The image features two river dolphin skulls, likely from the genus Inia, resting on a dark red, textured surface. The skulls are light brown or tan in color, with a prominent, elongated snout. The background is a deep red with some darker, shadowed areas, creating a dramatic and somewhat somber atmosphere. The text is overlaid on the left side of the image.

RIVER DOLPHINS

FERNANDO TRUJILLO

CONNECTING SCIENCE AND CONSERVATION
IN THE AMAZON AND ORINOCO BASINS

RIVER

DOLPHINS

CONNECTING SCIENCE AND CONSERVATION
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RIVER DOLPHINS



CONNECTING SCIENCE AND CONSERVATION
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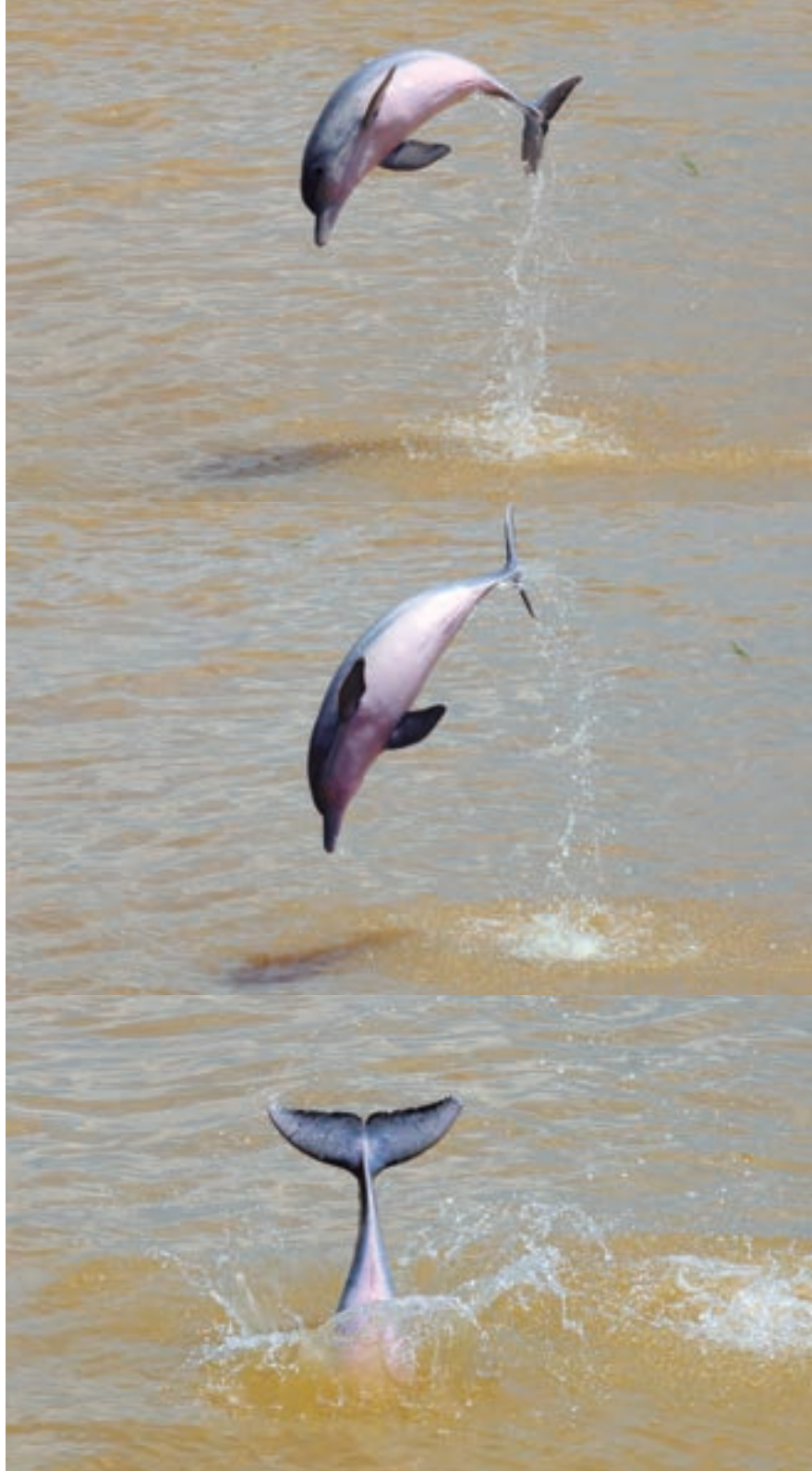
I want to dedicate this book in the first place to the river dolphins with the hope that they can last in time, and my daughters Diana and Sofia for always supporting me and believing in what I do.

RIVER

DOLPHINS

CONNECTING SCIENCE AND CONSERVATION
IN THE AMAZON AND ORINOCO BASINS

FERNANDO TRUJILLO









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FOREWORD



Enrique A. Crespo, Ph.D.
Cetacean Specialist Group (IUCN)
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When Fernando asked me to write the prologue for the book I was not sure whether to write about the book or about Fernando. I think the book speaks for itself when its pages are scrolled. Incredible collection of photographs and a text that guides you to understand what you are seeing: landscapes, species, dear colleagues in the region who work hard to protect and conserve that incredible ecosystem that faces a growing risk. Among those photographs stand out those of dolphins, manatees and otters, all of them equally important in the structure of that environment. As for Fernando, there are many things I could say or tell but there is no room for it. I met Fernando almost 30 years ago, in 1990 in Valdivia, Chile, at a meeting of aquatic mammals. I was impressed by his presentation and the first thing I asked him was how he managed to work in that environment in a complicated military and political context. We always remember my

question and his answer. From then on, everything was to work for a mutual knowledge and collaboration that became an extraordinary friendship and mutual support to make our beautiful South America a land where not only wildlife and flora were respected, but also the culture and customs of our original peoples. It was key in this regard that since 1997 I became the Latin American Coordinator of the IUCN Group of specialists. From that position I worked with a group of colleagues from all over the region, developing research useful for the conservation of cetaceans in Latin America putting more emphasis on the river dolphins in the Amazon and the Orinoquia. Dolphins are the flagship species that play a crucial role in the conservation of large biomes such as the Amazon and the Orinoco. The book describes the great problems of the world's largest rainforests: gold mining, oil extraction, hydroelectric dams, mercury pollution, dynamite fishing, deforestation for soybean cultivation and livestock rearing, and perhaps the most important, the population increase of the human being and the consequent modification of the natural spaces. Fernando addressed all these problems from basic and essential research to political action in his eagerness to curb the deterioration of the ecosystem and the conservation of its species, not without risk to his own person. Perhaps one of the things I most admire about his work was the consolidation of a human network formed by biologists, conservationists, researchers, fishermen, local people, NGO activists and officials from all the countries of the region, framing that cyclopean work in the Action Plan for the River Dolphins of South America, and extensive document that describes the problems and potential solutions. Later he promoted the corresponding national versions in Bolivia, Peru, Ecuador, Colombia, Venezuela and Brazil. It was an honor to have participated in some measure of all this, as well as to have been rewarded with his friendship all these years.



ABOUT THE AUTHOR



Danni Parks

Director, Whitley Fund for Nature (UK)

As this book tells you, Fernando and his NGO, Omacha, promote trans-boundary conservation of freshwater habitats and their wildlife using river dolphins as a flagship in the Amazon and Orinoco basins across Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela.

South America's river dolphin species face increasing pressure as a result of unsustainable fisheries management and are even killed for bait. Mercury pollution from illegal gold mining, habitat loss/fragmentation and the development of hydro-electrical dams which punctuate the waterways are growing threats, and research indicates river dolphin populations are declining. The current political situation and dramatic rise of fires in the Amazon is only serving to increase stress on this critical ecosystem.

Fernando first became known to the Whitley Fund for Nature (WFN) when he successfully applied for a 2007 Whitley Award and was recognised with the organisation's top prize, the Whitley Gold Award, in the same year. Since winning Fernando's work has gone from strength to strength. He has been awarded further WFN Continuation Funding grants on four occasions, enabling expansion of the project over the past 12 years as we and other supporters have partnered him on this journey.

I visited Fernando in Colombia in 2017 and was blown away by the scale at which he operates - working alongside indigenous communities, with the media, researchers, NGOs and decision makers to drive change and protect the Amazon Basin at the national and international level.

With more than 30 years' experience, Fernando has become the world's leading expert on this group of cetaceans. His multi-faceted approach is highly effective and the following achievements particularly resonate: numbers of *Inia geoffrensis* were estimated for the first time following the largest research effort ever coordinated and the subsequent re-classification of the species by the IUCN from 'Data Deficient' to 'Endangered' in 2018; legally binding Action Plans have now been published for river dolphins in all six countries where Omacha works, paving the way for future conservation efforts; over 1.5million hectares of river dolphin habitat has been afforded better protection after the declaration of multiple largescale Ramsar sites and significant advances in local fisheries management; Colombia successfully banned the trade of mota fish after Omacha evidenced mota contain toxic levels of mercury (making them unsafe for human consumption), and exposed the illegal killing of river dolphins for use as bait. The ban will not only benefit human health, but reduce the killing of dolphins for this purpose.

Fernando is rare among scientists in that in addition to passion and academic ability, he is a talented communicator and as such has been able to foster widespread collaboration in South America to achieve success against the odds. The work of Fernando and his highly capable team give me great hope for the future of the Amazon and it's unique pink river dolphins, but it will take the on-going support of domestic and international funders, as well as public, corporate and political will to deliver.



PREFACE

After working for 30 years for the conservation of river dolphins in the Amazon, my perspectives, goals and work paths have changed significantly. What began as a romantic approach to save the emblematic pink dolphins changed as I understood the context where these animals lived. The dolphins then, became the excuse to explore and understand the ecological and social dynamics, changes, realities and the different faces of the region. The Amazon Basin is a gigantic area of more than 7 million square kilometers, where more than 34 million people live today, of which less than 4 million are indigenous. The region has undergone a process of colonization and large-scale demographic growth, mainly in Brazil. This area has experienced a history of extractive processes based on the abundance and excessive use of its natural resources. First the exploitation of rubber and quinine in the nineteenth century, followed by the extraction of skins of felines, caimans and otters that brought many of these species to the brink of extinction. Then, with the introduction of electric generators and the installation of cold rooms in the 1950s, the fishing activity was triggered, and the extraction of large catfish changed fish populations and their dynamics. Along with this, thousands of hectares of forest were and are still deforested to give way to cattle raising and to extensive monocultures of soybean, especially in the south of the Basin. Illicit activities such as coca cultivation and illegal gold mining have also left a profound environmental and social footprint. The growing industry and the population increase has generated an increase in electricity demand and the response to this has been the excessive construction of hundreds of hydroelectric plants in Brazil, Bolivia and Peru that are responsible of fragmenting rivers, habitats and populations, within the complex freshwater network of the Amazon. To all that, non of the local communities have been benefited by these economic booms, and many losses including lives and cultures have resulted.

The picture is not encouraging, the sustainability of the region and its peoples is in danger. Despite governmental and institutional discourses, there is still a big gap between coherent policies and concrete actions of short and medium term that ensure the conservation and sustainable use of the basins and its resources. In this sense, it becomes essential that scientific research generates key information that supports decision making processes and promotes clear and innovative conservation strategies. The use of river dolphins as emblematic and flagships species, has helped to connect science and conservation, integrating social, economic and political issues, and contributing to the conservation of the largest tropical rainforest of the planet.

After all these years, dolphins have become an opportunity to evaluate and understand the complex problems presented by the Amazon and Orinoco basins, and they become a bridge to connect science and conservation, incorporating the social, economic and politics.



Photos: Leo Spencer



INTRODUCTION

River dolphins are relatively little known species in the world and face major threats. They are distributed in developing countries such as China, India, Nepal, Pakistan and Bangladesh in Asia and Colombia, Venezuela, Brazil, Bolivia, Peru and Ecuador in South America. Although they are found in two different continents, the threats are similar: directed catches, conflicts with fisheries, habitat loss, river pollution, loss of connectivity and climate change. In general, the survival of these species is closely connected with the conservation of their habitats.

In South America for more than 30 years, efforts have been made to increase knowledge on these species, mostly in Colombia and Brazil where several research groups have been leading these processes. In other countries such as Peru, Ecuador, Bolivia and Venezuela, efforts have been more intermittent, with funding being one of the main constraints. A critical aspect of dolphin conservation has been the scale of work, as much research has been confined to relatively small areas. Additionally, the level of interaction between researchers was very low for many years, therefore research methodologies to assess populations were very varied and did not allow comparisons among areas, countries and even species. An example of this was the lack of consolidated methodologies in the region regarding population estimates of dolphins. For many years, it was recommended in many international workshops that a robust methodology should be developed to estimate the abundance of these species, but it was not until 2000 in the framework of the International Whaling Commission (IWC) in Australia that a regional effort to address this issue started. The first efforts to standardize the methodology were made with the support of the University of Sant Andrews and were led by the Omacha Foundation in 2001. This enabled the creation of the South American River Dolphin abundance Estimation Program with the strong support of Omacha, WWF, the Whitley Fund for Nature and many more regional partners. Since then, there have been more than 30 expeditions throughout South America where more than 300 researchers have been trained. These

expeditions have covered 32.000 km of rivers, lakes, tributaries and flooded forests, allowing researchers to evaluate not only the state of conservation of dolphins but also of rivers and wetlands, identifying the main threats to their conservation and understanding social and cultural dynamics that either put in risk the species or are conservation opportunities. Besides all this, the initiative has created a strong network of researchers, knowledge and capacity building opportunities among the countries.

In addition to presenting data on these scientific efforts, this book also includes (I) an analysis of the main threats to dolphins and aquatic ecosystems, (II) some examples of the work done with local people that has generated economic alternatives that stimulate the conservation of the species; (III) political actions such as the formulation and implementation of conservation action plans in different countries; and finally (IV) the vision that many of the most committed researchers have on the future of the species and their habitats.

One of the highlighted conclusions of not only the book but of my life as a conservationist is that to preserve dolphins, we must have an integrated approach, not only focused on the ecology of the species, but also on the social, economic and political aspects that shape that ecology. It is understandable that this can intimidate many researchers, and some prefer to stay in their comfort zone waiting for someone else to think and act out of the box, although it really is necessary to have a more committed and determined attitude if we want to guarantee the conservation of these species and their habitats.

What is presented in this book is the result of the work of many people and organizations in several countries for several years. I hope it will be useful and a source of inspiration and hope.



Photo: Philipp Lichtenbeck





















1 River dolphin species





River dolphins are distributed exclusively in Asia and South America, where they face great threats, mainly due to the deterioration of their habitats.

