva de Producción de Fauna Cuyabeno (Trujillo *et al.* 2016b), and with a survey effort of 86 km, a total of nine individuals were recorded in two family groups (six and three individuals respectively).

HABITAT USE

Studies focusing on habitat use have been carried out with groups of giant otters occurring in black-water lake systems, linked to small rivers, flooded forests and swamps (Lasso 2003; Pinos 2005), where marked seasonal fluctuations in water levels influence giant otter habitat use. During the dry season, giant otter home ranges are restricted, and they capture fish very easily in ponds or in areas of lakes and rivers with water flow, where they also use different den sites and marking areas or latrines along the river banks. Meanwhile, during the rainy season, water levels increase and flood wide areas of adjacent forest and swamp, including several den sites and latrines, and the home ranges of different groups increase and overlap (Utreras *et al.* 2005).

THREATS

During the 20th century, the main threat to giant otters in the Ecuadorian Amazon was intensive commercial hunting to supply the international pelt market, especially between the 1940's and the mid-1980's. During this period of almost 40 years, it has been estimated that Ecuador exported between 30,000 and 40,000 giant otter pelts. This caused a population decline that almost extirpated the species from the northern Ecuadorian Amazon (Utreras & Jorgenson 2003).

Currently, the main threats to the conservation of giant otters include the pollution and degradation of aquatic habitats due to an increase in human activities (Utreras 2001b; Utreras *et al.* 2013), such as oil extraction (oil spills), the advan-

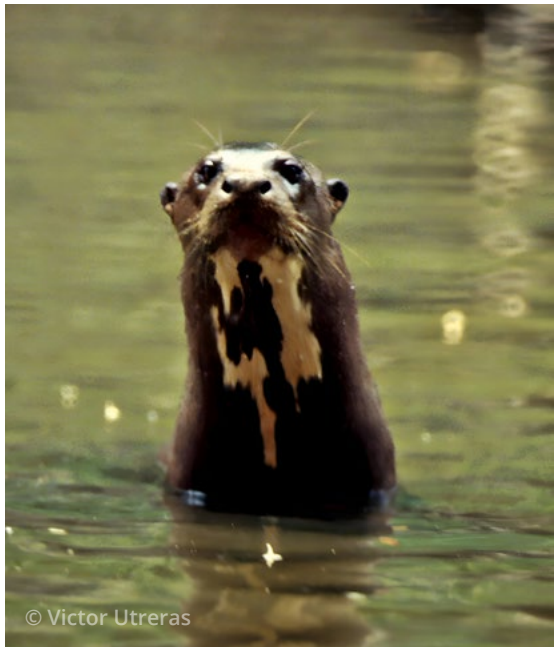
ce of extensive monoculture agriculture (fertilizers and insecticides), and mining (heavy metals). Many of these toxic substances severely affect aquatic habitats in the short term, and can also produce poisoning by bioaccumulation (Cabana & Rasmussen 1994; Chan *et al.* 2003; Arnot & Gobas 2004; Torres *et al.* 2009).

Other threats include fishing with dynamite and chemical products (insecticides), poorly managed tourism activities that affect sensitive areas of the giant otters' home ranges (den sites and rest areas), and conflicts with local fishermen. Although hunting is not considered an important threat anymore, some local fishermen kill giant otters considering them competitors for fish stocks.

Finally, the construction of large infrastructure projects, such as hydroways and dams, can cause irreparable damage to aquatic ecosystems. For example, as part of the Coca Codo Sinclair hydroelectric project, a large dam was built on the Coca River, the largest tributary of the Napo River, causing a significant reduction of the river's water flow, changes in water quality, and severe sediment retention. In addition, the development of the ITT (Ishpingo – Tambococha – Tiputini) oil concession in the northeastern section of Yasuní National Park, is affecting the lower sections of the Napo and Yasuní rivers, including the Jatuncocha and Tambococha lake systems, important giant otter refuges (Utreras *et al.* 2013).

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

The Napo River basin, where currently most of the main threats to giant otters are concentrated, and where large infrastructure projects are being planned, including new oil and mining projects, harbors the most endangered populations of giant otters in Ecuador. These populations occupy suboptimal and marginal habitats, composed of aquatic habitats with different disturbance levels, and prone to geographic isolation, especially between the populations located north and south the Napo River.



KNOWLEDGE ABOUT THE SPECIES

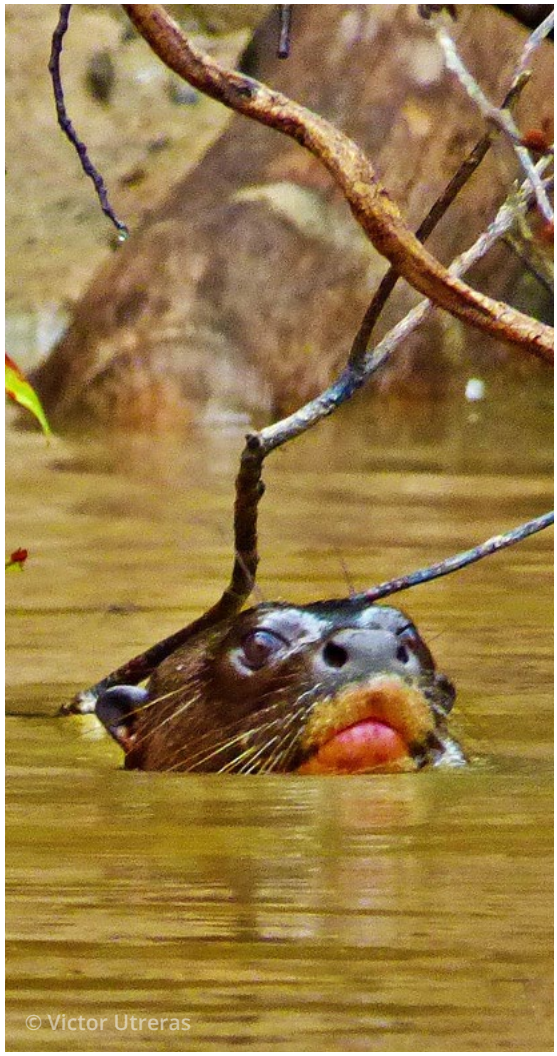
In Ecuador, there are few studies focusing on giant otters, and most were undertaken since the turn of the century. The majority of studies were executed in the Tiputini and Yasuni rivers, including the Tambococha and Jatuncocha lakes, and the Añangu Lake system in the northern section of Yasuni National Park. The main focus of research so far has been geographical distribution (Fersen *et al.* 1997; Utreras 2001b; Utreras & Araya 2002; Utreras & Jorgenson 2003), habitat use (Lasso 2003; Utreras & Pinos 2003; Pinos 2005; Carrera 2006), diet (Carrera 2003; Lasso 2003; Pinos 2005; Carrera 2006), home range estimation (Utreras *et al.* 2005), the impact of hunting (Utreras & Jorgenson 2003), and population surveys (Utreras 2001a; Trujillo *et al.* 2016).

LEGAL STATUS

The giant otter is a legally protected species in Ecuador. Giant otters are categorized as a Critically Endangered species (CR; Criteria C1) due to its small population size (Tirira 2021). The giant otter is a protected species in Ecuador since 1970, when by Presidential Decree its hunting was prohibited (Official Registry No. 818, November 20th 1970). It is currently categorized as a Critically Endangered species in Ecuador (Tirira, 2021). Recently, in 2023, the Ecuadorian government confirmed its status as a protected species, including the giant otter as a species threatened with extinction in Article 247 of the Organic Penal Code (COIP).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Most of the known populations are found inside two of the largest protected areas in Amazonian Ecuador (Cuyabeno Wildlife Reserve and Yasuní National Park), together encompassing an area of approximately 1,600,000 ha. In 2013, the Action Plan for the Conservation of Aquatic Mammals of the Ecuadorian Amazon was published (Utreras *et al.* 2013). The plan includes conservation strategies for the giant otter, and it was officialized by the Ministry of the Environment. Among the main strategies of the plan were the creation of the Cuyabeno- Lagartococha-Yasuní Ramsar Site (776,116 ha), officially recognized in 2017; train nature guides and improve tourism operations that focus on aquatic mammal observation; and train protected area staff in giant otter surveys and monitoring.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RECOMMENDATIONS FOR FUTURE EFFORTS

The execution of giant otter population surveys and monitoring is considered a priority action, especially in poorly known areas of its geographical distribution. It is also important to carry out impact assessments related to subsistence and commercial fishing, oil extraction, mining, tourism, and construction of large infrastructure projects. It is also important to develop genetic studies to understand the structure of the populations.

Tourism activities have increased in the current distribution of the species, especially in Añangu, Challuacocha, Garzacocha, Jatuncocha, Pilchicocha and Tambococha in the Napo basin, and the lower Pastaza basin, and it is necessary to develop management plans that allow ecotourism to benefit from the existence of giant otters as an attraction, but do not interfere with sensitive areas for the species (den sites and resting areas). Environmental education programs that focus on the importance of conserving giant otters and other endangered aquatic vertebrates, and on maintaining the ecological integrity of their aquatic ecosystems, are also necessary.

ACKNOWLEDGEMENTS

Giant otter research carried out by the Wildlife Conservation Society in Ecuador was funded by the Living Landscapes Program and the Gordon & Betty Moore Foundation. We are also grateful to Whitley Fund for Nature, Fundación Omacha, WWF, and the Ministry of the Environment and Water of Ecuador.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN FRENCH GUIANA

Benoit de Thoisy

LOCAL NAMES

Loutre géante (French), Tig dlo (creole), Yawakaka (Wayãpi (Wayana amerindian language), Awawa (Wayana amerindian language), Awali boya (Kaliña amerindian language), Yundu (Aluku Bush Negro language).

FRENCH GUIANA

HISTORICAL AND CURRENT DISTRIBUTION

In French Guiana, giant otters are present in most river drainages (Figure 1), except on the Mana River basin and the lower Maroni basin shared with Suriname and extensively destroyed by mining (Maroni basin: +400% of land deforested for mining between 2000-2015, Gallay *et al.* 2018). Lack of records may be explained by widespread pollution and also deficiency of field reports: those regions have been heavily invaded by illegal gold miners for almost three decades, and associated safety risks for field work preclude opportunities for surveys. In other basins, although the species is absent from the heavily disturbed main watercourses, it may still be present in smaller preserved tributaries. Giant otters are also still observed in small tributaries in northern French Guiana.

The following maps show the expert-defined historical distribution of the giant otter in the country (Figure 1), the areas with expert knowledge about giant otter (Figure 2), the areas where giant otter (*Pteronura brasiliensis*) no longer occurs, or only very sporadically (Figure 3), and the identified Priority Conservation Areas (Figure 4).

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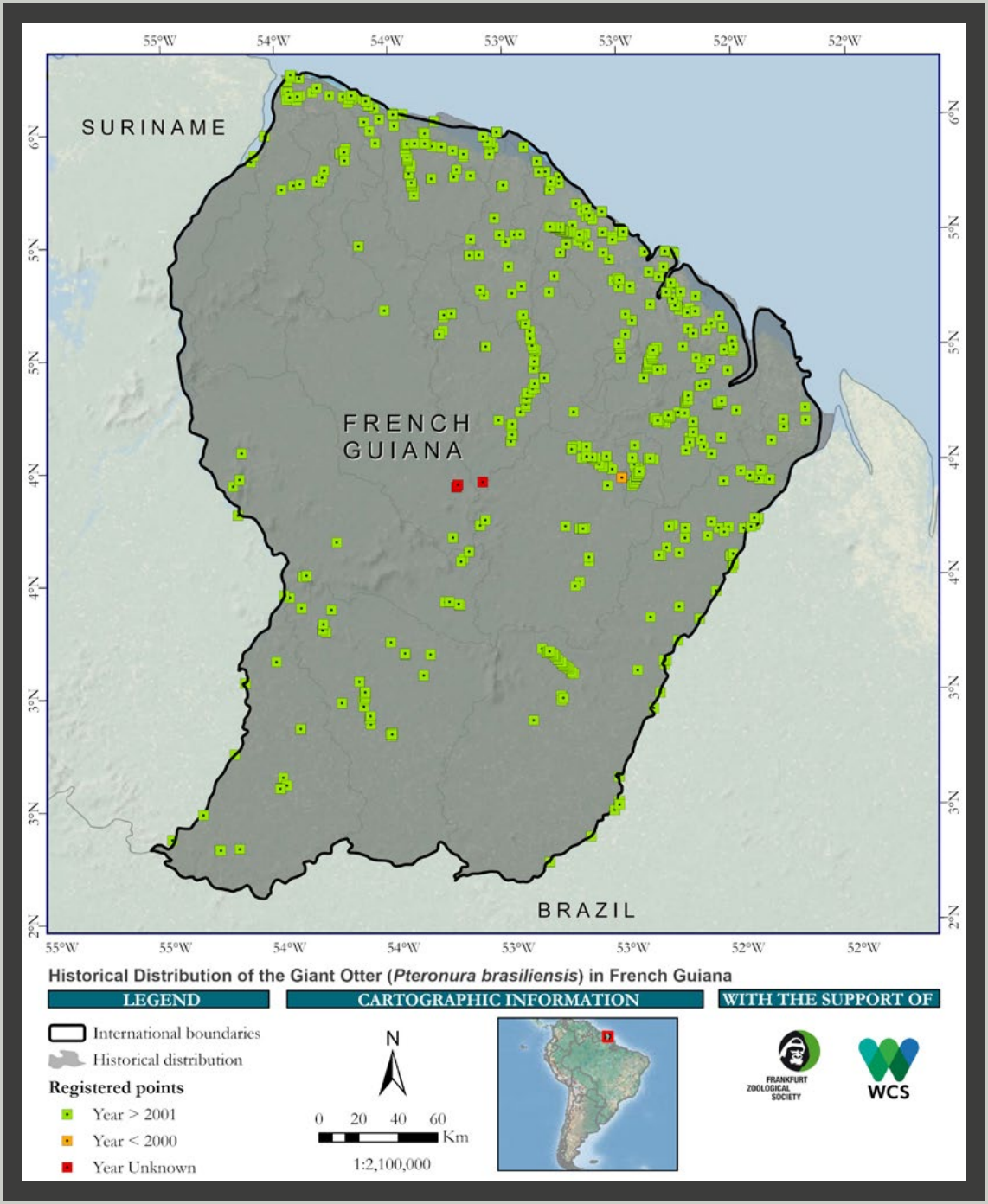


Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in French Guiana.

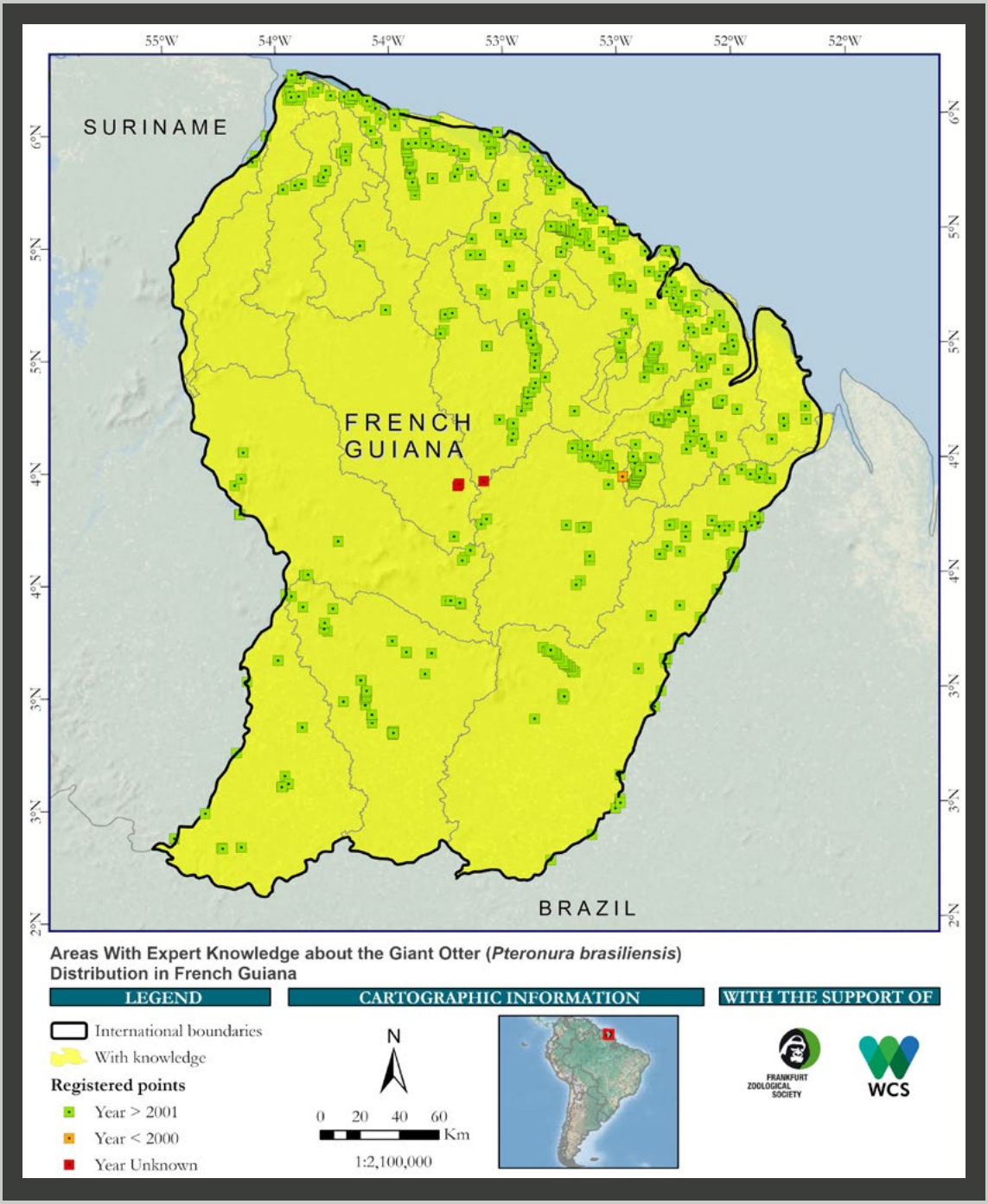


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in French Guiana.

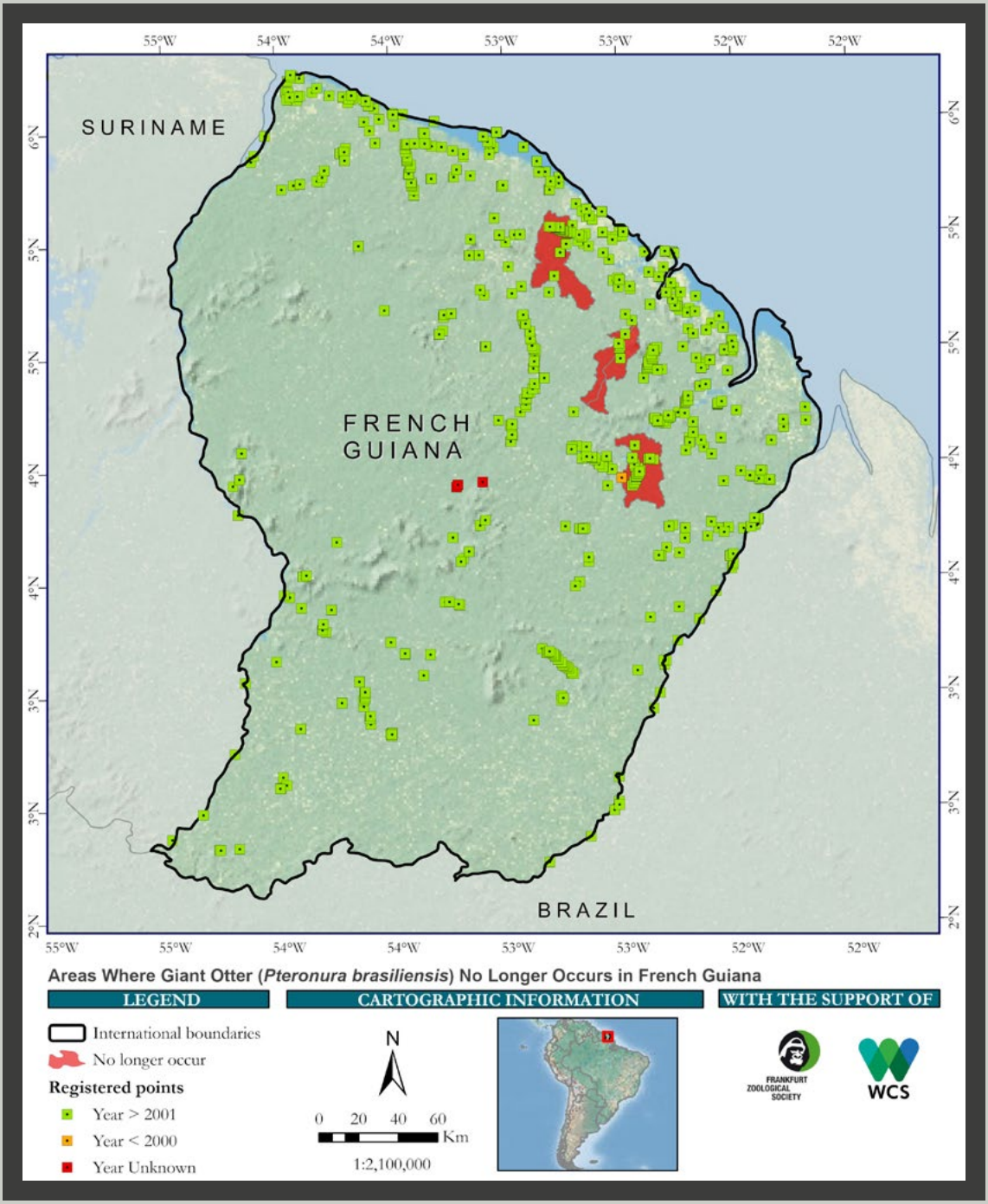


Figure 3. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in French Guiana.

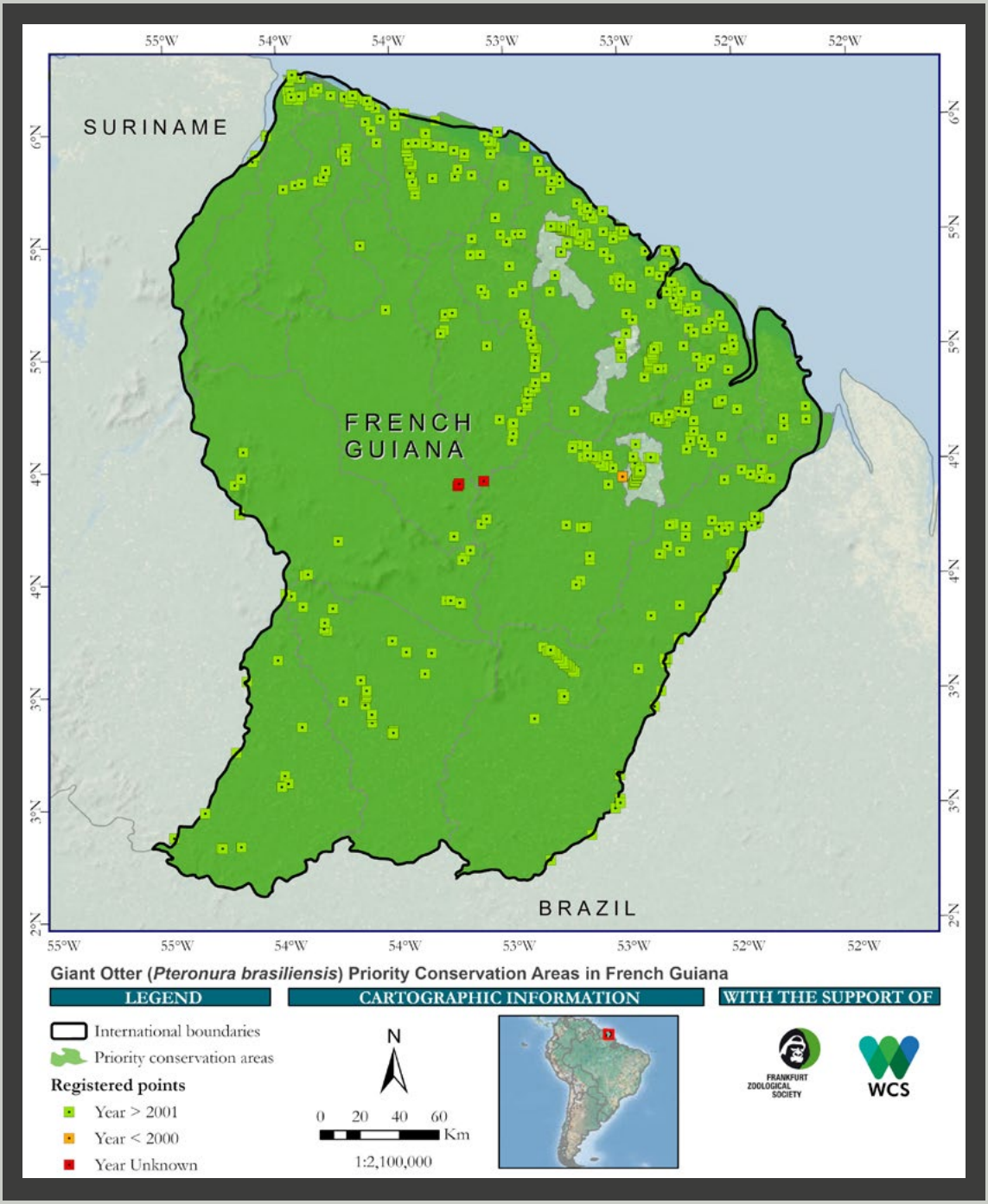


Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in French Guiana.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Giant otters were surveyed using direct sightings and records of tracks, feces, latrines and resting places in several watercourses between 2004 and 2010, and an update of surveys is underway (2020-2022).

Meanwhile the extent of threats and pressures on biodiversity, including mining, logging, human settlements, and hunting habits, was used to develop a human footprint index for French Guiana (de Thoisy *et al.* 2010: Figure 5). The human footprint was developed by superimposing geographical and human data, including human population densities, land use, settlements and camps, mining and forest activities, tracks, roads and rivers. Giant otter track counts on rivers with variable human footprint index levels show a clear negative trend. In areas free of disturbance (human footprint index <5), representing 63% of the entire territory, 0.8 to 1.8 signs were registered per km on the river. When the footprint index increases, giant otter abundances collapse, but interestingly presence signs are still recorded in areas with human footprint index values up to 15, representing a 180,000-ha loss of potential habitat. In 2005, 84% of the territory were below this cut-off value and by 2010, 82% of the country was below a human footprint index of 15 (de Thoisy *et al.* 2010; de Thoisy *unpub. data*). No recent evaluation of human footprint index is available, but there are recent spectacular increases in extractive activities in the region (Dézecache *et al.* 2017, Alvarez-Berrios & Aide, 2015), with deforestation increasing in the last 20 years (1,800 ha/year on the 2001-2005 period, 2,520 ha/year on 2006-2010, 3266 ha/year on 2011-2015, and 2,890 ha/year on 2016-2019) (Global Forest Watch), leading to a dramatic trend of habitat loss for otters. Although very recent trends of deforestation rates have stabilized, very small (<2ha) mining areas have become more and more common and widespread, and the need for higher resolution forest alerts maps for remote sensing surveillance of mining activities is required (Ballère *et al.* 2021).

The ongoing 2020 surveys revealed an extension of the gold mining impacts, with activities in areas never used before by miners, as increased gold prices likely allow exploitation of less profitable deposits. When comparing the 2020-2021 preliminary results with 2005-2010 results, the consequences on giant otter population were clear: of seven sampled sites, giant otters disappeared from four sites, sign abundance decreased from one site, and remained stable or slightly increased at two sites. Although some small remote tributaries may still serve as refuges, the recent absence of giant otter sign on some main water courses is alarming.

Giant otter population density estimates are not available for French Guiana. Nevertheless, sign counts may provide a relevant assessment of the number of animals present at a site: for 7 sites where group sizes were confirmed by direct sightings, sign counts (expressed as mean number of signs/km of river) were significantly related (r^2=0.7) to the abundance index (number of animals/km). Nevertheless, these promising assessments are too preliminary for an extrapolation at the country scale. In pristine areas, mean observed group size was 4.7 +/- 2.8 individuals (n=54), with

some groups including nine animals. Larger groups were found in more open habitats such as swamps and large tributaries. Group were smaller in forest tributaries, as well as in more disturbed areas.

HABITAT USE

In French Guiana, upland forest rivers are the main habitat for giant otters, but the species is also present in different forests types and biogeographic units, including rivers and tributaries running through highlands and *terrafirme* forests, swamp areas, flooded forests of the old alluvial plain, and some records in mangroves. Likely, absence of records in some habitats, for example in the northwest of the country (Figure 1) may be best explained by a lack of observers. Importantly, the map also highlights the importance of northern rivers and/or more downstream tributaries as suitable habitat. These areas also face higher pressures and benefit from lower protection levels than southern French Guiana (Figure 5).

THREATS

Gold mining is the main threat for aquatic species in French Guiana, including otters, and has increased over the last two decades (Hammond *et al.* 2006; Dézecache *et al.* 2017). The rivers of the Guiana Shield are characterized by some of the lowest natural suspended sediment loads in the world (Hammond *et al.* 2006), amplifying the detrimental role of exacerbated turbidity on biodiversity. Monitoring of gold mining using remote sensing was implemented at the end of the 1990´s (Gond & Brognolli 2005), quantifying the dramatic increase of pressures on terrestrial and freshwater habitats. French Guiana has a global forest cover of 80,000 km^2, and 110,000 km of fresh watercourses. In 1990, only 212 ha were used by miners, but this increased to more than 4,000 ha in 2000, 11,500 ha in 2006, 21,500 ha in 2010, and 27,878 ha in 2018. Regarding water pollution, 4,700 km of rivers with high water turbidity were detected in 2006, increasing to 6,000 km in 2010, and 6,799 km in 2018 (Coppel *et al.* 2008; Rahm *et al.* 2020).

Mercury contamination is important in another aquatic top-predator, the black caiman, *Melanosuchus niger* (Lemaire *et al.* 2021). Extensive surveys of mercury concentration in fish flesh revealed that mercury contamination is generalized in French Guiana (Richard *et al.* 2000), with almost all fish populations of small tributaries and rivers with levels above

the Environmental Quality Standard for biota established by the European Water Framework Directive (Gentès *et al.* 2019). High levels are especially noticeable in aymaras (*Hoplias aimara*) (Durrieu *et al.* 2005; Maury-Brachet *et al.* 2020). The impact of turbidity resulting from gold mining was recently assessed on fish populations (Brosse *et al.* 2010). Global fish biomass and richness did not decrease, but the functional structure of fish assemblages was significantly affected, favoring smaller and ubiquitous species at the expense of larger, habitat specialist species. Rarefaction of large predator species (*Hoplias aimara*) may have a consequence on otter populations. These pollution assessments do not necessarily mean that those areas are unsuitable for otters and lost forever. The density of the hydrologic network in the Guianas may provide some transient refuge areas for otters, putatively facilitating recolonization of deserted rivers as soon as they recover their ability to host populations. Due to the current extent of gold mining and associated pollution, the resilience of freshwater ecosystems will be key for the future of otters in the country.

The Petit Saut hydroelectric dam flooded 365 km² of pristine forest between 1994-96 (Vié 1999), with major changes in water quality, and a significant increase in mercury concentration in downstream fish flesh (Richard *et al.* 2002).

Giant otter poaching is not reported in French Guiana. Although some Amerindian groups claim competition with fishermen, no direct persecution of otters has been reported. Occasional records of otters kept as pets by Amerindian people are reported.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

Due to strict European laws on habitat protection, there is an expected strong involvement of governmental agencies in land planning and protection (de Thoisy 2018). The set of laws and decrees is expected to guarantee freshwater biodiversity, as soon as they are efficiently implemented in the field. Although otters may persist in lightly disturbed watercourses, pristine habitats are severely impacted by the ongoing gold mining rush (Rham *et al.* 2020).

KNOWLEDGE ABOUT THE SPECIES

Currently, only one NGO (Kwata) has a program dedicated to otter conservation, with field work and awareness activities implemented since the early 2000s. Key actions include population monitoring, assessment of threats and pressure impacts, modelling of the most suitable habitat, school and public conferences, and production of leaflets and a didactic book. A genetic recent study on otter feces in the Kaw Nature Reserve in northern French Guiana, where the dominant habitats are swamps and riparian forests, showed that the main prey are *Hoplosternum littorale*, *Chaetobranchus flavescens* and *Hoplias malabaricus* (Quéméré *et al.* 2021).