AAsian's river dolphins

In Asia in the Yangtze River was the Baiji dolphin (*Lipotes vexillifer*), but the negative interactions with fisheries and the loss of river connectivity by hydroelectric power contributed to accelerate its extinction, to the point that in 2006 this species was declared Ecologically Extinct by the IUCN. In this same river inhabits another species of cetacean that is the finless porpoise (*Neophocena asiaorientalis*) with populations that are very threatened for the same reasons. The finless porpoise is an example of the so-called facultative freshwater cetaceans, which consist of marine species that have made inroads into freshwater systems and have established fully adapted populations. Another example of this is the Irrawaddy dolphin (*Orcaella brevirostris*), that is a euryhaline species with discontinuous populations in marine coastal areas and also in freshwater ecosystems. The last ones, found in the Mekong River Basin in Cambodia, Filipinas and in the Mahakam river in Borneo, Indonesia. In the River Mekong its population is very threatened, and it has been estimated that there are less than 100 individuals.



The population increase around rivers such as the Ganges and the Mekong have significantly transformed the integrity of these aquatic ecosystems.



Distribution of river dolphins in Asia. The baiji (*Lipotes vexillifer*) use to occurred along the Yangtze river.

In the complex of the Ganges, Megna, Bramaputra and Indus inhabits another species of river dolphin, the Susu (*Platanista gangetica*) with two sub-species, one for the northeastern part of India, Bangladesh and Nepal (*P. gangetica gangetica*) and another for Pakistan (*P. gangetica minor*), being the latter the present in the Indus River, where its distribution is restricted to only seven segments of the river (80% less than its original distribution). In the Ganges, the enormous transformation of the river is due to human pressure (> 400 million people) and its consequent activities.



IUCN category status of freshwater dolphins in Asia

EN: Endangered. CR: Critically Endangered

Species	Common name	Countries		Source
<i>Platanista gangetica</i>	South Asian River dolphin, Susu	Bangladesh India Nepal Pakistan		Braulik, G.T. & Smith, B.D. 2017
<i>Neophocaena asiaorientalis</i> ssp. <i>asiaorientalis</i>	Yangtze finless porpoise	China (Shanghai, Jiangsu, Hubei, Anhui)		Wang, D., Turvey, S.T., Zhao, X. & Mei, Z. 2013.
<i>Lipotes vexillifer</i>	Baiji	China		Smith, B.D., Wang, D., Braulik, G.T., Reeves, R., Zhou, K., Barlow, J. & Pitman, R.L. 2017.
<i>Orcaella brevirostris</i>	Irrawaddy dolphin	Bangladesh Brunei Darussalam Cambodia India Indonesia Lao People's D. R. Malaysia Myanmar Philippines Singapore Thailand Viet Nam		Minton, G., Smith, B.D., Braulik, G.T., Krebs, D., Sutaria, D. & Reeves, R. 2017



The Susu (*Platanista gangetica*)



Photo: Yohkawa

Yangtze finless porpoise (*Neophocaena asiaeorientalis*)



Photo: François Xavier Pelletier

Baiji (*Lipotes vexillifer*)



The Irrawaddy dolphin (*Orcaella brevirostris*)



South American´s river dolphins

On the Atlantic coast of Brazil, Uruguay and Argentina inhabits the Franciscana (*Pontoporia blainville*), which although phylogenetically is a river dolphin, is currently only found in coastal marine environments. This species is very threatened by having negative interactions with fisheries. Sharing the same fishing areas with humans have resulted in an intense competition for the fishing result ending up in high mortality rates of dolphins. Faced with this situation, scientists from these countries have consolidated a joint initiative to evaluate and monitor their populations, as well as generate a conservation management plan.

In the Amazon and Orinoco basins five species of dolphins are currently identified. The most widely distributed is *Inia geoffrensis*, mainly in the Amazon basin. The gray dolphin or Tucuxi (*Sotalia fluviatilis*) in the Amazon basin; the Bolivian dolphin (*Inia boliviensis*) in Bolivia and the Madeira basin; the Araguaia dolphin (*Inia araguaiaensis*) in the Tocantins/Araguaia basin and the Guyana dolphin (*Sotalia guianensis*) in the Orinoco river in Venezuela. The taxonomy of these dolphins is still under review, but genetic and molecular analyzes are providing valuable information on different species and even the presence of hybrids.

The Franciscana
dolphin (*Pontoporia
blainville*),



Photo: Daniel Damilewicz



The Guyana dolphin (*Sotalia guianensis*), the Orinoco River in Venezuela.



The gray dolphin (*Sotalia fluviatilis*), the Amazon River in Colombia.



The Araguaia dolphin (*Inia araguaensis*) in the Tocantins river in Brazil.



The Bolivian dolphin (*Inia boliviensis*) in Bolivia.



The Pink dolphin (*Inia geoffrensis*) in the Meta River.



The case of *Sotalia* in the Orinoco River is also particular, since recent molecular studies suggest that it corresponds to *Sotalia guianensis*, but the animals are smaller, and like *Sotalia fluviatilis* in the Amazon they have the anterior edge of the dorsal fin completely straight, unlike the Guyana dolphin that has a small hump at the base. This would be another example of dolphin speciation that requires another type of genetic analysis to elucidate its taxonomic status. The genetic diversity and its analysis has made it possible to demonstrate that there are differentiated populations of dolphins that are experiencing greater threat than others, due to their geographical isolation and also to a greater exposure to human tensors.



Differences in the shape of the dorsal fin of *Sotalia guianensis* and *Sotalia fluviatilis*. Note the small hump in the anterior part of *S. guianensis*.



Aerial activity of *Sotalia fluviatilis* in Caballo Cocha Lake in Peru. Note the pink coloration of the belly.



The Bolivian dolphin (*Inia boliviensis*)



Distribution of the genus *Inia* in South America.

Status of threat

The threat category of these species in most of the countries where they live is Vulnerable (VU), although IUCN internationally classified them as Data Deficient (DD) in 2008. Based on this, a new assessment was made in 2018 in light of all the information generated in recent years and the increase in magnitude and scale of the threats. The result was that *Inia geoffrensis* is now considered as an Endangered species (EN). The main reasons for this, is that in at least two geographical locations in the Amazon there has been a significant decrease in the population size of this species that can be more than 50% for a period of three generations. Likewise, the threats have a pattern of increasing and intensifying, mainly due to economic policies and the demographic increase in both the Amazon and the Orinoco.



Because the taxonomy committee of the Marine Mammal Society only recognizes one species for the genus *Inia*, the assessment was done only for *Inia geoffrensis*, without considering *Inia boliviensis* or *Inia araguaensis*.

In the case of *Sotalia fluviatilis*, a new evaluation was also carried out, which will be published in 2019, where the category will most likely be endanger (EN). A species is included in the category EN when population size reduction of $\geq 50\%$, is projected or suspected to be met within the next 10 years or three generations.

The formation of the Amazon, as we know it today, is the product of millions of years of evolution. It is thought that 16 million years ago, with the formation of the Andes mountain range in the middle Miocene, the South American continent changed dramatically. In this process, there were marine transgressions and the creation of a large inland freshwater lake (Pebas) of more than one million km² (in what today corresponds to part of Colombia, Ecuador, Peru and the eastern region of Brazil). When it dried, about ten million years ago, it gave way to the flow of the great Amazon River towards the Atlantic, receiving contributions from hundreds of rivers along its course.

The dolphins are part of the dynamic evolutionary history of the Amazon, and their entry into the South American continent is linked to changes in relief such as the rise of the Andes, which induced the sinking of the plains allowing the massive entry of the waters of the Atlantic, forming the so-called epicontinental seas. Later, with the rains and the contribution of fresh water from several hydrological systems, this body of water acquired estuarine characteristics that allowed the adaptation of the ancestors of the pink dolphin (*Inia*) and the Franciscan dolphin (*Pontoporia*). The lifting of the relief halted the marine transgressions and allowed to go modeling the current hydrographic basins of the Amazon and Parana, being finally separated.

River dolphins, and in particular *Inia geoffrensis*, are one of the most successful predators in the Amazon and Orinoquia. They are present in most aquatic habitats: main channels, tributaries, confluences, lagoons and the flooded forest. For this They have an evolutionary history of more than two

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River dolphins' evolution, population structure and conservation genetics. Working on population genetics and evolution of river dolphins has been extremely challenging but incredibly fulfilling. I am a Colombian biologist and microbiologist who has been researching in the field of Conservation Genetics of Aquatic Vertebrates for almost 20 years. When I was starting my career, I collaborated with Dr. Healy Hamilton trying to understand the evolutionary processes of different species of river dolphins. We confirmed that river dolphins are polyphyletic, meaning that not all of them evolved from a single ancestral species, and also, that the evolution of river dolphins in South America (genus *Inia* and *Pontoporia*) was related to the geological changes and processes that gave origin to the main river basins in the continent. Some years later, for my Ph. D., I worked on the genetic characterization of the genus *Sotalia*. Results of my research using analyses of a variety of mitochondrial and nuclear genes, confirmed *Sotalia fluviatilis* as a full species, endemic to the Amazon Basin. This result was relevant for the conservation of South American River dolphins,

since we now have to understand the threats affecting this species and we need to design conservation strategies particular to this species. Recent work has also suggested reduced gene flow between the Eastern and Western Amazon, suggesting that there may be fine scale population differentiation, but some gene flow between neighbouring locations, that needs to be maintained and that could be affected by the constructions of dams or excessive boat traffic. I have also collaborating with researchers in Colombia, Brazil and Bolivia to understand the taxonomy of the genus *Inia*, which appears to be much more complex that anyone could imagine. We consider there is enough molecular information to consider at least three species within the genus *Inia*: *Inia geoffrensis* (Main Amazon River Basin and the high Orinoco), *Inia boliviensis* (Bolivian Amazon, river Madeira and Inteñez) and *Inia araguaensis* (Araguaia and Tocantins River). However, such designation is still not accepted at the international level. We hope that new genomic and morphologic analyses will provide the information needed to confirm these taxonomic designations.



Photo: Julio García Robles

Botos have a variable coloring pattern that can range from gray to intense pink. Sometimes these pink tones can be accentuated by physical activity.







Inia geoffrensis is the top predator in the aquatic ecosystems of the Amazon and the Orinoquia, since it is present in different types of habitats, including the flooded forest.

million years that has allowed them to generate interesting morphological adaptations such as free vertebrae in the neck that allows great mobility in their head, and special joints in their pectoral fins that can rotate in such a way They are easily propelled into the flooded forest without major problems.

Their heterodont teeth (incisive and molariform) give them the possibility of capturing and crushing species with hard exoskeletons, especially silurid fish. The low dorsal fin and keel is another great advantage to be able to swim easily under the floating vegetation where a large amount of fish accumulates. Although their eyes are small they are functional and well adapted to the lighting conditions under water. However, the sensory part is complemented by its sonar system that allows them, through the generation of echolocation sounds, to detect their prey and avoid obstacles such as fishing nets.

Coloration can vary greatly between individuals and from one geographic region to another. In general, when they are born they are dark gray and as they grow they can be light gray. Sometimes, when these animals are very active their coloration can turn pink as a thermoregulation strategy where the blood flows actively to the blood vessels of the skin. After the activity ceases they gradually return to their original tonality. Although in general *Inia* is not very active on the surface, occasionally, especially during periods of low water, they can form reproductive and food aggregations where they can eventually be observed jumping. They are much more active in the Orinoquia, where also make up more numerous aggregations, showing the creation of subgroups by age category (adults, juveniles and mothers with offspring). In this region, it is common to observe animals exhibiting the caudal fin on the surface very frequently, as well as swimming on the surface, removing the caudal fin and hitting the water.

This species is the largest of the river dolphins, reaching up to 2.75 meters and weights that exceed 200 kg. The males are significantly larger and more robust than the females, being a very dimorphic species. The pregnancy period is estimate in 12 to 13 months, with a parental care ranging from 1,5 to 5 years.






An interesting behavior of *Inia* observed in many regions is to interact with objects such as branches and transport them in their fins, back and even in the mouth.



IUCN category status of freshwater dolphins in South America

EN: Endangered. VU: Vulnerable. NT: Near to threat. NE: Not evaluated.

Country	Species					Source
	<i>Inia geoffrensis</i>	<i>Inia boliviensis</i>	<i>Inia araguaensis</i>	<i>Sotalia fluviatilis</i>	<i>Sotalia guianensis</i>	
Colombia	VU			VU	VU	Red Book of Mammals of Colombia
Venezuela	VU				VU	Red Book of Mammals of Venezuela
Brazil			NE	NT	NE	National Action Plan for Aquatic Mammals and small cetaceans of Brazil
Peru	NE			NE		
Ecuador						Red Book of Mammals of Ecuador
Bolivia		VU				Red Book of Vertebrates of Bolivia (2009)



In the Orinoquia the botos are very active on the surface and exhibit a large array of behaviors including the caudal fin.



Distribution of the
genus *Sotalia* in
America.



The gray dolphin (*Sotalia fluviatilis*) has a more recent evolutionary history in the Amazon with about 500 thousand years. Their movements and use of the habitat are more restricted to channels, lagoons and tributaries with good depth, where they search in a group way for their prey. In general, family groups make up between 2 to 30 individuals moving synchronously. It is one of the smallest dolphins in the world, with a length of 1.50 meters and weights of up to 60 kg. Its external appearance is that of a marine dolphin, with short snout, triangular dorsal fin and small pectoral fins. Its tail fin is triangular with a notch in the middle part. The coloration is gray on the back and pale or pink on the belly. Like *Inia*, the tone of the belly becomes a more intense pink when they are very active.

The behavior at the surface is characterized by a large number of jumps, especially during the low water period, where they fish more actively and there is a higher level of social interaction. Sometimes they can exhibit a large number of jumps with side falls, which seems to be associated with efforts to free themselves from ectoparasites (fish of the family Trichomycteridae). *Inia* seems to be more tolerant of these fish.



In the low water season it is common to observe how the dolphins present external parasites that correspond to fishes of the family Trichomycteridae.





2 The Amazon, Orinoco and Tocantins basins: a changing landscape and economy





In four centuries, the economic dynamics have had a great impact on the natural and cultural biodiversity of the region.

The Amazon Basin covers an area of approximately 7 million square kilometers including territories in Brazil, Ecuador, Colombia, Venezuela, Peru, Bolivia, Guyana, French Guiana and Suriname. The Amazon River is the second longest in the world with about 6,500 km in length and more than 1,000 tributaries, among which the Negro, Putumayo, Japura, Purus, Tapajos, Tocantins, Jurua, Ucayali and Trombetas rivers stand out. All this extensive fluvial network of about one million km² provides approximately 17% of all the fresh water of the planet.

Most of the basin corresponds to Brazil, but in other countries such as Guyanas, Colombia, Peru, Ecuador and Venezuela the Amazon represents more than 40% of its territory. Contrary to what most people think, more than 30 million people have settled in the basin, adding to the almost 4 million indigenous people who have populated the area for more than 11 thousand years. All this is undoubtedly leaving a deep footprint that has already generated the loss of about 17% of all the original forest cover.