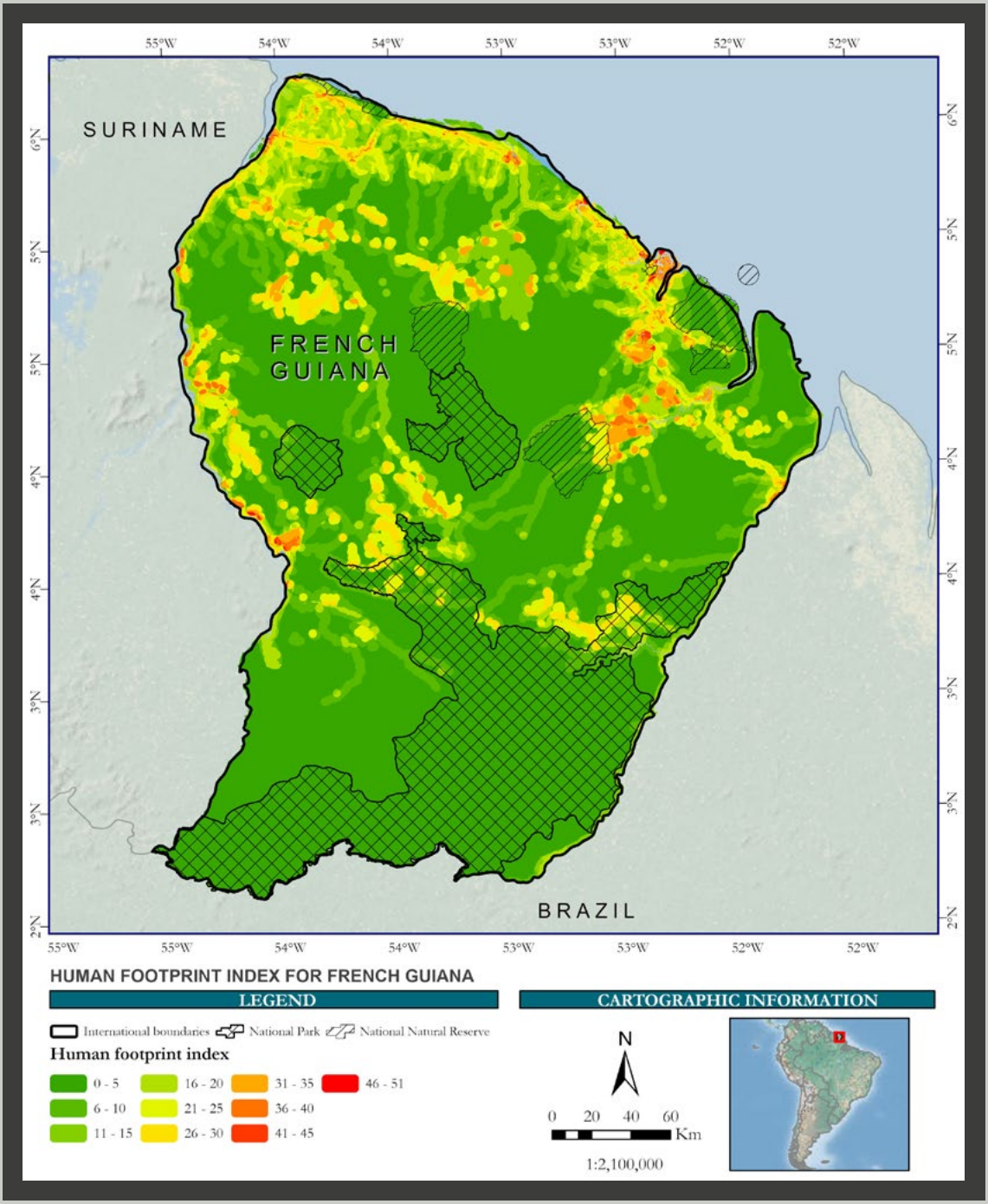


Figure 5. Human footprint index for French Guiana. Footprint increases from green to warmer colors. Simple hatches: Nature Reserves; Cross hatches: National Park.

LEGAL STATUS

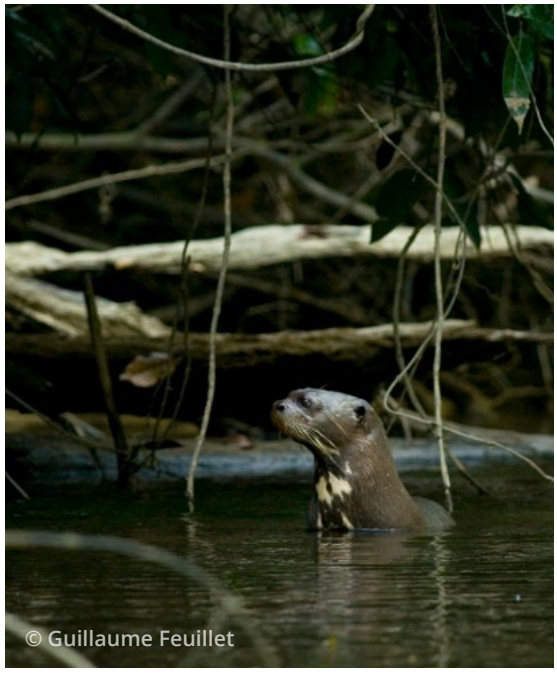
Since 1986, the giant otter is protected by a Ministry Decree.

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Protected areas with giant otter populations include five protected areas, all in northern French Guiana: Nouragues Nature Reserve (100,000 ha), Trinité Nature Reserve (76,000 ha), Kaw Roura Nature Reserve (94,500 ha), Amana Nature Reserve (14,800 ha) and Trésor Nature Reserve (2,500 ha). Watercourses have rarely been considered in the design of protected areas, and rivers are the boundaries of the Nouragues and Trinité Reserves, thereby limiting efficient protection of aquatic biodiversity. The national parks (20,000 km²) in French Guiana ensures that the country contains a rather comprehensive and well configured network of protected areas.

In theory, outside of protected areas, all forests in French Guiana are protected by national and European laws against deforestation and timber extraction. In forest areas dedicated to logging, the National Forest Agency controls all forest operations, and the presence of forest officers prevents illegal timber extraction. Several French laws are dedicated to forest protection, and offences would break several laws and/or European directives. This set of regulations is expected to protect watercourses and associated species. In 2006, French laws prohibited the use of mercury for gold mining, and in early 2011 cyanide was also prohibited. Nevertheless, most of the numerous illegal gold mining camps still use mercury supplied from neighboring mining areas Suriname and Brazil.

Some other initiatives are expected to further reduce indirect impacts. WWF works on gold traceability along the production process, from field extraction to sale of final products. The National Forest Agency and loggers agreed in 2010 on a charter expected to maintain low impact practices, including protection of riparian habitats and all watercourses and tributaries.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RECOMMENDATIONS FOR FUTURE EFFORT

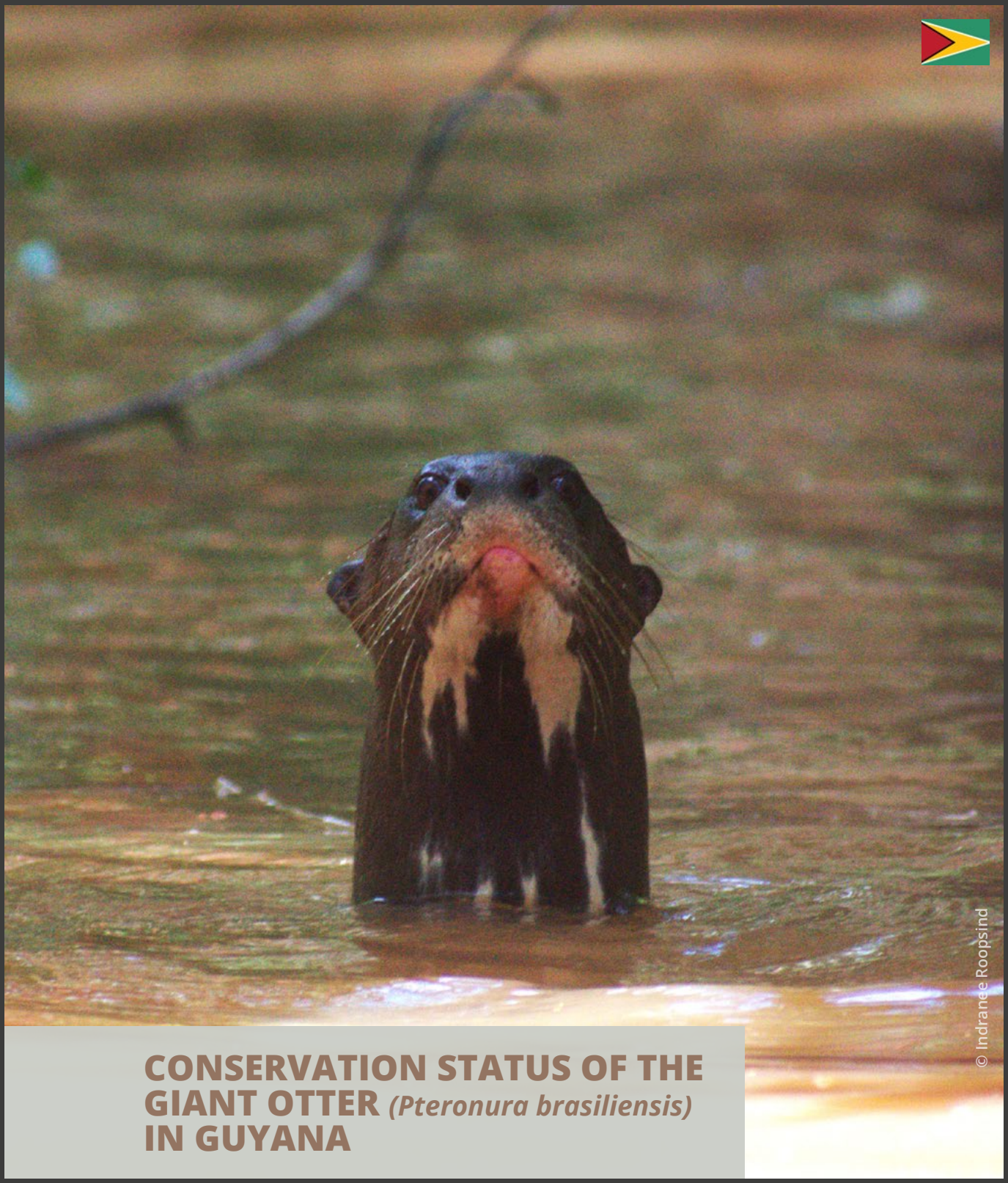
The Red List regional assessment classified the giant otter as Endangered, due to decline of habitat quality resulting from gold mining (UICN *et al.* 2017), although large areas of suitable habitat are still under low pressure. The first obvious recommendation is the need to mitigate the extension of gold mining.

Regarding research, the resilience of freshwater habitats and biodiversity is still poorly investigated. However, even in areas where mining activities had stopped for one year, fish community resilience was incomplete (Brosse *et al.* 2010). Studies on the restoration of populations of larger species, including otters, will require long-term monitoring of dispersal between watersheds and along watersheds. Highly variable genetic markers could be useful to achieve this target.

Also, due to the difficulty in monitoring population distribution, abundances and trends at a large scale, remote-sensing tools, species distribution models, and human footprint analyses should be developed as complementary to field work, thereby facilitating more dynamic and predictive assessments of population status.

ACKNOWLEDGEMENTS

Giant otter monitoring in French Guiana, implemented by Kwata NGO for 15 years, is funded by European funds, Ministry of Environment (DEAL/DGTM) and the Parc Amazonien de Guyane National Park. Warm acknowledgments to the public and participative database FauneGuyane, managed by the Gepog NGO, that facilitated a recent increase of referenced records for the species.



CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN GUYANA

Zelda van der Waal & Indranee Roopsind

LOCAL NAMES

Giant river otter (English), Turara (Makushi), Saaru (Wapishana), Eniabu peru (Arawak), Water dog (Creole), Turáclá (Patamona).

HISTORICAL AND CURRENT DISTRIBUTION

Giant otters are found across most of Guyana (Figure 1) including along the coast in the Berbice, Morawhanna, Mahaica, Mahaicony and Abary rivers, as well as in the interior on the Mazaruni, Potaro, Essequibo, Rewa, Burro-Burro and Rupununi rivers (Barnett *et al.* 2000; Sanderson & Ignacio 2001; Duplaix 2004; Sanderson *et al.* 2006; Pickles *et al.* 2009; Bicknell *et al.* 2011; F. Allicock *pers. comm.*; C. Bernard *pers. comm.*; J. de Freitas *pers. comm.*; M. Kalamaden *pers. comm.*; B. Lim *pers. comm.*; I. Roopsind *pers. obsv.*, J. Bicknell, A. Roopsind *pers. comm.,* Iwokrama 2002, 2009, 2012; A. Williams, *pers. comm.* WWF Guyana). Giant otters have been reported by local people in the northwest of Guyana. This occurrence was confirmed during a camera trapping project in early 2021 along the Kaituma River (8°1'10.16" N, 59°40'58.57" W), where there were photo captures of two adults, and a group of five individuals, including young (Matt Hallet *pers. comm.*). Giant otters have also been seen in the water reservoirs located on the coast of Guyana, with a sighting of a solitary male made in 2021 (6°47.272' N, 58°11.560' W: I. Roopsind *pers. obsv.*).

Giant otters are thought to be seen in the south of the country more often than they used to be (Diane McTurk *pers. comm.* 2012), however, it is unclear whether this increase is due to more individuals being present or to an increase in awareness and registered sightings. Observed group size of compiled records was between 1-8 individuals. Recent sightings in Guyana include a group of seven otters along the Manari Creek in March 2024 (L. Orella *pers. comm.*), a group of eight along the Rupununi River close to Wichibai in the South Rupununi in February 2024 (M. De Freitas *pers. comm.*) and a group of eight along the Takutu River in 2022 (I. Roopsind *pers. obsv.*). Other sightings include those made by the Frankfurt Zoological Society (A. Vosper *pers. comm.*), with four otters sighted in 2019 in Kanashen in the south of the country (1°50'16.69" N, 58°36'59.24" W), and the other two around the Kanuku Mountains, with five otters sighted (3°6'16.98" N, 59°14'14.13" W) and footprints along the Rupunini River (3°21'20.63" N,59°19'26.84" W). Additionally, in July 2023 there were observations of six otters in a waterbody along the Puriari River (6°20'13.47" N, 59°5'51.83" W), a tributary of the Mazaruni River (I. Roopsind *pers. obs.*).

Recent sightings also include a group of six otters along the Upper Canje River in March 2024 (D. Hemraj *pers. comm.*), as well as multiple sightings of 3 individuals along the Mahaica River (6°31'44.76" N, 57°53'14.64" W; S. Singh *pers. comm.*).

Historically, the distribution of giant otters includes most of Guyana (Figure 1), except for a region in the north-west of the country. Expert knowledge is lacking for this region (Figures 2 & 3). The identified Priority Conservation Areas cover the east and southern half of the country (Figure 4) and includes most of the locality records.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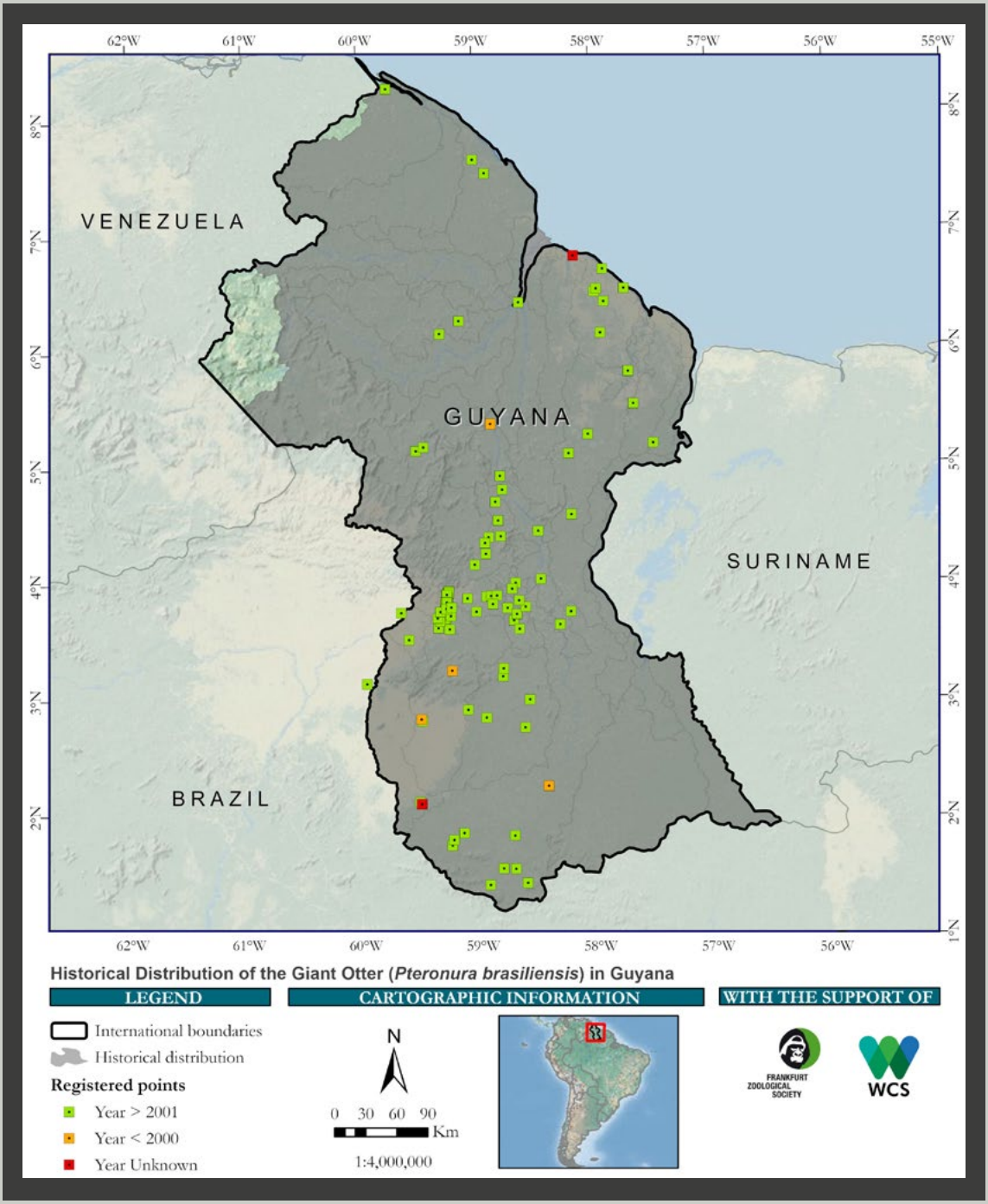

Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Guyana.

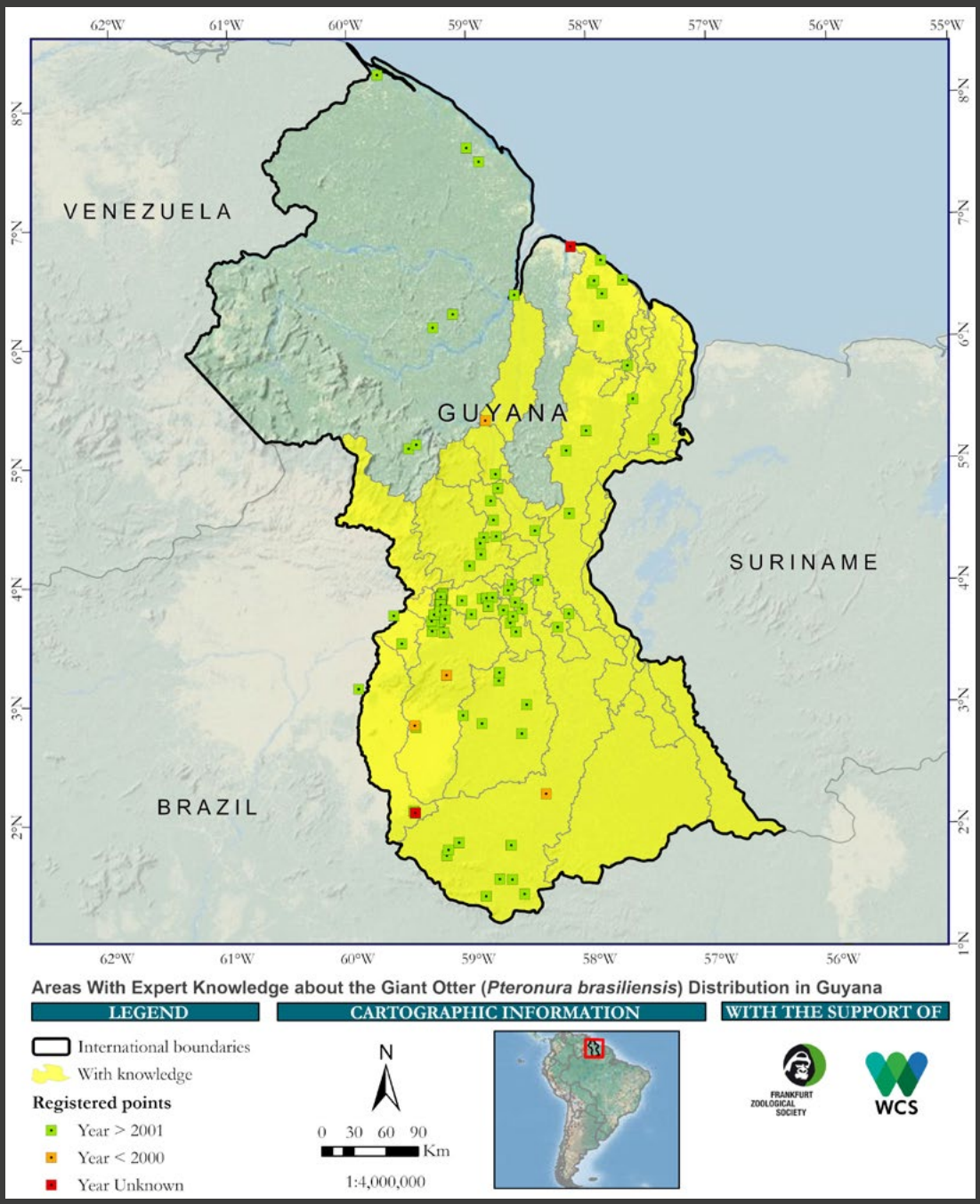

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Guyana.

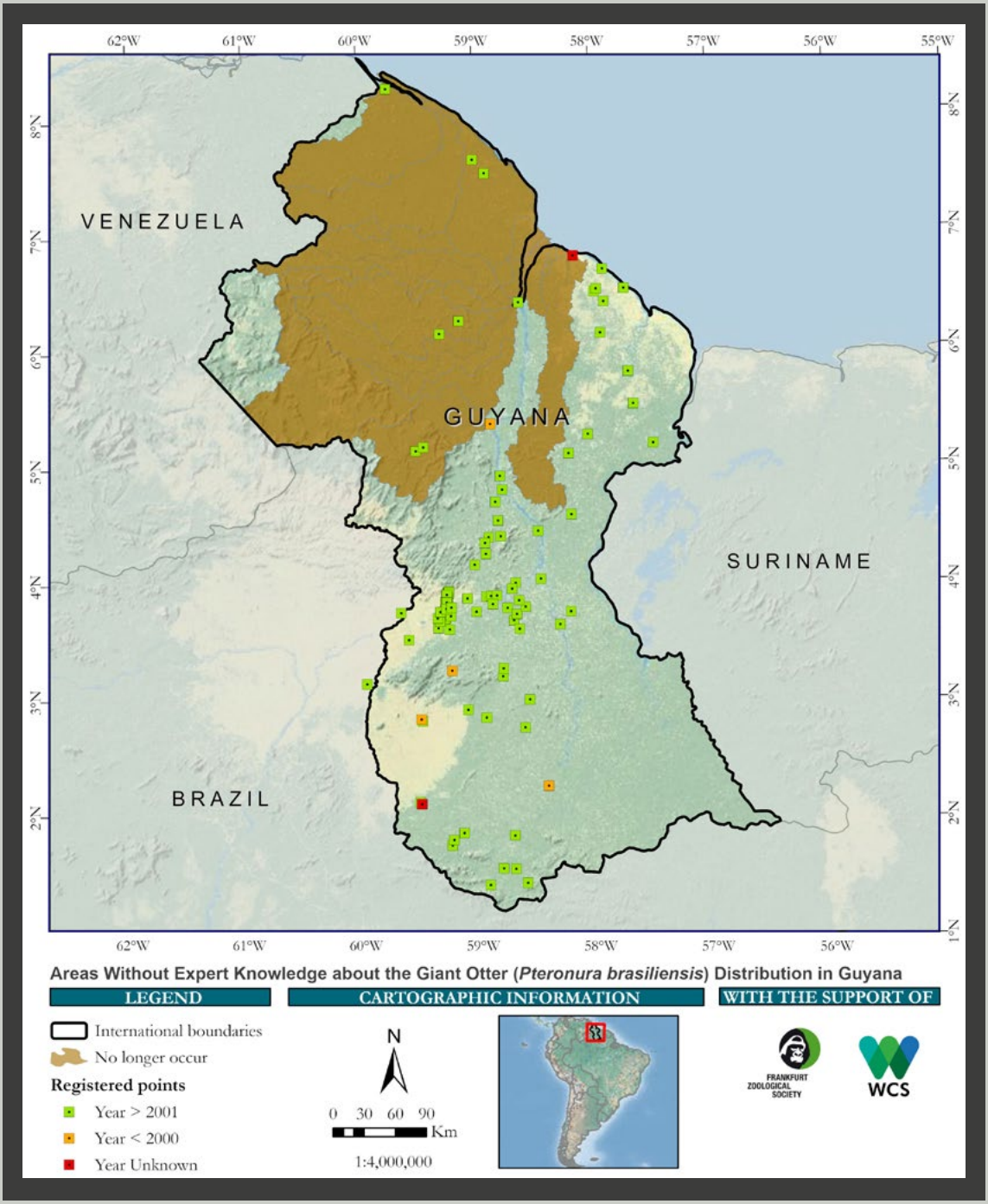

Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Guyana.

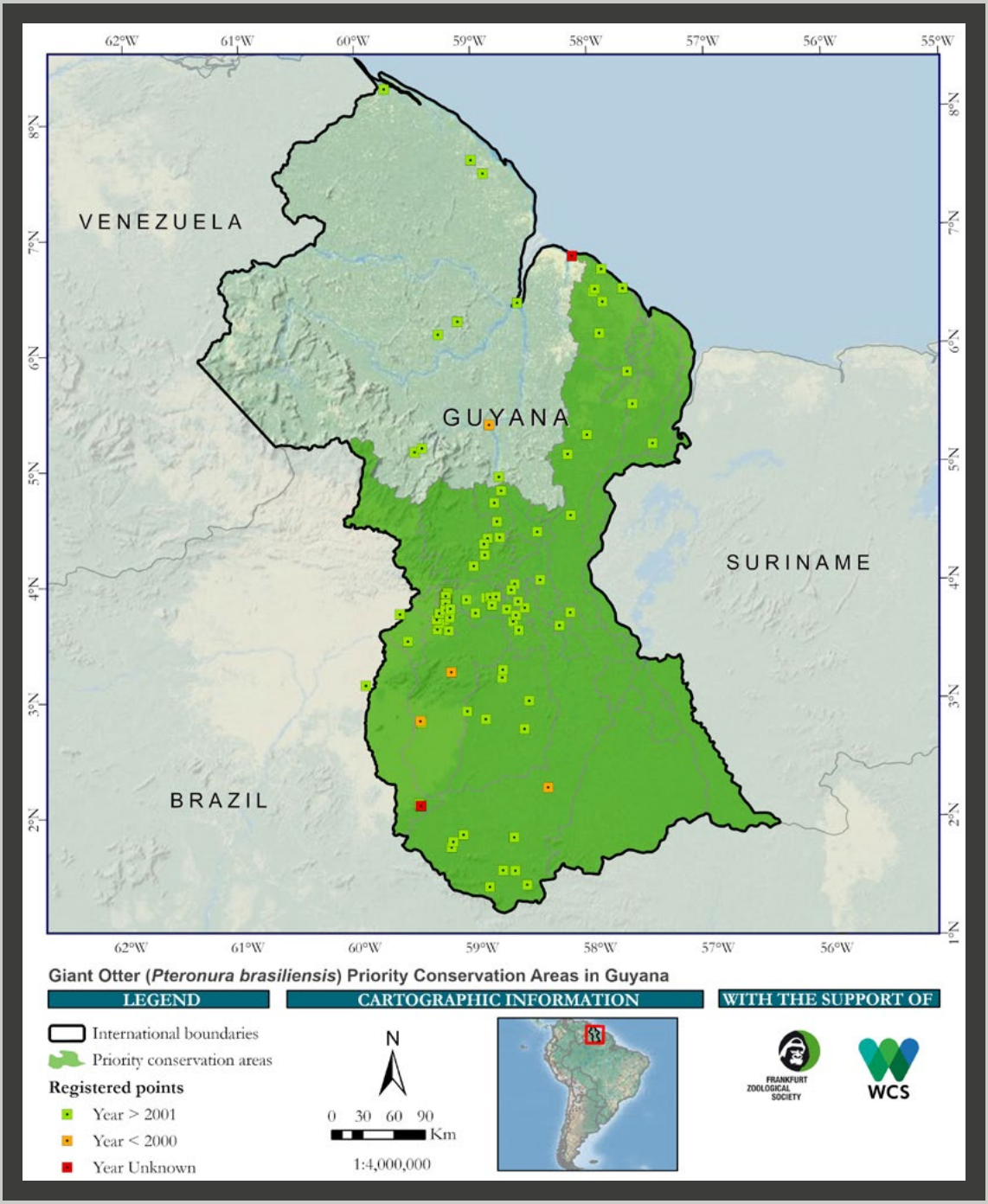

Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Guyana.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Giant otter population estimates are unavailable for most of Guyana, and therefore a population size estimation for the country is unknown. Nevertheless, Guyana is considered a major stronghold for the species and the need for better distributional and abundance data in the country is an urgent priority (Barnett *et al.* 2000).

Giant otters can be observed in the Kassikaytyu River, in South Rupununi (J. De Freitas *pers. comm.* 2012), though population estimates are not available. The Rewa Head and neighboring creeks (65 miles above Corona Falls) hold a minimum of 35 giant otters in 5 social groups, mostly on the lower Rewa (Pickles *et al.* 2011). The Surama region records about 10-15 individuals on a regular basis (Allicock *pers. comm.* 2012). The Iwokrama Forest Nature Reserve has recorded otter presence through "otter signs" (dens, campsite, and latrines), and found a frequency of 1.32 to 1.88 signs per km on portions of the Burro-Burro, Essequibo, Rewa and Rupununi rivers, and a lower frequency of 0.31 on the Siparuni River. The Karanambu area is considered a densely populated area with over 28 individual otters counted in a 40 km stretch of the Rupununi River (James 2010).

HABITAT USE

Giant otters are found in several aquatic habitats and their distribution is thought to be dependent mainly on fish abundance. Along the Rupununi River, near Karanambu, dens are built within both steep and slippery clay banks and sloping sand banks (*pers. obsv.* 2012; Duplaix 2004). The holts often take advantage of holes created by the roots of trees. Holts are surrounded by different vegetation types, such as mixed marsh and high swamp forest, low marsh forest, or oxbow lakes and ponds along the Rupununi River (Duplaix 2004), or seasonally flooded forest along the Essequibo River (*pers. obsv.* 2012). Giant otters have also been observed to make tunnels in grasses in the absence of elevated banks along the water reservoirs in Guyana (I. Roopsind *pers. obs.*).

During the rainy season, giant otters are rarely observed by local communities and so the habitat use of giant otters is unknown during these periods. In northern Guyana, the first rainy season occurs from mid-April to late July, and the second wet season is between mid-November and late January. In southern Guyana there is one extended wet season from mid-April to mid-September (Hydromet Guyana 2012).

THREATS

Direct threats to the giant otter are believed to be low due to the anecdotal number of recorded mortalities. Until 1975, giant otters were trapped for their skins and there are records of skins being bought in Aranaputa Village to make bags and belts, sold in town (NRBB 2000). There are cultural values regards the species, as claws are seen as a protection during menstruation, as Bina for a safe journey, and a charm for good fishing. Hunters were known to shoot giant otters after calling them, mostly as an entertainment. Hunters used to use a gun or to smoke the otters out of their burrows, using a mixture made with pepper (NRDDB 2000). These practices represented serious threats to giant otter populations as they led to the death of whole otter families. Hunting was forbidden in 1968 and the reinforcement by government rangers and patrols proved efficiency. However, in 2001 giant otters were reported to be hunted along the Canje River and in eastern Guyana near some bauxite mines (Barnett *et al.* 2001).