In four centuries, the economic dynamics have had a great impact on the natural and cultural biodiversity of the region. The extraction of rubber promoted processes of slavery of indigenous communities with very dramatic results on their populations. Subsequently, due to the international demand for furs, thousands of felines, otters and alligators were annihilated generating geographic extinctions. At the same time, population policies in the region were consolidated, accompanied by deforestation activities for the commercialization of timber and the opening of vast areas for agriculture and ranching. The opening of large roads has stimulated deforestation and consolidation of large urban centers such as Manaus and Belen de Pará (Brazil), Iquitos (Peru) and Leticia (Colombia).

Gold mining, mostly illegal, has promoted the dumping of more than 200,000 tons of mercury in rivers over four centuries with a huge impact on aquatic species and human health. The subject has been extensively evaluated by scientists and research institutes in many countries, but state and regional policies that actually seek remediation mechanisms are not yet seen. The entire aquatic chain, especially butt predators such as large catfish and dolphins have significant concentrations of mercury, as have indigenous communities being evaluated in countries like Colombia.

As part of the economic vision of the region, over the last thirty years the development of a large number of hydroelectric projects has been promoted, with more than 155 dams, mainly in Brazil and Peru, and at least 200 other proposals for new ventures. This is undoubtedly generating one of the greatest negative impacts on the aquatic ecosystems of the Amazon, compromising the ecological integrity of these systems. On the one hand with the loss of connectivity of these biological corridors and on the other with the interruption of the important migrations of fish, which for the most part have reproductive purposes.

The Orinoco basin is approximately 880,000 km² and is shared by Venezuela (76%) and Colombia (24%). The Orinoco River is considered the fourth longest of the world with 2,140 km and with a large number of tributaries such as the rivers Apure, Arauca, Atabapo, Guaviare, Caura, Inirida and Meta, among others.

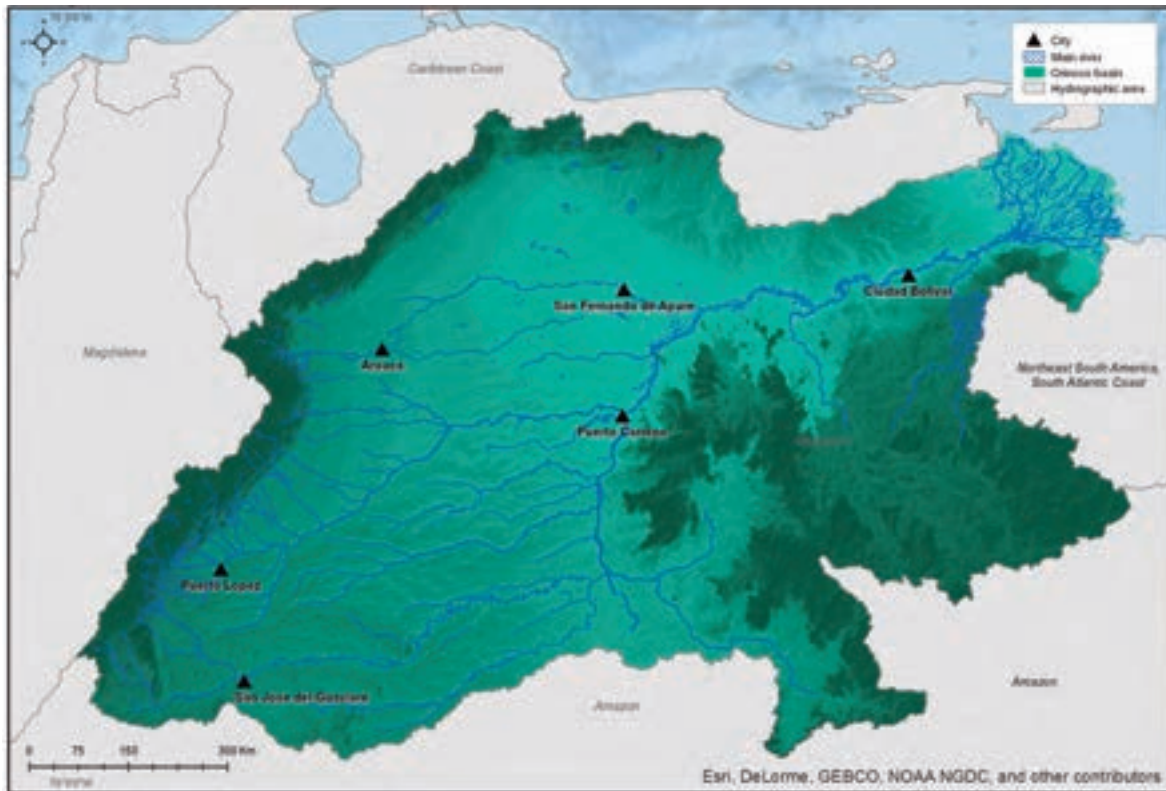


The Amazon basin is an extensive river network with thousands of rivers in an area of 7 million km².

Like the Amazon basin, the economic pulses have been similar and with equivalent consequences. The Orinoco River has become a strategic transportation route to move goods to the Atlantic Ocean. In the margin of the river have been consolidated important industries of iron and aluminum, and has been given the exploitation of gold and hydrocarbons. The development of hydropower is also an important factor in the region, with examples such as the Guri reservoir, which represents one of the largest hydroelectric initiatives in the world.

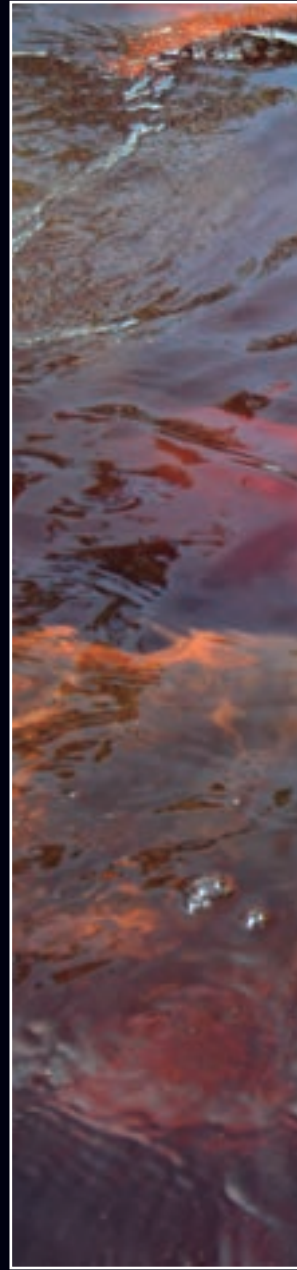
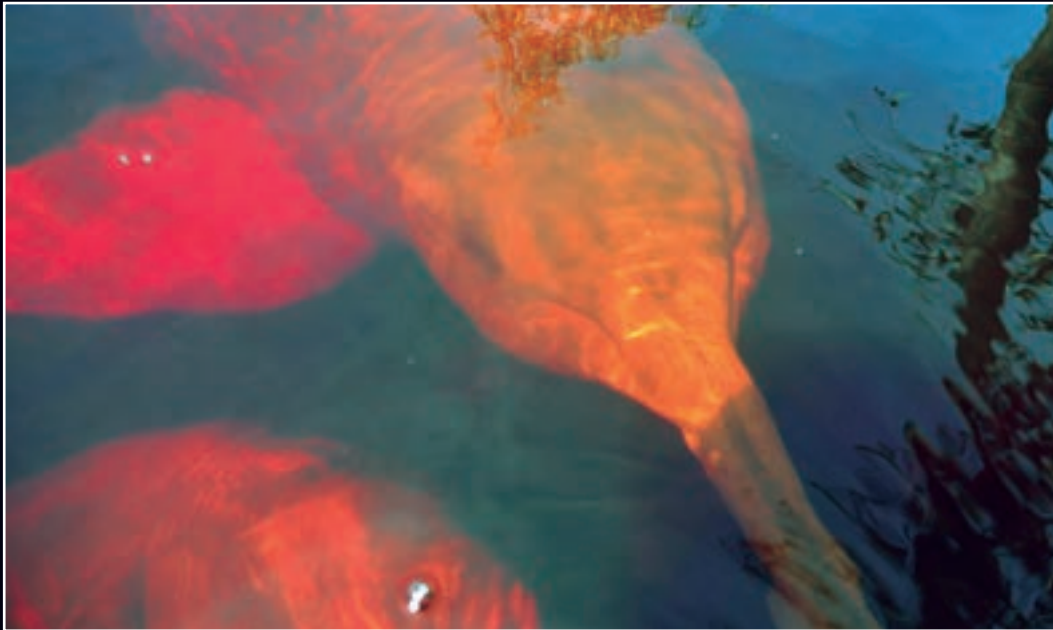


Ciudad Bolívar in the central part of the Orinoco River, around which there is great mining activity, including the transport of large quantities of bauxite



The Orinoco has an extensive river network in the territories of Venezuela and Colombia.

The third basin where river dolphins are present is the Tocantins-Araguaia, with an area of 767,000 km² and composed mainly of three rivers: the Araguaia (382,000 km²), the Tocantins (343,000 km²) and the Itacaiunes (42,000 km²). This basin is in critical condition due to the great transformation of its natural ecosystems, mainly due to the impact of the road from Belén to Brasília, agricultural activities, mining and the fragmentation of the river due to the construction of the Tucuruí hydroelectric plant in 1984. This is the largest dam in Brazilian territory, with a maximum power generation capacity of 8,370 MW. It has 24 dams in the middle of which there are groups of isolated dolphins.









3 From local to regional perspective





As I mentioned at the beginning of the book, the efforts of working with river dolphins were concentrated mainly in Colombia and Brazil in a permanent way.

In Colombia, the research was concentrated mainly in the Amazon River and in the confluence of the Meta, Bitá and Orinoco rivers, led by the Omacha Foundation. In Brazil, mainly in the Mamirauá Sustainable Reserve, guided by INPA and more recently for the Mamirauá Institute. In Peru, Ecuador and Bolivia the scientific evaluation of river dolphins has been more opportunistic along the time, despite the fact there are dedicate scientists in these countries trying to do their best.

In the case of Colombia, there is already 32 years of information in the Amazon River, especially in the lakes of Tarapoto, in the area of influence of the municipality of Puerto Nariño. The beginning of studies with dolphins in Colombia was not easy. In the first place, the Amazon region is well disconnected from the center of the country and access was not easy. I chose the place for several reasons: one was a brief encounter with the legendary Comandante Costeau who pointed out the lakes of Tarapoto as an interesting place to work with dolphins, and the other, because in 1986 there had been a dolphin capture to Leticia and I could access the information. In 1987 when I traveled on a cargo plane to the region, I found an area under the influence of illicit activities, so I decided to settle in a small indigenous population 87 km upriver from Leticia (Puerto Nariño). There, the learning process has been very valuable from the scientific, social and economic point of view. It was possible to understand and document the dynamics of seasonal and daily movements



of dolphins, their dependence on the presence and migrations of fish, and even the implementation for the first time of the photo identification technique, generating catalogs for different regions.

In the same way, it became evident the conflicts with fisheries. In this sense, it is valuable historical analysis, where it is observed that in the case of Colombia, with the introduction of fishing nets in the 1970s for the capture of large catfish there was a large mortality of dolphins. This introduction of networks was connected with the implementation of rooms for collecting and commercializing fish. Subsequently, we could monitor that in the 1980s-dolphin mortality continued, mainly in monofilament nets arranged parallel to the shore. In the 1990s, it was recorded that the dolphins had learned to dodge the nets and even some of them began to approach and draw fish from them, which began to generate conflict.

In the first decade of 2000, jointly between Omacha and the Sinchi Institute, the level of conflict with fishermen of large catfish was assessed, finding that the greatest number of dolphin predation on the nets occurred in high water periods, when it was more difficult to catch the fish as they scatter in the flooded jungle. However, the number of interactions is minimal when doing the analysis on all the sets of the networks.

This situation, however, led to a fisheries analysis in the region that showed a reduction in fish catch due to overfishing, which affected not only the local economy but also food security. In response to this, the consolidation of a management agreement on fisheries in the Tarapoto wetland system began, and after eight years it was consolidated and ratified by the indigenous communities and more recently by the National Fisheries Authority (AUNAP).

Another factor related to the reduction of the fish resource in this area has been the deforestation of the flooded forest, whose fruits depend a large proportion of fish. It is estimated that one hectare of flooded forest produces about 20 tons of fruits and seeds each year, of which 60% is consumed and dispersed by fish. To mitigate deforestation, a "pepeaderos" recovery program has been implemented, which is explained later in this book.



The dolphins have had to adapt to live in ecosystems transformed with high human presence.



One of the key factors in our conservation program of dolphins in the Amazon was the built of a field station from where we have promoted more than thirty dissertations and numerous investigations not only with dolphins but also with fish, fisheries, limnology, botany, biological assessments, manatees and caimans, among others. The permanent presence in Puerto Nariño allowed to develop a strategy of education and social responsibility of long term that led to turn the dolphins into iconic species for the conservation. In this sense, the tourism of dolphins was positioned and also the elaboration and sale of wood carvings and handicrafts allusive to the dolphins.

Despite all the significant advances in this small sector of the Amazon, great unsolved questions still subsisted, and in order to do so, it was necessary to change the geographical scale of analysis. Whenever scientists state that dolphins are very threatened, decision-makers ask how many dolphins there were, and there were no hard-fought responses to this, since the available estimates were restricted to small areas. For this reason, we had to move from the local to the regional approach, through a program to estimate the abundance of river dolphins in South America and in this way to make a more general analysis of the basins, beyond the limits of each country.

I remember that at a meeting of the International Whaling Commission in 2000 in Adelaide (Australia), it was again recommended to design a robust methodology to estimate the abundance of river dolphins. The first time this recommendation was made had been in China in 1986, almost fifteen years before and still nothing happened. For this reason, from Omacha, we joined forces with several researchers from the University of Sant Andrews (Scotland) and rented a boat in the Colombian Amazon in 2001. There, the process of designing a standardized method began, learning from what was previously done in Brazil and Colombia. by other researchers.

With this pilot experience, I decided to look for resources to evaluate different rivers along the entire Amazon and Orinoco basin. At first it seemed an impossible task from the financial point of view, but in 2003 and 2005 we could start to cross rivers in several countries, using regional cargo or passenger



River dolphin catching a payara fish at the confluence of the Orinoco and El Meta.

ships, and getting professionals to donate their time without charging fees. In the end, we only paid rent for boats, food, fuel and air transportation for scientists. With these first expeditions, WWF and WCS became interested in supporting this cause, and in 2006 we managed to create the "South American initiative to estimate abundance of river dolphins".

I must say that in the process were key researchers who until then worked in isolation in Ecuador, Bolivia, Peru and Venezuela, since with them we were creating a network of work in the Andean countries. Later, in 2012, the Mamirauá Institute became interested in applying this methodology in Brazil and we were able to carry out a training process on the Tefé River, which was consolidated into a long-term alliance.





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4 Counting River dolphins





It was necessary to generate information on the abundance of dolphins in the Amazon and Orinoco basins.

Boat counting

As mentioned above, it was necessary to generate information on the abundance of dolphins in the Amazon and Orinoco basins on a larger scale, and for this reason an abundance estimation program was consolidated at the South American level.

In this process a methodology that was replicable and allows comparisons between geographic regions and basins was designed and adjusted over time. One of the most important aspects was to recognize the heterogeneity of aquatic habitats and to understand that the dolphins make a differential use of them, influenced fundamentally by the availability of prey. Likewise, in the methodological analysis it was fundamental to consider the flood pulses. In the first instance, estimates of abundance in the dry season seemed most reasonable, when dolphins were confined to relatively small areas. However, at this time navigation is difficult by sand banks and shallow areas, in addition to excluding the habitats to be sampled, making greater effort in the main channels and leaving aside gaps and tributaries. The opposite situation occurs in the raining periods when hundreds of kilometers of jungle are flooded and fish and dolphins are dispersed, making it very difficult to detect them. For this reason, the transition periods from high to low waters and vice versa were selected to make the monitoring.



The details of the methodology have been extensively illustrated in different scientific publications (Gómez *et al.* 2011, Trujillo *et al.* 2011, Williams *et al.* 2016). The way in which this program was approached was through a scheme of training of researchers and generation of the estimates simultaneously. Between 2006 and 2018, 30 expeditions have been carried out in six countries covering the main rivers of the Amazon and Orinoco basins. This has involved the participation and training of 326 people including scientists from 16 countries, park rangers, indigenous leaders and local researchers.

Some of the evaluations have been done at key sites such as the Tapajos and the Tocantins in Brazil, where there are hydroelectric projects that have fragmented important habitats for dolphins; in other cases, in rivers where dolphin hunting has been reported to be used as bait in the capture of "piracatinga" (*Callophrys macropterus*). The results obtained to date confirm that there is a great variation in the abundance of dolphins in each of the basins.



Photo: Fly North

From the limnological point of view there are different types of waters in the Amazon; the whites are undoubtedly the most productive and where more dolphins can concentrate







There are areas with very low densities in Ecuador and others very high in rivers such as Purus and Itenez in Brazil and Bolivia. In specific cases, such as the Amazon River in Colombia, and the Meta River, where it has been possible to make several evaluations in different years, show trends of population decrease for *Inia geoffrensis* (Williams *et al.* 2016, Trujillo *et al.* 2016, Mosquera-Guerra *et al.* 2015). To illustrate a little more this heterogeneity of dolphin densities in each river, I can say that in river systems in Ecuador, where we sampled 8 days about 550 km, we only counted 28 dolphins. In contrast, in rivers like the Purus, in the same number of days and similar distance the number was 2,700.

These differences are very big and explaining them really is not that simple. The ecosystems in the aforementioned example are in relatively good condition, and there is no strong evidence of environmental disturbance by human activities. However, the issue of limnology and the productivity of rivers can be a relevant factor. In Ecuador, the waters are more of forest origin and do not have as many nutrients as the Purus in Brazil.

Another study of a very relevant population trend was carried out in a small area of the Mamirauá Sustainable Reserve in Brazil by INPA scientists, where data from 22 years were analyzed that showed an important trend of population reduction in recent years. In this area, this study represents one of the first scientific evidence of population decline of river dolphins.

This pattern of decline in several regions has to be carefully analyzed, since the abundance of these species is very heterogeneous throughout its distribution in the Amazon and Orinoquia. Therefore, it is essential to carry out other evaluations in key sites to identify the population pattern of these species. At this point it is essential to take into account the scale of the study, because if the area is very small, other variables could influence the analysis. In an area where human pressures are increasing such as boat traffic and overfishing, dolphins can leave the area in search of one with better conditions, without this really signifying a process of extinction or population reduction.

The estimates of abundance made so far in this program and in other studies carried out in the region certainly allow the assesment of these species

CEDRIC GILLMAN

SOLINIA

Peru



Nowadays conservation is a terrific word, people all over the world want evolution and this is the key! We are in a transition period where the new technologies are improving fast, changing our life everyday. It's our challenge to use these new technics and tools in the conservation projects. A high speed, camera gives us high definition photos or videos to study the biology of the river dolphins, a drone allows us to better observe their behavior and their importance in the environment, high frequency submarine microphones help us to listen to them

and to understand their acoustic performance, a small transmitter can help to trace their migration and new softwares are developed to analyse these lots of data. The future is full of promises but it all depends on our adaptability, biologists becoming engineers, it's our responsibility to go with the tide and to enter in a new conservation era.

and include the different threats to define the most appropriate category of management according to IUCN guidelines.

The initiative to estimate the abundance of these species has also served to create a large database with more than 32,000 records resulting from these expeditions, satellite tracking of individuals and valuable contributions from other organizations working in Brazil, Peru, Bolivia, Ecuador, Colombia and Venezuela.



The use of drones has opened up new possibilities to study river dolphins.



Other methods to count dolphins

Although in recent years a robust methodology has been consolidated to estimate the abundance of river dolphins from boats, it is important to recognize that it is necessary to look for complementary methods to reduce variability and sources of error in counts. One of the emerging methods in recent years is the use of drones, which allows the presence of dolphins to be evaluated from the air. One of the pioneers in this process has been the WWF Brazil team and the Mamirauá Institute researchers, who have carried out evaluations in various sectors of the Amazon. In Colombia, the Omacha Foundation has also conducted surveys in the Orinoco and the Amazon. The results so far show the usefulness of this method in zones of confluence, lagoons and clear bodies of water, where the dolphins can be detected more easily, even before emerging.

In these areas, it has become evident that there is a tendency to underestimate the number of dolphins from boats, and the use of drones can help create a correction factor for this. However, it is still necessary to solve some problems such as the battery life of the drones, which in general do not exceed 20 minutes, and the time that must be spent reviewing hours of videos to corroborate detections. At the moment, it seems to be a complementary technique to transects by boat.

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As an ecologist, I am interested to study ecosystems as a whole, abundance and distribution of organisms, and the relationships with their environment. The freshwater environments, in special the Amazon, are key areas to study the complexity of the factors that drives process of biodiversity, and population dynamics of biological communities. Since 2010, I have been dedicated to study two species of small odontoceti (dolphins - cetacean) in South America, the Amazonian pink-dolphin or boto *Inia* spp. and the tucuxi-dolphin *Sotalia fluviatilis*. The Amazonian biome that extends through the Amazon, Orinoco and Tocantins river basins has been suffering intense and significant changes as result of a variety of human interference, and the climate change. The studies concerning to boto and tucuxi dolphins have shown their deep relationship with the environment. These animals are completely adapted to the dynamicity of the water transition, as well as identify the most productive areas changing their movement's patterns. However, fundamental information as density and abundance of these dolphins remained poorly known until 2010. Density and abundance of biological populations are the most baseline information for biologists/ecologists and



environmental managers. The impacts of threats to any species cannot be assessed qualitatively without robust and reliable abundance data. In the last five years, these parameters were focus of many studies, and data regarding abundance of boto and tucuxi dolphins in different areas of the Amazon are now available. Together with South American River Dolphin Initiative (SARDI) – a network of Universities, Institutes, and ONG – We are now focusing our attention to improve logistical and analytical methods, as well as complimentary tools to enable the access to reliable data regarding trends in abundance for both species.



One way to study the movements of dolphins is being able to identify them by markings on their dorsal fins. Often, unfortunately, these marks are produced by collisions with boats.

Photo-identification is another method that can allow estimating the abundance of river dolphins. Since the nineties I began to make great efforts with this, especially in the Colombian Amazon (Trujillo 1994). Taking good pictures of river dolphins is not an easy task, and at first with analog photography was a more uncertain process. However, in a few years we were able to build a catalog for the Puerto Nariño area with more than 100 recognized animals. The main criteria are the presence of indentations and scars in the dorsal fin, and in the case of *Inia* other marks on the body, and even fractures in the upper and lower jaw. For *Sotalia* the process is more difficult because the notches are small and requires good photographs for identification. In several regions, it helps to complement the identification, the depigmentation of the upper part of the fin that is white and may vary from one individual to another.

MARCELO OLIVEIRA

Senior Programme Officer
WWF Brazil

DRONES: A GAME CHANGER FOR POPULATION STUDIES TARGETING RIVER DOLPHIN

Quantifying the distribution and abundance of river dolphin is key for sound management and conservation. Although much effort has been invested into freshwater dolphin surveys, little is known about population trends in the Amazon and Orinoco basins. Therefore, improving the efficiency of survey techniques to estimate the distribution and density of freshwater wildlife species is a priority

Unmanned Aerial Vehicles (UAVs), or drones, have been increasingly recognized as a potential game changer for environmental monitoring. The use of small multi-rotor UAVs for river dolphin population estimates has shown promising results. Although detection rates were lower when compared to visual counting, adjustments on camera or even the use of different sensors, as thermal cameras, could improve its detection rates. Furthermore, the development of algorithms for automated counting of animals in imagery can reduce the large amount of time for manual processing and revision of the collected data. In addition, UAVs can be of critical



importance for surveys in narrow waterways (<200 m), where visual surveys are held from canoes and cross-channel transects are not feasible, hampering the use of the most accepted method, the distance model.

The good news is that we know that UAVs can be used to detect river dolphin species and potentially improve estimates that are traditionally obtained exclusively through visual surveys, providing a less expensive method when compared to the traditional method.



This technique allowed me three decades ago to realize that dolphins could change color from gray to pink in a few minutes with the increase of their physical activity. Comparing sequences of photos, we were able to detect this on many occasions.

For abundance estimates, we apply the capture-recapture method using models of closed populations (for short time intervals) and open for longer-term analyzes. This was particularly useful for estimating abundances of *Inia* in lake systems such as Caballo Cocha, Peru (Gómez *et al.* 2013).

Another method that could provide important information is acoustics, since these species inhabit turbid water ecosystems where they have had to develop special adaptations to communicate and to detect their prey. Studies using these methods have been relatively limited, with isolated efforts in Colombia, Peru, Brazil and Bolivia. More recently, the use of C-PODS or passive acoustic detection methods that are being used with cetaceans in different parts of the world began. In the case of river dolphins, they have been used in the Peruvian Amazon by the organization Prodelphinus. The advantages that this method could have are associated with evaluating remote regions with continuous monitoring throughout different climatic seasons.

Understanding dolphin´s movements and use of the hábitat

During the last five years, there has been growing concern about the loss of connectivity and fragmentation in the rivers of the Amazon and the Orinoquia. The large amount of hydroelectric and infrastructure construction is negatively influencing the migration of many species, mainly fish, which has a considerable impact on fisheries and the food security of millions of human beings in these regions.

In several scientific forums, we addressed this issue and concluded that it was necessary to monitor species to see the effect that this type of infrastructure could have on their movements. Ichthyologists have made considerable progress in understanding the migrations of large catfish and identifying important areas of reproduction and growth. However, in the case of dolphins our information has been more scarce and based on the

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South America River Dolphins Initiative

The basins of the Amazon and Orinoco rivers contain the largest diversity of river dolphin species on the planet. This richness in species is the product of millions of years of evolution where the complex geological processes that formed these basins played a modeling role in the evolution of dolphins and their habitats.

Genetic studies reconstructed the first movements of *Inia* from the Atlantic Ocean towards the interior of the continent to what is now Bolivia, where some individuals were isolated 5 million years ago with the formation of the Madeira rapids, giving rise to the Bolivian bufeo (*Inia boliviensis*). Other populations were also separated between the Amazon and Orinoco due to faults in the Guyana shield, such as the Canal del Casiquiare, which enabled the formation of streams that isolated the subspecies of *Inia geoffrensis*. In 2014 an international group of researchers described a new species of river dolphin scientifically named *Inia araguaiaensis* and whose process of genetic distancing was generated by a geographical barrier known as the rapids of the hydrographic complex formed by the Araguaia-Tocantins rivers.

Today, the flow of sediments from the Andes to the Atlantic, the migrations of large catfish and the movement of river dolphins in the Amazon and Orinoquia, are not being limited by geological accidents that generate over millions of years new species but



by more than a hundred hydroelectric projects that isolate populations by deteriorating their genetic flow and stopping ecological processes that we are just beginning to understand in a basin scale. In the framework of the regional effort of the South American River Dolphins Initiative (SARDI) research group, more than 20 river dolphins were tagged in Colombia, Brazil, Bolivia and Peru. The dolphins have brought us closer to understanding the functioning of different aquatic landscapes where in transparent waters poor in nutrients and with scarce biomass such as the rivers Iténez/Guaporé and Tapajos in Bolivia and Brazil, the dolphins have long displacements up



to 400 kilometers that make them migratory species with transboundary uses of habitats. In white waters, such as Colombia and Peru, pink dolphin movements are smaller, but vary between flood pulses and are strongly influenced by climatic seasonality that determines the levels of productivity and the presence of their prey. Another factor that determines the displacement of dolphins, is the degree of disturbance of their habitats, these cetaceans prefer quiet places such as natural national parks and areas with sustainable use such as Ramsar sites Tarapoto in the Amazon and Bita in the Colombian Orinoco.

This initial effort on a regional scale allows us to understand, through the river dolphins, the vulnerability of two of the main river basins of the planet, these cetaceans, like those of the other aquatic vertebrate species, require healthy rivers with a diversity of landscapes aquatic as tributaries, channels, confluences and beaches and influenced by flood and non-fragmented pulses where the controlled flow limits the flow of sediments and stops the reproductive processes of the fish upstream, placing the supply of dolphin prey in serious danger and food security of more than 35 million people living in the Amazon today.

Finally, the future of river dolphins and unique river basins like the Amazon and Orinoquia, is in our hands and in the capacity that we have to understand these unique evolutionary processes that turn these aquatic ecosystems into the most diverse of the planet.

observation of dolphins identified photographically, mainly in Colombia, and the monitoring of animals marked with liquid nitrogen in a long-term program in Mamirauá. These studies have provided important information, but due to the scale they are insufficient to explain large movements and the selection of priority habitats for dolphins. For that reason, in 2017 we decided to start a satellite monitoring program for dolphins in the Amazon and Orinoquia. For this we made an alliance between WWF (Brazil, Colombia, Peru, Bolivia, Ecuador), Omacha Foundation, Faunagua, Mamirauá Institute and Prodelphinus and we identified key sites to install the transmitters. In the first place, we decided to only mark *Inia geoffrensis*, mainly adult and juvenile males and adult females, based on the hypothesis that the males disperse more and apparently perform displacements at greater distances. In the case of females, previous studies show more marked patterns of residence. It was ruled out to install transmitters in gray dolphins (*Sotalia fluviatilis*) because it is a species much more sensitive to capture and handling.

The transmitters used were SPOT299A of Wildlife Computers and three experimental ones with GPS included. To date, 23 transmitters have been installed: 5 in the Tapajos river in Brazil, 5 in the San Miguel area, Itenez basin in Bolivia, 2 in the Ramsar site of Tarapoto (Colombian Amazonia), 3 in the Orinoco river (Colombia / Venezuela) and 8 in the Peruvian Amazon.