Gold mining and changing land use practices, especially along riparian zones may be the most important threats to giant otters in Guyana. In 2004, the gold mining sector was made up of 11,000 persons and has been increasing ever since (Hays & Vieira 2004). Artisanal gold mining is a threat due to water pollution, mercury pollution and degradation of habitat. People and fish were sampled in areas in the vicinity of gold mining, and mercury levels were higher than the amount considered safe (Duplaix 2004; Hays & Vieira 2001), with this level increasing with higher fish consumption. Mercury levels are probably unsafe for giant otters, who live in the rivers, feed exclusively on fish and are in constant contact with sediments.

Overfishing, and diseases are not documented and are not considered as significant threats in Guyana. The oil industry and hydroelectric development are relatively new developments in Guyana and have not been assessed as having any immediate threats to giant otters.

Conflicts with fishermen exist as giant otters are perceived as pests by a minority of villagers. Otters are very efficient at fishing. Local communities in the Rupununi often have perceptions that otters concentrate fishing efforts and consumption on species that are consumed by villagers, for example, *Osteoglossum bicirrhosum* (arawana), *Cichlaocellaris*(lukanani),*Pseudoplatysoma* sp. (tigerfish), *Serrasalamus* sp. (perai) and *Myleus* sp. (pacu). However, analysis of giant otter scat from the Rupununi and Rewa rivers in 2002, showed a dietary preference for slow moving predators such as *Hoplias malabaricus* (houri) and *Hoplerythrinus unitaeniatus* (yarrow).

It is said that "when Turaras (giant otters) are around, the fish do not bite hooks" (NRDDB 2000), which resulted in individual otters being shot occasionally in the past.

Live capture of young giant otters for the pet trade is an occasional threat, however, they become undesirable as they grow up, consuming larger quantities of food and behaving more rowdily, and often get killed or chased away (NRDDB 2000).

Giant river otters are perfect candidates for ecotourism; however, no regulation

currently exists to regulate this activity, and potential impacts in Guyana are not documented. The Karanambu ranch is the most well-known giant otter watching destination in the country.

Climate change is an important factor via extended La Niña conditions, which result in high rainfall and water levels in Guyana. Giant otter habitat use changes given water levels, although the precise consequences are undetermined. Similarly, increased intrusion of tidal water into freshwater is a potential threat. Salt water penetrates the river system during the flood tide. The extent of these tides is likely to increase with rising sea levels, beach erosion and mangrove destruction (Narayan, 2006).

Human presence and especially boat traffic is thought to be associated with lower sighting frequencies. However, giant otters can still be seen in relatively busier areas, such as the Rupununi River, sometimes even found on boat landings.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

Changes in distribution of the giant river otter due to human threats have not been documented. However, changing land use, especially along riparian zones, and mining pollution may strongly impact the population's distribution. Gold mining is more important in northern Guyana, but there is a growing shift towards the southern rivers of the country. In any case, populations in northern Guyana are likely to decrease and suffer from mercury pollution, whose effects will only be revealed in the long term.

As giant otters occupy wetlands differently according to wet and dry seasons, climate change may affect their distribution. Guyana has undergone unusually long periods of La Niña, which brings flooding conditions and may affect giant otter habitat use and reproduction.

KNOWLEDGE ABOUT THE SPECIES

Giant otters were surveyed in 2002 in the Rupununi River and the Iwokrama forest, which led to mapping of den locations and to estimates of otter population densities. Another survey took place in 2009 along the Essequibo, Burro-Burro and Siparuni rivers, where otter sightings are still recorded to this day.

Karanambu is known to have a high number of otters, especially on the Rupununi River, a tributary of the Essequibo. A study was conducted between 2002-2004 to gather quantitative and qualitative information on giant otters near Karanambu (Duplaix 2004), with a follow-up survey in 2010. Diane McTurk has rehabilitated orphaned otters at Karanambu for over 30 years with expert knowledge on captive otter ecology and behavior (McTurk & Spelman 2005). However, little field research has been conducted at the site.

LEGAL STATUS

Internationally, the giant otter is listed on Appendix I of the Convention on International Trade in Endangered Species (CITES), as Endangered under the United States Endangered Species Act and as Endangered under the IUCN Red List.

In Guyana, the giant otter is listed on Schedule IV of the Species Protection Regulations (1999), made pursuant to the Environmental Protection Act (1996). The schedule IV lists species requiring protection in Guyana, indicating otters are subjected to the provisions of Species Protection Regulations (1999), which regulates wildlife trade. Additional measures to protect giant otters in Guyana are not yet clearly defined (A. Sankar - Head of Wildlife Division *pers. comm.* 2012).


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PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Training and workshops

In 2010, a wildlife club workshop at Karanambu used a citizen science method, where visitors and tourists participate in the monitoring activity and upload photos to a Google Earth database, which is used to identify and monitor individuals (S. James *pers. comm.* 2012).

Knowledge dissemination, education and awareness-raising

An Iwokrama workshop in 1998 led to the creation of a brochure containing detailed information regarding community-based wildlife management in the North Rupununi. This was made accessible to local communities and generated a higher wildlife conservation awareness amongst the North Rupununi inhabitants, including for giant otters (NRDDB & Iwokrama 1999). In 2010, the Karanambu wildlife club workshop aimed to disseminate knowledge, discuss issues, and find solutions to challenges.

Management and protected areas

Giant otters occur in the following protected areas in Guyana: the Iwokrama Wilderness Preserve (1997, 360,000 ha), where giant otters are part of the Iwokrama Centre's Forest Impact Monitoring program, the Kaieteur National Park (1929, 242 square miles), the Kanuku Mountains (2011), and the Konashen district Community Owned Conservation Area (2004, 4,000 km^2).

RECOMMENDATIONS FOR FUTURE EFFORT

Research

The species requires extensive monitoring. Community-based surveys may be the best way to record reliable counts and geographical distribution, as local communities are able to identify otters individually. Research is needed on the precise distribution of the species, as well as interactions with their natural habitats and population dynamics. Consistent surveys are required to run comparative studies and quantify the evolution of population size and distribution. Information collected by each community needs to be gathered into a single database to facilitate a global understanding of trends, generate comprehensive maps and design relevant conservation plans. In order to design relevant population management measures, seasonal habitat use needs to be investigated and home range determined. In Ecuador the use of satellite or radio-transmitters is recommended as a tool to monitor the species (Utreras *et al.* 2005).

The recent increase in community interest in ecotourism also needs to be addressed. However, before designing a relevant population management plan, the ecological requirements of the species must be better understood. In the meantime, the impacts of ecotourism have not been described, and a precautionary approach should be employed.

Training

The combination of information rigorously collected by communities with an ecological modelling analysis would lead to a deep understanding of giant otter populations. Training should be dispensed to local communities regarding efficient survey methods and data storage. The standardization of the methodology to all concerned communities would generate a highly reliable dataset and accentuate a collective conservation mindset throughout the communities.

Education and awareness

Environmental education is essential to the protection of giant otter populations and should be continuously promoted within the communities. Wildlife clubs, festivals and workshops are efficient means to convey the conservation message within local communities across Guyana.

ACKNOWLEDGEMENTS

We thank Matt Hallet, Lissa Orella, Devya Hemraj, Sarah Singh, Maya De Freitas from Guyana and Ashley Vosper from the Frankfurt Zoological Society for providing more recent records in Guyana. We also thank the other participants who contributed to the Guyana country working group at the Range Wide Priority Setting workshop in Puerto Maldonado: Thadaigh Bagally from the Frankfurt Zoological Society, Francisco Gomes and Adit Sharma from the National Parks Service, and Luisa Velez and Christina Ward from Colors for Conservation.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN PARAGUAY

Jose L. Cartes, Robert Pickles & Veronica Zambrana

LOCAL NAMES

Arirãi (Guarani), Jagua kaka (Guarani), Lobo marino (Spanish), Lobomarín (local name).

HISTORICAL AND CURRENT DISTRIBUTION

Historical documents mention the presence of giant otter in almost all the river systems of the country (Paraguay and Parana rivers), with references from the mid 1600's until the mid-20th century (Figure 1). For example, Father Roque Gonzalez de Santacruz (early 1600's) reported a "notable abundance of wolves swimming in the Jesuit Channel" (Parana River at Yacyreta Islands).

Figure 2 details the expert opinion regarding areas with knowledge about giant otter distribution in Paraguay, and Figure 3 details the areas where giant otters are no longer considered to occur in Paraguay.

In 1984 however, Melquist published a regional assessment mentioning "River Ypane" as the only record for Paraguay. Several Rapid Ecological Evaluations (REE) conducted by the Fundación Moisés Bertoni in the establishment of private reserves recorded a handful of references from elderly hunters, who said that giant otters were "common in the old days" (Ramon Villalba *pers. comm.*). These records relate to the Mbaracayú Reserve in the Jejuí and Jejuimi rivers (Fundación Moisés Bertoni 1998; Esquivel 2001; Guyra Paraguay 2004) and Ka'i Rague Reserve in the Ypane River (Macedo *et al.* 1996). From 1999, José Luis Cartes and others have identified a resident population in the Negro River on the border with Bolivia and Brazil (Mercolli *et al.* 1999). Carlos Valiente (*pers. comm.*) also found evidence for the presence of giant otters near Fuerte Olimpo in the Paraguay River and some tributaries.

In 2013 new localities were recorded further south (Cartes *et al.* 2013), in Presidente Hayes at the mouth of the Montelindo River, and in Puerto Antequera, San Pedro, at the mouth of the Jejuí River. At that time, a possible repopulation of otters was suggested in the southernmost sections of the Upper Paraguay and the Bahía Negra area. More recent records from 2022 have added new points at: Villa del Rosario (Puerto Rosario) and near the mouth of the Piribebuy River where it joins the Paraguay River.

Current giant otter distribution is restricted to the upper Paraguay basin, from the mouth of Piribebuy River to the northern border where the experts consider that there are two small Priority Conservation Areas for the species (Figure 4).

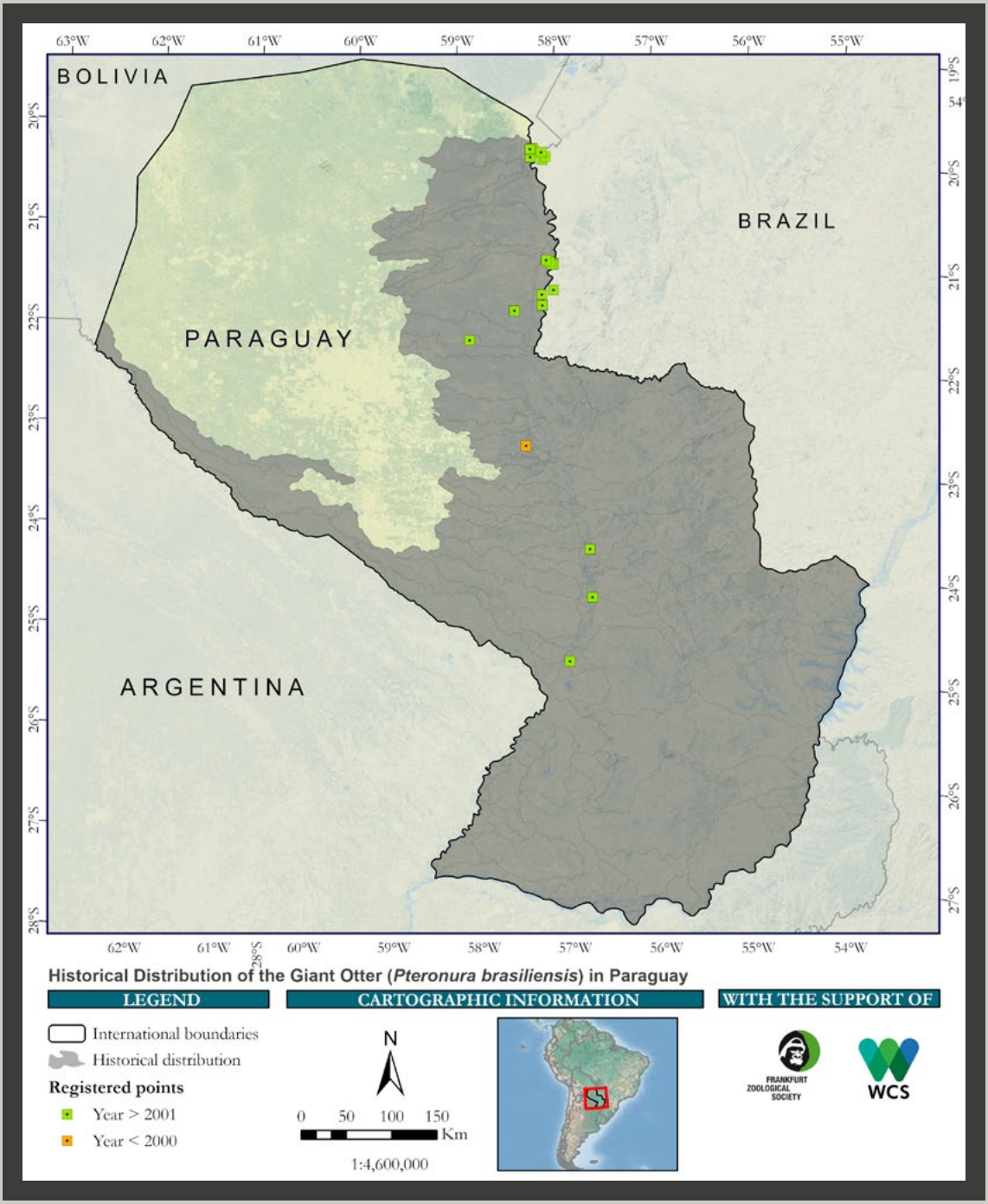


Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Paraguay.

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Paraguay.

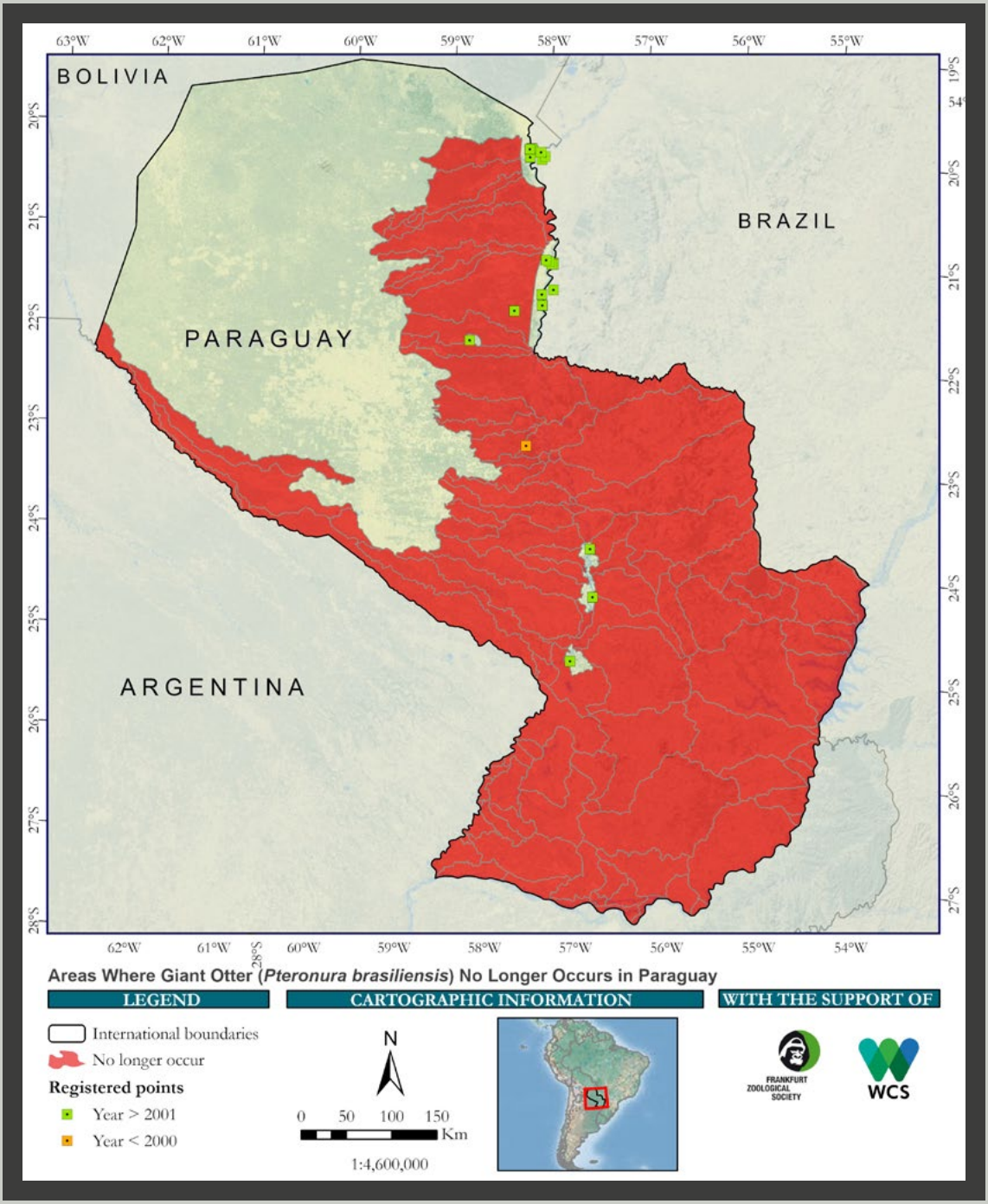


Figure 3. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Paraguay.

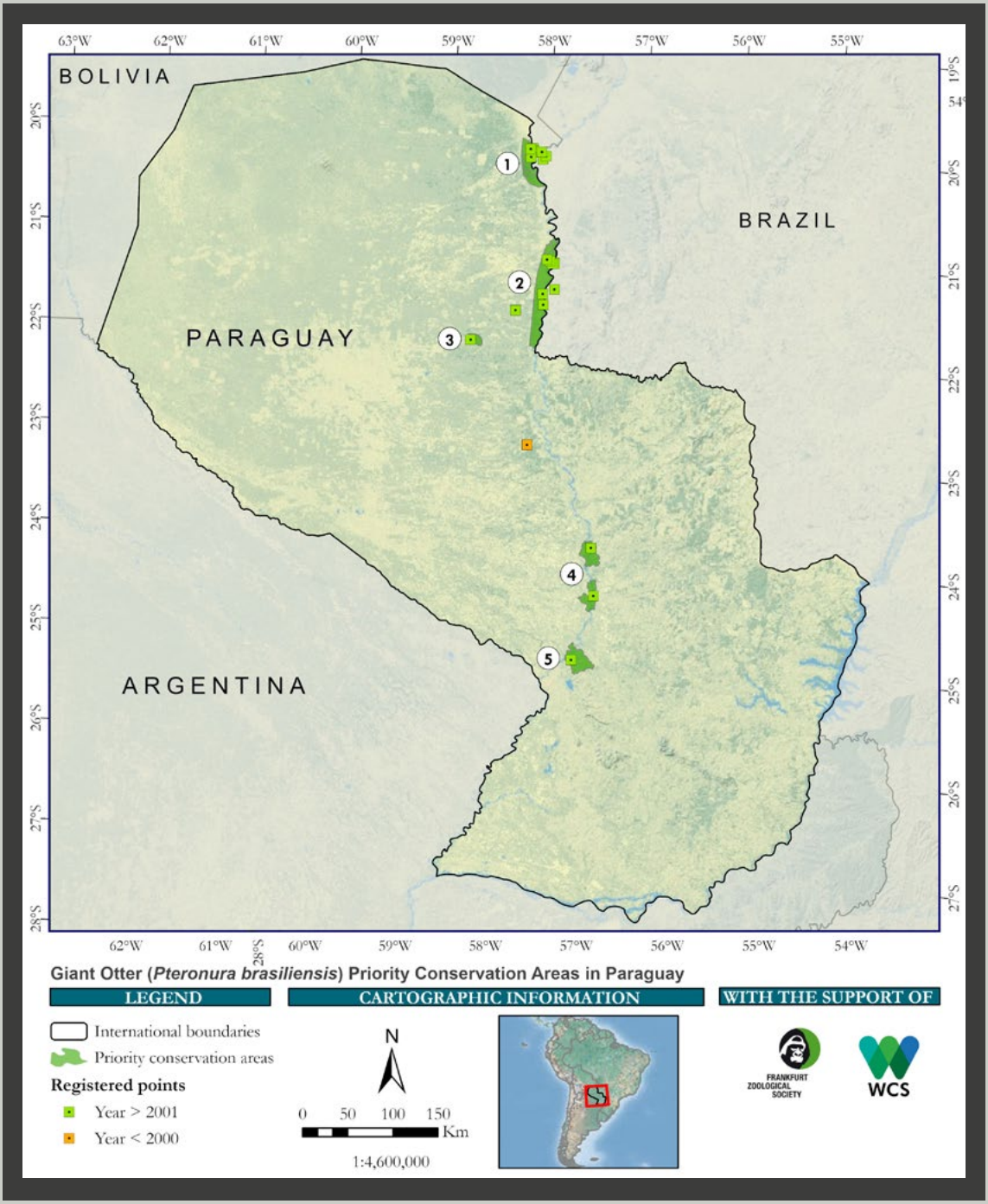


Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Paraguay.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Based on sightings data, the minimum population size of giant otters for Paraguay is between approximately 30 to 50 individuals. While this is likely to be a conservative estimate, the known range of the species in Paraguay is extremely small and the population is fragmented and low density. The entire Paraguayan population is restricted to the Paraguay River and Negro River along its north-eastern border. The Paraguayan giant otter population can be subdivided into six sectors: (1) Negro River, (2) upper Paraguay River and Bahía Negra, (3) Paraguay River between Puerto Guaraní and Carmelo Peralta, (4) the Nameless River between Puerto Guaraní and Carmelo Peralta, and (5) the southern section of the Paraguay River between the mouths of the Montelindo and Jejui rivers, including Puerto Rosario, and (6) the mouth of the Piribebuy River.

Sector 1
Negro River

A population of between 10 and 16 giant otters has been continuously monitored from 1999 until 2021. This population has holts on both sides of the Negro River, along the border between Bolivia (Otuquis National Park) and Paraguay (Paraguayan Pantanal Nature Reserve & Three Giants Biological Station). In 1999, as part of an REE for Fortín Patria Ranch in Paraguay, a team of scientists from Fundación Bertoni and Fundación Desdel Chaco, investigated the Negro River. They recorded a total of seven giant otters, two inhabited dens and one active latrine. From 2006, observations have been made of groups in the Negro River and the Paraguay River (J.L. Cartes unpublished data). The last systematic survey of the Negro River was by Robert Pickles and Veronica Zambrana of the Zoological Society of London and Asociación FaunAgua. This expedition made recordings from the mouth of the river up to the point where the river leaves the Paraguayan border and flows through Bolivian territory (S19°49'39.1", W58°09'50.8"). The expedition recorded a total of 16 giant otters in two packs, with very few holts (four), latrines (one) and campsites (six) observed. A recent count in 2021 totaled 19 individuals.

Sector 2
Upper Paraguay River and Bahia Negra

A single den, recently used but abandoned, was found on the Paraguay River just downstream of Bahia Negra itself, between Bahia Negra and the community of Diana (ZSL/FaunAgua Expedition 2008). No giant otters were seen. The river remained very low during the drought of 2019 to 2021, and five other dens were located between Bahia Negra and the region between right bank of the Bahia Negra and the left bank of the Nabileque in the Pantanal of Brazil (Rodrigo Zarate *pers. comm.*). As a note, a juvenile was raised by Mrs. Nilza Suarez in Bahia Negra, between 2014-15 that the locals called "*Lobi*". Upon reaching maturity *Lobi* returned to the wild.

Sector 3
Paraguay River between Puerto Guaraní and Carmelo Peralta

Giant otter sightings were recorded by Carlos Valiente † (*pers. comm.*), a nature tourism manager and Nature Broadcast producer, at Puerto María, Estancia Pantanal

on the Paraguay River (S21°36'38.78", W57°56'14.48"). This was the southernmost recorded point of the giant otter range in Paraguay up to 2013. A television film crew from Red Guarani – Naturaleza Paraguay published a documentary in which they filmed giant otters on the Paraguay River between Puerto Guaraní and Carmelo Peralta across from Pão do Açúcar on the Brazilian side (S21°30'17.57", W57°57'0.46"). Other sightings along the Paraguay River and associated meanders south of Puerto Guaraní were made (S21°11'17.58", W57°51'15.20"; S21°11'53.71", W57°51'0.67"; S21°11'58.02", W57°52'14.74"; S21°10'33.99", W57°53'54.38").

Sector 4
Nameless tributary between Puerto Guaraní and Carmelo Peralta

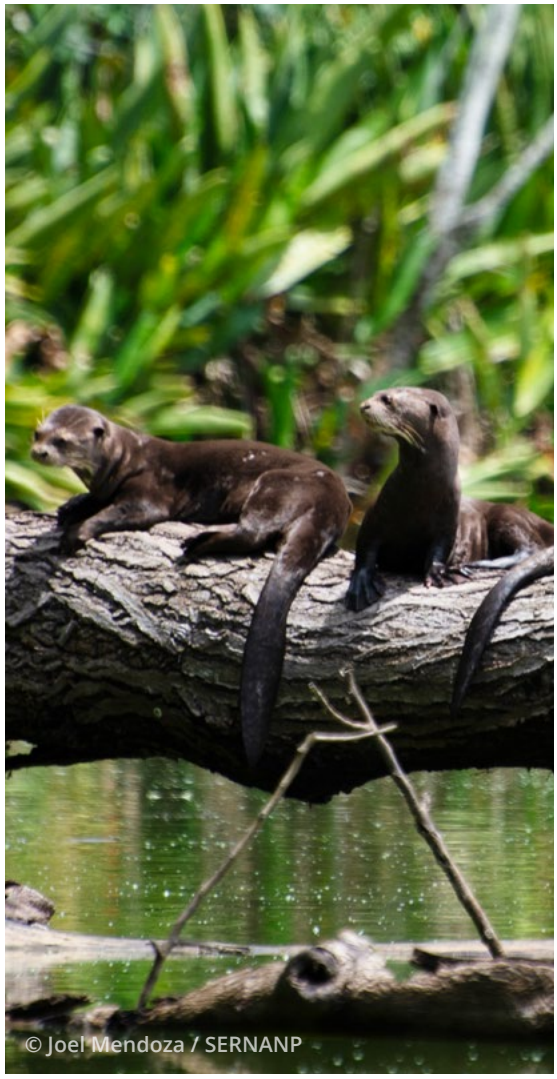
Giant otters have been observed in a nameless river which joins the Paraguay River between Puerto Guaraní and Carmelo Peralta (S21°9'53.64", W57°55'50.85").

Sector 5
Section of the Paraguay River between the mouths of the Montelindo and Jejuí rivers (Cartes *et al.* 2013)

Two giant otter pups were captured by fishermen from Puerto Antequera with the intention of sale for the pet trade. They stated that the cubs were captured at the junction of the Paraguay and Montelindo rivers. They subsequently died due to lack of proper care. The presence of these cubs captured much further south than estimated is an important finding. In 2022, J. Cartes identified a new locality in the south of this sector: Puerto Rosario (S24°25'50.75", W57°09'48.39") through interviews with local fishermen and Mr. Guillaume Martin.

Sector 6
The mouth of the Piribebuy River (S25° 04' 35,04", W 57° 20' 34,7")

This is the southernmost recent record from Mr. Guillaume Martin, owner of "Lobope Turismo". This contact has registered two individuals of giant otter with photographs when navigating the Piribebuy River, including two encounters in August and September 2022. Surprisingly, this locality is only 58 km by river from Asuncion city.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HABITAT USE

To date there are no habitat use studies in Paraguay. All records relate to the upper Paraguay River, a region with a high abundance and diversity of fish species. Notably, the entire region comprises a seasonally inundated lagoon complex due to the Paraguay River floodplain. All giant otter holts in the upper Paraguay River were excavated in the banks of raised tree-covered 'islands', with no holts observed in the low-lying grass-covered banks. Holts were typically excavated under tree roots.


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THREATS

Between 1999 until 2009 there were no direct threats to giant otters recorded in the region. Local fishermen considered otters a problem due to perceived competition for fish and net damage. However, persecution or control of giant otters has not been reported in the region. In August 2010, a dead giant otter was recorded near Tres Fronteras in the Paraguay River on the border with Brazil and Bolivia. A post mortem revealed a gunshot wound to the head as the cause of death. Local people blamed foreign hunters from Ciudad del Este as the people that kill otters and other wildlife. Between 2009 and 2010 a decline in fisheries was recorded, perhaps due to overfishing (more intensive use of nets with a higher probability of bycatch) and climate change patterns. This situation may increase conflict between fishermen and otters (Carlos Valiente *pers. comm.*). The case of *Lobi*, the pet adopted in Bahía Negra in 2014, is a result of this conflict with fishermen, as his group was eliminated by them and orphaned. At that site they use lines with hooks called "espineles", from which the otters occasionally eat.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

The giant otter has only recently begun to recolonize the river systems of Paraguay. People in Bahía Negra state that the giant otter disappeared due to overhunting linked to the fur trade between the 1940´s and the 1970's. They also say that the otter has returned after a "long time", and is continuously spreading south. This suggests that the Paraguay River may constitute a corridor for giant otter dispersal, with a likely slow southerly expansion of the species.

While the population of giant otters in Paraguay is considered to be increasing, it must be cautioned that this increase, and recolonization of previous river systems is extremely slow, and the tiny population is in a highly fragile state. Furthermore, predicting the future distribution trend of the species in Paraguay is hampered by a lack of good population estimates. The monitored Negro River population has increased from seven in 1999 to 16 in 2008 and may have formed two different packs, but may have reached carrying capacity for this river, with otters dispersing from these packs along the Paraguay River corridor. To facilitate the recovery of the giant otter in Paraguay it is therefore essential that the Paraguay River and associated tributaries are free of threats and can provide adequate habitat. Sporadic hunting occurs at low levels, but will have a disproportionate impact on the recovery of the giant otter in Paraguay due to the small population size. Construction of the Hidrovia project, in which the Paraguay River is canalized to allow the navigation of large barges during the dry season, will cause local habitat disturbance for the giant otter through an increase in river traffic. In the long term, the projected modifications to the river may lead to water-table decreases, which would reduce prey and habitat availability for the otter (Gottgens *et al.* 2001).

KNOWLEDGE ABOUT THE SPECIES

The only research on the species are the aforementioned population surveys.

LEGAL STATUS

In Paraguay the giant otter is considered Critically Endangered as established by the Environment Secretariat Resolution N° 524/06 (March 17th 2006) and updated in 2017 (Giordano *et al.* 2017) with Resolution N° 632/17, based on the national wildlife law (96/92). The IUCN criteria applied to this update were "A2cd", mainly because the species has been extirpated from most of its historical distribution, with a population reduction in its area of occupancy, as well as the observed increase in persecution or retaliatory hunting. The most recent status assessment was published in 2022 (Smith 2022).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

The Negro River is almost entirely encompassed by protected areas on both sides: Otuquis National Park in Bolivia, and a complex of private and national protected areas in Paraguay, including Fortín Patria, Fortín Galpón, Río Negro National Park and the Paraguayan Pantanal Nature Reserve. Nevertheless, rivers in Paraguay are open for public use and transit, so must be controlled.

Currently, there has been a substantial increase in the presence of hunters in the Negro River. They harvest wild meat for illegal trade, mainly caimans, capybaras, deer, and peccaries. The presence of these hunters is a threat not only because of their activity, but also because of the fires they cause. In 2019 a large fire affected the Pantanal in Bolivia and Paraguay, and in 2020 in Brazil. In turn, fires affect water quality and ichthyofauna. There is no other initiative regarding giant otter conservation.

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RECOMMENDATIONS FOR FUTURE EFFORT

The most pressing need is for a thorough nation-wide survey. It is not clear yet how giant otter populations are recovering in the southern range of its distribution. It is important to investigate the presence, density and movements of this species in rivers where anecdotal evidence suggests it occurs, and also in the tributaries of the Paraguay River into which the population may expand. A systematic approach will be crucial for providing the baseline for a national giant otter species management plan. Molecular studies may also be useful in determining whether there is gene flow occurring among the remaining population fragments, what levels of genetic diversity exist within the Paraguayan population and revealing the effective population size.

Due to the international status of the Paraguay River, conservation efforts are particularly challenging and will require international cooperation. The environmental impact resulting from modifications to the Paraguay River must be monitored. Efforts must be made to increase education and awareness in order to prevent sporadic killing of giant otters. This species could also be a flagship for ecotourism given the position of the research base Tres Gigantes on the Negro River.

ACKNOWLEDGEMENTS

To Carlos Valiente † and Dr. Arnoldo Wiens from the *Naturaleza Paraguay* broadcast (TV Channel 2 *Red Guaraní*), and to Ramon Villalba for providing important data about giant otters. To Alichi Garcia and the people of Bahia Negra who provided information about giant otter presence and threats. To Rodrigo Zárate for the recent data from Bahía Negra. To Guillaume Martin for data and photographs of his recent records.

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN PERU

Jessica Groenendijk, Maribel Recharte, Leydi Auccacusi Choque, Juvenal Silva, Joel Mendoza & Mark Bowler

LOCAL NAMES

Lobo de río, nutria gigante (Spanish), parari (Machiguenga), kashonale (Piro), Chavaro (Yine).

HISTORICAL AND CURRENT DISTRIBUTION

Historically, the giant otter was distributed throughout the Peruvian Amazon lowlands east of the Andes mountains (Figure 1).

The historical distribution of giant otters is believed to have been limited by altitude (Duplaix 1980). Based on confirmed giant otter localities across the range, the group of giant otter experts participating in the Giant Otter Range-Wide Priority Setting Exercise set 500 m a.s.l. as the upper distributional limit for the species (Figure 1). Figure 1 does not consider other limitations for the geographic distribution of giant otters such as forest cover, the width and depth of streams and rivers (Duplaix 1980), or food availability (Duplaix *et al.* 2015), but giant otters have a reasonably high adaptive capacity favoring their presence in different habitat types.

Hunting for the pelt trade was the single, greatest factor in the reduction of its population in Peru and is directly responsible for its current endangered status (although more recent threat factors are contributing to the maintenance of this status). Between 1946 and 1973, 23,980 giant otter pelts were officially exported from Peru, excluding those skins which were exported via Leticia, Colombia (Brack-Egg 1978). The export of pelts from Peru was banned in 1970 and professional hunting of wildlife in the Peruvian Amazon was prohibited in 1973. But it was the inclusion of the giant otter in Appendix I of CITES in 1973, and the coming into force of international trade restrictions on giant otter skins in 1975 that finally ended the economic benefits of giant otter hunting (Recharte & Bodmer 2010).

Workshop participants identified the places where the giant otter is confirmed to be present (Figure 2), which include several protected areas in the north, such as the Pacaya-Samiria National Reserve, Pucacuro National Reserve, Matses National Reserve, Yaguas National Park, Gueppi-Sekime National Park, Cordillera Azul National Park, Cordillera Escalera Regional Conservation Area, Tamshiyacu-Tahuayo Regional Conservation Area, Maijuna-Kichwa Regional Conservation Area, Nanay-Pintuyacu-Chambira Regional Conservation Area (although only the Nanay River was visited), and possibly in the Santiago-Comaina Reserved Zone and surrounding areas. Giant otter presence outside protected areas is usually recorded in the buffer zones such as the Yavari-Mirín zone. Reports of presence completely outside protected areas are limited and more ambiguous.

In southern Peru, giant otters are known to be present in the Manu National Park, Alto Purus National Park, Tambopata National Reserve, Bahuaja-Sonene National Park, Amarakaeri Communal Reserve, Yanesha Communal Reserve, and Purus Communal Reserve (Figure 2).

There is evidence that in some isolated regions or protected areas giant otter populations are experiencing a slow recovery from the decades of the pelt trade, such as in Manu National Park in southeastern Peru (Groenendijk & Hajek in prep.) where the population has probably reached carrying capacity, and on the Yavarí-Mirín and Yavarí rivers in north-eastern Peru (Recharte & Bodmer 2010).

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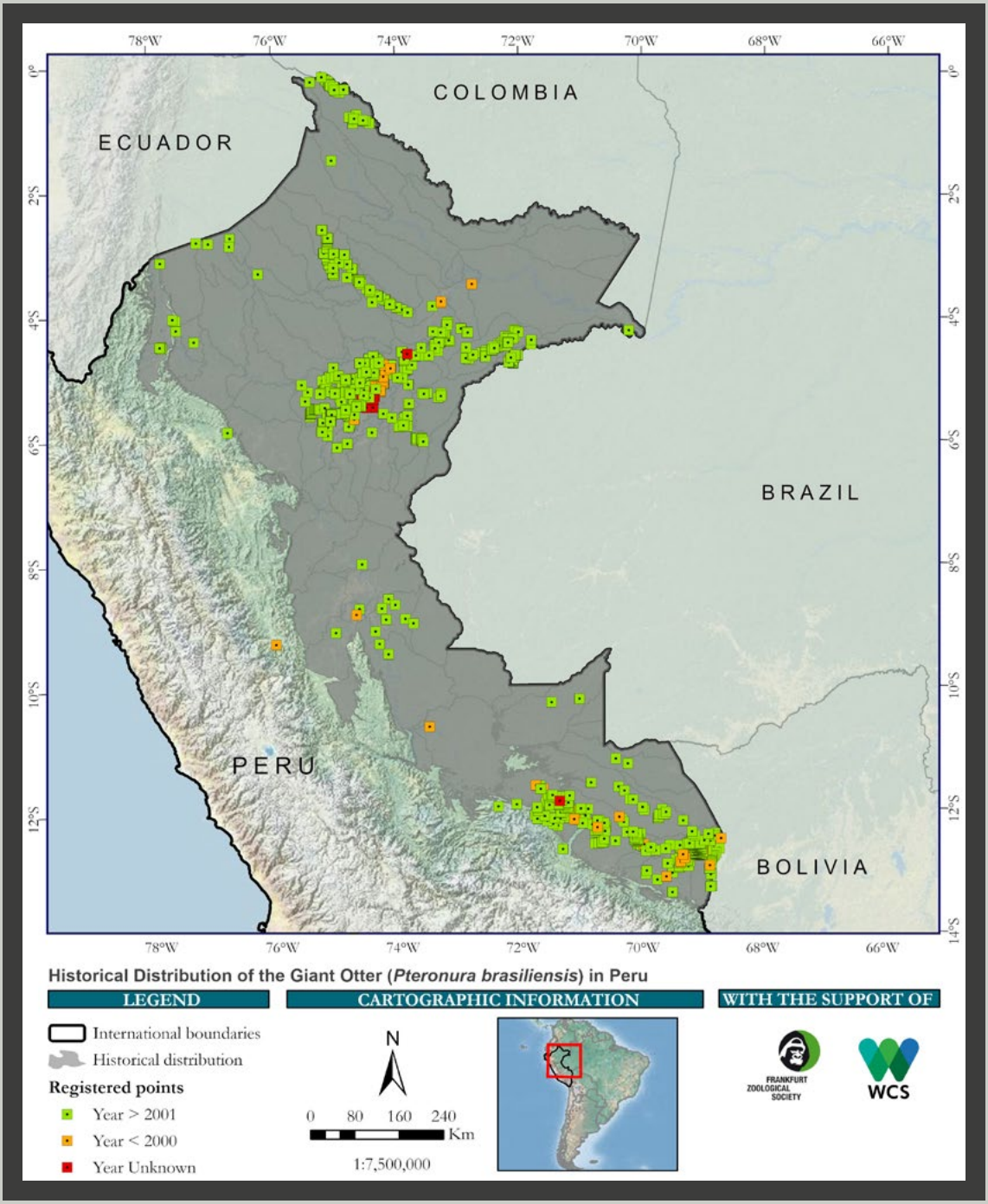

Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Peru.

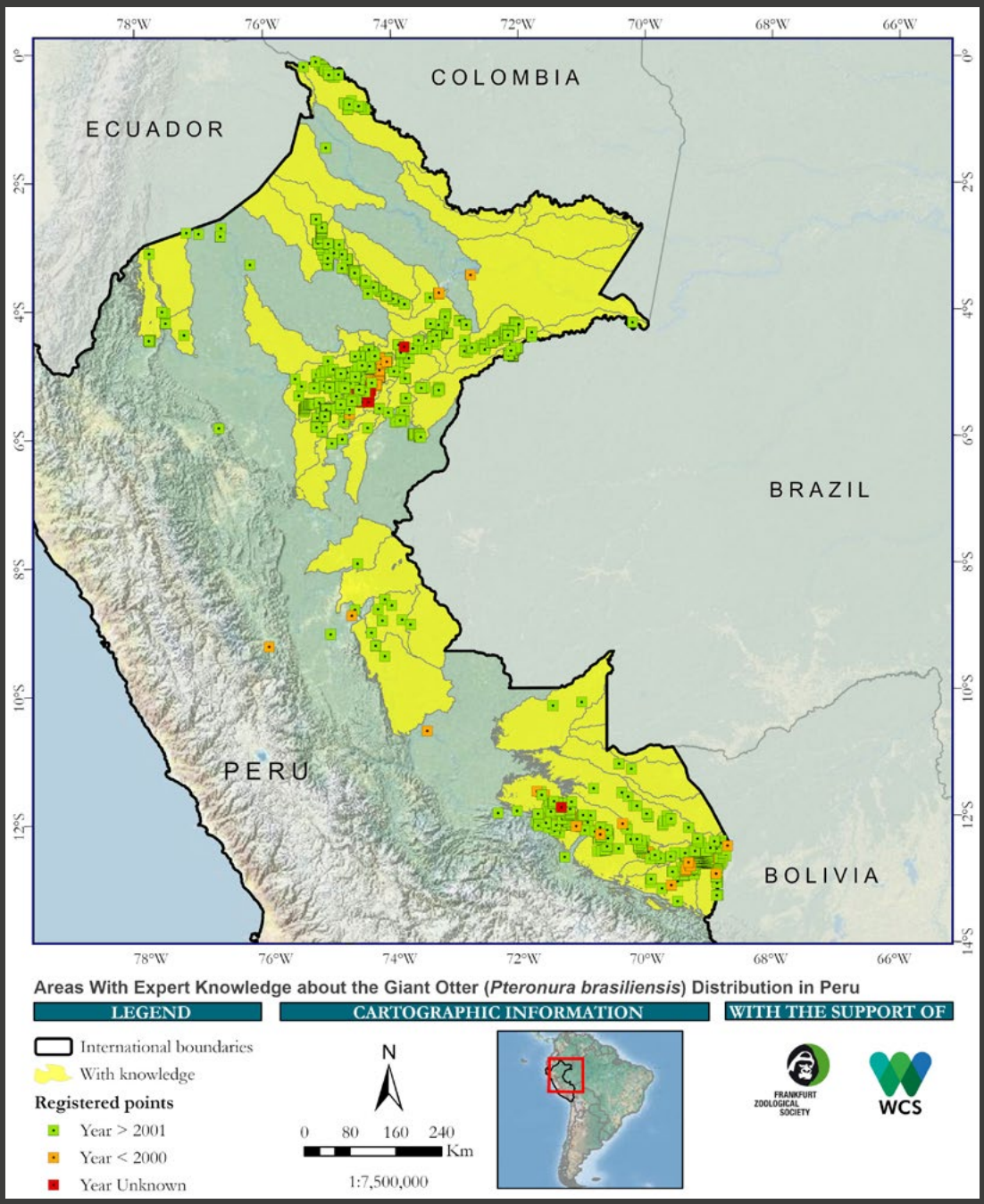

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Peru.

Between 1990 and 2021, numerous surveys and population censuses of giant otters have been carried out by the Frankfurt Zoological Society on the Los Amigos, Las Piedras, Palma Real, Patuyacu, La Torre, Chuncho, Heath, Manu, Pinquen, Blanco, Azul, and Malinowsky rivers, and on oxbow lakes of the Tambopata and Madre de Dios rivers in the Department of Madre de Dios, in south-eastern Peru. The annual census conducted by FZS in Peru have expanded to the Yaguas National Parks in Loreto, the Alto Purus National Park, as well as the Purus Communal Reserve in Ucayali. To respect the presence of indigenous groups living in voluntary isolation, full access to protected areas such as Alto Purus and Manu is not possible. These groups and their potential territories are under special protection from the Peruvian government (Ministry of Culture and Ministry of Environment via SERNANP National Protected Natural Areas Service). For the same reasons, access restrictions also apply to indigenous reserves such as Madre de Dios or Murunahua. Conservation International carried out three surveys in 1997, 1998, and 1999 in the Candamo River (Mitchell 2000).

Surveys in the Department of Ucayali in 2003 (Lasso & Acosta) indicated that giant otters are only present in very low densities. More recent surveys have not been published. Several surveys were conducted in the Pacaya-Samiria National Reserve, and on the Yavarí and Yavarí-Mirín rivers (Department of Loreto) between 2002 and 2005. Giant otter presence was confirmed in all these locations (Figure 2). Surveys were also carried out in 2000 on the Napo, Lagartococha, and Aoshiri rivers in north-western Peru, and giant otters were encountered only on the Aoshiri River. However, in October 2011 the species was confirmed on the Lagartococha River, and WWF-Peru has reported a come-back in the Gueppi Reserved Zone. In 2019 giant otters were confirmed in surveys on the Sucusari stream (B. Griffiths, unpublished data) a tributary close to the mouth of the Napo River, and very close to the city of Iquitos. It is not clear if this indicates an expansion downstream from the Gueppi populations, or upriver from expanding populations in southern Loreto, or even overland from populations in the Algodon-Putumayo basin where giant otters are now widely distributed (Gilmore *et al.* 2010; Pitman *et al.* 2011, 2013, 2016). Giant otters have also been conformed on the Trapiche (Tramm 2014), Cordillera Escalera (Pitman *et al*. 2014) and Cerros de Kampankis (Pitman *et al.* 2012).

Between 2013 and 2018 surveys on the Nanay, Pucacuro, Samiria, Pacaya and Tamshiyacu rivers demonstrated naive occupancies of 75-90% (Recharte *et al.* in prep.). Although all discovered populations are associated with protected areas, some of these rivers represent some of the most accessible catchments close to Iquitos city. The mouth of the Nanay is found on the outskirts of the city itself. These areas have been recolonized after a long absence. Surveys are lacking in remote non-protected areas, but no surveys or inventories on major rivers in Loreto in the last decade have failed to find giant otters, regardless of the area's protected status. The most parsimonious conclusion is that giant otters have recovered most of their original range in Loreto, except in immediate proximity to humans, and on rivers and lakes under very high anthropogenic influence.

With the recent (2018) creation of the Yaguas National Park, the Frankfurt Zoological Society began monitoring the giant otter in 14 lakes and the Garza, Hipona, Grillo, Huacachina and Agua Blanca streams, all tributaries of the Yaguas River, recording giant otter individuals in three lakes and in the Yaguas River itself. However, due to flooding regimes, no signs of presence, such as campsites, dens or tracks were recorded during the surveys.

Protected areas benefit from continuous wildlife monitoring carried out by park rangers and mammal researchers. Figure 3 identifies areas outside protected areas where the presence of giant otters is unknown due to lack of specific monitoring for giant otters and wildlife.

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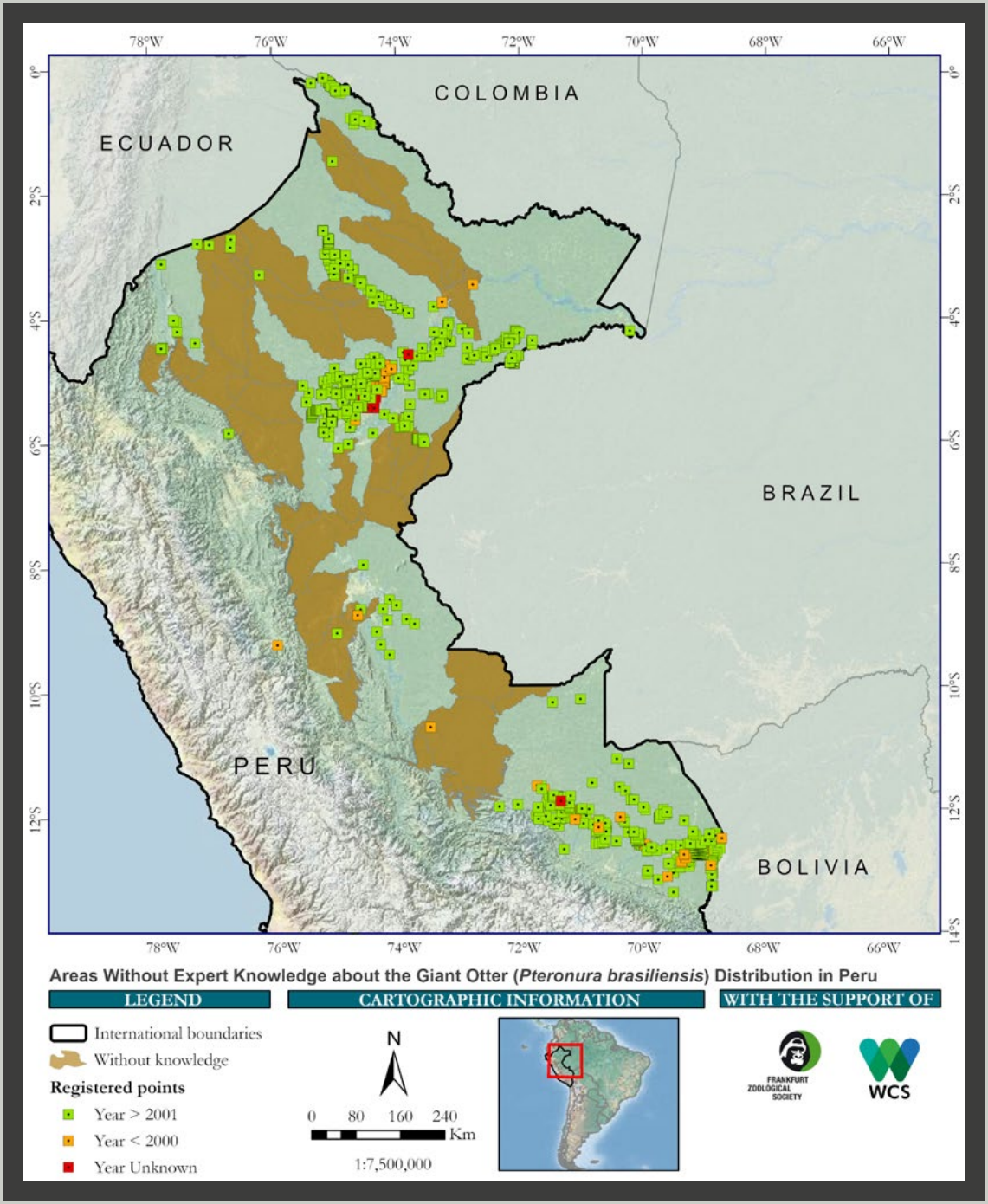

Figure 3. Areas without expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Peru.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Population numbers of the species have been investigated in several rivers and lakes, particularly within the department of Madre de Dios, south-eastern Peru, as well as in the Pacaya-Samiria National Reserve, central northern Peru, and on the border with Brazil on the Yavarí and Yavarí-Mirín rivers. The population number on a national level is unknown.

Madre de Dios

Since 1990, giant otter surveys have been carried out on an annual basis in the Manu Biosphere Reserve which was prioritized in *Otters: An Action Plan for their Conservation* (Foster-Turley *et al.* 1990). The surveys incorporate the Manu River itself, and a total of up to 28 associated oxbow lakes. Dry season census results have fluctuated between 33 and 84 different individuals (Schenck 1999; Williams *et al.* 2008; Groenendijk *et al.* 2014).

Between 2008 and 2010 surveys in the Madre de Dios watershed, 180 individuals were found, of which, 142 were in protected areas (57 Manu National Park, 50 Tambopata National Reserve, 30 Bahuaja-Sonene National Park, 5 Los Amigos Conservation Concession) and 38 in unprotected areas (Williams *et al.* 2008). These are equivalent to absolute densities (at a landscape level) of 0.005/km^2 in Manu and Bahuaja-Sonene National Parks (though these protected areas include unsuitable montane habitats), and 0.02/km^2 in Tambopata National Reserve. However, they reflect densities of up to 1 individual per 5 km length of the Manu River and 1 individual per 7 km of the Heath River. As it is hard to measure area of suitable habitat precisely, using linear river length seems an adequate way to measure relative densities (Williams *et al.* 2008; Silva & Mendoza 2009, 2010; Silva *et al.* 2008).

During the Frankfurt Zoological Society assessments in 2014 and 2015, 128 and 144 individuals were found respectively in the Madre de Dios basin. In 2014, 106 otters resided within the Manu National Park, Bahuaja Sonene National Park, Tambopata National Reserve, and the Amarakaeri Communal Reserve, distributed in 17 social groups. The Manu River had the highest number of social groups. The largest family groups observed were composed of eight individuals along the Manu and Heath rivers. Outside the protected areas, 22 giant otters were recorded, distributed in five family groups, with the largest family group (6 individuals) located in the Las Piedras River (Mendoza *et al.* 2017).

Pacaya-Samiria National Reserve

The project "*Determination of the Distribution and Abundance of the Giant Otter in the Pacaya-Samiria National Reserve*" was initiated in 1999. In the Yanayacu-Pucate river basin, 46 sightings were made and at least 18 different giant otters were identified. Sightings were largely of solitary individuals, but 2 groups of 7 animals were also encountered. In the Pacaya river basin, sightings of 28 individuals were principally concentrated on Tipishca Cahuana ('tipishca' signifies a slow-moving branch of the river) and Cocha Yarina (Isola 2000).

A WCS project "*Conservación de fauna silvestre en la cuenca del Samiria, Reserva Nacional Pacaya-Samiria (RNPS)*" in 2005 focused on the Samiria and Yanayacu rivers. In the Samiria River 14 individuals were registered (Recharte 2007) consisting of three family groups: Huama Lake with four individuals, Armana stream with four individuals and Machana stream (connected to Ungurahui lake) with six individuals. In Caro Lake, a solitary animal was observed. In the Yanayacu River, 7 individuals were registered during a short period of fieldwork, including a group of 5 individuals in Ahuara stream, a solitary otter in Tacari and one in the Yanayacu River itself. However, within censuses during this expedition, no giant river otters were recorded. The aquatic transects covered 10 km of census on the mid Yanayacu River. Evidence of otters and remains of fish were recorded (Bowler *et al.* 2005). In 2011, the project: "*Conflict between giant river otter populations and fishing communities in the northeastern Peruvian Amazon*" censused the Yanayacu River and registered three individuals in Pavayacu stream and in censuses in Samiria River three individuals were registered in Wiuri stream (Recharte 2011).

Yavarí and Yavarí-Mirín Rivers

The first study to determine the distribution and abundance of the giant otter on the Yavarí-Mirín River was in 2001 (Isola & Benavides 2002). During the survey, 19 giant otters were registered in the Yavarí-Mirín river basin and 19 sites with evidence of otters were recorded. During 2003 to 2005, the Project: "*Conservación de la vida silvestre en la Amazonia Peruana de Loreto (Convenio WCS-DICE)*" censused the Yavarí and Yavarí-Mirín rivers in different areas, registering 53 individuals (Roberts 2004; Recharte 2007). Censuses recorded the recovery of giant otters on the Yavarí and Yavarí-Mirín rivers (Recharte & Bodmer 2010). In 2009, the project: "*Conflict between giant river otter populations and fishing communities in the northeastern Peruvian Amazon*" censused the area belonging to the Lago Preto Conservation Concession and registered 7 individuals (Bowler *et al.* 2005). In 2005 and 2006, a group of giant otters on the Lago Buen Fin of the Yavarí River was habituated and became the focus of two behavioral studies by students of the University of Kent (Hoffman 2008; Gyongi 2009).

Tapiche River, Loreto

In 2002, Isola (2002) carried out a study in the middle sector of the Tapiche river basin during two hydrological seasons: high level water and low-level water. The focal area was the Yanayacu River due to the relatively low human population and unconfirmed reports of giant otters. Isola covered 33 km of rivers, lakes and streams and registered 12 sightings of giant otters: ten observations were of solitary individuals, 2 of a family group of 5 individuals, and 21 sign sites, including dens, remains of fish, tracks, and latrines.

Yaguas National Park

In 2018 and 2019, the Giant Otter Monitoring Program of the Frankfurt Zoological Society assessed the Yaguas River and its tributaries, covering a total of 180.94 km, and registering 21 giant otter individuals, distributed in three

family groups, found mainly in three lakes and the Yaguas River.

Department of Ucayali

In August and December 2003, the distribution of the giant otter in the department of Ucayali, central Peruvian Amazon, was investigated, with the aim of elaborating upon existing, scarce information on distribution of the species in the area, but also to test standardized field survey technique guidelines proposed in "*Surveying and Monitoring Distribution and Population Trends of the Giant Otter – Guidelines for a Standardization of Survey Methods*" (Groenendijk *et al.* 2005). Giant otter presence was confirmed, but in very low densities.

In 2013, in the Pucacuro National Reserve, 12 giant otter observations were made along 64 km of river, or 128 km^2, considering a 1 km buffer each side of the river, with most observations made by park guards in the lower portion of the protected area, and few records in the middle section due to low sampling effort (Ruck *et al.* 2014).

Between 2015-2017, Los Angeles Zoo financed two projects along the Nanay, Pacaya, Pucacuro, Samiria and Tamshiyacu rivers in Loreto: '*The distribution of giant otters in Peru - what determines their recovery?*' and '*Monitoring giant otters use of lakes, and the effects of human activity on their behavior*'. These projects evaluated the presence of giant otters using a modified occupancy model for use along rivers. The surveys revealed naive occupancies of 75-90% on these rivers (Recharte *et al.* in prep.).

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HABITAT USE

The species occurs in all aquatic habitats in the Peruvian Amazon lowlands but favors larger lakes and slow-moving rivers. In Madre de Dios, white-water bodies dominate, so-called due to sediments which tend to remain in constant suspension. Otters prefer the oxbow lakes or 'cochas' which characteristically have no current, less variable water levels, and fish are abundant due to a high primary production and concentration of nutrients. Sedimentation results in water that is clearer than that of the parent river. Schenck (1999) and Groenendijk & Hajek (2006) found that total lake surface area was closely and positively correlated to group size.

In south-eastern Peru, giant otter home ranges are stable throughout the year and usually encompass at least one oxbow lake, which forms the core territory, and several nearby streams or swamp areas, and a stretch of the parent river. Most breeding groups are found on lakes and breeding success is correlated with lake size. Groups breeding in streams and rivers have lower breeding success (Groenendijk *et al.* 2014). Rivers are often used solely to travel from one oxbow lake to another. However, in isolated areas where there is little human disturbance, the rivers themselves are inhabited on a more permanent basis by this species (Schenck 1999; Groenendijk *et al.* 2014). Studies suggest that the Madre de Dios River itself, of which the Manu River is a tributary, and the huge oxbow lakes associated with it, historically sheltered the highest density of giant otters in the region (Schenck 1999; Groenendijk & Hajek 2006). However, the Madre de Dios is now a major transport route, and human colonization and disturbance along it increase the risk of group extinction, while decreasing opportunities for oxbow lake re-colonization, thereby forcing the giant otters into the smaller tributaries such as the protected Manu River. It is important to highlight that the species' dispersal remains perhaps the least understood aspect of its life history. The longest documented dispersal distance is at least 252 km between the Los Amigos River and the Manu River, demonstrating that the species has a significant capacity to disperse across river basins.

Surveys in Loreto, where many study sites have extensive areas of flooded forest, have revealed giant otters frequently use smaller streams and river channels, even where there are few lakes. Seasonal flooding of productive riverine forests can lead to higher concentrations of fish in lakes and streams during the dry season, than similar-sized bodies of water would be able to support in non-flooded areas. This may partially explain the apparently high occupancy of giant otters in Loreto (Recharte *et al.* in prep).

THREATS

Today, small numbers of giant otter individuals continue to be killed, largely for fun, out of ignorance or fear, or because they are seen as competitors for fish. Cubs are sometimes captured illegally to keep as pets. Although rare, otters occasionally become trapped in fishing nets and drown (Huayaba *pers. comm.*). However, human colonization and encroachment, destruction of riparian habitat, overfishing, contamination of aquatic ecosystems, domestic animal diseases, and even poorly managed tourism are now seen as key threats (Staib & Schenck 1994; Groenendijk 1998; Schenck 1999).

Gold mining

The Madre de Dios Department is Peru's third largest producer of gold and generates 70% of Peru's artisanal gold production. Between 2000 and 2010, the price of gold has increased 360% with a constant rate of increase of about 18% per year. Peruvian mercury imports have risen 42% (2006-2009) to 130 t/yr, almost all of which is used directly in artisanal gold mining. Forest conversion to mining increased six-fold from 2003-2006 (292 ha/yr) to 2006-2009 (1915 ha/yr) (Swenson *et al.* 2011). Mercury concentrations in most fish species around Manu National Park were higher than what is considered tolerable in the Eurasian otter (Gutleb *et al.* 1997). However, expected high concentrations of methylmercury in giant otter tissues have not been corroborated due to the difficulty of finding dead giant otters. Surveys in 2008 and 2010 in areas with gold mining failed to find any sign of giant otter presence, even where operations were relatively small and artisanal (Williams *et al.* 2008). The

increase in gold mining along the Madre de Dios, Malinowski, Palma Real, Patuyacu and Inambari rivers has resulted in near extinction of the species on these river systems, with giant otters only surviving in tributaries and lakes where there is no mining. However, in 2020, park rangers from the Tambopata National Reserve and some researchers have observed individual giant otters in abandoned gold mining ponds.

Conflict with fishermen

In 2009 and 2010 there were reports of fishermen killing giant otters in Bahuaja-Sonene National Park due to perceived conflict. There was also an increase in use of monofilament nets in lakes of the region, including within protected areas. There are reports that giant otters have occasionally been shot at fish farms in Madre de Dios and, whilst the increase in number of farms in the region increases the risk of conflict, an unpublished survey of fish farm owners found that they generally do not consider the species a problem (Mendoza *unpubl.*); perhaps as fish farms are mainly located in areas where giant otters have already been extirpated. The main threat to this economic activity was actually the spectacled caiman. However, years later, around 2017-2018, the death of a giant otter was reported at one of the fish farms located along the Interoceanic Highway. This suggests that a new survey should be conducted among fish farm owners to verify whether sightings of giant otters in the area are now more frequent.

In north-eastern Peru, in 2005, fishermen mentioned a potential conflict due to the perceived recovery of giant otter populations on the Yanayacu River (Recharte *et al.* 2008). Giant otters were blamed for declining stocks of arowana, the juveniles of which are sold to the aquarium trade. A perceived increase in giant otter populations has coincided with a fall in arowana harvested by some households, although there is no evidence to support the relationship (Recharte *et al.* 2008).

In Loreto in the last decade, the rise in numbers of giant otters in areas where the species was previously extirpated has brought otters into contact with people who have grown up without this species. Many such people feel scared of the otters when they encounter them up close, especially when the otters are in a big group and perform territorial behavior and vocalizations. Over the past 10 years, people have gradually become more used to seeing these animals once again in the lakes, streams, and rivers where they fish, and now think that giant otters are competitors for fish and blame them for damaging the fishing nets leading riverine people to negative perceptions towards giant otters (Recharte *et al*. 2015).


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Between 2014 and 2017, Recharte (2018) determined the extent to which giant otters cause damage to fisheries in comparison to other aquatic predators, exploring perceptions and attitudes towards wildlife using structured interviews and focus groups in three areas: Pacaya-Samiria National Reserve, Pucacuro National Reserve and Maijuna Kichwa Regional Communal Area. Perception interviews with 302 people, as well as 12 fishermen trained to complete fishing registers compared the perception of damage with actual events of damage in relation to negative interactions between people and aquatic predators. Perception and attitudes towards aquatic predators varied between communities. Despite the dominance of farming as a livelihood in Pucacuro National Reserve, and the lesser importance of fishing compared to people from the other protected areas, respondents listed aquatic predators among the top 10 most damaging animals, while arboreal and terrestrial animals ranked lower. People in Pacaya-Samiria National Reserve expressed more tolerance to interactions with aquatic predators. People from Pucacuro National Reserve and Maijuna Kichwa Regional Communal Area have highly negative perceptions about giant otters, but fishing registers demonstrated that this species only very rarely damages nets during occasional encounters with fishermen. Pink river dolphins and caimans damaged the nets more than the otters. Furthermore, fish such as piranha, suckermouth catfish, and wolf fish *Hoplias*, among others, broke nets with the same frequency as aquatic predators. Negative perceptions lead to retaliation against giant otters and other aquatic predators, especially when animals were perceived as responsible for breaking nets (Recharte 2018).