The process has been carried out following strict protocols for the capture and handling

VICTOR UTRERAS

Coordinador del Proyecto Paisajes - Vida Silvestre (MAE/PNUD)
Ecuador



In the context of the Amazon Basin and the distribution of river dolphins, Ecuador has the smallest portion; However, this Amazonian Andean region is recognized for its great biodiversity on a global scale. Part of this biodiversity is made up of large aquatic vertebrates, including the two species of river dolphins (*Inia geoffrensis* and *Sotalia fluviatilis*), the Amazonian manatee (*Trichechus inunguis*), the two species of otters (*Pteronura brasiliensis* and *Lontra longicaudis*), alligators, paiches and the great migratory catfish.

The fraction of the Ecuadorian Amazon covers an area of 114,418 km², which corresponds to about 3% of the total area of the Amazon basin. This small territory, with a relatively restricted distribution of the two species of river dolphins, with low population numbers and a growing human activity has serious implications for the conservation of these species in the long term. In Ecuador both the pink dolphin (*I. geoffrensis*) and the gray dolphin (*S. fluviatilis*) are categorized as Endangered. The main threats to its conservation are centered on the degradation of its habitats due to the growing human activity, among these threats are the contamination of rivers and lake systems by

oil spills, by the leaching of agrochemicals used in extensive monocultures, by the advance of mining and discharge of wastewater from population centers located in piedmont areas. Likewise, there is fishing with toxic chemicals, fishing with dynamite, increasing the traffic of motor boats, and the extraction of sand and stone from rivers for the construction of infrastructure.

The complex panorama raised regarding the conservation of river dolphins in Ecuador, demands answers based mainly on the transformation of the current model of extractivist development of the Amazon, towards a more sustainable model, that allows to mitigate the degradation of aquatic ecosystems, maintain their ecological integrity and preserve the vital services they provide to human well-being. The conservation of river dolphins will depend on the capacity we have to properly manage aquatic habitats from the integrating vision of the landscape, with the multidisciplinary competition of local actors.



Satellite tags used to evaluate the movement and habitat use of dolphins.

of animals, supported by local fishing teams, biologists and veterinarians. In general, the time the animals spent outside the water ranged between 12 and 40 minutes. During this time, the dolphins were sedated locally in the dorsal fin, measured, weighed, and secretion samples were collected using isopos, tissue samples for genetics, mercury and isotopes. In Brazil, dolphins were also scanned.

The duration of the batteries was in a range between one and six months, and the generated information allowed to identify movements between 18 and 350 km, corroborating that the females use more recurrently the same areas and the males disperse more. Also, very interesting was to determine that depending on the type of water (white, black, clear) the animals move more or not in response to the availability of prey possibly. Another important variable was the time of year in which the dolphins were tagged, as for example in the case of Tarapoto, a female marked in high waters made a constant use of the lakes, while in the summer it remained more in the main river.

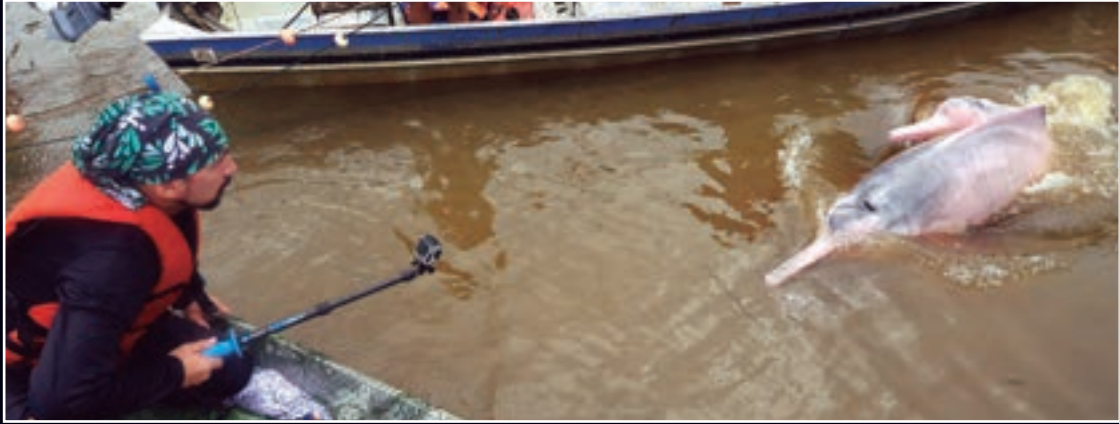
This study until now is in its infancy, but in a preliminary way it is generating very important information, at the same time that it has allowed to articulate efforts between several countries and research groups to understand the movement of these species on a more regional scale. The goal of two years is that at least 50 dolphins have "told us" which are the most important areas of use and how they respond from the point of view of dispersion to human activities and intervened areas.



The capture of the dolphins was done with a careful protocol to avoid any damage to the animals. It consisted of the capture in networks, restriction of the animals in a stretcher, veterinary evaluation, measurement and weight, installation of the device and release.

Amazonas 2017

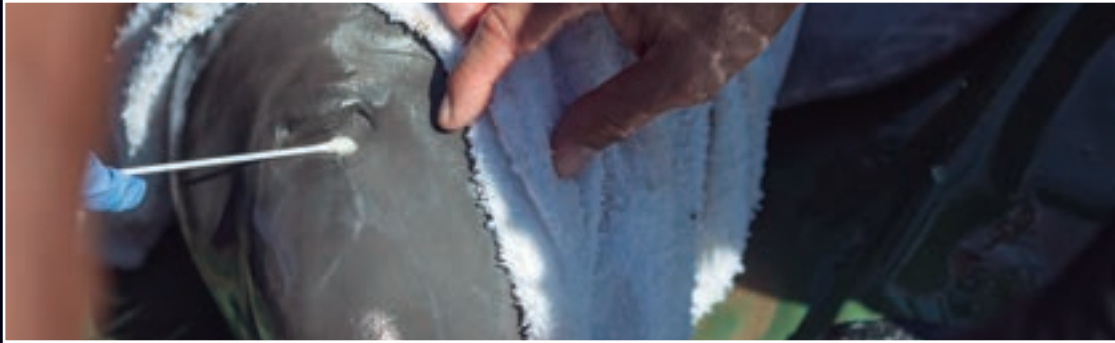




Photos: Julio García Robles

Orinoco 2018





Photos: Luis Barreto





5 Main threats



Photo: Kike Calvo



The aquatic ecosystems in the Amazon represent the main biological corridors of this region.

It is through them that human settlement has managed to penetrate and colonize this vast region of the planet. Over many years, man has left his deep mark, in most cases in a very negative way. Although there is evidence of nearly 12,000 years of human settlement, the great impacts are evident over less than 100 years and are strongly concentrated in the last forty years.

Lost of connectivity

One of the main threats in the region is undoubtedly the loss of connectivity of the rivers generated by the construction of hydroelectric plants. What at first seemed a legitimate interest to look for alternatives for the generation of "clean" energy at the global level, became an activity with environmental and social impacts of great size. The production of electricity from turbines moved by the water current seemed sensible and promising, but the scale and scope of the projects began to stimulate the construction of large dams by cutting the connectivity of some rivers. To date there are more than 150 dams that have a capacity of about 18,000 MW, and another 21 large ones are planned, which are expected to increase this capacity to 37,000 MW. Within these last ones, great controversy by the environmental and social impacts exists, as it is the case of Belo Monte, Jirau and San Antonio. Most of the dams are concentrated in Brazil, with a presence also in Peru, Bolivia, Ecuador and Guyana. Although



Tucuruí dam on the Tocantins river in Brazil. This dam left a dolphin population isolated that turned out to be a new species recently described.

the large hydroelectric plants have the most negative perception, it is important not to forget the smaller dams, which can have a very important cumulative effect in terms of loss of connectivity and transformation of the ecological conditions of the bodies of water.

Although at present the most attention is focused on the hydroelectric power plants in the middle and lower parts of the Amazon, undoubtedly the ones that should cause the most concern is those that are being built and those that are projected in the Andean and high Amazon regions of Peru. Ictiologists and limnologists have generated a warning voice because the implementation of these dams will significantly affect the contribution of sediments and nutrients from the Amazon tributaries, which will undoubtedly generate negative impacts on the productivity of the rivers and the fish biomass.



One of the main motivations for generating electricity is associated with the millennium objectives that seek to provide this service to more than 2 billion human beings who do not have it on the planet yet. However, currently the generation of electricity by hydroelectric power plants is focused on meeting the demands of industries and the sale of services and not on local communities.

The impact on aquatic biodiversity, mainly fish, dolphins, manatees, turtles and otters is focused on the disconnection of the system and the limitation or impossibility of making both longitudinal and lateral migrations. In the case of fish, these effects have been well documented in the Amazon, mainly in Brazil.

Presence of dams in the Amazon and Orinoco basins.



Photos: Julio García Robles



The increased demand for fishery products in the Amazon led to increased pressure and use of fishing nets, many of monofilament, in which dolphins frequently die.

For dolphins, the presence of physical barriers isolates populations and puts them in a situation of impoverished environments and low genetic turnover. A concrete example of this is in the case of *Inia araguaensis* in the Tocantins river, from the Tucuruí dam, where in several segments of the river there are groups of dolphins totally isolated. There the turbidity conditions have changed and the water has become more transparent and with a notable decrease in nutrients, which is undoubtedly affecting the availability of fish. This dam was built in 1984 and only until a few years ago began to evaluate the situation of the dolphins. This raises big questions: should we think about the relocation of these animals that are trapped between locks? What would be the transfer site? Should animals be gathered in an area of the Tocantins river, or should they be moved to the Amazon, even taking into account that it is a different species?

Another similar situation occurs in the Madeira River, where recent genetic studies show the presence of *Inia geoffrensis* (Brazil), *Inia boliviensis* and even hybrids product of reproduction of these species. With the construction of the Teotonio and Jiraú dams the gene flow was closed and the possibility of movement for these species was definitely interrupted.

Of the 155 dams in operation, 11 are in the distribution of the dolphins, 4 of the 21 projected would also be, and the most worrying is that of the planned, 55 would affect the dolphins if they are built. This decrease in the distribution area applies to one of the key indicators of the IUCN when defining threat categories.

The benefit of these hydroelectric plants seems to be far from the environmental and social costs they are generating.

Conflicts with fisheries

The technification of fishing and the possibility of cold storage of fish broke the balance that existed in the Amazon when it was only populated by indigenous communities. This story is relatively recent, and goes back to the sixties when the first electric generators arrived in the Amazon and opened the possibility of freezing and marketing the product to distant cities with high



In some regions of the Amazon, fishermen perceive dolphins as competition and choose to shoot or poison them.



Photos: Julio García Robles

Photo: Julio García Robles



River dolphins have been in the waters of the Amazon and Orinoquia for thousands of years. However, in the last 30 years human activities have put them in serious danger.



demand for fish. Previously there was a commercialization of fish in dry and smoked form. One of the countries that opened this type of trade was Colombia, where there is a great appetite for big catfish. This demand marked for several decades the capture of these species from Brazil and Peru.

In general, large driftnets (350-500 m long) began to be used in the Amazon in the mid-sixties and early seventies. At this time, fishermen report that a significant number of dolphins accidentally fell into these fishing gear. This is not surprising, considering that they are mainly used in rivers of turbid waters where dolphins depend mostly on their system of echolocation and not their vision.

In the eighties when I began my research with river dolphins in the Colombian Amazon, I witnessed a significant number of dolphins drowned (bycatch) in nets (an average of 12 annually in an area of 45 km of river). The meshes that generated higher mortality were no longer those of drift, but those of monofilament that were placed crossed from side to side in the small tributaries or perpendicular to the shore, generating a cone or tunnel. These nylon nets are very difficult to detect by the dolphins. The victims were mostly calves and young dolphins, fortunately adults managed to break the network and escape.

Something interesting was happening over the years, and it was that the dolphins in the late eighties avoided the nets, in the nineties they learned to approach with care, and in some areas, they learned to get the fish caught in the nets. This led to the creation of a conflict between fishermen and dolphins at the end of this decade. This situation became more dramatic with commercial fishermen of driftnets, who sometimes drew large catfish from the net with deep wounds left by the dolphins. This meant that the price paid for these fish was very low. In the first decade of 2000 they began to report retaliations of the fishermen towards the dolphins. Two dramatic examples of this occurred in the lakes of Caballo Cocha and Bagazán in Peru that left more than 40 dolphins killed by consuming fish that were previously injected with an agrochemical called Folidol.



Some dolphins like this *Sotalia* have strong scars produced by interactions with nets.



Abrupt changes in the speed of the boats can cause collisions with the dolphins and injure them.

The drift fishermen created a very negative perception of the dolphins whom they considered a great competition in fishing. They argued large economic losses at the beginning of 2000. For that reason, in the border area between Colombia and Peru we implemented an evaluation over a year to measure the frequency of interactions between dolphins and this type of fishery. In the evaluation, the methodology with the fishermen was agreed with and jointly



worked with them. The results were clear: the greatest number of interactions with fishing occur during the high-water period when the fish are dispersed in the flooded forest and their capture is much more difficult. The other finding is that less than 3% of the fish caught in the nets had dolphin bites, and 7% had attack marks from other scavenger fish. The other interesting finding that coincides with that reported in other areas is that the dolphins that interact with the nets are generally the same, that is to say that there are groups that adopt this type of behavior, and not all dolphins do.

In general, the bycatch is one of the great threats in the Amazon and Orinoquia because the fishing effort has increased considerably and there are many more nets operating. The magnitude of this threat is unknown until now because recovering the bodies is difficult and sometimes the fishermen hide them to avoid problems with environmental authorities, regardless of whether it was an accidental entanglement.

Direct takes

Although more than 3000 species of fish have been reported in the Amazon, no more than 40 have a commercial interest. In fact, only 12 species, mainly large catfish, accumulate 80% of all the fishing landings in the region.

With the processes of overfishing, the stocks of many of these large catfish species have started to collapse and the capture volumes have not been maintained. Faced with this situation, traders have looked for other replacement species, the most important of which is the piracatinga (*Calophysus macropterus*), which is an omnivorous scavenger fish. This species does not have regional consumption because most people associate it with the consumption of decomposing animals. This process was initially developed in Colombia, where there is a significant consumption of a fish from the Magdalena River locally called "capaz" (*Pimelodus grosskopfii*), whose populations collapsed in the early 2000s, and from which the piracatinga was used. as a replacement in the markets without consumers knowing.



The decrease in catches of large catfish opened the opportunity to commercialize piracatinga on a large scale, initially flooding markets in Colombia, but later positioning itself in Brazil as well. In none of the cities where this species is sold do consumers know the provenance or the form of capture. This is a clear example of the lack of consumer awareness that occurs throughout the world, both with fisheries issues, such as timber and minerals.