Infrastructure

At least one giant otter has so far been road killed on the Interoceanic highway near Iberia (Williams *pers. comm.* 2010).

In Loreto, several development projects threaten to drastically affect giant otter conservation in Peru. The Ministry of Transport and Communication signed a concession contract to build an Amazonian *Hydrovia* or Waterway, to improve the navigability of the Amazon River. This will dredge large sections of 2,600 km of river about 56 m wide and 12 m deep. Although the ecological effect of this project is unknown, changes in flood dynamics may be drastic and fish populations may change considerably. Many predict a negative impact for aquatic wildlife, especially fish, the main source of food for giant otters (R. Bodmer *pers. comm.* 2018). Loreto has several recovering populations of giant otters, but projects such as this, along with several major road infrastructure initiatives are going to drastically change access to the forest and river areas and threaten to impact wild populations of giant otters. This will isolate and reduce gene flow between populations that in some areas may already have been through population bottlenecks. Recharte (*in prep.*) highlights a need to develop more 'conservation marketing' throughout Peru to bring ecological issues into the political landscape. This may be a necessary step before significant progress can be made in using giant otters as a tool to influence large political and development decisions in Peru (Recharte 2018).

Hydroelectric development

Whilst there are several schemes proposed in Peru, these are mainly located in

headwaters and are unlikely to directly threaten populations of giant otters though they could change river dynamics and impact fish populations.

Destruction of riparian habitat

There are far fewer giant otters in unprotected areas where habitat around lakes is altered, although it is unclear whether this is a result of habitat loss or other associated threats.

Domestic animal disease

Giant otter cubs held in captivity have died of canine parvovirus and all mustelids are susceptible to canine distemper, so domestic animal diseases could pose a serious threat to wild giant otter populations. Infection could also occur in remote areas since transient otters and people hunting with dogs travel large distances with potential for contact and infection of immunologically naive populations (Schenck *et al.* 1997).

Unregulated tourism

Giant otters remain susceptible to disturbance from tourism, particularly on breeding lakes. With increasing tourism in Peru, it has proved important to control tourism on lakes both in and outside protected areas (Schenck & Staib 2000; Groenendijk & Hajek 2006). Monitoring of giant otter and tourist groups before and after implementation of management zoning has shown that giant otter reproductive success and sighting success by tourists on unmanaged lakes is considerably lower than on managed lakes.

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

If existing threats such as gold mining, habitat loss, fishing pressure, fish farms and road networks continue to increase then the species will continue to decline in unprotected areas, and it is likely that within a decade or two only small and isolated relict populations persist in protected areas.

KNOWLEDGE ABOUT THE SPECIES

The Frankfurt Zoological Society Giant Otter Research and Conservation Project has conducted extensive research into giant otter distribution, habitat use, ecology, social behavior, and protection (Schenck 1999; Staib 2005) in the Madre de Dios Department.

In Peru, very little is known about giant otter habitat use and population dynamics in small rivers as compared to large rivers with associated oxbow lakes. A long-term study initiated by FZS in 1999, examined giant otter group dynamics and habitat use in smaller rivers to evaluate their conservation significance in regions where oxbow lakes are rare or very small (Groenendijk *et al.* 2014).

Roberto Quispe, from the San Marcos University in Lima, wrote his undergraduate thesis in 2002 '*Determinación del regimen alimentario del Lobo de Río Pteronura brasiliensis mediante el analisis de partes duras presentes en las heces, en la cuenca del Río Palma Real, Madre de Dios, Peru*', investigating giant otter diet by means of seasonal (wet versus dry) and habitat (lentic versus lotic) comparisons, using hard parts (scales, bony plates, teeth, otoliths and spines) of fish species found in fecal remains. More than 51,000 items were analyzed, the vast majority scales.

For her doctorate dissertation "*Behavior and Ecology of the Giant Otter in Oxbow Lakes of the Manu Biosphere Reserve, Peru*" (2008), Lisa Davenport explored three objectives:

1. to investigate whether oxbow lakes return to random or predictable faunal communities after annual flooding;
2. to document seasonal and annual patterns in the diets of giant otters on two phytoplankton-dominated oxbow lakes; and
3. to document and characterize helping behavior in giant otters.

LEGAL STATUS

In Peru, the giant otter is classified as Endangered and protected by State legislation - SD N° 004-2014-MINAGRI (El Peruano, 2004). In May 2011, the species received additional protection in Madre de Dios via a Regional Executive Resolution N° 313 – 2011 – GOREMAD/PR which establishes a legal basis for a regional conservation plan that is currently in development (Williams *et al.* 2008).

In the same year, the regional government of Madre de Dios declared the giant otter as a representative species for conservation and protection by Regional Ordinance N° 005-2011/GRMDD/CR.

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

The Frankfurt Zoological Society has supported conservation initiatives in Peru, particularly in the Department of Madre de Dios, since 1990. In north-eastern Peru, Wildlife Conservation Society and Durrell Institute of Conservation and Ecology (University of Kent, UK), under the project "*Conservación de la Vida Silvestre en la Amazonia Peruana de Loreto*" monitored giant otters in the Yavarí, Yavarí-Mirín and Samiria rivers between 2001 and 2009. In 2009, Rufford Small Grants funded a project: "*Conflict between giant river otter populations and fishing communities in the northeastern Peruvian Amazon*".

Training and knowledge dissemination

In September 1998, the first *International Symposium for the Conservation of the Giant Otter* was held in Lima, the main objective of which was to highlight the need for a national conservation strategy for the species. Christof Schenck's and Elke Staib's doctorate theses were translated into Spanish for greater accessibility.

Several park guard and tourism guide capacity building courses have been held in Madre de Dios. Also, in December 2001 and April 2002, a one-day workshop '*Research and conservation of the giant otter and ox-bow lakes in the Madre de Dios region*' was organized in Puerto Maldonado and in Cusco respectively, bringing together representatives of the protected areas authority, NGOs, and nature tourism companies to share research findings and work towards a variety of ox-bow lake management models for the area.

In 2002 and 2003, two international giant otter field courses were held in Madre de Dios to standardize distribution survey and population census methodologies, as well as habitat management techniques. The courses brought together giant otter specialists from all countries in the giant otter's current distribution range with the objective of contributing and comparing experiences from different work areas in South America.

A "Friends of the Giant Otter" newsletter was launched in 2000 and 17 issues have been sent in Spanish and English to over 350 enthusiasts since then. The purpose of the newsletter is to bring together all those who are interested in giant otter conservation, to act as a networking tool with which to increase communication and collaboration. Although first intended for Peruvian 'friends', the bulletin was increasingly sent further abroad, particularly to other South American countries.

Education and awareness-raising

The Frankfurt Zoological Society produced information leaflets and a booklet to aid tourists and local people in getting to know the giant otter, and to initiate appropriate behavior when visiting areas inhabited by the species. Several giant otter posters were also produced by FZS and widely distributed, with the intention of raising awareness of the species' conservation status.

During 2000, a German film crew representing the television channel Bayerischer Rundfunk visited Manu to film a documentary on giant otters and their conservation. A Spanish version of this film "*Gigantes de la Selva*" was later released on Peruvian television. A second documentary on the biodiversity of Manu, with a focus on giant otters, was filmed in 2002 for the German ARD channel. This was released on Peruvian television as "*Manu – Hotspot de la Biodiversidad*". Additional films have been made for a BBC children's program and German television, and a BBC production was filmed in early 2012.

An Environmental Education Program first started in 2002 by the Frankfurt Zoological Society and continues to run in Madre de Dios by the Tambopata National Reserve, with approximately 2,500 children per year, and over 18,000 in total, involved in three environmental education initiatives ("*Camino al Lago Sandoval*", "*Pepe, el Lobo de Rio*", and the Plan Ambiental Regional), all of which include giant otters as ambassadors of aquatic ecosystems.

The "*Pepe, el Lobo de Rio*" coloring book activity and drawing competition was first conducted in 1998 in the area surrounding the Pacaya-Samiria National Reserve. It was then repeated in 2000-2001 involving approx. 4000 children in three key protected areas and in four regionally important cities. Since then, it has been conducted every two years in Madre de Dios, focusing on the capital of Puerto Maldonado.

In 2011, a breakthrough was made in the conservation of the giant otter when it was declared emblematic for the Madre de Dios region. In response, in May 2011 the first giant otter festival was held in Puerto Maldonado with the aim of raising awareness about the species among local people. This festival is no longer held solely for the giant otter in the region of Madre de Dios; it has now expanded into a broader event, the "Biofest," which celebrates the biodiversity of the region in general. This change attracts more attention and resources, as the festival aims to highlight the area's natural and cultural wealth, promoting conservation and the sustainable use of resources. The Biofest is held annually in May and led by the Tambopata National Reserve and the Regional Government of Madre de Dios.

Informative posters were distributed in the communities on the Yavarí-Mirín River as a part of an environmental education initiative (Isola & Benavides 2001). Interviews and an environmental education program were carried out in three communities of the Yanayacu River in the Pacaya-Samiria National Reserve as part of the "*Conflict between giant river otter populations and fishing communities in the northeastern Peruvian Amazon*" (Recharte 2010). Subsequently, interviews were conducted in the San Martin de Tipishca community on the Samiria River and the Nueva Esperanza community on the Yavarí-Mirín River (Recharte 2011).

Since 2009, several communities were visited: San Martin de Tipishca in Samiria River, 20 de Enero, Arequipa and Yarina on the Yanayacu River and Nueva Esperanza on the Yavarí-Mirín River to 1) determine attitudes to local people toward the recovery and presence of giant otters, and 2) determine if local people value giant otters as a flagship species. Additionally, community meetings were carried out as part of the environmental education and attempt to alleviate fishermen's concerns about prey competition, helping to change negative perceptions towards giant river otters (Recharte 2011). In 2015, a follow-up environmental education session about giant otters tried to re-contact schoolchildren from the 2009 session and examined their current attitudes towards giant otters (Recharte 2018).

Habitat and human/giant otter conflict management

Over the past two decades, several new protected areas have been created or expanded in size. For example, on 4 September 2000, a Supreme Decree was signed that more than doubled the size of the Bahuaja-Sonene National Park (now 1,091,496 ha). Today, more than 17% of the national territory falls within the National System for Protected Natural Areas of the State (SINANPE).

Tourism Site Management Plans for 9 lakes in Madre de Dios (Lago Sandoval - where the construction of a Control Post and Interpretation Centre was completed by FZS in 2003 -, Tres Chimbadas, Cocococha, Capiripa, Kamungo, Salvador, Otorongo, Cashu, and Sachavacayoc) were developed, and general guidelines are currently being produced. The government is collaborating to ensure national uptake of these guidelines.

In 2022, Frankfurt Zoological Society conducted an analysis of the conflict between fisher people and the giant otter that helped to develop a strategy for the protection and conservation of the species in the Purus Communal Reserve and its buffer, Ucayali.

A regional conservation plan for the species is being developed in Madre de Dios and will be approved and implemented by the regional government.

Giant otter experts in Peru identified three large Priority Conservation Areas in the country (Figure 4), reflecting the expert knowledge areas in the north and south of the country detailed in Figure 2.

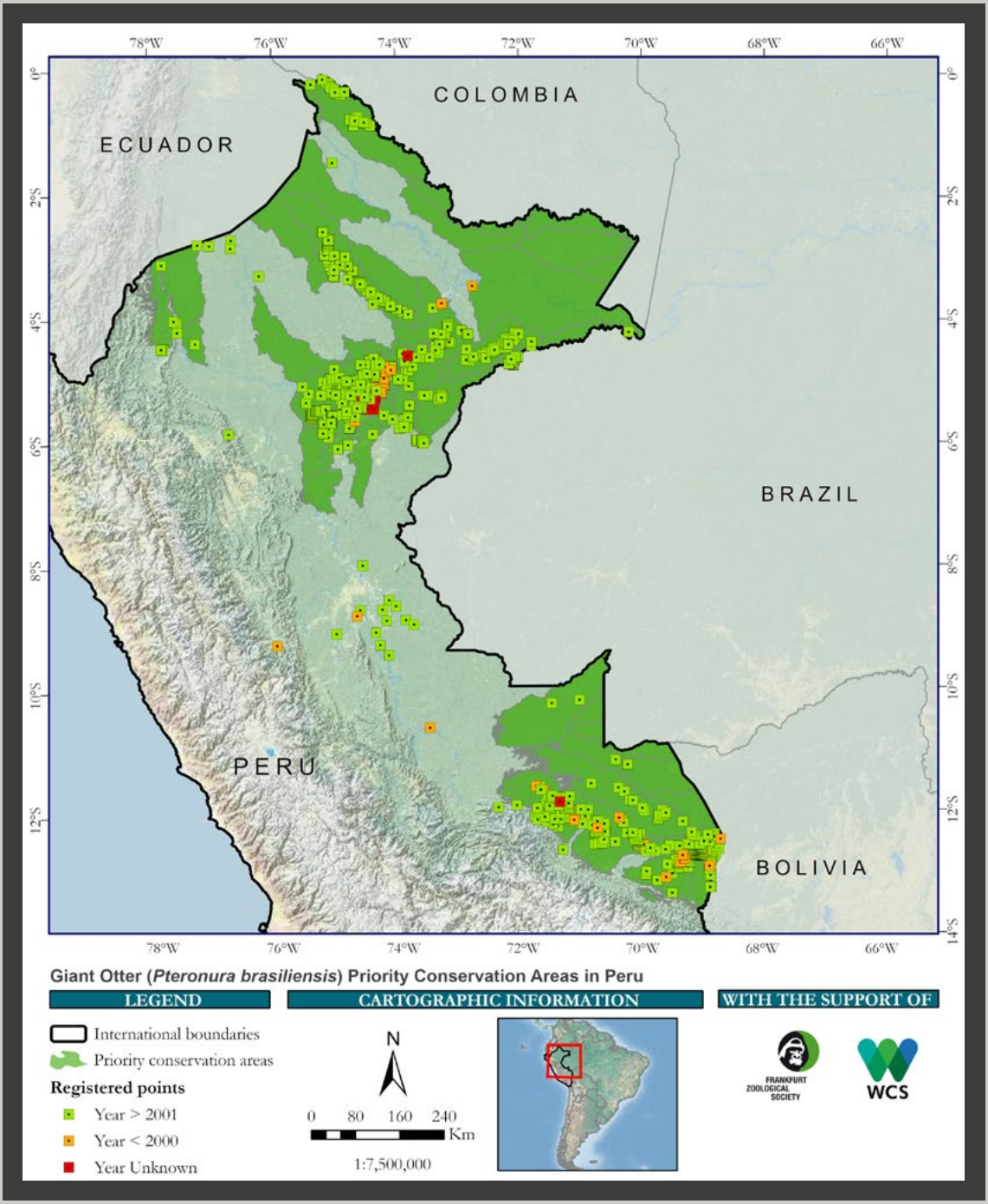

Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas and systematized locality records in Peru.

RECOMMENDATIONS FOR FUTURE EFFORT

In Peru, the recommendations for the future can be summarized by the following bullet points:

Research

- Study fragmentation of giant otter populations in Madre de Dios.
- Study restoration of habitats disturbed by gold-mining and possible re-colonization by giant otters.
- Continue research into human-giant otter conflicts with fishermen and at fish farms.
- Continue research into predator-prey relationships.
- Initiate collaborations between field scientists, geneticists, and zoos to evaluate the potential of genetic analysis tools in giant otter research.
- Mercury concentration studies in giant otter.
- Dispersion of the giant otter, survival success, and reproductive activity of solitary individuals.

Training and knowledge dissemination

- Strengthen "*Friends of the Giant Otter*" as a South America-wide network for the interchange of giant otter research and conservation experiences.
- Strengthen the "*Asociación para la Conservación de las Nutrias del Amazonia Peruana (ACNAP)*" as a national network to monitor otters and promote their conservation.
- Organize training courses for ecotourism guides, park guards and biologists on giant otter monitoring and habitat and tourism management.

Education and awareness raising

- Involve national and international media (radio, television, internet, newspapers) in raising awareness of the species, its conservation status, and what is being done to help.
- Expand local environmental education programs, in which the giant otter figures as a flagship, bioindicator, and umbrella species.

Habitat and human/giant otter conflict management

- Develop and conduct a national census of the species aimed at estimating numbers in key populations and producing a national distribution map.
- Continue the annual population surveys in Madre de Dios.
- Increase awareness of the threat unmanaged tourism poses and promote giant otter friendly tourism nationally.
- Produce concise otter habitat management guidelines and disseminate these within the appropriate national bodies, as part of a wider, national in situ conservation strategy for the giant otter.

ACKNOWLEDGEMENTS

To Robert Wallace for leading the overall initiative and the compilation of information on giant otter records in South America, an initiative that began in 2018 during the "*Regional Workshop for the Conservation of the Giant Otter, applying the Range Wide Priority Setting Methodology*". To the Frankfurt Zoological Society, an institution dedicated for almost 30 years to the constant monitoring of the giant otter in southeastern and northern Peru, along with the articulated work with SERNANP, providing current data on the species and facilitating information for this chapter.

We would also like to thank each of the researchers involved in this exciting task: Nicole Abanto, Alejandro Alarcon, Adi Barocas, Johny Farfan, Cesar Flores, John Flores, Hauke Hoops, Keyly Huamaní, Germán Sebastian, Willy Maldonado, Joel Mendoza, Oscar Mujica, Vladimir Ramirez, José Antonio Ochoa, Eddy Torres, Danilo Jordán; and finally to thank all the staff of the Natural Protected Areas for their collaboration during the fieldwork.

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CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN SURINAME

Nicole Duplaix

LOCAL NAMES

bigi watradagu (Surinamese), braziliaanse reuzeotter (Dutch).

HISTORICAL AND CURRENT DISTRIBUTION

The distribution of the giant otter in Suriname overlaps that of the Neotropical otter, with both species inhabiting lowland tropical rainforests, and even coastal mangroves and abandoned plantation canals (Duplaix *pers. obs.*). However, *Pteronura* prefers remote and undisturbed rivers and creeks of the interior (Duplaix 1980, 2003). Their populations were regarded as stable until illegal gold mining started in 2000, which has increased exponentially in the last two decades as the price of gold has soared to $1,500/oz.

Figures 1-3 show the expert opinion on the historical distribution of the giant otter in Suriname (Figure 1), the area considered as with expert knowledge (Figure 2), and the area identified as a Priority Conservation Area for the giant otter in Suriname. Essentially, despite concerns about gold mining, the entire distribution is still considered a conservation stronghold for the species.

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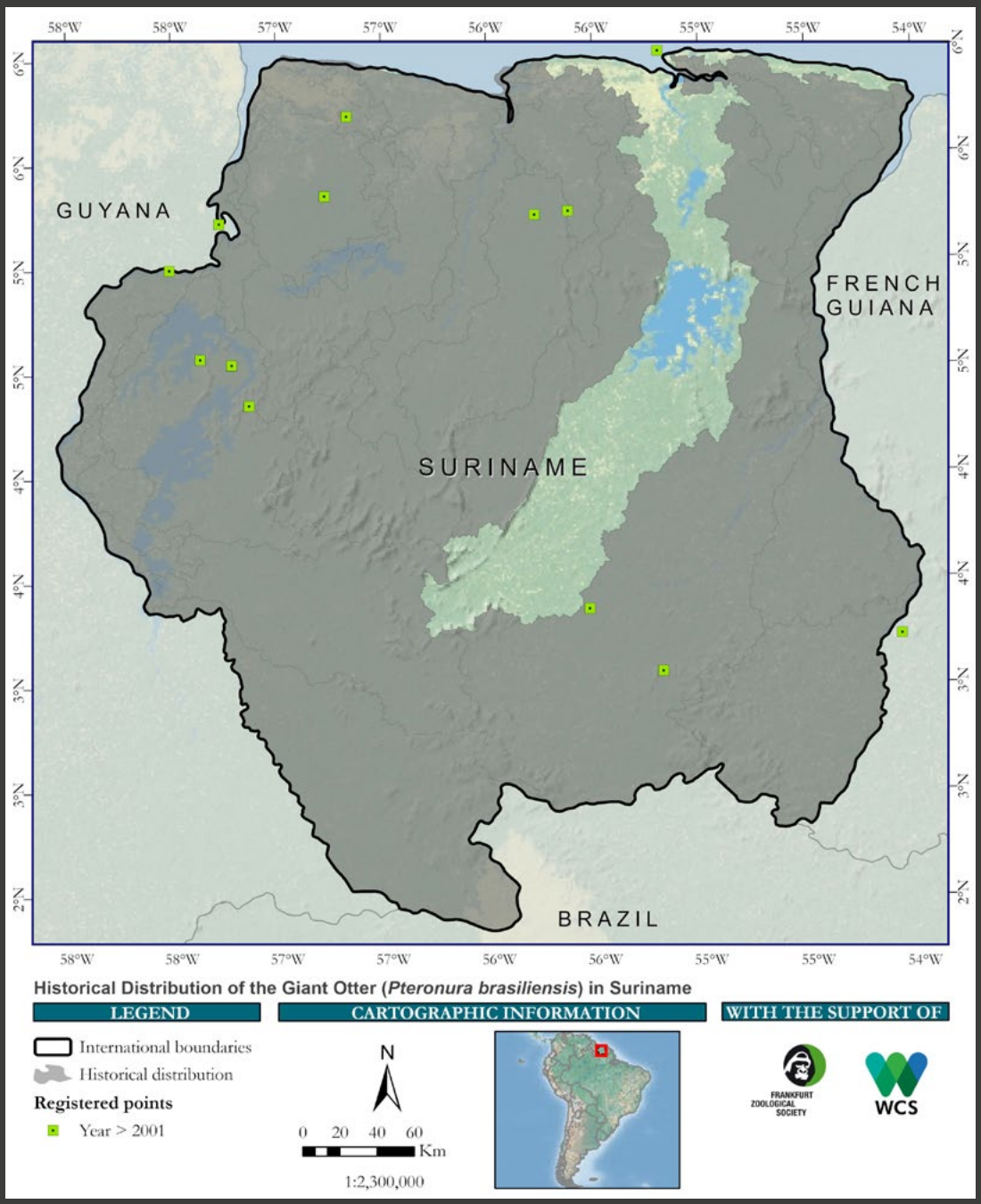


Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) in Suriname.

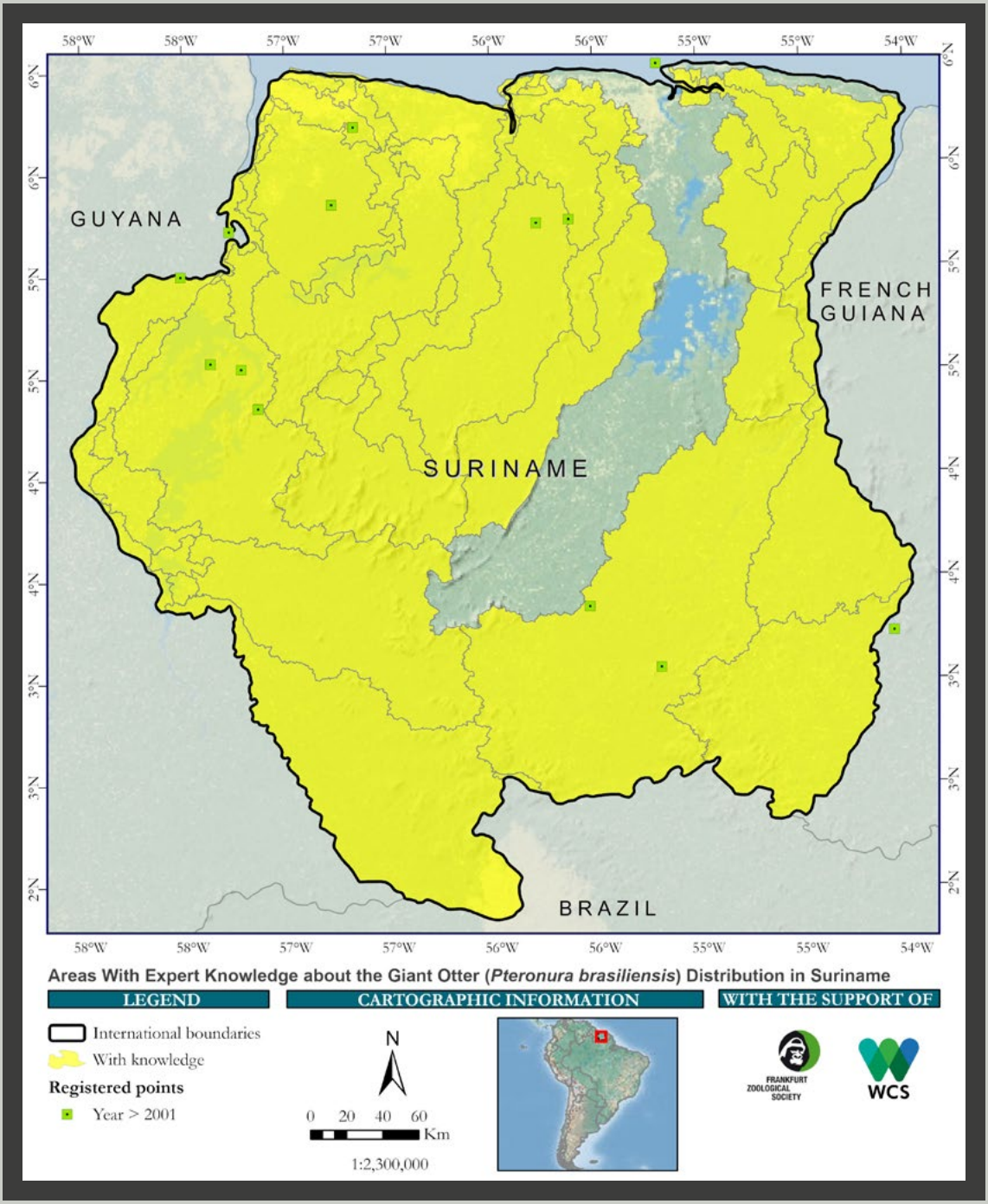


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution in Suriname.

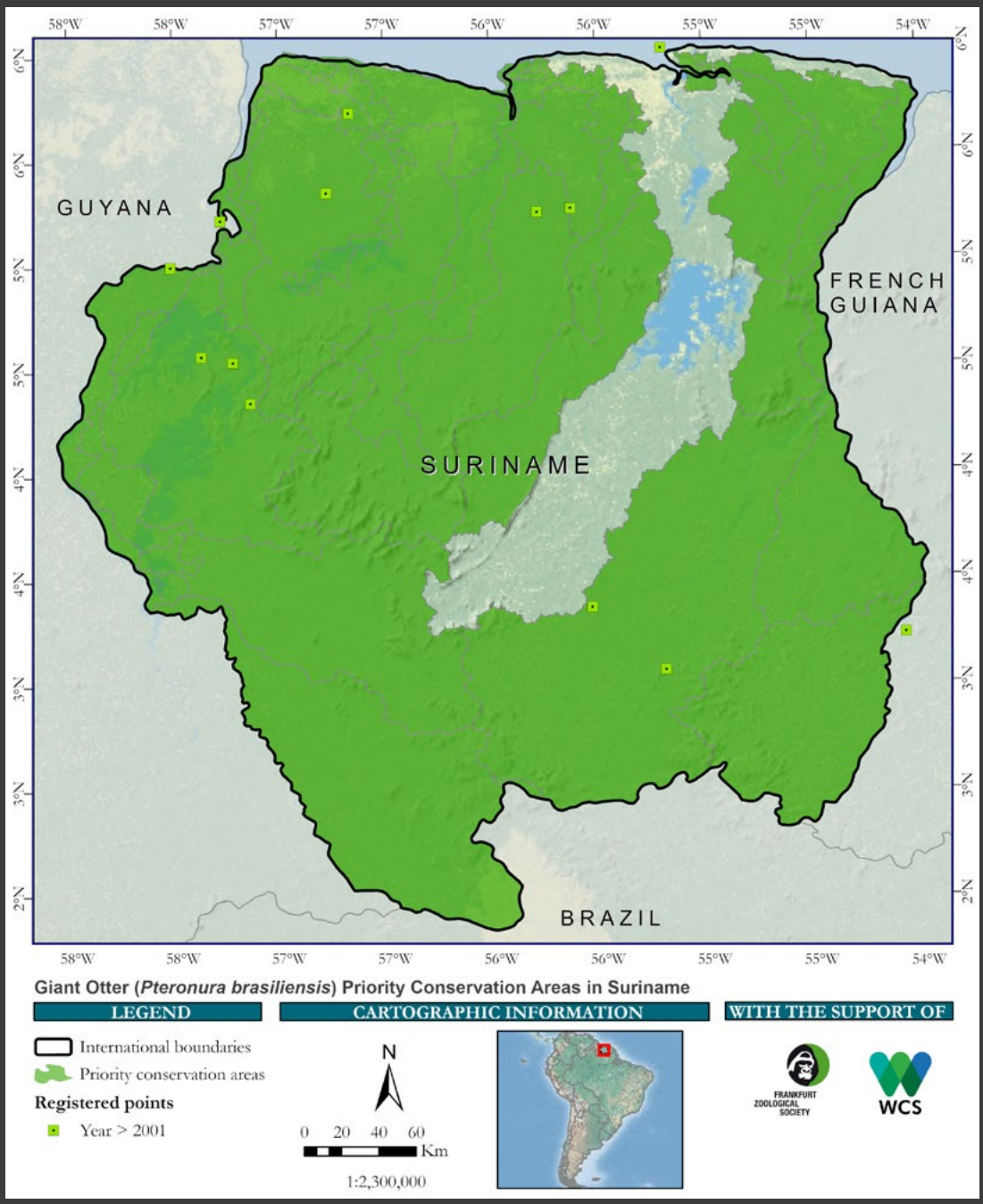
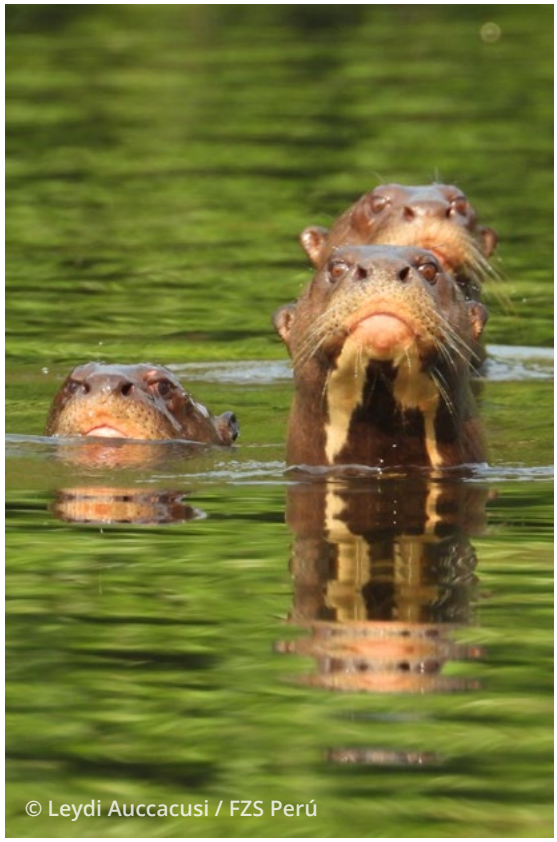


Figure 3. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas in Suriname.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

Population levels of giant otters in the Guianas were once considered the highest in South America. While giant otter populations remain high in areas of Suriname where gold mining does not occur (Central Suriname Reserve), these populations are becoming more isolated from one another.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HABITAT USE

Giant otters in Suriname prefer the quiet forested creeks and rivers in the interior, although they may be found in coastal and savannah rivers as well. The forested creeks in the undeveloped interior remain largely undisturbed (until now at least) and offer ideal habitat.

THREATS

The greatest threat to giant otters in Suriname is the expansion of national (legal) and illegal gold mining activities that affect many of the watersheds where they occur. The following watersheds affected by gold mining include: Coesewijne, Commewijne, Saramacca, Tapanahony, Lawa, and the Brokopondo Lake area, and probably many others. The illegal gold mining in the remote interior is realized by Brazilian gold miners who hire local Suriname villagers. The Brazilians are reported to shoot most wildlife, including otters.

Largely unmonitored, the large and small gold-mining activities result in significant environmental and public health hazards due to chemical and environmental degradation. Large concentrations of sediments are deposited in the rivers, high levels of mercury evaporate and seep into the watershed, multiple pools of polluted water dot the land, and large riparian areas are laid bare. These types of damage have been recorded at the top of most of the watersheds in the region, presenting severe long-term threats to the water quality of the rivers and creeks downstream and to all who depend on them. For instance, in the Comewijne River, fish populations are affected by increased turbidity, and mercury levels

have skyrocketed to ten times the norm – as evidenced by mercury levels found in *Hoplias* – a favorite fish of both people and giant otters (Qwik & Ouboter 2000).