The situation became critical because to capture this fish, dolphins and caiman's bodies were used as attractants. This led to the illegal hunting of these species, particularly in Brazil. Researchers from that country estimated that about 1,000 dolphins were hunted annually in the area of the Mamirauá Sustainable Reserve and a large number of black caimans (*Melanusuchus niger*).

Undoubtedly one of the biggest threats to river dolphins in the last decade was being used as bait for piracatinga fishing. Hundreds of dolphins were hunted for this.





Deforestation

The loss of plant cover in the Amazon has received global attention. Transformation engines such as cattle ranching, soybean crops and road construction have contributed most to this process. It is estimated that to date more than 570,000 km² of forests have been lost in the Amazon, mainly in the southern part of the Amazon River, in the States of Rondonia and Acre. The data oscillate between 14 and 20% of loss of the original forest cover in the region. In this process, Brazil has been responsible for about 75% of deforestation, followed by Bolivia, Peru and Colombia, where together 25 different fronts of deforestation have been identified, most of them directly associated with the presence of roads.

Deforestation areas in the Amazon basin.



The international prices of soybean have motivated large-scale cultivation in Brazil and Bolivia, although there have been initiatives to ban the purchase of soy from the Amazon. This has been associated with other complex processes such as land speculation and forced displacement.

Deforestation can be analyzed from two perspectives, the large-scale one described above, which can be monitored with remote sensors, and the selective one associated with the extraction of trees of high economic value due to its wood such as cedar (*Cedrela odorata*), Mahogany (*Swietenia macrophylla*) and Ipe (*Handroanthus* sp.), many of which are already overexploited. This type of deforestation is more difficult to quantify and measure with satellite images, and its ecological impact is not yet fully understood. As most of these tree species have been depleted, pressure has been directed to other species, including those of the flooded forest, where significant impacts are being generated.

It is estimated that one hectare of flooded forest in the Amazon can produce up to 20 tons of seeds each year, which largely corresponds to the allochthonous food for many fish species. This happens, because there is a great synchronicity between the flood pulses and the formation and release of fruits in the period of higher water level. The fish help the dispersion of seeds, by consuming the fleshy part of the fruit and releasing the seed, sometimes upstream. This makes this type of ecosystem has great ecological importance and sustain many species.

For the indigenous Tikuna, the fish originate from a magical tree that is on the banks of the rivers. They tell us that when the rains begin and the jungle is flooded, small worms form in the trees that, with lightning and thunder, become frightened and fall into the water, transforming into fish. The natives say that white men do not know how to differentiate these trees and cut them all, causing the number of fish in the rivers to be reduced. This explanation coincides fully with the scientific one, since the processes of deforestation of the flooded forest are having important impacts on fish populations in varzea and igapós forests. The decline of fish also has consequences for dolphins who must look for their prey in other more productive areas.

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The Upper Amazon River basin contains the only population of the Bolivian river dolphin locally called Bufeo (*Inia boliviensis*). Bolivia is a landlocked country; therefore, the symbolic value of this species, must be promoted and increase the knowledge on the basic biology and ecology which still is deficient, furthermore many inhabitants are unaware of their occurrence, especially in the Andean cities. In recent years the interest on the Bolivian river dolphin has increased but also the threats that are facing. The bufeo is distributed mainly in rivers of Beni Department and most of the area of its distribution is unprotected. Compared to other river dolphin species, scientific surveys counting bufeo populations have shown that are relatively still in good conditions, however, the fact that this population is geographically isolated and has a significantly smaller range than the other river dolphin species needs to be taken into consideration. It is also imperative to continue generating information on its ecology, and to strength strategies to protect their habitat, monitoring population and conservation activities community-based.



The uniqueness and charm of this species was recognized by authorities, declaring it as a “Natural Heritage” of the Beni Department (Law evicted on March 2008), also was declared “City Heritage and symbol of the Santísima Trinidad city” (Council Law 12/2012) and the National Government declared “Natural Heritage” of Bolivia (National Law 284). These are the only recognition as a Natural Heritage to a wildlife species in the country, but they did not guarantee funds or further conservation actions. Thus, the bufeos are still jeopardized with threats such as habitat degradation and fragmentation, water pollution, boat traffic, overfishing, deliberate killing as retaliation or to use them as a bait, etc.

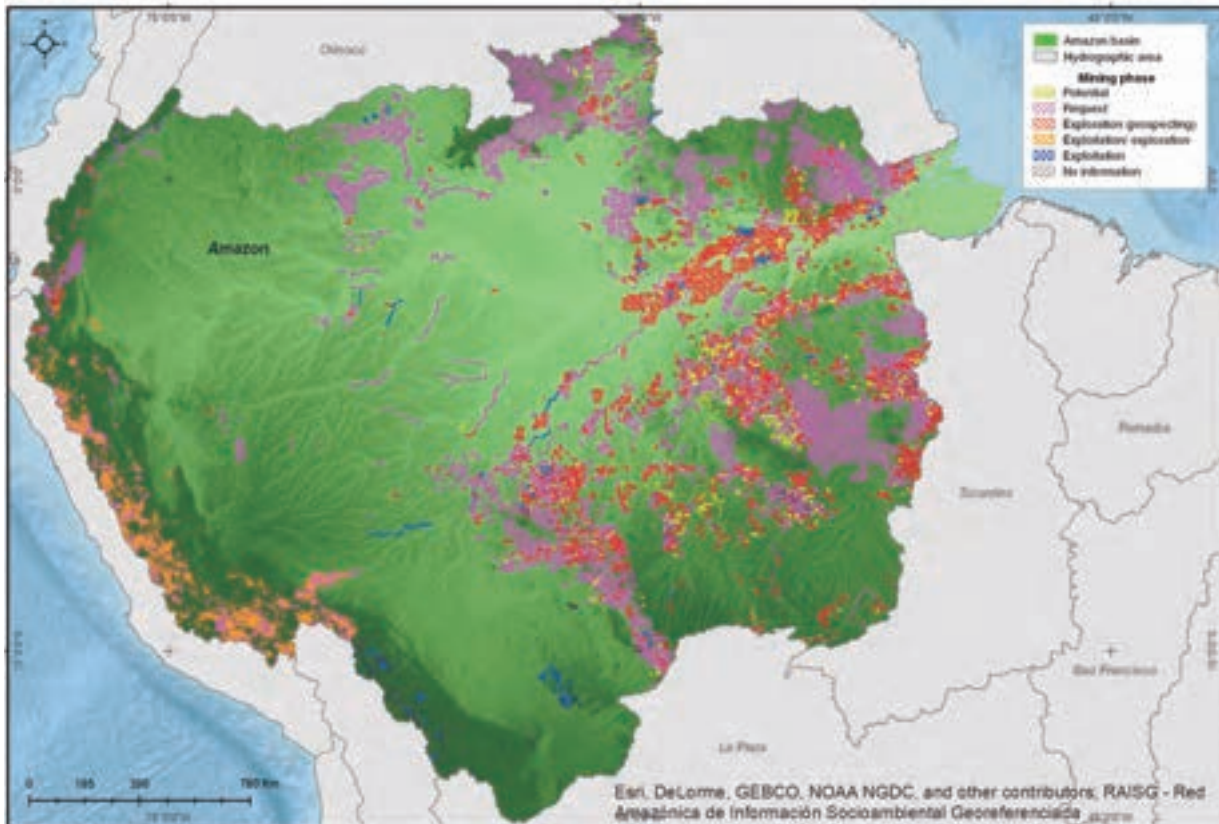
Unfortunately, besides to the mentioned threats, the economic and development programs of the actual Government have favored aggressive agricultural expansion, and other highly extractive activities such as gold mining, and the construction of mega infrastructure that are pressuring the ecosystems affecting wildlife in general; as an example, in Santa Cruz Department extensive soy beans crops have devastated the rainforest and small streams and tributary rivers are used to water thousands of crop hectares, increasing the cases of stranded and dead bufeos. On the other hand, there are programs working for the bufeo and their habitat conservation in Bolivia, focusing on environmental education activities, promoting good practices in ecotourism in Municipal Protected Areas and other activities. These activities are developed by independent researchers and organizations. The good news is that in the last years a collaboration among national and international researchers began. By increasing communication through meetings and workshops led to share methods, experiences, and cooperation. All these researchers share a common goal, in this way the efforts for South American river dolphin conservation was strengthened giving more hope for the species.

Pollution by mercury

Throughout almost four centuries, gold mining, especially illegal mining, has contributed more than 200,000 tons of mercury in the Amazon and Orinoquia. The process of gold amalgamation has involved the use of this large metal in large quantities without any control by the governments in the region. This is exacerbated by the fact that there are natural deposits of inorganic mercury in the region, which with deforestation and forest burning processes are exposed and enter aquatic ecosystems mainly in the form of methylmercury, which according to the Minamata Agreement is the sixth most toxic compound on the planet. To date there are numerous scientific studies that show the high levels of this metal in fish and human communities in the Amazon. In the case of fish, the process of bioaccumulation is presented, especially in carnivores and omnivores such as the case of large catfish, which are the most commercialized species towards urban centers often far from the Amazon. This means that not only riverine communities that have a high consumption of fish have high concentrations of mercury, but also the toxicity moves outside the region.

Mercury is an invisible enemy and completely underestimated in the region. Slowly it goes bioaccumulating until reaching very high concentrations that result in damage to the nervous system and affecting pregnancy processes among others. It is expected that in about ten years this silent process will be manifested in diseases in many communities riverenas.

The impact of this metal on dolphins has not been fully studied, especially in freshwater cetaceans. In marine species, the presence of selenium microcrystals



has been described that help to render mercury innocuous, especially in internal organs. In the Amazon and Orinoco, we have been evaluating the presence of mercury in dolphins, since they are predators at the top of the aquatic chain. The findings are revealing in the sense that, in several regions, both males, females and young have concentrations of this metal. The highest values are found in the Arauca river (3.9 mg/L) in the Orinoquia. All this region is subject to mining exploitation, and within the short-term plans of the Government of Venezuela is the so-called "mining arch" on the Orinoco River, encouraging the extraction of gold and diamonds.

Gold mining in the Amazon basin.



Extreme droughts are becoming more frequent in the Orinoquia and Amazonia. This significantly affects the flood pulses of the forest and the productivity of aquatic ecosystems.



Photo: Julio García Robles

Climate change

The Amazon is not a region that is exempt from climate change., the sum of variables such as the increase in deforestation and the alteration of the hydrological regime seem to be accelerating desertification processes. El Niño phenomena seem to increase in intensity and frequency, allowing modeling that in 2030 the temperature may increase between 2° and 3° C and there will be less precipitation during dry periods. This has direct repercussions on the flow of nutrients in the rivers, which will undoubtedly affect mainly the fish communities.

Some scientists consider that one of the most important phenomena in the Amazon and Orinoquia are the flood pulses. This seasonal variation

MARIANA ESCOBAR

Museo Noel Kempft
Bolivia.

It has been 9 years since the news that one day took thousands of Bolivians by surprise, the stranding of a group of bufeos (river dolphins) in the vicinity of the Rio Grande. Instead of finding an Amazon-type landscape, an agricultural, mechanized area with extensive crops of soy, sunflower and corn was found. This area is part of what is known as the Integrated North of Santa Cruz, characterized by a broad agro-industrial growth. 26 bufeos were rescued, transferred and released which at the time was an unprecedented action in Bolivia. The expectation of the news about the situation of the bufeos caught the interest of the public opinion and of the mass media and it is thus that during the rescue phase the mass media transmitted the news of the advances of the activity; unbelievably, this stranding situation allowed the population to know about the existence of dolphins in the country and therefore the rescue activity was followed with great interest.

Since 2010 I have been working actively in the rescue of dolphins in the department of Santa Cruz, where there are repeated stranding



incidents, mainly in the lower Rio Grande basin. This vast agricultural extension generates a desolate panorama for the water network of the zone, where there is a high desiccation, accelerated by the effects of climate change, a situation that is aggravated by the construction of agricultural channels, intentional dredging of lagoons and alteration of courses of natural water, aspects that as a whole have led us to mobilize 46 bufeos in 6 rescue campaigns.

2012 was an important year for the bufeo (*Inia boliviensis*) through Law 284 with which it was declared a Natural Heritage of Bolivia, the National Plan for the conservation of the



species was published, and the Humedales Protected Area of the North, today known as the Conservation Unit which houses the Grande rivers in its lower basin, Ichilo and Yapacaní. The panorama looked promising for the welfare of such a precious species, however there were no changes in the traditional action and the agricultural frontier continued its growth.

For the Conservation Unit, strict control of natural resources has been difficult and with respect to the Dolphin Management Plan, pioneering studies of meeting rates have been carried out (Ríos Grande, Yapacaní, Pirai and Ichilo) and environmental education workshops with local people. However, the excessive loss of the forest and the desiccation processes continue to affect the lands and water resources of this region, generating a negative outlook for the species.

It would be vital that the role and importance of river dolphins be taken more seriously, generating more environmentally friendly practices, strengthening social and management aspects, providing alternatives to the actors that interact in these places and the interest of understanding the requirements of the species, its needs and its interactions with the environment.

of river level from the low to high water period can be up to 15 meters in the vertical plane to hundreds of kilometers in the lateral plane. The flood pulse is similar to a process of "breathing" by aquatic systems. When the water goes down, the whole system contracts, disconnecting lakes and tributaries from the main rivers, and concentrating the fish in a reduced area. This is the time of abundance for great predators like dolphins. On the contrary, when the forest is flooded, the fish are dispersed kilometers and their capture is more difficult. This flood allows fish that are isolated in remote lagoons to enter the main system through lateral and reproductive migrations, guaranteeing the productivity of the region.

When these pulses are altered, the availability of the fish also, causing the dolphins to move to other areas in search of prey. With the phenomenon of El Niño, droughts have become more extreme in various places in the Amazon and Orinoquia, causing the dolphins not to detect the descent in the water level in time and to be trapped in small water wells where they eventually die. This situation has worsened in the last ten years, with more frequent reports of dolphins having to be rescued in the Colombian Orinoquia and in Bolivia (Rio Grande). In the latter case, the drying of bodies of water has accelerated with the capture of water for large-scale agricultural processes.



Photo: Alexandra Gartner



Photo: Julio Garcia Robles

Increasingly frequent episodes where dolphins are trapped in shallow areas and must be moved before they die.



Mass tourism can be counterproductive in the Amazon, and more so in those cases that involve feeding dolphins and allowing many people to swim with them.

Bad tourism practices

The Amazon has been consolidated in one of the most desirable tourist destinations globally. Tourists from all over the world travel to Brazil, Peru, Colombia, Ecuador and Bolivia to learn about the incredible biodiversity of the region. In this huge kaleidoscope of attractions, river dolphins have positioned themselves as one of the main motivations of travel to the Amazon.