The pelt trade has never been a threat to either otter species (L. l*ongicaudis* and P. *brasiliensis*) in Suriname, although it has been reported in Guyana and French Guiana as late as the early 1970s (Duplaix 1980). A few individuals are killed each year by hunters and gold miners in Suriname, merely as target practice or because they are seen as competitors for fish. Unfortunately, this is probably increasing due to the increased presence of Brazilian gold miners. A giant otter was shot by hunters in French Guiana, near Suriname, and confiscated (Thiollay pers. comm. 2000). Cubs of both species are sometimes captured illegally to keep as pets by the indigenous populations of the interior (Duplaix *et al.* 2001). Otters have also drowned accidentally in fishing nets or traps (Duplaix 1980, 2004). However, current human population expansion and habitat destruction due to increased logging activities and gold mining, as well as over-fishing with nets stretched across small creeks, and domestic animal diseases such as distemper, are all also threats to otters in Suriname today (Duplaix 1980, 2003; Groenendijk 1998; Duplaix *et al.* 2001, 2018).

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

The future of giant otters in Suriname is not as secure as it once was. Giant otters will be eradicated by the pollution and human activities associated with legal and illegal gold mining as they already have been in some of the major rivers of Guyana and French Guiana. At present, only the Central Suriname Nature Reserve remains a secure haven.

KNOWLEDGE ABOUT THE SPECIES

Otter surveys along the major rivers of Suriname were carried out in 1976-1978 (Duplaix 1980) and again in 2001-2003 (Duplaix 2003). The giant otter and neotropical otter populations were both considered stable at that time and no major threats were reported. In 2004-2005, illegal gold mining activities began in the Commewijne and Coesewijne watersheds (including the Reserve there), both of which were once giant otter strongholds.

LEGAL STATUS

Protection of biodiversity, including wildlife trade, comes under the Nature Preservation Act (GB 1954, No. 26), the Game Law (GB 1954, No. 25, with amendments in 1971, 1980, 1982, 1986, 1994) and the Game Resolution of 1970 (GB 1973, with amendments in 1973). Both otter species are protected under the Game Law of 1954 (GB 1954 no.25, amended in 1980, 1982, 1994) and under the Law on Regulation for Import and Export of 20 March 1954 (GB 1981 no. 43). Further, the export and import of otters is prohibited under State Resolution Negative List (SB 1999 no. 34 of 31 March 1999) without written exemption of the Minister of the Environment and in consultation with the President of the Republic of Suriname (Duplaix 2001). Suriname is a signatory country of CITES (1981), and of the Ramsar Convention (1985). However, the protection of wildlife in the interior of Suriname under the Game Law is not enforced and wildlife is harvested at will in most areas of the interior.

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

Historically, Suriname was regarded as a leader in conservation and forestry management in the Guyana Shield region. A total of 13 Nature Reserves, one Nature Park and one multiple-use management area existed in 1990 and five others, proposed in 1980, were never ratified (Mittermeier *et al.* 1990; Duplaix 2003). In 1999 the 1,600,000-ha Central Suriname Reserve (CNSR) was declared which includes three reserves. This is pristine, uninhabited rainforest and prime giant otter habitat. Giant and/or Neotropical otters have been observed in at least 11 of these reserves and parks (Duplaix 2004). The CSNR remains a magnificent reserve where both species of otter are present.

The local conservation initiatives spearheaded by Conservation International resulted in the expansion of the Central Suriname reserves, a fish rapid bio-assessment in the CSNR, and many local educational outreach activities in the capital, Paramaribo. World Wildlife Fund-Guianas launched a Gold Mining Pollution Abatement program in 2008. However, the Brownsberg Nature Reserve and the Coewijne Nature Reserves, are both now at the center of gold-mining exploitation, and otters are no longer reported.

RECOMMENDATIONS FOR FUTURE EFFORT

If the gold mining activities can be controlled and curtailed in the interior of Suriname, giant otters will survive in most watersheds. If not, they will disappear as they have in so many other watersheds in South America (Duplaix *et al.* 2018).

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN URUGUAY

Martín Buschiazzo & Alvaro Soutullo

LOCAL NAMES

Lobo grande de río, Lobo corbata, Lobo gargantilla.

HISTORICAL AND CURRENT DISTRIBUTION

The existing bibliography mentions the Uruguay river, north of the Negro River, the Negro River itself, and major tributaries of both rivers (Devincenzi 1935), as well as the Laguna Merin basin (Prigioni *et al.* 2006; Buschiazzo *et al.* 2015) as distribution areas for the species in Uruguay. The only existing collection material is a skull from the Negro River deposited in the National Museum of Natural History (MNHN 1266). There are a number of isolated sightings that coincide with the proposed distribution (Aplin 1894; Devincenzi 1935; Barattini 1959; Ximenez *et al.* 1972; Soutullo et al. 1998; Buschiazzo *et al.* 2015).

The following maps show the historical distribution of *Pteronura brasiliensis* in Uruguay based on historical records (Figure 1) and expert knowledge (Figure 2), as well as areas where the giant otter is known to no longer occur in the country (Figure 3). Overall, we consider that the species is not currently found in Uruguay.

Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) and systematized locality records in Uruguay.

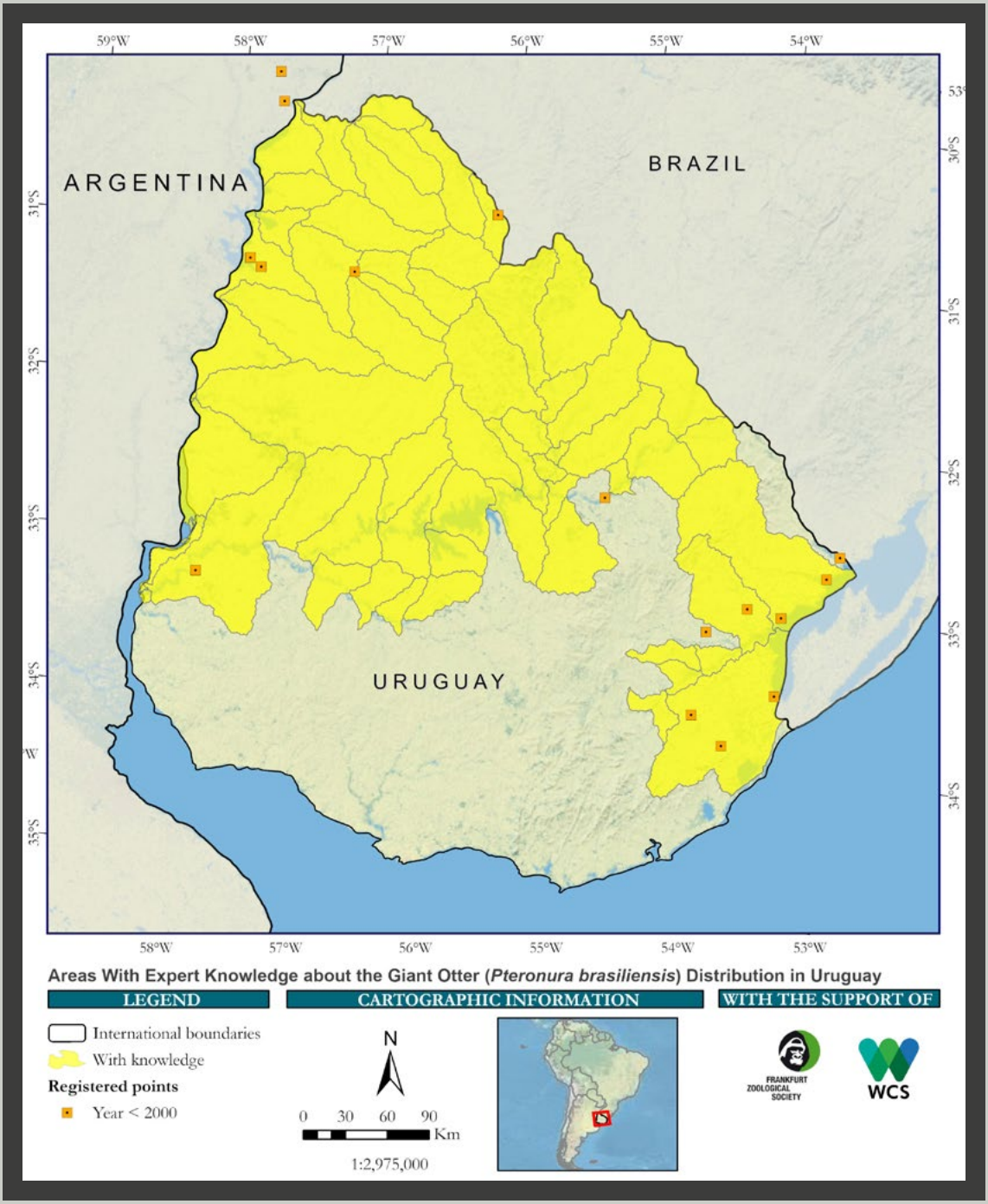

Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution and systematized locality records in Uruguay.

Figure 3. Areas where giant otter (*Pteronura brasiliensis*) no longer occurs and systematized locality records in Uruguay.

POPULATION, ABUNDANCE, AND/OR DENSITY ESTIMATES

There are no data on population abundance in the country. According to fishermen records, groups of up to five and six giant otter individuals were observed in the Laguna Merin basin up to the 1950's (Prigioni et al. 2006).

HABITAT USE

No specific studies have been conducted in Uruguay. Aplin (1894) mentions the presence of a specimen in the rapids area of a river with dense forest on its banks. Others mention streams, rivers, lagoons, and swamps with dense vegetation (Achaval *et al.* 2004), rivers with fairly dense riparian forest vegetation (Prigioni *et al.* 2006) and sandy beaches along rivers (Buschiazzo *et al.* 2015).

THREATS

Aplin (1894) mentions that a fisherman told him about the discomfort caused by giant otters eating fish from fishing gear, but he does not mention whether fishermen hunted them directly. It is unclear whether hydroelectric developments have affected populations. All of the dams built in Uruguay are located within their historical range - one on the Uruguay River and three on the Negro River - but it is not possible to determine their effect due to a lack of population studies, both before and after the construction of the dams. The dams were built in 1945, 1960, 1981 (Gabriel Terra, Baygorria, Palmar, Negro River) and 1974 (Salto Grande, Uruguay River). It seems logical to assume that populations would be diminished by dam construction. However, the main cause of the giant otter population reduction was hunting either out of curiosity or ignorance, or commercial hunting for their fur (Gonzalez & Martinez 2010).

PREDICTED FUTURE DISTRIBUTION TRENDS IN RESPONSE TO CURRENT AND ANTICIPATED THREATS

In the panorama of uncertainty about the presence of the species, the Uruguay population is probably non-viable. The return of the species to the country and the establishment of a viable population would need long-term conservation efforts coordinated with neighboring countries, and also involving different stakeholders. Currently the greatest risk for the species would be human conflict and hunting. There are no plans for the construction of new dams in the country so this threat will probably not increase.


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KNOWLEDGE ABOUT THE SPECIES

No research has been carried out in Uruguay with *Pteronura brasiliensis* as a focal species. An historical sighting (Aplin 1894) described the habitat of the observed specimen and that it was feeding on a cormorant (*Phalacrocorax brasilianus*). Devincenzi (1935) details anatomical data based on skins and skulls from the Uruguay river and makes a very brief commentary on distribution, habitat and behavior of the species. The only specimen collected and residing in a scientific collection in Uruguay (Ximenez *et al.* 1972) is at the National Museum of Natural History (MNHN 1266). A preliminary census of otter populations revealed six possible new locations for giant otters (Soutullo *et al.* 1998), including in northern Uruguay in 1960, 1977, 1979 and 1996, and two possible records in the 1930's and 1950's in the eastern marshes. A series of giant otter footprints were found in 2004 on the Laguna Merin coast in the department of Treinta y Tres (32º 59' 48" S; 53º 31' 32" W), and comments by fishermen in the Laguna Merin basin mention records of the species between 1990 and 1994, and that the species was relatively common up to the 1940´s and 1950's (Prigioni *et al.* 2006). Finally, a review of existing information and unpublished data for the giant otter in the country revealed two new possible locations in eastern Uruguay, both from the Laguna Merin basin in 2008 and 2012 (Buschiazzo *et al.* 2015).

LEGAL STATUS

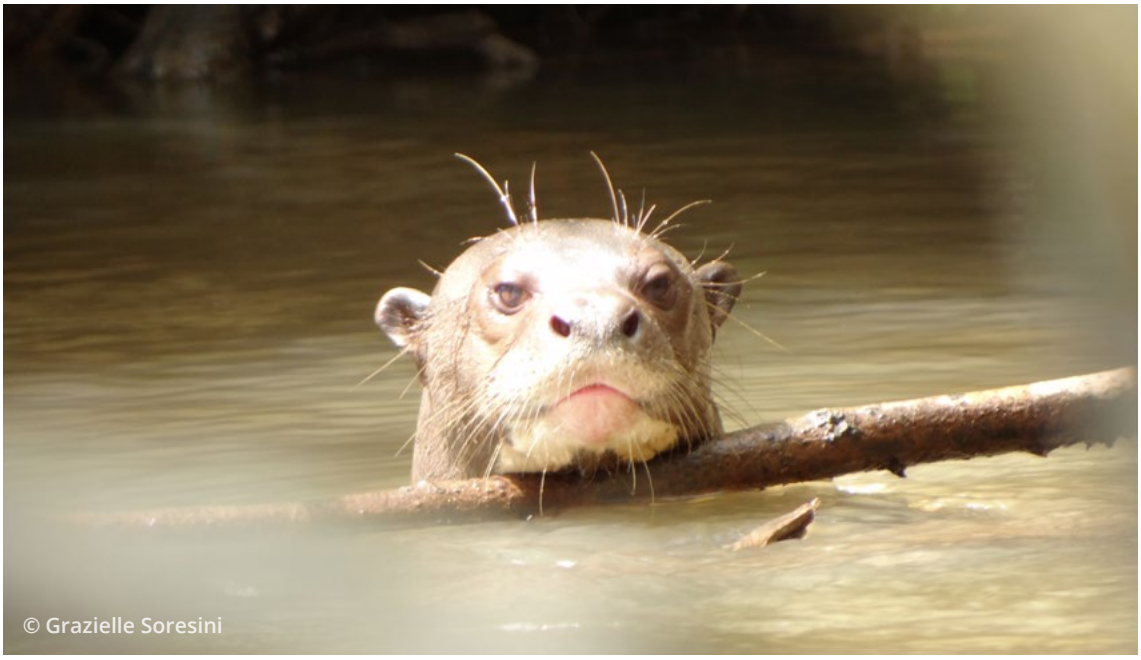
There is no specific law that protects the giant otter in Uruguay, but there are a set of more general laws and their respective regulatory decrees that provide protection:

- Law 9.481 - Protection of National Fauna.
- Law 16.408 - Approval of the Convention on Biological Diversity.
- Law 16.736 - Regulation of Hunting Permits.
- Law 17.234 - Creation of the National System of Natural Protected Areas.
- Law 17.283 - General Protection of the Environment.

Several of these laws are not very effective due to failures in their application, regulation and/or control. As of 2009 the species is on the list of priority species for conservation according to the report presented by the National System of Protected Areas (Soutullo *et al.* 2009).

PAST, CURRENT AND PLANNED CONSERVATION INITIATIVES

There are no direct efforts for the conservation of *Pteronura brasiliensis* in Uruguay. Since the approval of the new National System of Protected Areas (SNAP), initiatives to generate protected areas have been given greater impetus, but so far there are no proposals for the areas where possible recent sightings were recorded (Buschiazzo *et al.* 2015). The creation of protected areas in these areas would help conserve the habitats where they are most likely to be found. Future initiatives will depend directly on the possibility of confirming their presence in Uruguay, and then determining precisely the areas where the greatest conservation efforts should be made, in collaboration with neighboring countries to improve connectivity and the establishment of viable populations.



RECOMMENDATIONS FOR FUTURE EFFORT

Efforts in the immediate future should focus on the confirmation of the presence of the species in Uruguay, mainly in the places with possible sightings of the species: the Laguna Merin basin and the northern basin of the Uruguay River. If the presence of giant otters is confirmed, the viability of the population(s) should be investigated, both from a genetic and an ecological perspective, as well as their connectivity with populations in Argentina and Brazil. Appropriate environmental education efforts should then be made with local people, rural schools and nearby cities. Even if presence is not confirmed, environmental education efforts should focus on the species as an example of a possible extinction due to human causes, thereby generating awareness for the conservation of other species.

ACKNOWLEDGEMENTS

We want to thank Rob Wallace and the editorial team for the invitation to participate in this publication.

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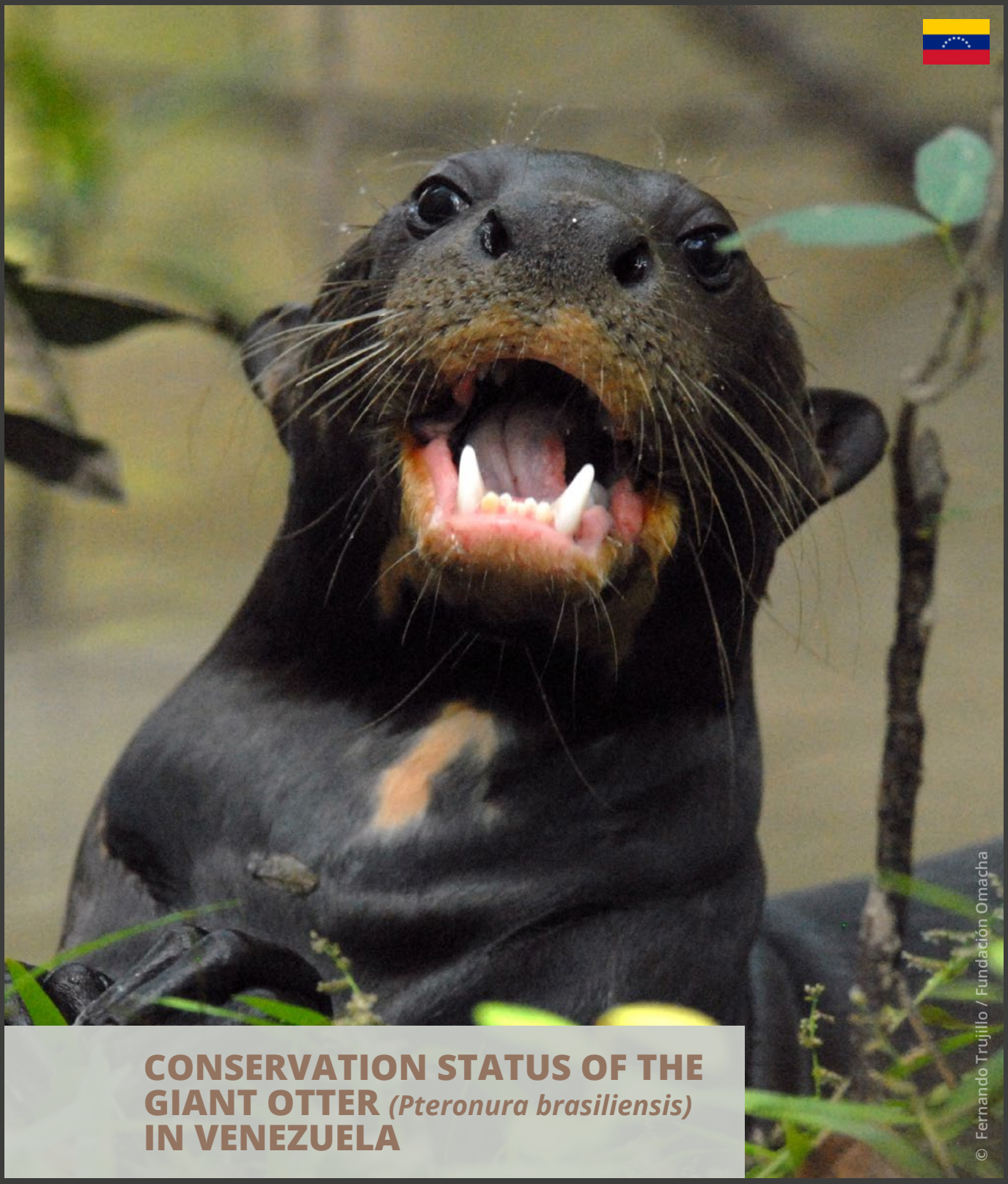

CONSERVATION STATUS OF THE GIANT OTTER *(Pteronura brasiliensis)* IN VENEZUELA

Salvador Boher & Hannah Heither

LOCAL NAMES

Perro de agua, Perro de agua grande, Nutria del Orinoco, Perro lobo de agua (Gulf of Paria), Copulo (ethnic Warao), Hetehia (ethnic Yanomami).

HISTORICAL AND CURRENT DISTRIBUTION

Recent populations are recorded in the Hato Garza (2003) area of Apure Federal State, the Orinoco, Caura and Zuata rivers, as well as in Jaua-Sarisariñama National Park in Bolívar Federal State, and the Mochima and Turuépano national parks in the Sucre Federal State (Matos 2003, 2004; Navarro Rodriguez 2006; Rodríguez & Rojas-Suárez 2008; Castellanos 2010, 2011; Heither & Müller 2010, 2011; Boher *et al.* 2017; unpubl. data) (Figure 1). According to Rodríguez & Rojas-Suárez (2008), giant otters occur northeast of the Andean mountain chain of Merida at elevations between 0-240 m. Giant otter range across the Llanos area and the Orinoco and Amazon and Deltas Bioregions, at elevations between 0 and 550 m.

The giant otter historical distribution in Venezuela (Figure 1) is based on previously published information (Mondolfi 1970). Areas considered as with expert knowledge for Venezuela (Figure 2) were based on Boher and colleagues (2017), as were the polygons identified as areas where the giant otter no longer occurs in Venezuela (Figure 3). Based on previous studies (Boher *et al.* 2017), one area was identified as a Priority Conservation Area for the giant otter in Venezuela (Figure 4).

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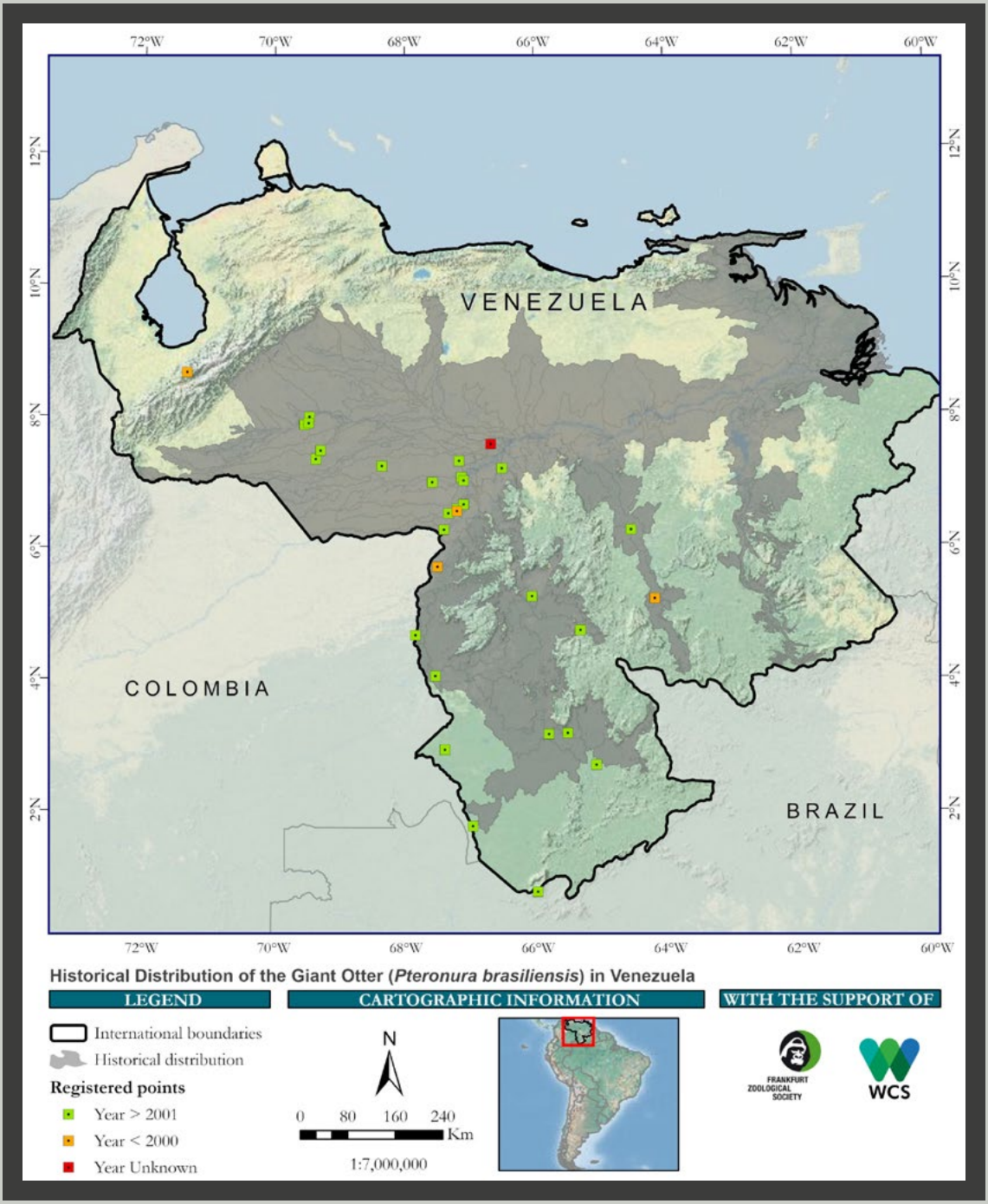


Figure 1. Figure 1. Historical distribution of the giant otter (*Pteronura brasiliensis*) in Venezuela.

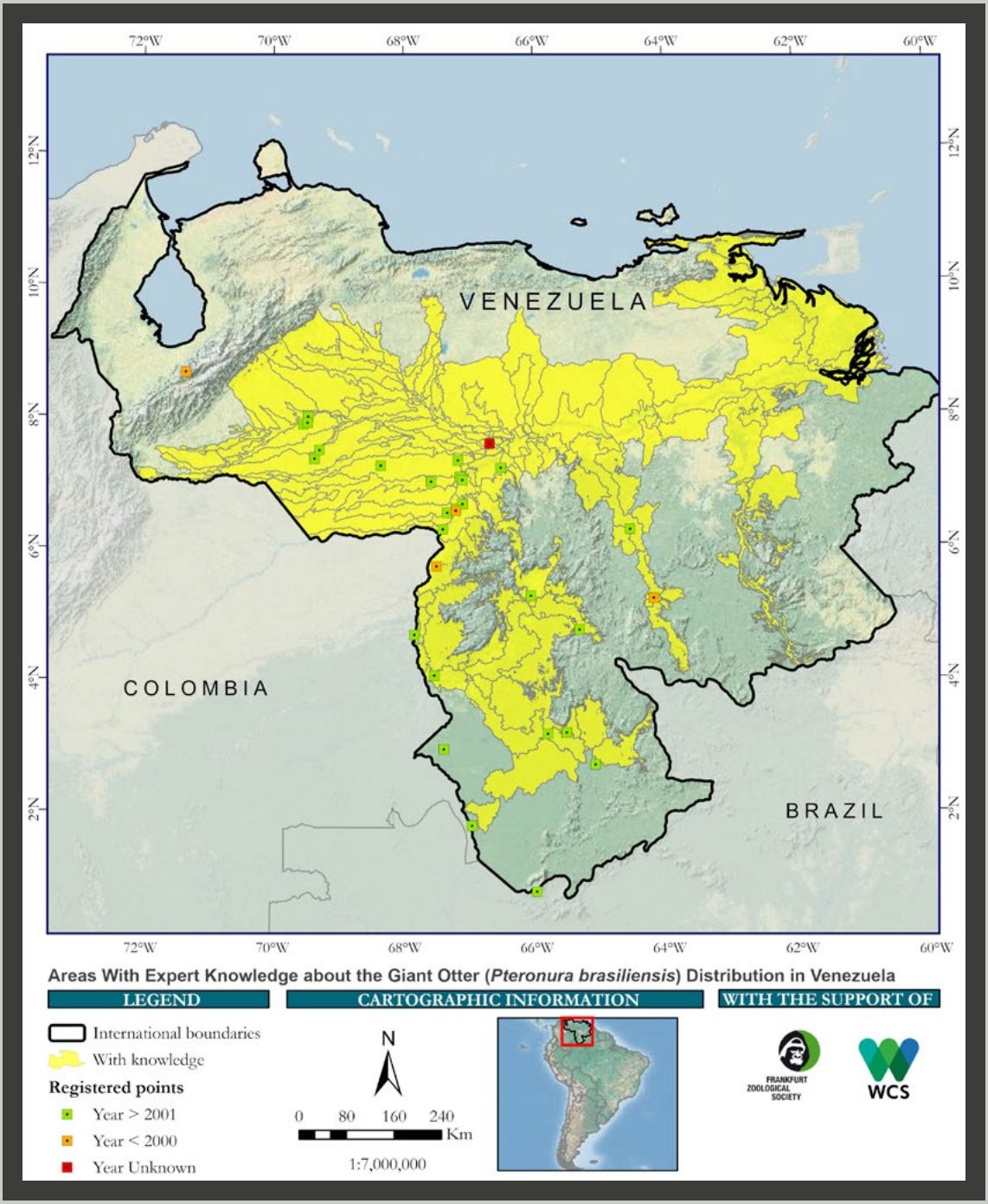


Figure 2. Areas with expert knowledge about giant otter (*Pteronura brasiliensis*) distribution in Venezuela.

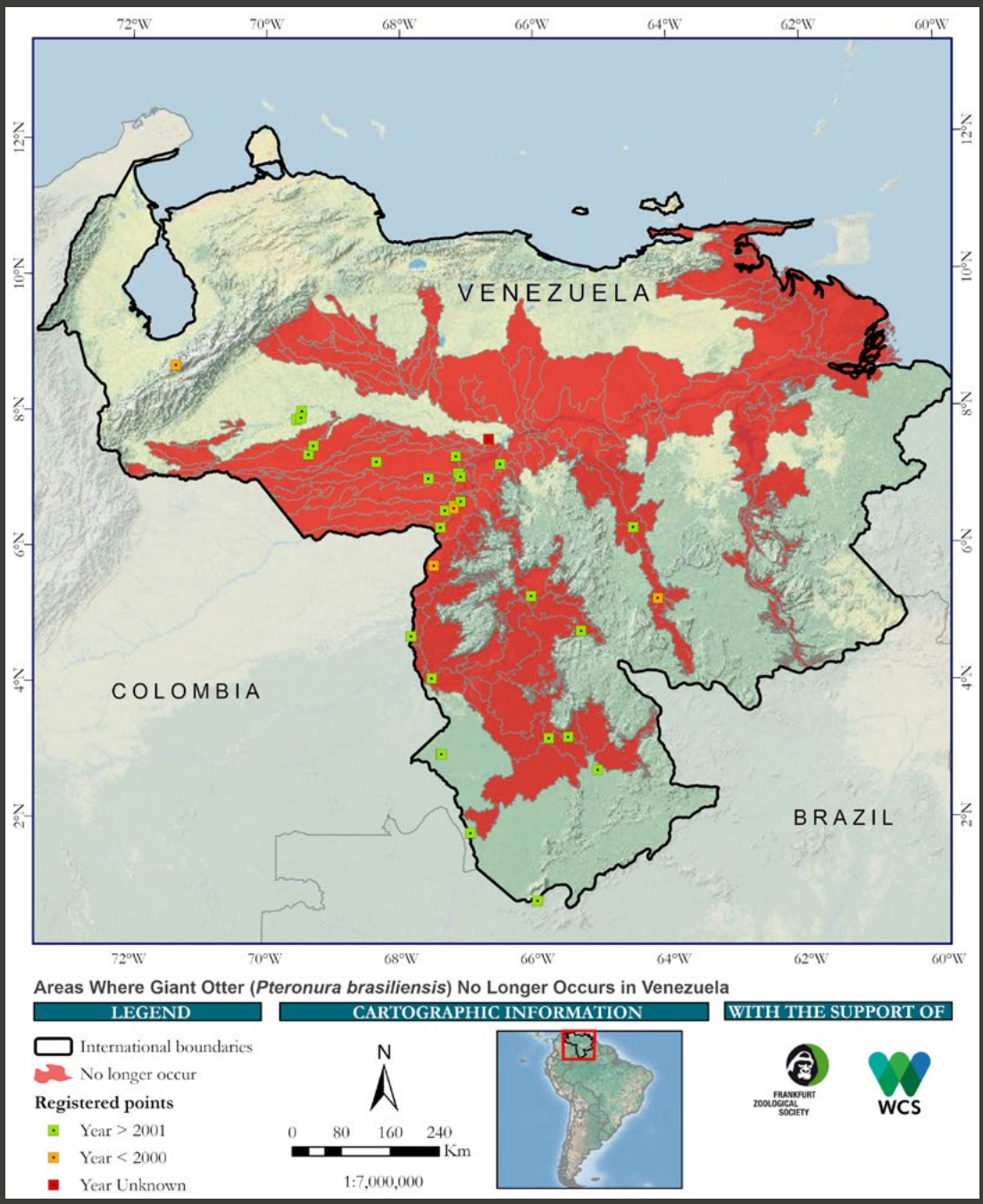
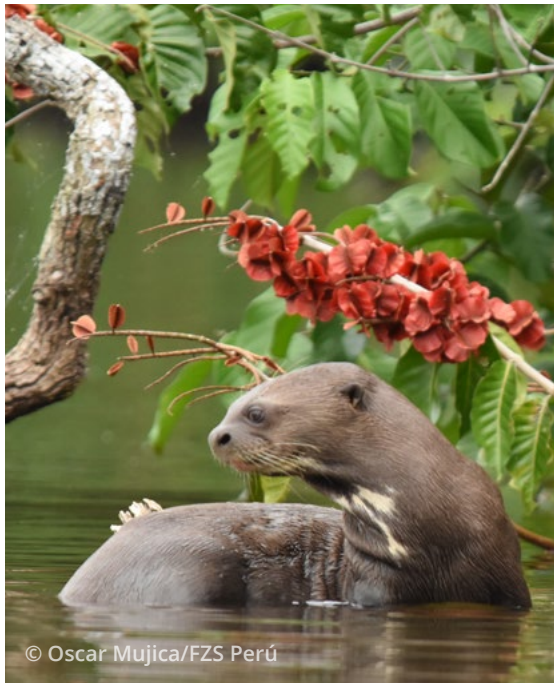


Figure 3. Areas where giant otter (*Pteronura brasiliensis)* no longer occurs in Venezuela.

Figure 4. Giant otter (*Pteronura brasiliensis*) Priority Conservation Areas in Venezuela.

KNOWLEDGE ABOUT THE SPECIES

In the Orinoco area, Salvador Boher, Rosauro Navarro Rodriguez and Hernan Gerardo Castellanos recorded giant otters between 2006 and 2011. Giant otter populations in the Llanos and delta regions, as well as the Caura and Nichare rivers are frequently surveyed by researchers. In 2001 in the Turuépano National Park, giant otter monitoring was undertaken by the Vuelta Larga Foundation.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POPULATION ABUNDANCE, NUMBERS AND DENSITY ESTIMATES

There is a lack of population estimates in Venezuela. Species abundances decreased in the past and are still decreasing due to several anthropogenic influences. At the beginning of the 1970's, giant otters were common in the Orinoco, Caura, Ventuari, Apure, Arauca, Portuguesa and Capanaparo rivers (Mondolfi 1970). According to one estimate, populations decreased 50% in the last 30 years.

Llanos Bioregion

Caño Guaritico Wildlife Refuge, Apure Federal State, 0.1 individuals/km (Boher 1995, 1996, 1997, 2009, 2012, 2015, 2017).

Orinoco River and its inundation area, Apure Federal State, La Tortuga Arrau Wildlife Refuge and Santos Luzardo National Park (Cinaruco-Capanaparo), 0.0059 individuals/km (Boher 1995, 1996, 1997, 2007, 2008, 2009; Rodriguez *et al.* 2011).

Delta Systems Bioregion

Agua Blanca lake, Caituco Lake, rivers of Turuépano National Park and environs, Sucre Federal State, 2001 (16 individuals) (Ceballos-Mago), 2010 (tracks, sign), 2011 (sign) (Heither & Müller).

Guarapiche Forest Reserve, Caño La Brea (2001 (4 individuals) (Ceballos-Mago), 2008 (10 individuals) (Müller), 6 individuals (Heither & Müller 2011)).

Orinoco Delta Biosphere Reserve, 0.01 individuals/km (Boher 2004, 2006, 2009).

Cordillera Oriental Bioregion

Neverí River, Mochima National Park, Sucre Federal State, 2 individuals (Heither & Müller 2011).

HABITAT USE

Giant otters are associated with freshwater systems of rivers, canals and lakes, as well as estuaries (Müller 2011). Giant otter presence is related to intact freshwater ecosystems, where they mainly hunt on fish, especially Cichlidae, Megalopidae, Moronidae, Ictaluridae, with molluscs also part of their diet (Müller *pers. comm.* 2010). Giant otters prefer black waters with a slow current, little sediments and overhanging bank vegetation (Boher 2012).

In the Cordillera Oriental Bioregion, giant otters occur in brackish, tidal waters, with mangroves as the dominant vegetation (Heither 2011). During rainy season (June-Dec), in many locations giant otters extend their territories by following migrating fish to inundated areas (Heither & Müller 2011). In the Cordillera Oriental Bioregion, giant otters occur in marshlands during this period (Müller 2010).

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THREATS

Human settlement

Increasing human settlement, mainly in northern Venezuela, causes habitat loss and fragmentation (Rincón 2010). Waters are often used as a cheap waste disposal medium causing disturbance and contamination.

Hydroelectric dams

Large-scale hydroelectric dams in the Orinoco River resulted in highly negative impacts on aquatic ecosystems (Carter & Rosas 1997) and dams are proliferating (Müller 2011). Generally, these dams were constructed in clear and black waters, which are both favorable habitat for giant otters. Damming also increases accessibility for hunters. Additionally, dams are breaking fish migratory routes and changing hydrological and water quality, affecting the whole ecosystem and causing local extinctions of giant otter populations (Junk 1983).

Deforestation

In the 1970's annual deforestation in Venezuela was estimated at 245,000 ha. This increased in the 1980's to 599,000 ha per year and is still increasing (Carle 1993). Two thirds of the native forest north of the Orinoco River has been cleared (Carle 1993). Deforestation and associated disturbance lead to the disappearance of giant otter populations.

Agriculture

Deforestation is associated in most areas with agriculture (Müller *pers. comm.* 2010). This activity not only damages the environment, but is unsustainable, with soils becoming nutrient poor and unsuitable for further agriculture (Carter & Rosas 1997), leading to further deforestation. The use of pesticides and fertilizers caused a mass mortality of fish in the Orinoco sub-basins in the Cojedes and Portuguesa federal states, which both have giant otter habitat (Carter & Rosas 1997).

Gold mining

Gold mining in Venezuela takes place in the Orinoco basin and the Amazon (Kruuk 2006). If mercury is present in water, it can get transformed into methylmercury. This toxic solute is absorbed into the food chain intensifying in successive trophic levels, with carnivorous species particularly vulnerable to higher contamination levels. Mercury contamination in carnivores leads to damage to the central nervous system leading to decreasing coordination, paralysis and then death (Kruuk 2006).

Bioaccumulation of methylmercury in otters has been reported, which means that the older the individual, the higher the level of verifiable mercury in the body (Kruuk & Conroy 1991). There is no research about mercury contamination in Venezuela, and further research will be necessary to document the impact on giant otters.

Oil exploitation

Exploitation of petroleum assures 4/5 of exports, half of revenues and 25% of the aggregate output of Venezuela. In particu-

lar, oil exploitation takes place in the Orinoco region (Carter & Rosas 1997). Also, in the Sucre Federal State, petroleum was exploited in the past and there are still residua in the water (Müller *pers. comm.* 2010). By drilling fossil fuels, the surrounding waters were contaminated with oil, effluents, clay and chemicals, which all cause damage to the ecosystem (Carter & Rosas 1997). The effects of oil contamination on the environment are physical, as well as toxic, and organisms may die as a result of asphyxia, starvation, or intoxication (Hoff *et al.* 2002).

Fisheries

Extensive fishing can lead to decreasing prey availability for giant otters. Many fishermen consider giant otters as a competitor and kill them (Goméz & Jorgenson 1999). Other threats include collisions with motorboats, or casualties due to fishing methods, like netting or intoxication at fishing sites (Goméz & Jorgenson 1999). The most implemented fishing method in Venezuela is the use of nets, which have a high impact on the ecosystem gravely by not being selective, and in addition constitute a possible threat for giant otters if they become entangled (Müller *pers. comm.* 2010). Phytotoxins, are very harmful for the ecosystem and perilous for giant otters, are also used occasionally (Müller *pers. comm*. 2010).

Public attitudes

Many local people are frightened of giant otters due to a lack of species knowledge. Fishermen killed individuals at Caituco Lake in the Sucre Federal State (Müller *pers. comm.* 2010; Quijada *pers. comm.* 2010). Sporadic, trading of giant otter cubs occurs, for instance, in the western part of Sucre Federal State (Dubois *pers. comm.* 2010).

Tourism

Tourism infrastructure in Venezuela is decreasing, although previously it has grown in the Orinoco and its delta, where motorboat use may affect giant otter populations.

Los Llanos Bioregion

Habitat loss by deforestation close to waters, competition with rural and commercial fishermen, as well as the threat of entanglement in nets and disturbance by boats, increasing agriculture and contamination (Boher 2012).

Orinoco Bioregion

Habitat destruction and fragmentation associated to gold mining, deforestation, oil exploitation, and dams, as well as hunting pressure by local people and unregulated tourism (Carter & Rosas 1997; Boher 2012).

Delta System Bioregion

Conflicts with fishermen, and local and indigenous people (Boher 2012).

Cordillera Oriental Bioregion

Habitat loss and fragmentation due to increasing agriculture, competition with fishermen, and trading otter cubs as pets (Dubois *pers. comm.* 2010; Müller *pers. comm.* 2010).

Amazon Bioregion

Habitat loss and fragmentation by illegal gold mining and deforestation.

PREDICTED FUTURE DISTRIBUTION TRENDS

Populations in the Llanos may decrease further due to increasing human settlement. The Orinoco and Amazon populations are extremely vulnerable due to increasing gold mining, deforestation and agriculture.


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LEGAL STATUS

Giant otters are on Appendix I of the Convention on International Trade in Endangered Species (CITES). In the Red Book of Venezuelan Fauna, giant otters are categorized as an Endangered species (A2cd) indicating a reduction in national population numbers (Rodríguez & Rojas-Suárez 2008, 2015). In Venezuela, giant otters are also protected by the following laws and regulations:

- Biodiversity Act (Official Journal of the Bolivarian Republic of Venezuela Nº 39.070, 1st December 2008).
- Wildlife Protection Law (Official Journal of the Bolivarian Republic of Venezuela Nº 29.289, 11th August 1970).
- Wildlife Protection Law Regulation, Decree Nº 3.269 (Official Journal of the Bolivarian Republic of Venezuela Nº5.302, 29th January 1999).
- Venezuelan Hunting Act, Decree Nº 1.485 (Official Journal of the Bolivarian Republic of Venezuela Nº 36.059, 7th October 1996).

In Venezuela, 55.6% of the territory is designated as protected area, mainly in indigenous territories, especially in the Guyana Shield (Bevilacqua *et al.* 2006). Protected areas with confirmed giant otter presence are listed according to bioregions below.

Los Llanos Bioregion

Santos Luzardo (Cinaruco-Capanaparo), Aguaro-Guariquito and Río Viejo (San Camilo) national parks, Caño Guaritico Wildlife Refuge and Caño Morichal Wildlife Reserve. Habitats are black waters.

Delta Systems Bioregion

Turuépano and Delta del Orinoco (Mariusa) national parks and Delta del Orinoco Biosphere Reserve. Habitats are black, white and brackish water.

Cordillera Oriental Bioregion

Mochima National Park. Habitat is black water.

Amazon Bioregion

Yapacana, Serranía La Neblina and Parima-Tapirapecó national parks. Habitat is black water.

RECOMMENDATIONS FOR FUTURE EFFORT EDUCATION

Education

In areas with giant otter presence, education programs should be developed to create awareness among local and indigenous people about the importance of the species and its habitat.

Research

The current national distribution must be identified by evaluating populations around the Los Llanos and Amazon. On a national scale, population trends and densities are needed, as well as evaluations of the genetic pool in order to prevent inbreeding in small, isolated populations. The extent and effects of gold mining in the Amazon and oil exploitation in the Orinoco River on giant otter populations are important to estimate. The effects of intensive agriculture and hydroelectric dams on local giant otter populations in the Orinoco River and its sub basins in the Barinas and Portuguesa Federal states should also be evaluated.

Policy

Human activities, such as fishing and gold mining, should be adapted and controlled through the zoning of protected areas. Giant otter populations within and outside protected areas should be evaluated, and if possible, protected areas should be enlarged to include populations outside protected areas, as well as connect isolated populations with corridors.

ACKNOWLEDGEMENTS

We thank the Sociedad Venezolana de Ciencias Naturales (SVCN) for providing unpublished data which they house in their information center.

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GIANT OTTER (*Pteronura brasiliensis*) RANGE WIDE PRIORITY SETTING RESULTS

Robert B. Wallace, Ariel Reinaga, Guido Ayala, Mark Bowler, Martín Buschiazzo, Sebastian Di Martino, Jessica Groenendijk, Hauke Hoops, Miriam Marmontel, Fernanda Michalski, Oscar Mujica, Karen Pérez, Maribel Recharte, Marcelo Rheingantz, Fernando Trujillo, Galo Zapata Ríos, Leydi V. Auccacusi Choque, María del Pilar Becerra Cardona, Salvador Boher, Jose L. Cartes, André Coelho, Benoit de Thoisy, Nicole Duplaix, Guillermo Gil, Caroline Leuchtenberger, Danielle Lima, Indranee Roopsind, Alvaro Soutullo, Victor Utreras B., Paul André Van Damme, Talía Zamboni & Veronica Zambrana

HISTORICAL RANGE OF THE GIANT OTTER

Workshop participants redefined the historical range of the giant otter using the IUCN map (Groenendijk *et al.* 2023). Country working groups worked independently at the workshop to redefine the map for each country and then met to discuss results, which was especially important for a number of border areas across the range (Figure 1). The expert driven revision of the giant otter historical range resulted in an overall polygon of 9,021,590 km^2.

Figure 1 is a classic polygon distribution map; however, giant otters are an aquatic species, and so as an expert group we agreed to produce a map which highlights that the species is tied to the lotic and lenthic systems of the distribution (rivers, lakes, oxbow lakes, and lagoons) (Figure 2), by producing a 1 km buffer along either side of rivers classified from Strahler Order 2 and higher. Strahler's method (Strahler 1957) classifies the hydrographic network by assigning a numerical order to each segment of a river or stream according to the contribution of its tributaries, where first order streams have no tributaries, and the order is increased when two streams of the same order join. This procedure massively reduces the size of the distribution polygon to 2,813,539 km^2, or 31.2% of the traditional historical distribution polygon (Table 1). Overlaying the distribution points revealed that this reduced area captured almost 70% of the systematized distribution points.

GIANT OTTER DISTRIBUTION POINTS

Prior to the Range Wide Priority Setting workshop, we performed a literature review of giant otter distribution, and prior to the workshop, during the workshop and in the post-workshop period, experts also provided previously unpublished information on giant otter distribution, as well as a review of iNaturalist and the Global Biodiversity Information Facility, totaling 5,593 points to the overall database of giant otter distribution. Table 1 summarizes the number of giant otter data points per country in the overall database, as well as overall distribution point density considering the size of the giant otter's historical distribution in each country (Figure 2).

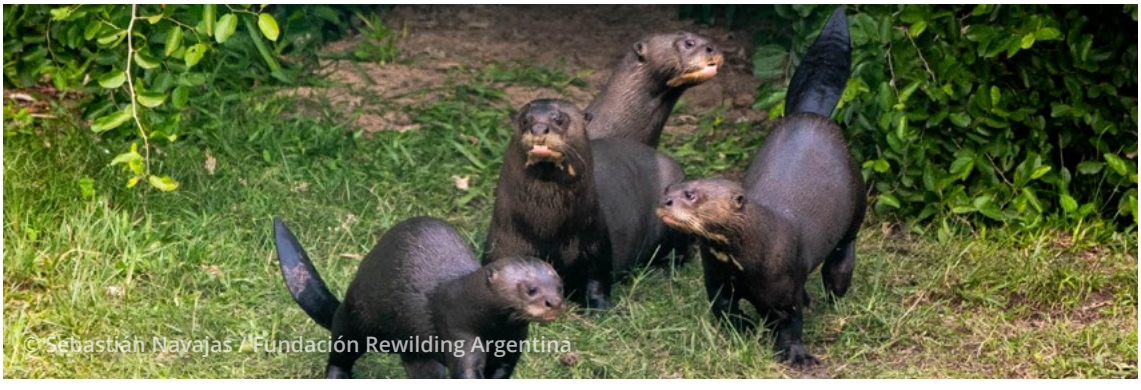

Figure 1. General distribution of the Giant Otter (*Pteronura brasiliensis*) in South America.

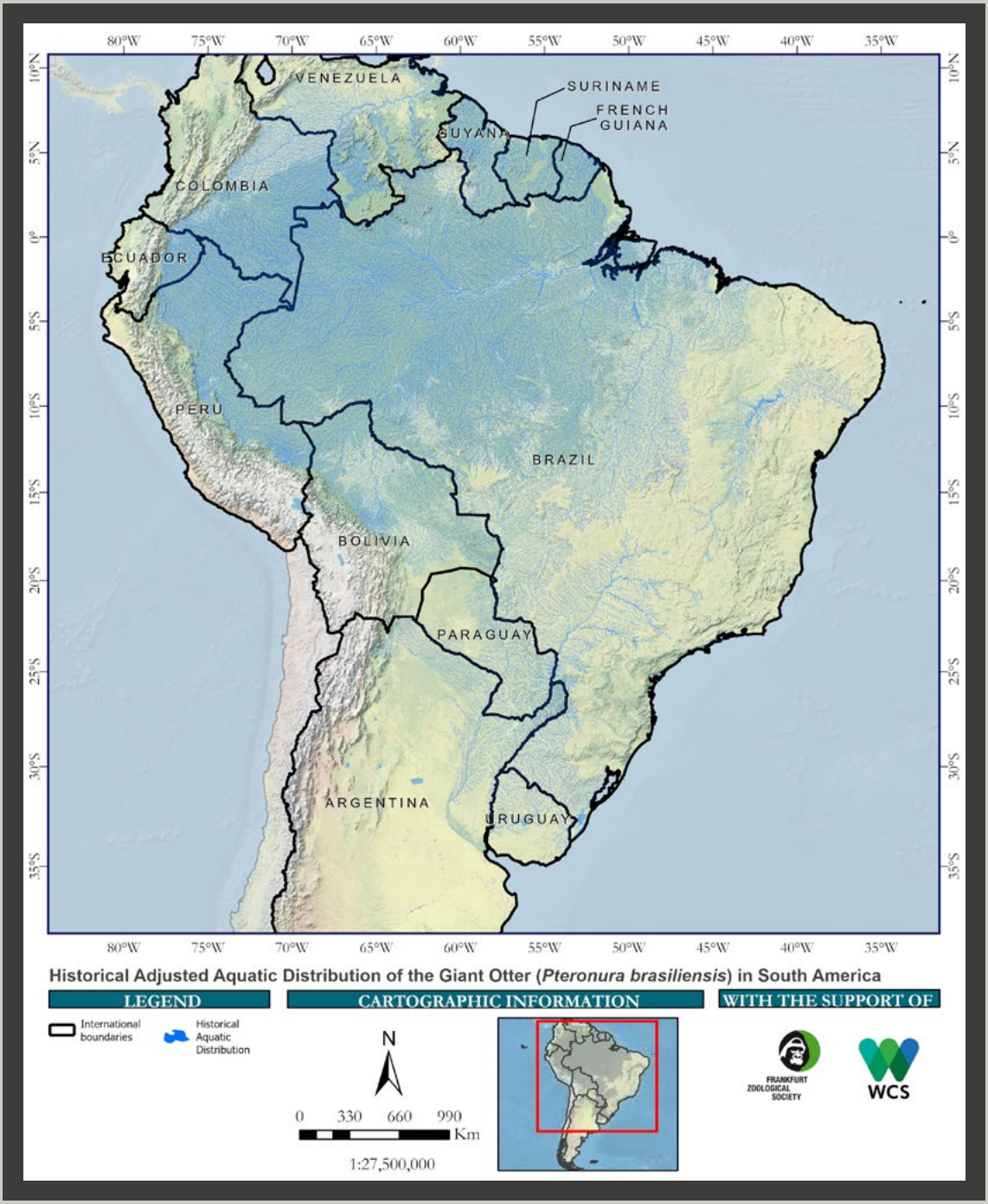

Figure 2. Historical adjusted aquatic distribution of the Giant Otter (*Pteronura brasiliensis*) in South America.

Table 1. Giant Otter (*Pteronura brasiliensis*) Distribution Points by Country

Country	Historical Giant Otter Distribution Size (km²)	% Historical Range	# Distribution Points used in RWPS	Distribution Point Density (Points per 1,000 km²)	Historical Adjusted Giant Otter Aquatic Distribution (km²)
Argentina	297,245.19	3.29%	69	0.232	77,279.14
Bolivia	562,630.12	6.24%	898	1.596	161,003.37
Brazil	5,580,734.20	61.86%	1,003	0.180	1,695,852.12
Colombia	690,116.33	7.65%	476	0.690	268,947.29
Ecuador	70,467.23	0.78%	262	3.718	31,453.50
French Guiana	94,579.33	1.05%	766	8.099	30,396.43
Guyana	232,984.77	2.58%	318	1.365	67,139.07
Paraguay	229,704.22	2.54%	27	0.118	56,501.49
Peru	565,509.15	6.27%	1,714	3.031	226,275.47
Suriname	144,683.84	1.61%	13	0.090	37,982.84
Uruguay	100,846.36	1.12%	14	0.139	27,156.25
Venezuela	452,088.88	5.01%	33	0.073	133,552.07
TOTAL	**9,021,589.61**		**5,593**	**0.620**	**2,813,539.04**

The resulting number of distribution points for each country ranges from 13 in Suriname, to 1,714 in Peru (Table 1). The portion of the historical distribution range in each country varied dramatically, ranging from 0.78% in Ecuador to 61.86% in Brazil, with Bolivia, Colombia, Peru, and Venezuela each having more than 5%, and collectively covering 24.9% of the historical distribution. Argentina, Ecuador, French Guiana, Guyana, Paraguay, Suriname, and Uruguay each had significantly less than 5% of the historical distribution of the giant otter (Table 1).

We calculated a standardized distribution point density expressed as the number of distribution points per 1,000 km² (Table 1). There was a relatively low distribution point density (<1/1,000 km²) for Argentina, Brazil, Paraguay, Suriname, Uruguay, and Venezuela, and a higher distribution point density for Bolivia, Colombia, and Guyana, (> 0.5/1,000 km²), and especially Ecuador French Guiana, and Peru (> 3/1,000 km²).

The map of systematized distribution points (Figure 3) for giant otters underlines the patchy distribution for the giant otter across its historical range, further highlighting the factors which justify its Endangered IUCN status (Groenendijk *et al.* 2023).

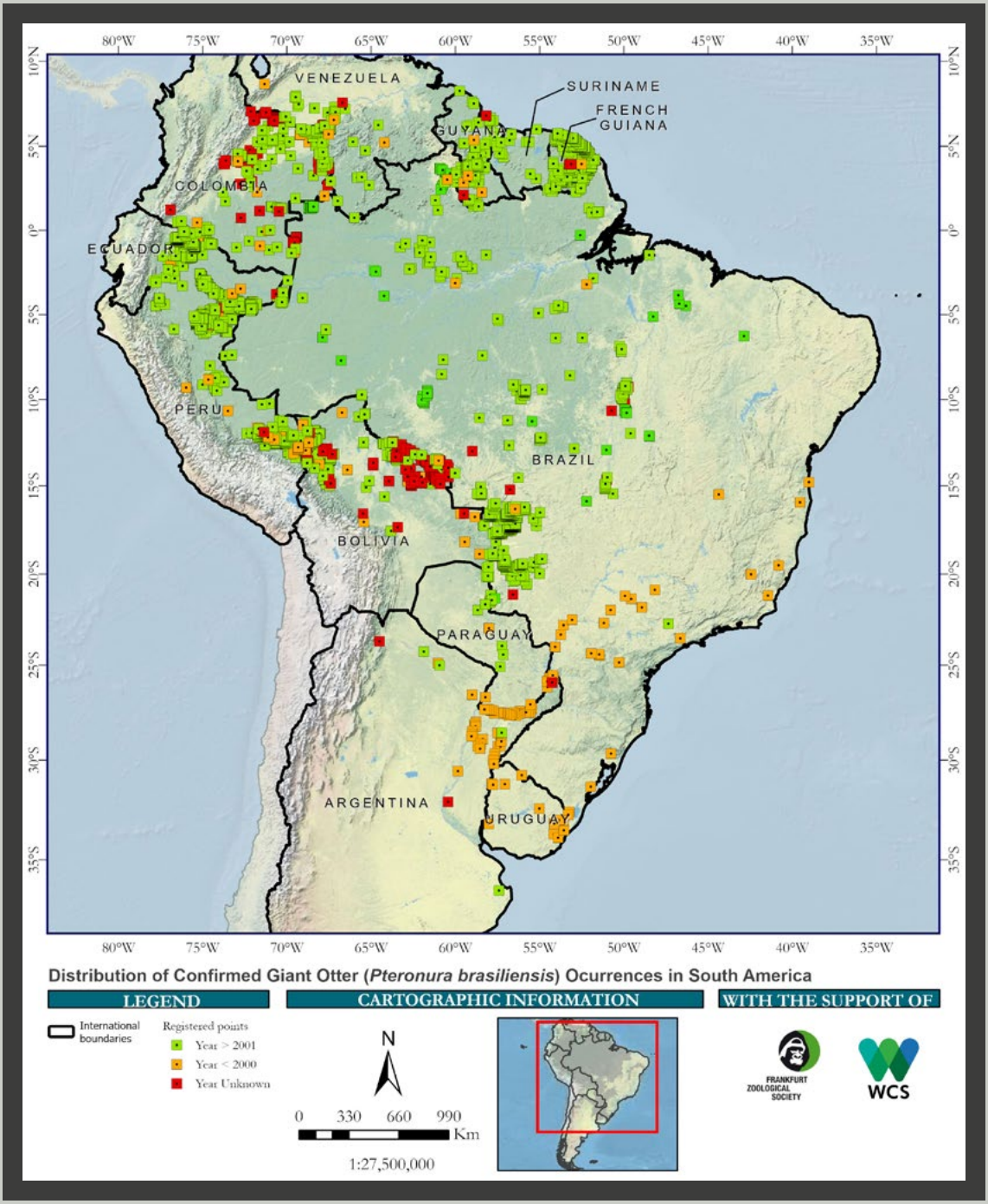

Figure 3. Distribution of confirmed Giant Otter (*Pteronura brasiliensis*) ocurrences in South America.

AREA WITH AND WITHOUT EXPERT KNOWLEDGE FOR GIANT OTTERS

Within the historical distribution of a focal species, the Range-Wide Priority Setting methodology identifies areas where expert knowledge exists for a species, as well as recognizing areas where expert knowledge is lacking or absent (Wallace *et al.* 2014, 2020). This distinction facilitates the identification of potentially important conservation areas for basic surveys for the focal species.

Giant otter experts detailed areas with (Figure 4) or without (Figure 5) expert knowledge. Overall, experts expressed knowledge about 62.79% of the giant otter revised historical knowledge when including areas where giant otters are now considered absent (Table 2). Experts considered 37.21% of the historical range as areas without expert knowledge about giant otters (Table 2).

Table 2. Giant Otter *(Pteronura brasiliensis)* Expert Knowledge Across the Revised Historical Distribution

Country	Historical Distribution	With Knowledge	Area (km²) Without Knowledge	No Longer Present	Priority Areas	% Historical Adjusted Giant Otter Aquatic Distribution (km²)
Argentina	297,245.2	139,665.3	157,580.0	260,650.2	36,595.0	2.75%
Bolivia	562,630.1	288,590.8	274,039.3	65,110.1	215,608.5	5.72%
Brazil	5,580,734.2	3,262,009.6	2,318,724.6	630,421.1	1,171,946.2	60.27%
Colombia	690,116.3	396,650.6	293,465.7	30,304.7	365,535.9	9.56%
Ecuador	70,467.2	65,995.0	4,472.2	0.0	65,995.0	1.12%
French Guiana	94,579.3	94,579.3	0.0	1,975.8	92,603.5	1.08%
Guyana	232,984.8	138,195.7	94,789.0	0.0	130,147.4	2.39%
Paraguay	229,704.2	229,704.2	0.0	226,377.8	1,896.9	2.01%
Peru	565,509.1	352,826.1	212,683.0	0.0	304,425.8	8.04%
Suriname	144,683.8	143,842.4	841.4	0.0	143,842.4	1.35%
Uruguay	100,846.4	100,846.4	0.0	68,878.9	25,805.2	0.96%
Venezuela	452,088.9	452,088.9	0.0	409,288.0	42,503.5	4.75%
TOTAL	**9,021,589.6**	**5,664,994.3**	**3,356,595.3**	**1,693,006.6**	**2,596,905.2**	

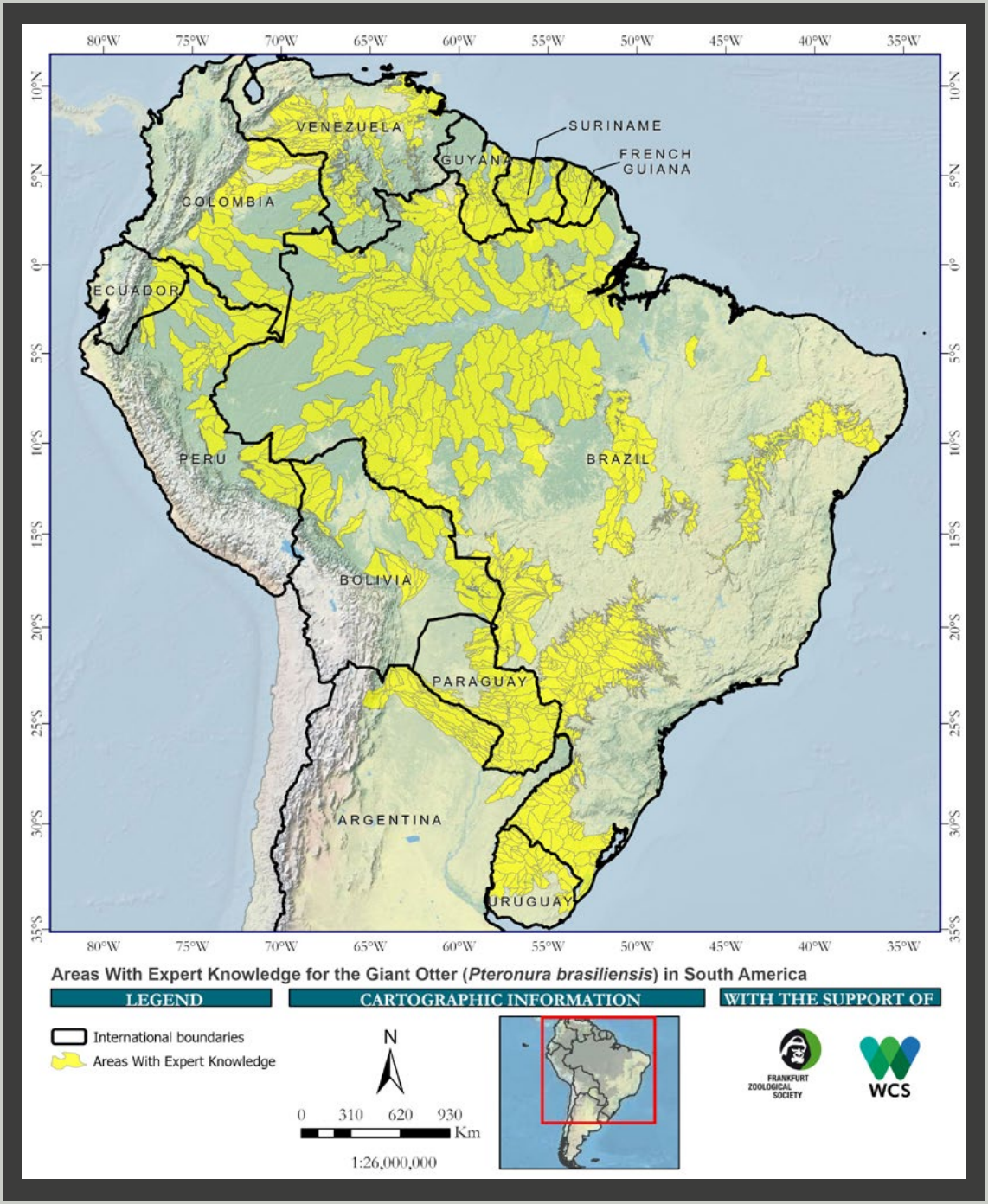

Figure 4. Areas with expert knowledge Giant Otter (*Pteronura brasiliensis*) in South America.