Personally, I remember in 1988 several chronicles for TV that I made in the community of Puerto Nariño, in the Colombian Amazon, that derived that Lonley Planet in its 1990 edition began to publicize the observation of dolphins in this destination. Over the years, the lakes of Tarapoto were consolidated as one of the best sites to watch these cetaceans, in addition to the scenic value of the site was the great folkloric wealth of the natives on the dolphins whom they consider sacred beings. In 2007 we decided to evaluate how important the dolphins really were as a tourist attraction, and we were surprised that 94% of all tourists coming to this region, stated that their main motivation was to know the "emblematic pink dolphins".

When doing an economic analysis, we found that these tourists were generating US \$ 6 million per year. This figure was updated in 2014 and had already amounted to US \$ 8.3 million / year, consolidating these species as one of the main attractions in the region. Parallel to this, a process of work was developed with indigenous craftsmen who manufacture wooden dolphins for sale, generating income for more than 300 families.

Although dolphins have become an important economic alternative in the region, bad practices can make this activity a threat to these species. In fact, about ten years ago, a practice that included feeding dolphins and getting them to swim with tourists began to be implemented in the central Amazon of Brazil, near Manaus.

Basically, this started in floating houses where tourists bought fish and fed dolphins freely without any control. This occurred mainly in a region called Novairon and later spread to other nearby areas, reaching more than 10 of these sites. The Government of Brazil began a process to regularize this practice, prohibiting in the first instance that tourists feed the dolphins directly.



Dolphins are wild species and the great value of tourism must be focused on seeing them free and not forcing contact and less generating practices where they depend on human beings.



In some of these sites more than 400 tourists swim daily with groups of 4 to 5 customary dolphins. In some of these groups, offspring that never learned to catch fish because they are immersed in this practice have been born.

Currently, a protocol is being implemented where only two or three times a week the dolphins receive food, to avoid losing the ability to hunt by themselves and are completely dependent on humans. Likewise, the Government of Brazil approved in 2018 a law to regulate this activity.

When evaluating this practice from the tourist point of view it is found that many people consider that it does not make sense to offer this type of activity when it is relatively easy for tourists to observe the dolphins in their natural environment and with wild behaviors on a boat trip.

The dolphin habituation is a negative practice that goes against tourism sustainability in the region, and worst of all, it can begin to be copied in other countries.

The bet without a doubt, in the Amazon and Orinoquia must be that of a tourism of respectful and sustainable nature that integrates the local communities. In this activity, undoubtedly dolphins can become one of the main attractions.

Some of the largest cities in the Amazon and Orinoco basins.

City	Country	Habitants
Manaus	Brazil	> 3.000.000
Belem de Pará	Brazil	2.000.000
Macapá	Brazil	370.000
Porto Velho	Brazil	300.000
Coari	Brazil	100.000
Santarem	Brazil	200.000
Iquitos	Peru	600.000
Puerto Maldonado	Peru	300.000
Leticia	Colombia	45.000
Pto. Asis	Colombia	65.000
Lago Agrio	Ecuador	100.000
Pto. Francisco de Orellana	Ecuador	50.000
Ciudad Bolivar	Venezuela	650.000
Ciudad Guayana	Venezuela	900.000

Demographic growth in the Amazon and Orinoco basins

In the Amazon basin, indigenous settlements are estimated between 14,000 and 12,000 years old with relatively low densities. However, this situation has changed dramatically in the last fifty years, where public policies, especially in Brazil, have encouraged the settlement of this region. As mentioned above, the current population in the Amazon exceeds 34 million people, with an indigenous representation of no more than 3.5 million. This means that an intense process of colonization stimulated by public policies has been generated. This has created a pattern of growth of cities along the Amazon River and large tributaries. It is estimated that 65% of the population of the region is settled in cities.

A clear example of governmental policies is the planning and construction of extensive roads along the forest like the controversial Trans Amazonian Highway that has sought to connect the Atlantic with the Pacific. These strong



The migration of people with other cultures and beliefs to the Amazon has led to negative practices such as the use of dolphin oil as sexual fetishes.

political integration initiatives led to the creation of IIRSA (Initiative for Integration of Regional Infrastructure) in order to stimulate the construction of road and energy infrastructure in the region, with several economic objectives, including targeting Asian markets. It is estimated that there are at least 544 infrastructure projects in the process of construction and planning.

These extensive roads seek to integrate the Amazon region and the Orinoco into the central economies of each country and generate regional possibilities. However, the lack of planning and, above all, the governability of these isolated regions have meant that roads are precisely the trigger that has stimulated the excessive growth of deforestation and activities such as illegal mining.

The effect of the roads has been evaluated by social and environmental researchers, and they describe that from the main routes a figure of "fishbone" is formed with hundreds of perpendicular roads going into the jungle associated with colonization and extractive processes. Undoubtedly, the effect of these roads and population growth not only affects terrestrial ecosystems, but also the aquatic ones. As urban centers are consolidated, the demand for fish and



The central part of the Orinoco River concentrates a large number of cities and industrial activity that pollutes aquatic ecosystems.

timber increases, as does the impact of solid waste and wastewater on aquatic ecosystems. Similarly, boat traffic has increased dramatically in recent years generating negative impacts from the acoustic point of view, disturbance of fish populations and other species of aquatic vertebrates such as dolphins, caimans, manatees and otters.

The growth of large cities in the Amazon has occurred mainly in Brazil, where settlements such as Manaus with more than three million inhabitants and Belem de Para with about two million are reported. Although nature tourism is promoted in some of these cities, in others, emerging economies based more on livestock, mining, oil and gas extraction, soybean crops and electricity generation have already been developed. In the Orinoquia, especially in Venezuela, the situation is similar, since along the Orinoco River, large cities such as Ciudad Bolivar and Guayana have been consolidated, the latter with almost one million inhabitants. In the area of Puerto Ordaz, at the confluence of Caroní with the Orinoco, large-scale mining activities associated with the extraction of iron, aluminum, bauxite, gold and diamonds have been consolidated.









6 Protected areas and their role on the conservation of river dolphins





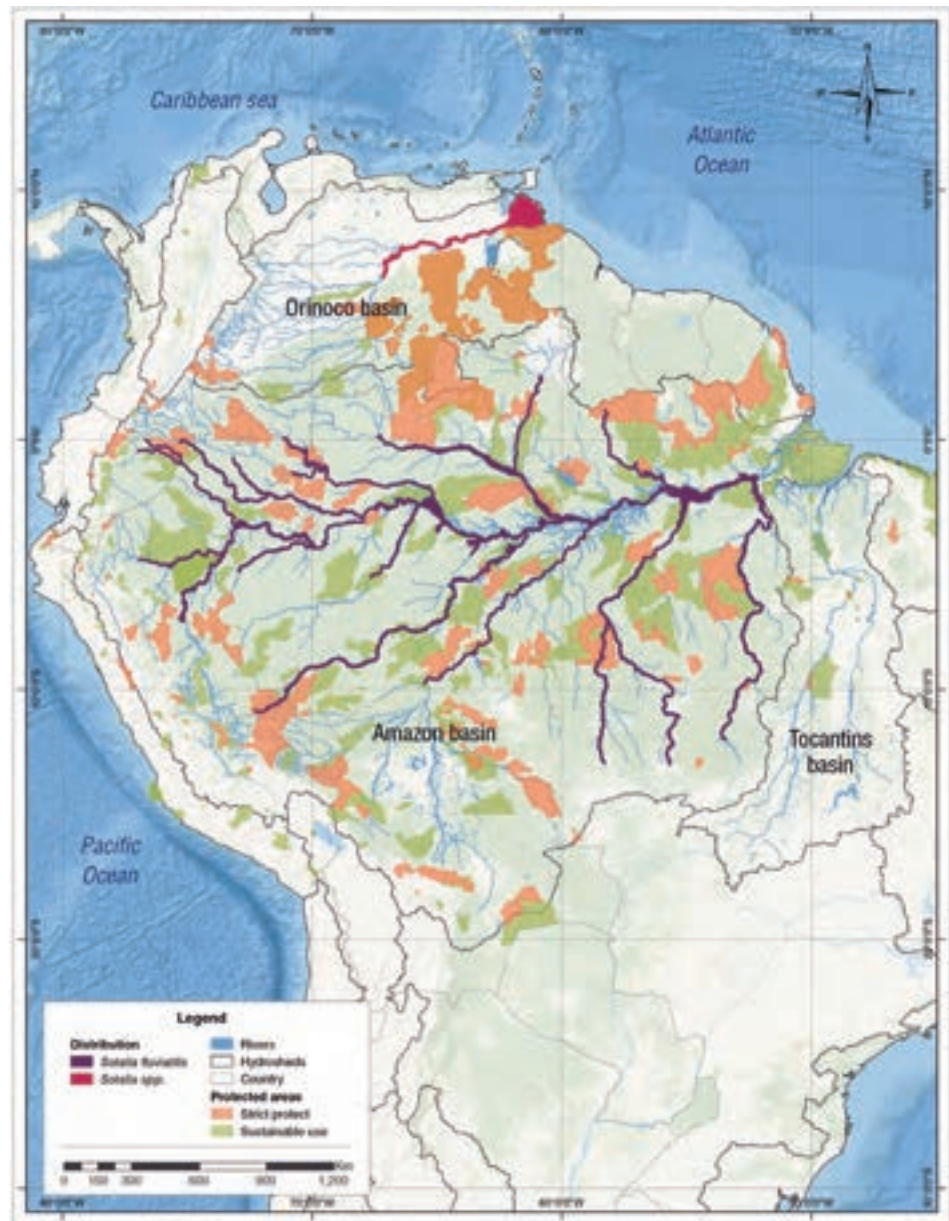
At the moment, there is an important number of protected areas in the Amazon and in the Orinoco, comprising a total area of 905.684 km²

At the moment, there is an important number of protected areas in the Amazon and in the Orinoco, comprising a total area of 905.684 km², which is equivalent to 12% of the whole area. Most of these areas have been consolidated with a terrestrial approach, where rivers are usually the edges or boundary of the area but it is not clear whether or not they are part of the protection figure. Likewise, when reviewing which are the conservation value objects of these protected areas, the majority correspond to terrestrial ecosystems and species. In this sense, aquatic ecosystems and species such as dolphins, manatees, otters, caimans and fish there are not specific protected in these areas, with some exceptions. Many of these species move or are migratory and make their conservation difficult within a particular area. In an analysis to establish the percentage of dolphin presence in protected areas, we find a very low representation for *Inia geoffrensis* (16%) and higher for *Inia boliviensis* (61%). In the case of *Sotalia fluviatilis*, the scenario is more negative with only 6.6%.

One of the challenges we have set for ourselves is to work more closely with the protected areas systems in several countries. First positioning the dolphins as conservation value species, and second training park rangers in monitoring processes when the expeditions have been made. The response in several countries has been very positive, and the first concrete efforts are already being made in Colombia, Bolivia, Peru and Ecuador.



Protected and sustainable areas and river dolphin distribution.







Protected areas are key to the conservation of aquatic ecosystems and the entire life associated with them, such as fish and dolphins.

From the hydrological point of view, the aquatic ecosystems in the Amazon represent about one million Km² constituted in main rivers, tributaries, lagoons and floodplain. That is why it is fundamental to look for suitable figures that motivate the conservation of these ecosystems. One of them is undoubtedly Ramsar sites that focus on the recognition of important wetlands. Ramsar is an international convention with 169 adherent countries committed to the conservation of wetlands that are nominated at the national level. They are not protected areas in the strict sense of the word, but they have a resolution from each government where they commit to elaborate a zoning of use and a management plan. It is forbidden mining activities, the exploitation of hydrocarbons and any other activity that severely modifies ecosystems.

ROBERT SALVATIERRA MONTAÑO

Head of Protection

Noel Kempff National Nature Park

Santa Cruz (Bolivia)

25 years of service in the system of protected areas of Bolivia.

Since 8 years ago he served at Noel Kempff National Nature Park



We consider the bufeos as a species that allows the conservation of the park by depending on the dynamics of the river. Besides being an emblematic species since it is the only species of river dolphin that we have in Bolivia, there is a law that considers it a Bolivian. and being in its presence helps the conservation of the protected area, as well as its sensitivity to changes in water quality, the dynamics of the towns and rivers also make it a very important indicator for the protected area and Another dynamic has been that it can become another attraction for the theme that is ecological

tourism or nature, the observation and the interest of the population to conserve this species and to be able to know it and taking it in the bays of the park can be turned into income for the communities within the area protected by those and many reasons we are in this studies and in others that come, we will find that there are many other values that are very vulnerable in other regions and here in the park is protected. retaliation or to use them as a bait, etc.

In the Colombian Amazon, perhaps one of my greatest satisfactions, is that after more than 25 years looking for conservation figures for the lakes of Tarapoto, it was possible to specify the designation of this whole area as a Ramsar site. In total 44,600 hectares within an indigenous reservation, and including more than 20 lakes and 22 local communities. Just the place where I started working with these species and where we have been able to articulate various conservation strategies: management plans, responsible dolphin watching, recovery of the flooded forest and fishing agreements.



Ramsar sites such as Tarapoto in Colombia guarantee important conservation areas for dolphins.

For the Amazon basin, there is a great initiative promoting Ramsar sites and trying to find connectivity between them. Recently, Ecuador designated an area of 720,000 hectares in the Cuyabeno area, being one of the largest in the region, and a key location for dolphins, manatees and otters.

In the Orinoco, we achieved in 2018 between the Ministry of Environment, Omacha and WWF to designate the entire Bitá River basin in Colombia as a Ramsar site with an area of 822,000 ha generating an important precedent of the use of this figure for a whole basin and not just a part of it. The challenges are enormous to ensure that these areas effectively guarantee the conservation of dolphins and their habitats, but we are already working on several strategies that include population assessments, satellite tracking and the implementation of dolphin watching activities with good practices.

SAULO USMA

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Freshwater Specialist
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RIVER DOLPHINS AS KEY SPECIES TO DESIGNATED RAMSAR AREAS

The river dolphins of South America have always had great cultural, biological and economic value. However, in the last 10 years, the conservation of its species has had an umbrella effect on a high richness of species associated with wetlands. This is proven in the formulation of management plans for river dolphin species in Ecuador, Peru, Venezuela, Brazil and Colombia that include other species of aquatic mammals thanks to the joint work of several NGOs, universities and research institutes that supported the environmental and fisheries authorities of these countries.

The implementation of these management plans has included the identification, declaration and sustainable management of the key wetlands for the reproduction and feeding of these charismatic species, achieving a spectacular regional impact because, to date, five new Ramsar sites have been designated with more than 8 million hectares, including the three largest Ramsar sites in Ecuador (Cuyabeno



Lagartococha Yasuní: 773,668.5 hectares), Colombia (Río Bitá: 824,536 hectares) and Bolivia (Llanos de Moxos: 6.9) million hectares) which is also the largest Ramsar site in the world.

Together with the conservation of dolphins and their ecosystems, the new Ramsar sites are allowing greater participation of indigenous and local communities in the formulation and implementation of their management plans. They participate in the fisheries management of their wetlands to increase their food resources that they share with the dolphins. They are beginning to become part of the monitoring, control and surveillance systems of their natural resources and are promoting productive economic activities such as sustainable tourism that includes the responsible observation of dolphins and responsible sport fishing.