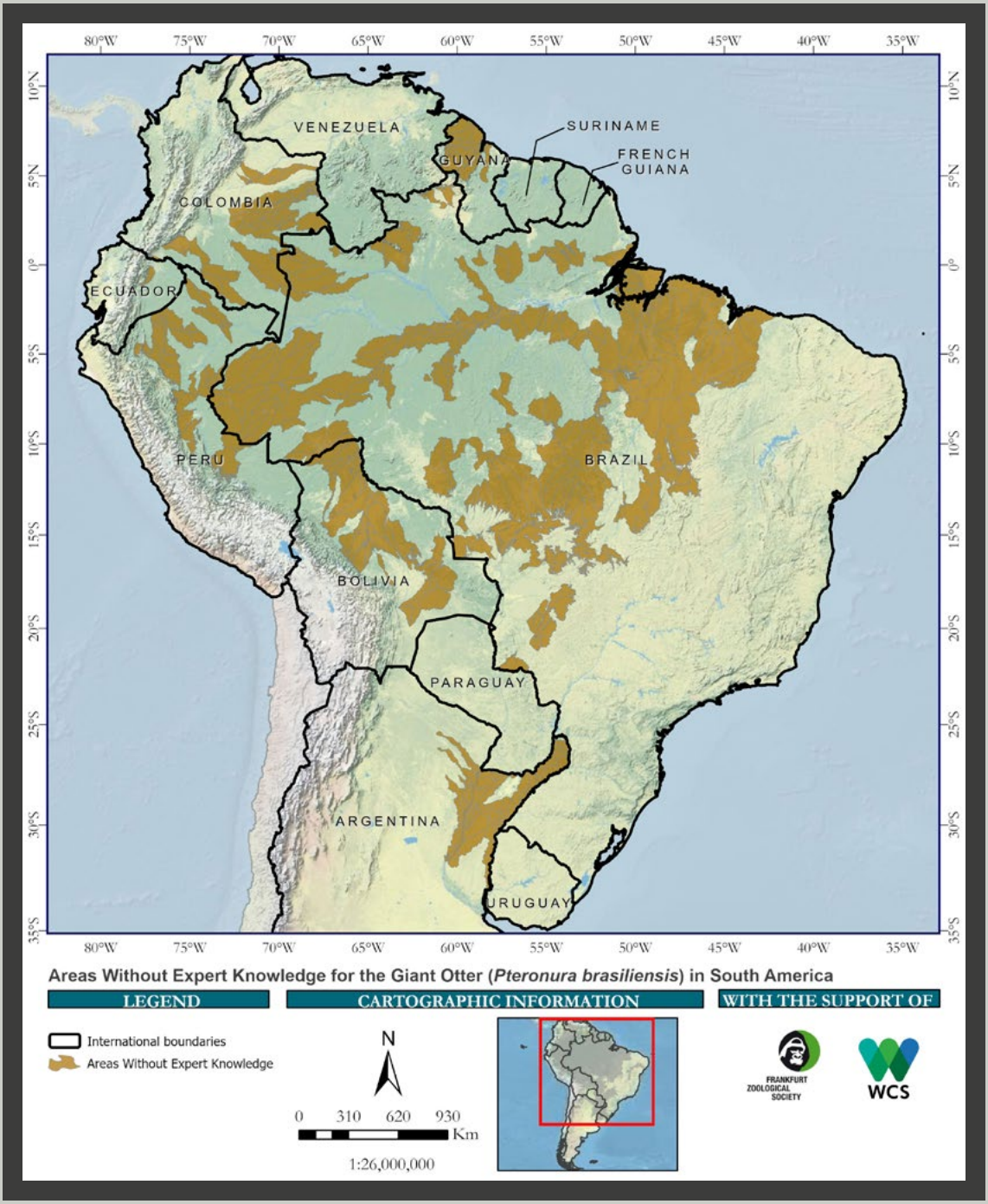

Figure 5. Areas without expert knowledge for the Giant Otters (*Pteronura brasiliensis*) in South America.

AREAS WHERE GIANT OTTER NO LONGER OCCUR

Unfortunately, there are large areas where workshop participants were also sure that giant otters no longer occur within their historical range (Figure 6), amounting to 18.77% of the estimated historical range. These areas are concentrated in the southeast of the historical distribution in Argentina, Paraguay, Uruguay, small areas in central Bolivia, and extreme southeastern Brazil, as well as parts of eastern Brazil, and another concentration of areas where giant otters have been extirpated from in the north of the historical range in Venezuela and some watersheds in Colombia.

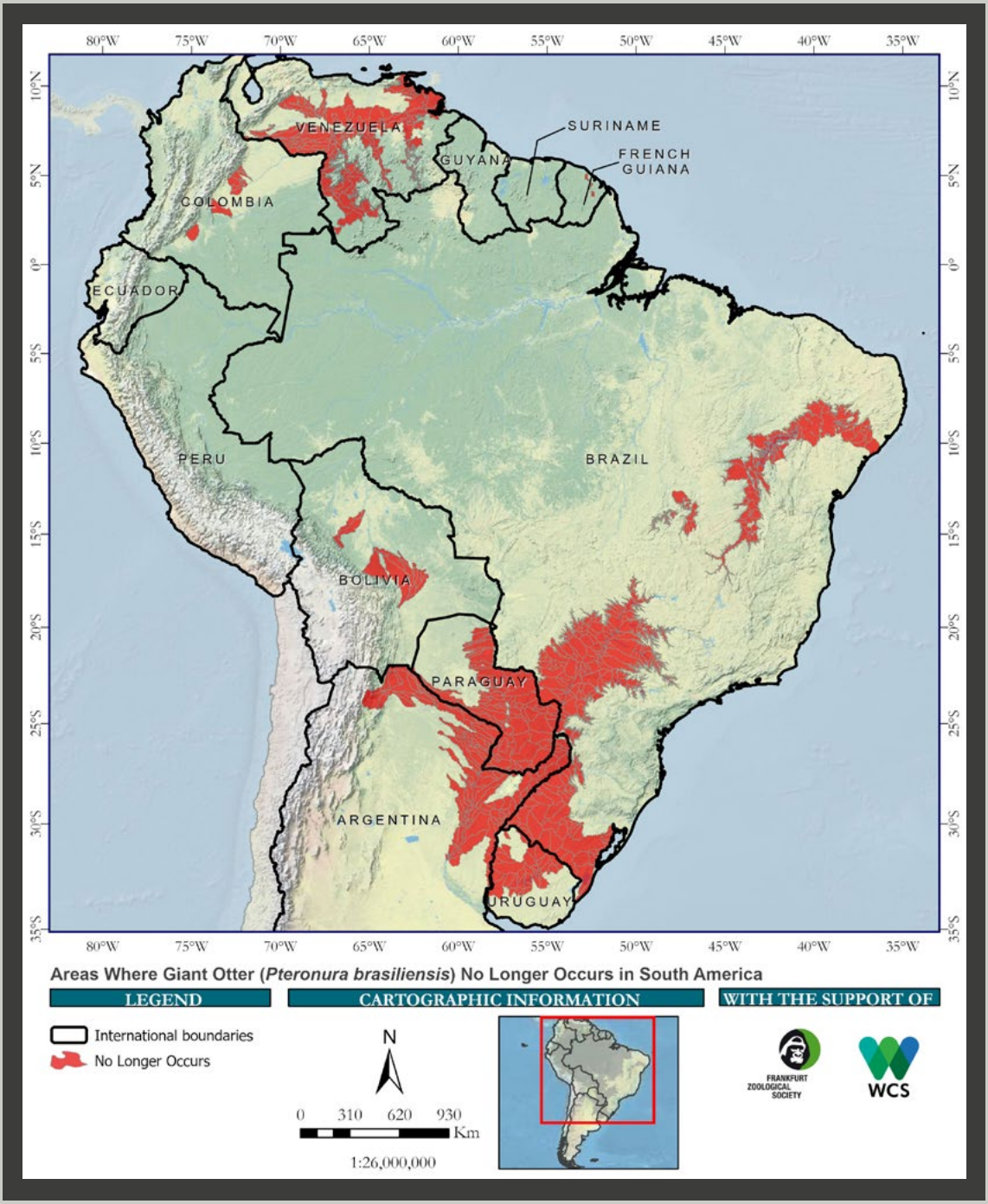

Figure 6. Areas where Giant Otter (*Pteronura brasiliensis*) no longer occurs in South America.

GIANT OTTER PRIORITY CONSERVATION UNITS

At the workshop 36 Giant Otter Priority Conservation Units (GOPCUs) were proposed by giant otter experts (Table 3) representing 28.79% of the historical range. Almost half of the area prioritized as GOPCUs in Brazil (45.13%), significantly less than would be expected based on the portion of the historical range for Brazil (61.86%; see Table 1), a situation repeated for Argentina, Paraguay, Uruguay, and Venezuela. In contrast, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, and Suriname all prioritized larger areas as GOPCUs than might be expected based on the percentage of the historical range (Tables 1 & 3).

Table 3. Size and Area Percentage of Giant Otter (*Pteronura brasiliensis*) Priority Conservation Units (GOPCU) by Country

Giant Otter Priority Conservation Units (GOPCU)	N°	Area (km^2)	% Total Conservation Unit Area
Total Area in Giant Otter Priority Conservation Units (GOPCU)	36	2,596,905	100
Giant Otter Priority Conservation Units (GOPCU) Argentina	3	36,595	1.41
Giant Otter Priority Conservation Units (GOPCU) Bolivia	4	215,608	8.30
Giant Otter Priority Conservation Units (GOPCU) Brazil	11	1,171,946	45.13
Giant Otter Priority Conservation Units (GOPCU) Colombia	7	365,536	14.08
Giant Otter Priority Conservation Units (GOPCU) Ecuador	1	65,995	2.54
Giant Otter Priority Conservation Units (GOPCU) French Guiana	1	92,604	3.57
Giant Otter Priority Conservation Units (GOPCU) Guyana	1	130,147	5.01
Giant Otter Priority Conservation Units (GOPCU) Paraguay	1	1,897	0.07
Giant Otter Priority Conservation Units (GOPCU) Peru	3	304,426	11.72
Giant Otter Priority Conservation Units (GOPCU) Suriname	1	143,842	5.54
Giant Otter Priority Conservation Units (GOPCU) Uruguay	2	25,805	0.99
Giant Otter Priority Conservation Units (GOPCU) Venezuela	1	42,504	1.64

During the Range Wide Priority Workshop, and in subsequent post-workshop consultations, participants in neighboring countries worked to combine some of the proposed 36 Giant Otter Priority Conservation Units. Table 4 summarizes the combinations that were made by neighboring countries for eight Giant Otter Priority Conservation Units – three of those combinations involved two countries, four involved three countries, and one was a combination of nationally identified GOPCUs from five countries. This process reduced the number from a total of 36 to 22 Giant Otter Priority Conservation Units (Table 5, Figure 7).

These GOPCUs range from nine rather small areas of <25,000 km^2 in Argentina, Brazil, Colombia, and Uruguay, four intermediately sized GOPCUs (>25,000 and <100,000 km^2) each of which are also found within individual countries, to nine large areas of well over 100,000 km^2, the majority of which are transboundary and within the Amazon basin (Table 5). Table 5 also details the major BL3 (basin level 3) river basins (Venticinque *et al.* 2016) covered by each GOPCU. Overall, 35.28% of the area identified as Giant Otter Priority Conservation Units lies within formal protected areas, and this value ranged from 0.01% to 99.77% across the 22 GOPCUs identified by experts in this process (Table 5). Encouragingly, at least 22% of most (8 out of 9) of the largest and most important Type I GOPCUs (>250 reproducing adults) are under formal protection, although most (6 out of 8) of the Type II GOPCUs (>50 reproducing adults) have less than 10% under protection. The five Type III population recovery GOPCUs (<50 reproducing adults) identified in the extreme south of the historical range were far more variable in levels of protection (Table 5). Table 5 also details the aquatic portion of the individual and collective GOPCUs reducing their effective size by an order of magnitude.


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Table 4. Table 4. Summary of workshop and post-workshop combinations for the 36 originally proposed Giant Otter (*Pteronura brasilensis*) Priority Conservation Units

GOPCUs	Country	Area (km²)
GOPCU - 1	Venezuela	42,503.5
GOPCU - 2	Colombia	72,497.5
GOPCU - 3	Colombia	64,330.9
GOPCU - 4	Colombia	21,414.0
GOPCU - 5	Brazil	453,171.7
	Colombia	9,386.7
	French Guiana	92,603,5
	Guyana	130,147.4
	Suriname	143,842.4
GOPCU - 6	Brazil	7,385.4
	Colombia	155,728.9
GOPCU - 7	Colombia	25,811.3
	Ecuador	65,995
	Peru	56,107.4
GOPCU - 8	Brazil	38,829.1
	Colombia	16,366.7
	Peru	161,771
GOPCU - 9	Brazil	6,724.7
GOPCU - 10	Brazil	5,472.1
GOPCU - 11	Bolivia	67,473
	Brazil	24,531.8
	Peru	86,547.4
GOPCU - 12	Bolivia	1,728
	Brazil	151,684.2
GOPCU - 13	Bolivia	80,173.2
	Brazil	61,125.9
GOPCU - 14	Brazil	54,188.6
GOPCU - 15	Brazil	191,315.3
GOPCU - 16	Brazil	10,472.1
GOPCU - 17	Bolivia	66,234.3
	Brazil	167,045.2
	Paraguay	1,896.9

GOPCU - 18	Argentina	22,423.2
GOPCU - 19	Argentina	12,804.7
GOPCU - 20	Argentina	1,367.1
GOPCU - 21	Uruguay	15,564.7
GOPCU - 22	Uruguay	10,240.5

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Table 5. Final List of Giant Otter (*Pteronura brasiliensis)* Priority Conservation Units (GOPCU)

GOPCU	Countries	Name	Watersheds (BL3)	Area (km^2)	Aquatic Area (km^2)	GOPCU Type	Total % Protected
GOPCU - 1	Venezuela	Apure	Apure, Arauca, Guárico, Mocapra, Orinoco, Portuguesa	42,503.50	11,747.46	II	3.95
GOPCU - 2	Colombia	Arauca	Apure, Arauca, Bita, Capanaparo, Cinaruco, Meta, Orinoco, Tomo, Vichada	72,497.45	25,446.30	II	1.93
GOPCU - 3	Colombia	Meta River	Guaviare, Meta, Orinoco, Tomo, Tuparro, Upper Meta, Vichada	64,330.86	24,720.65	II	9.91
GOPCU - 4	Colombia	Estrella Fluvial Inírida	Atabapo, Guaviare, Inírida, Negro, Orinoco	21,414.04	8,291.84	II	5.42
GOPCU - 5	Colombia Brazil Guyana Suriname French Guiana	Guianan Shield	Amazon floodplain, Berbice-Demerara, Branco, Coastal basins North, Coppename, Courantyne, Essequibo, Inírida, Japurá – Caquetá, Jari, Maroni, Mazaruni-Cuyuni, Piorini, Negro, Suriname, Suriname mainstem, Trombetas, Uatumã	829,151.73	248,191.08	I	44.52
GOPCU - 6	Colombia Brazil	Chiribiquete, Japurá, Putumayo	Guaviare, Içá – Putumayo, Inírida, Japurá – Caquetá, Negro	163,114.27	63,870.58	I	41.48
GOPCU - 7	Colombia Ecuador Peru	Putumayo, Napo, Pastaza	Içá – Putumayo, Japurá – Caquetá, Marañón, Nanay, Napo	147,913.66	63,526.58	I	25.37

GOPCU - 8	Peru Brazil Colombia	Amazon, Içá - Putumayo, Ucayali, Marañon	Amazon floodplain, Huallaga, Içá – Putumayo, Japurá – Caquetá, Javari, Juruá, Jutaí, Marañón, Nanay, Napo, Ucayali	216,966.78	86,013.51	I	12.84
GOPCU - 9	Brazil	Juruá	Juruá, Purús	6,724.71	2,353.22	II	91.98
GOPCU - 10	Brazil	Purús	Purús	5,472.13	1,965.67	II	83.68
GOPCU - 11	Peru Brazil Bolivia	Madidi-Manu	Beni, Juruá, Madeira, Madre de Dios, Purús, Ucayali	178,552.26	60,970.39	I	57.7
GOPCU - 12	Bolivia Brazil	Madeira	Madeira, Madre de Dios, Mamoré, Purús	153,412.18	54,535.73	I	51.96
GOPCU - 13	Bolivia Brazil	Guaporé-Iténez	Iténez, Itonamas, Blanco, Paraguá	141,299.05	36,268.85	I	55.54
GOPCU - 14	Brazil	Tapajós	Iriri, Juruena, São Manoel, Tapajós, Xingu	54,188.60	17,918.64	II	8.41
GOPCU - 15	Brazil	Cerrado	Araguaia, Tocantins, Xingu	191,315.31	53,433.95	I	29.83
GOPCU - 16	Brazil	Gurupi	Coastal basins South, Mearim, Tocantins	10,472.06	2,001.97	II	5.91
GOPCU - 17	Bolivia Brazil Paraguay	Pantanal	Cuiabá, Otuquis, Paraguay, Taquari	235,176.41	58,478.82	I	22.34
GOPCU - 18	Argentina	Bermejo	Bermejo, Chaco Central	22,423.22	6,036.47	III	9.09
GOPCU - 19	Argentina	Santa Lucía	Corrientes	12,804.66	3,417.69	III	92.42
GOPCU - 20	Argentina	Paraná	Iguaçú, Paraná	1,367.11	548.84	III	99.77
GOPCU - 21	Uruguay	Cuareím-Arandi	Arapey Grande, Cuareim, Uruguay	15,564.67	4,425.44	III	0.01
GOPCU - 22	Uruguay	Tacuarí-Laguna Merín	Cebollati, Laguna Merín, Tacuarí	10,240.51	2,887.23	III	13.26
Total				**2,596,905.18**	**837,050.90**		**35.28**

Overall, the 22 identified GOPCUs provide a representative coverage of the historical distribution of the giant otter, although the extreme eastern historical distribution is missing, as is a large part of the central Brazilian Amazon (Figure 7).

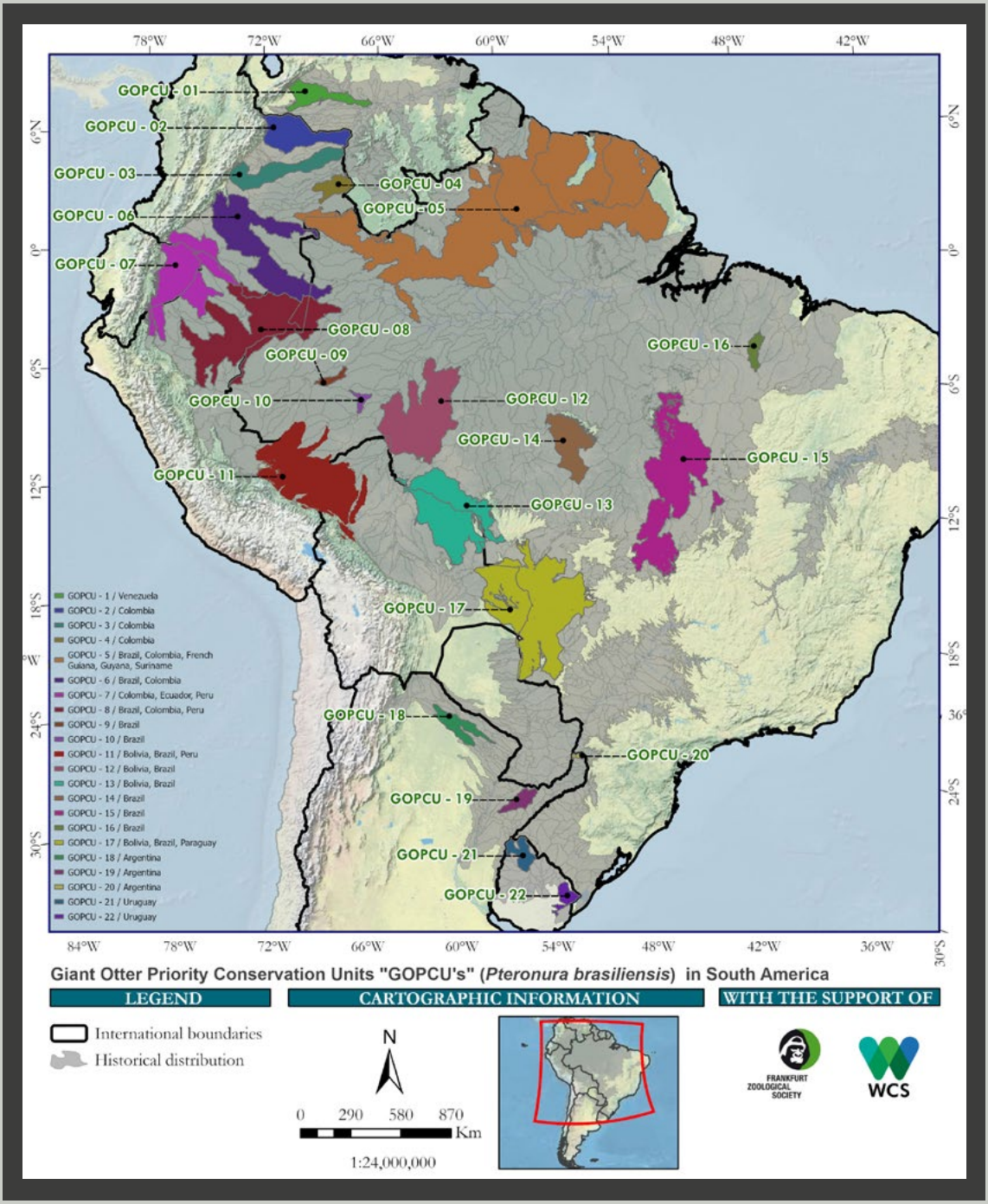

Figure 7. Giant Otter (*Pteronura brasiliensis*) Priority Conservation Units in South America.

GIANT OTTER (*Pteronura brasiliensis*) RANGE WIDE PRIORITY SETTING DISCUSSION & RECOMMENDATIONS

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HISTORICAL RANGE OF THE GIANT OTTER

The giant otter historical range developed by the experts significantly increased the previously estimated historical range for the species (Colodetti 2014; Groenendijk *et al.* 2023). Our version of the historical range as an overall polygon covers 9,021,590 km^2, which is substantially less than for some other large charismatic wildlife species in Latin America, such as the jaguar (Panthera onca: 19 million km^2, Sanderson *et al.* 2002), white-lipped peccary (*Tayassu pecari*: 14,220,461 km^2, Taber *et al.* 2009) and lowland tapir (*Tapirus terrestris*: 13,129,874 km^2, Taber *et al.* 2009), but substantially more than for the Andean bear (*Tremarctos ornatus*: 607,257 km^2 in Bolivia and Peru which represents 70% of the overall range, Wallace *et al.* 2014), or the Andean condor (*Vultur gryphus*: 3,230,061 km^2, Wallace *et al.* 2020, 2022).

Nevertheless, the workshop participants felt strongly that for a primarily aquatic species, the overall distribution polygon and the area it represents are gross exaggerations of the reality of the species distribution. The estimated aquatic historical distribution of 2,811,512 km^2, or 31.2% of the overall historical distribution polygon, is a much lower distribution area, and the map further highlights the restricted and linear distribution of the species. In any case, the overall and the aquatic giant otter historical ranges are important perspectives with which to set conservation targets in the future, as well as with which to measure the decline to date.

GIANT OTTER DISTRIBUTION POINTS

The overall number of distribution points (n=3,874) is impressive for an Endangered species; however, further effort is needed to systematize information in Suriname and Venezuela, and especially Brazil, given the size of the distribution area.

EXPERT KNOWLEDGE COVERAGE WITHIN THE GIANT OTTER HISTORICAL RANGE

According to the opinion of participating experts, giant otters are known to be present in 44.02% and absent in 18.77% of the revised historical range, amounting to a total knowledge coverage of 62.79%, or almost two thirds of the historical range. Nevertheless, there were also significant areas without expert knowledge about giant otters totaling 37.21% of the historical range, and particularly notable in Argentina, Bolivia, Brazil, Colombia and Peru.

An expert knowledge coverage of 62.79% is considerably lower than most other iconic lowland species for which Range-Wide Priority Setting exercises exist in the region. The original RWPS for the jaguar detailed expert knowledge areas covering 83% of the historical range (Sanderson *et al.* 2002), which increased in 2006 to 96% (Marieb 2007). Expert knowledge covered 99.1% and 99.6% of the historical range for the less cryptic, white-lipped peccary and lowland tapir, respectively (Taber *et al.* 2009). However, expert knowledge coverage was just 57.7%

for Andean bears in Bolivia and Peru (Wallace *et al.* 2014), and 65.8% for the Andean condor across its continental range (Wallace *et al.* 2020, 2022), both of which have exceptionally linear distributions, largely confined to the eastern slopes of the Andes mountain range from Venezuela to Bolivia in the case of the Andean bear, stretching further south to Argentina and Chile in the case of the Andean condor. However, as an aquatic species, the giant otter is also particularly vulnerable to water-related threats such as contamination and pollution because watercourses can run for up to thousands of kilometers, and therefore threats need to be considered at the scale of the entire watershed beyond the limits of giant otter distribution.

As a large, social and vocal carnivore that inhabits waterways giant otters are usually rather evident when they are present in any numbers. Additionally, giant otters leave signs along the waterways such as dens, spraints, and feeding sites. Thus, *Pteronura* is not a particularly cryptic species, and so if no information is available from experts, it underlines the need to conduct rapid surveys along the major waterways and oxbow lakes in the areas identified by giant otter experts as areas without expert knowledge. This priority action would greatly improve our current understanding of the distribution and population status of the species.

GIANT OTTER ACTUAL RANGE

Thirteen polygons were identified where giant otters are considered extirpated in almost 19% of their historical distribution. In comparison, jaguars are extirpated in 39% of their historical range (Marieb 2007), and white-lipped peccaries and lowland tapirs in 20% and 14% of their historical ranges, respectively (Taber *et al.* 2009). In Bolivia and Peru, Andean bears are considered extirpated from 3% of their range (Wallace *et al.* 2014), and continentally Andean condors are extirpated from 7% of their range (Wallace *et al.* 2020, 2022). Nevertheless, there is another 38% of the giant otter historical distribution for which experts did not have information and published information was not available. Given that jaguars, lowland tapirs and white-lipped peccaries have similar overall distributions as that of the giant otter and larger areas where they are extirpated, that giant otters are relatively conspicuous, and that giant otters were also the highest value skin during the skin trade, it is very possible that the area where the giant otter is extirpated is considerably larger. The threats outlined in the country chapters in this book in combination with confirmed local extirpations herein underline the need for species-specific conservation planning and actions, including further expert participation and/or fieldwork.

GIANT OTTER PRIORITY CONSERVATION UNITS (GOPCU)

Participating giant otter experts proposed a total of twenty-two Giant Otter Priority Conservation Units from northern Argentina to Venezuela which collectively represent the highest probability for the long-term conservation of giant otters across the actual range. The Giant Otter Priority Conservation Units (GOPCUs) cover 28.79% of the estimated historical range of the species.

Experts defined Giant Otter Priority Conservation Units across the range which ranged from relatively small areas of just 1,367 km^2 in Cuareím-Arandi in Uruguay, to huge areas of up to 829,152 km^2 in the Guiana Shield of Brazil, Colombia, French Guiana, Guyana, and Suriname. The GOPCUs were divided into three population size classes:

- **Type I** – Relatively large GOPCUs with resident and stable giant otter population of >250 reproducing adults,
- **Type II** – Medium sized GOPCUs with resident and stable giant otter population of >50 reproducing adults,
- **Type III** – Relatively small GOPCUs but with potential recovering population of < 50 reproducing adults.

In general, GOPCUs are relatively small in the southern portion of the range (Argentina, Paraguay and Uruguay), reflecting the extremely threatened status in those countries, as well as in most of the eastern portion of the range in Brazil. Understandably, these populations are mostly considered as possible recovery populations or in the best cases medium sized GOPCUs. Most of the medium and large sized GOPCUs that protect conservation significant populations are in the Amazon and Orinoco basins, as well as the Pantanal. These GOPCUs will require landscape-scale conservation interventions with a particular emphasis on watershed management which together underlines the need for integrated conservation approaches that embrace the importance of working beyond protected area limits and with a wide range of local actors.

Overall, an impressive 35.3% of the GOPCUs are under formal protection, although there is considerable variation between GOPCUs, with protected percentages varying between 0% to over 99% for the smaller areas. The average for the Type III GOPCUs is 42.9%, which drops to 26.4% for the Type II GOPCUs, but encouragingly is higher (31.3%) in the most important Type I GOPCUs with populations higher than 250 individuals (Table 5 in Results chapter herein).

Whether populations of this size are truly sustainable in the long-term is the subject of some debate in the minimum viable population literature (Reed *et al.* 2003; Traill *et al.* 2007), and the most recent estimates suggest at least 1,000 individuals for slow reproducing species (Pérez-Pereira *et al.* 2022). These arguments are particularly concerning for terrestrial species such as previously considered species for Range Wide Priority Setting exercises (Andean bears, jaguars, white-lipped peccaries, lowland tapirs) for whom connectivity can more easily be compromised. Most of the individual populations of giant otters in the GOPCUs do not meet this criterion, and as

an aquatic species connectivity between populations can be compromised, which together further emphasizes the need for dedicated population monitoring programs in the GOPCUs.

In summary, this process resulted in maps detailing a) the historical distribution of the giant otter, b) the current distribution of the giant otter, c) aquatic historical distribution for giant otter, d) a systematized database of giant otter distribution records, and e) a suite of Giant Otter Priority Conservation Areas.

NEXT STEPS AND RECOMMENDATIONS

Finally, based on the discussions at the workshop in Puerto Maldonado, Peru, and the results of this Range Wide Priority Setting Exercise for the giant otter we propose the following priority next steps and recommendations:

1. Publish the results of the Range Wide Priority Setting Exercise in an international scientific journal, as an additional action to highlight the need for giant otter conservation efforts.

2. Produce a list of priority sites for developing population estimates in the Giant Otter Priority Conservation Units that will provide a range of reliable values across the range with which to better inform future conservation decision making processes.

3. Organize international meetings in the future to discuss, analyze, improve and evaluate priority interventions for the conservation of giant otters.

4. Develop specific and comprehensive analyses and conservation plans with integrated and diverse conservation actions for the identified Giant Otter Priority Conservation Units.

5. Evaluate the presence of giant otters in areas without knowledge about them, or with poor knowledge within existing Giant Otter Priority Conservation Units.

6. Formalize a digital information exchange mechanism and library for giant otter experts and conservation practitioners.

7. Encourage greater international collaboration and interaction, as most of the expert-identified Giant Otter Priority Conservation Units span more than one country.

8. Work with governments to address the most pressing threats to giant otter populations, especially gold mining and associated mercury poisoning and riverine habitat destruction, livestock production, deforestation, forest fires, conflicts between fisherpeople and giant otters, depletion of prey through

overfishing, and hydroelectric dams and other major infrastructures.

9. Promote and increase environmental education and outreach related to the conservation of giant otters as a symbol of the aquatic environs of Tropical South America.

10. Develop landscape-scale and watershed-relevant comprehensive conservation action to ensure the future of the existing most important giant otter populations in the Giant Otter Priority Conservation Units and promote further population recovery in good quality habitat.

11. Continue to inform key decision makers about the plight of the giant otter and the importance of species-specific conservation action.

12. Respectfully engage with local communities and Indigenous Peoples to recognize, showcase, promote and learn about their crucial role in the conservation of wildlife, biodiversity, water, nature and the environment.

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ASSESSING AN AQUATIC ICON: A RANGE WIDE PRIORITY SETTING EXERCISE FOR THE GIANT OTTER *(Pteronura brasiliensis)*

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