The conservation of dolphins and their habitats benefits other very threatened aquatic vertebrates such as manatees and giant otters.







7 Generating economic alternatives





An absolutely relevant aspect for the conservation of the Amazon and Orinoquia is that environmentally sustainable economic alternatives...

An absolutely relevant aspect for the conservation of the Amazon and Orinoquia is that environmentally sustainable economic alternatives must be proposed to the local communities that live there. The issue is complex, since in these remote areas the presence of government institutions is relatively weak, and this favors the establishment of illegal activities such as illegal mining, coca cultivation, overfishing and large plantations with monocultures with incipient control.

The vision that exists from the cities is that the Amazon should be conserved as a great patrimony of the planet and as a strategy to mitigate climate change. However, the 34 million human beings living in the region with economic expectations similar to those of large cities are forgotten or not taken into account. In that order of ideas, it is fundamental to create economic alternatives at different scales that can reach mainly local communities. It is important to say that great efforts are being made and in several countries, green businesses are promoted. However, many times these proposals arise from the perspective of the cities and not from the communities themselves, which often leads to failure. There are already many lessons learned and balance points must be sought to guarantee participatory processes with the communities, the creation of value chains, the training of local people and long-term accompaniments.



Dolphin watching

As I mentioned earlier, tourism can be a good alternative if it is planned in an organized and inclusive manner. In this sense, the dolphins are one of the great attractions to visit the Amazon and the Orinoquia. The great empathy that people feel towards these species make them excellent ambassadors of the conservation of aquatic ecosystems in these regions.

Our pilot work was initially consolidated in the Colombian Amazon, around Puerto Nariño town and the lakes of Tarapoto. On this site the Omacha Foundation was combining training processes of local guides in good practices of dolphin watching, training and improvement of handicrafts, and generation of infrastructure and logistics for the development of the sighting.

Initially the courses and certifications were given by the Omacha Foundation, but over time we realized that especially the certification was not very useful for the local people. For this reason, we began to work with the National Learning System (SENA), which is the Colombian Government organization that trains tourism guides. This allowed the certifications to have a relevance of labor nature and accreditation by the Government. Accompanying these trainings dolphin watching guides have been designed and printed in Colombia and Bolivia, and until now we have trained more than 300 persons in three countries.

To complement the tourist activity, for 25 years we began to work with indigenous craftsmen to stimulate them to carve dolphins and other aquatic species present in the Tarapoto lakes such as manatees, black caimans and pirarucus. At the beginning the quality were not very promising, but over time, the skill of some artisans became exceptional and the pieces in wood began to sell very well in the region. To date more than 300 families receive income from this activity, and handicrafts are sold not only in the Amazon region, but also in the rest of the country. This process has played an important role, not only to generate income, but also as a reinforcement of the importance of these species in the indigenous world.

Some of the master craftsmen are already elderly, so we decided to start a training process for indigenous youth over the past five years. These trainings



Responsible observation of dolphins involving local communities can be a valuable conservation tool.

have not only been done inside Colombia, but these teachers have also been taken to Peru. The courses have included the delivery of kits of tools to carve and trainings to plant trees from which they obtain the wood so as not to generate a negative process. To date, more than 250 young artisans have been trained.

The set of activities positioning the dolphins as a tourist attraction have made that besides the crafts, many public places have paintings alluding to these species.

Also, the stories and legends around the dolphins have been recovered, some of them beautifully represented in typical dances of the indigenous Tikunas, Yaguas and Cocamas in the area of Puerto Nariño.



Photo: Julio Garcia Robles

Dolphins are of great importance for local indigenous communities. These water beings are revered and respected.

Box with mitology about river dolphins

River dolphins in the Amazon are charismatic species that are deeply immersed in local cultures, especially indigenous ones. Around the bugeo or pink dolphin, innumerable stories, myths and legends are woven that reflect in principle a great respect towards this species that, on occasion, is accompanied by taboos and fears. Some stories are similar throughout the Amazon basin, in countries such as Brazil, Colombia, Peru and Ecuador, especially those that speak of the power that bugeos have to become in human beings and to seduce women and men to take them to their submerged city.

River dolphins are part of the important species for most indigenous communities of the Amazon. For them, dolphins are magical creatures that live in cities underwater. The botos in particular are seen with great respect and even with fear, as some ethnic groups such as the Huitotos and Cocamas believe





that they can generate diseases of a spiritual nature. Often, communities related to fishing and water had a shamanic relationship with dolphins, in which the shaman spiritually invoke a tooth to the dolphin, and then it was delivered to a fisherman to expand their fishing skills. The tooth allows him to "see" underwater and know where the fish are. Unfortunately, with the arrival of settlers, some of these stories were distorted, and dolphins were hunted to use their teeth, not for fishing, but to attract women. This was particularly common in the decade of the eighties in several Amazonian countries.

Pink dolphins are associated with the belief that they had the capacity to transform themselves into humans and approach indigenous communities where they seduced women and took them away or left them pregnant. This is a recurrent story in Colombia, Peru, Brazil and Ecuador and seems to be associated with the time of the conquest, when Europeans were mobilized by the rivers of the Amazon and had contact with the Indians. The stories tell that the dolphins were transformed into men with a pink complexion and that they covered their breathing holes with a hat. Then at night they disappeared with the women in the rivers.



The Tikunas Indians have traditional dances where they recreate the shamanic importance of dolphins.



Tikuna story by
Alba Lucía Ahué

The bugeos are human as one; formerly they became rebels and punished them.

His spirit is like that of people, that's why I do not know He can eat them or mistreat them. If you look at them a lot, they take the souls of people. They come from the river Chowuatw, a sacred river, beautiful and crystalline. When there are big thunders is because they jump on the river and the wave is the one that makes the thunder sound and in this way they go from that world to ours. The story tells that an indigenous Tikuna called Wifakw, Joi's son, had a dream to move from another world. In the dream, Wifakw realized that the bugeos live in a crystalline river, on whose banks there are many trees in the shape of pineapple. They are always lying on the bank of the Chowuatw River.

When a person dies, they get upset, jump a lot and grieve. He witnessed a man who had died and who was walking towards the Turitá trunk, that it was a sacred tree; when it approached, the trunk opened for the man to pass.

According they explained to him, when a man dies and has not made many mistakes, they let him go through the trunk and bugeos wallow and throw it into the water and then to the ground, bathing it well. After this helps him pass the trunk so he can go elsewhere. Wifakw three days later, saw another person who died and who came walking, but when he was crossing the trunk it closed and disappeared, possibly because he was a person who had made many mistakes and why the bugeos did not help.

Then he saw another family that was taking leaves and the bugeos were upset and jumped, the bees shouted and They cried, and in the end they were able to pass through the Turitá trunk, because they were good people.

With big rays, the bugeos fall in this world, especially in the Amazon River. These bugeos that fall are of the great ones, they are the Choreuma, that is to say, the kings of the other world. After having seen all this, Wifakwu descended again to his world, as if going down a ladder. When He arrived to his community he told them everything he saw in the sacred river and he taught the Ticunas to respect to the bugeos.





Fishing agreements

One of the great crises that exists in the Amazon and Orinoquia is related to fisheries. The overexploitation of fisheries has depleted stocks of key species such as large catfish, pirarucu and many species of characids and cichlids for local consumption. This has generated that dolphins, caimans, otters and other species are considered as competition for fishing, but after several analyzes, the conclusion is that it is urgent to do fishery planning processes that seek to recover this resource.

Addressing this issue is not easy, because although there are laws and regulations, the presence of governments is weak and there are usually no one who enforces the guidelines and fishing bans. For this reason, in the last 10 years the strategy has emerged in Brazil, Peru and Colombia that the local communities themselves establish rules of use or rules endorsed by themselves in the Amazon. Fishing is done in areas of common use, where the property is of the nation or collective, which makes it unclear the level of responsibility of the users of the resource.

In the case of Colombia, we started this process in 1992 in the municipality of Puerto Nariño, with the objective of adequately managing fishing in the lakes of Tarapoto. On that occasion the Colombian fishing authority and Omacha proposed to the indigenous people rules of use of the lakes, with restrictions for certain fishing gears. In a very short time we realized that the process failed, basically because the rules of use were imposed by external actors and did not arise from themselves. Years later, in 2008, the indigenous leaders of the community asked us for support to do the process again, but this time based on their own proposals. This took almost five years of meetings, workshops and consultations until finally a regulation emerged that was approved in a large indigenous forum in the region. Within a few months these agreements were endorsed by the country's fishing authority (AUNAP) through a national resolution. To implement it, a houseboat was built that was installed at the entrance of the lakes to carry out the control and surveillance processes. 46 indigenous fishermen were trained to carry out the monitoring and take fishery information.

With this process, the nets were banned most of the year in the lakes, and the capture of species such as pirarucu was prohibited. The results are already observed after several years, and fishing has been recovering, as well as the presence of species that were in poor condition. This has simultaneously caused numerous groups of dolphins to return to the lakes and reuse them as a nursery. The process has not been easy, but in the end, around these lakes it has been possible to consolidate fishing agreements, a management plan as a Ramsar site and a tourism management process, turning this area into



Photo: Julio García Robles

In several Ramsar sites such as the one in Tarapoto, the natives have become fishermen guardians, and they have houseboats from where they do their surveillance and monitoring.



a management model, where the dolphins were the tool to develop all these management strategies.

Similar processes have been developed in nearby areas, specifically in Peru, in the Caballo Cocha lake. This site supports important populations of dolphins of both species and consumer and commercial fisheries. Unfortunately, it is one of the areas where dolphin bycatch and retaliation of fishermen towards these species has been reported. In 2010, 20 dead dolphins were found, poisoned with fish that had been injected with an agrochemical called folidol. This situation deserves that together with the Peruvian authorities we will build a fisheries management plan for the lake and position the dolphins as a tourist attraction.

In the last two years, the NGO Solinia de Iquitos (Peru) has joined the initiative, carrying out education campaigns in the area. Likewise, the government of Peru is being encouraged to consider these lakes as a Ramsar site and in this way seek complementation with the Ramsar site of Tarapoto.

Researchers who work for the conservation of dolphins should work articulately with other professionals such as ichthyologists, economists and anthropologists to be able to have a more holistic approach and look for mechanisms to manage key aquatic habitats.

25 years ago, when people asked me about the importance of aquaculture in the Amazon it seemed to me that it was not necessary or relevant, after all it was one of the most productive rivers on the planet. However, currently with overfished fish populations and with the demographic increase of the population in the region, it becomes an urgent alternative, with native species. The issue of fisheries is absolutely central to priorities in the Amazon and Orinoco, as it not only sustains an important part of the local economy, but also guarantees the food security of the riverine communities. It is a matter of the state of health of the rivers, and the collapse of fishing is one of the worrying symptoms that reflects a cascade of variables ranging from overfishing to loss of habitat quality, deforestation, pollution and fragmentation.

LILIA JAVA

Cocama indigenous

Local leader

Local Coordinator Omacha Foundation

Puerto Nariño town,

Colombian Amazon



I am an indigenous Cocama and from a very young age I got involved in fighting for the rights of our indigenous peoples. In this process, I supported the formulation of the life plan of my indigenous reserve (TICOYA) where one of the aspects that seemed most important to me is the proper management of natural resources. Our people have grown in number and the region has reached many people from other parts and that is why fish and game have become scarce. About eight years ago I joined the Omacha Foundation as their project coordinator in the Amazon, and one of the first things I put my energy into was to take forward fishing agreements in the lakes of Tarapoto to recover fishing and guarantee the food security of my people. In this process, work with fishermen, biologists, economists and indigenous and environmental authorities. It took us a long time to agree, but we all coincided that it was important to set rules to fish sustainably with traditional gear and guarantee fish in the long term. I directly coordinate the indigenous lookouts who take care of the lake and the agreements, and the monitoring of the fishing. For me it has been gratifying to see the results

of this effort, since after four years of work we see again more fish and species like the pirarucu that had practically disappeared.

In this process, the dolphins were very important, because thanks to the resources that the foundation obtained for these species, we were also able to deal with the fishing theme and add the theme of nature tourism. These species have a great cultural and mythological significance for us indigenous people. They are sacred beings of water who deserve respect and guarantee their space and rights in nature; at the bottom of the rivers they have their malocas where they live like the people. The dolphins show us where there is an abundance of fish with their presence. Unfortunately, in recent years I have seen how they have been decreasing in number and that worries us, because on the one hand we see that in places where the communities are not organized and care for the fish, they are disappearing. On the other hand, for many communities, dolphins have become the main tourist attraction, and this generates important income for us.



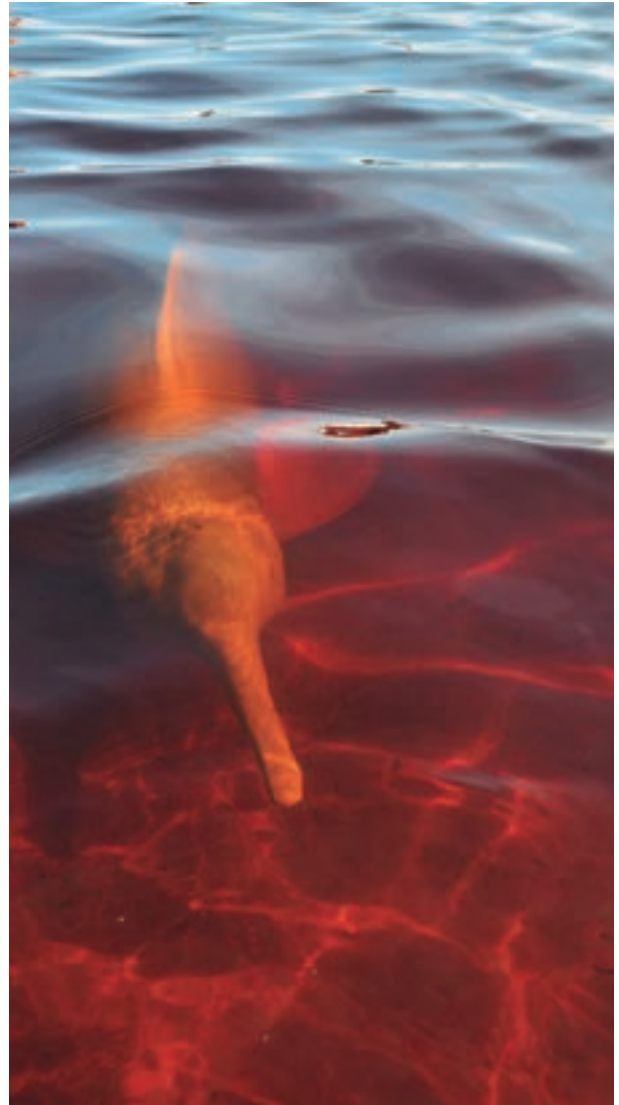
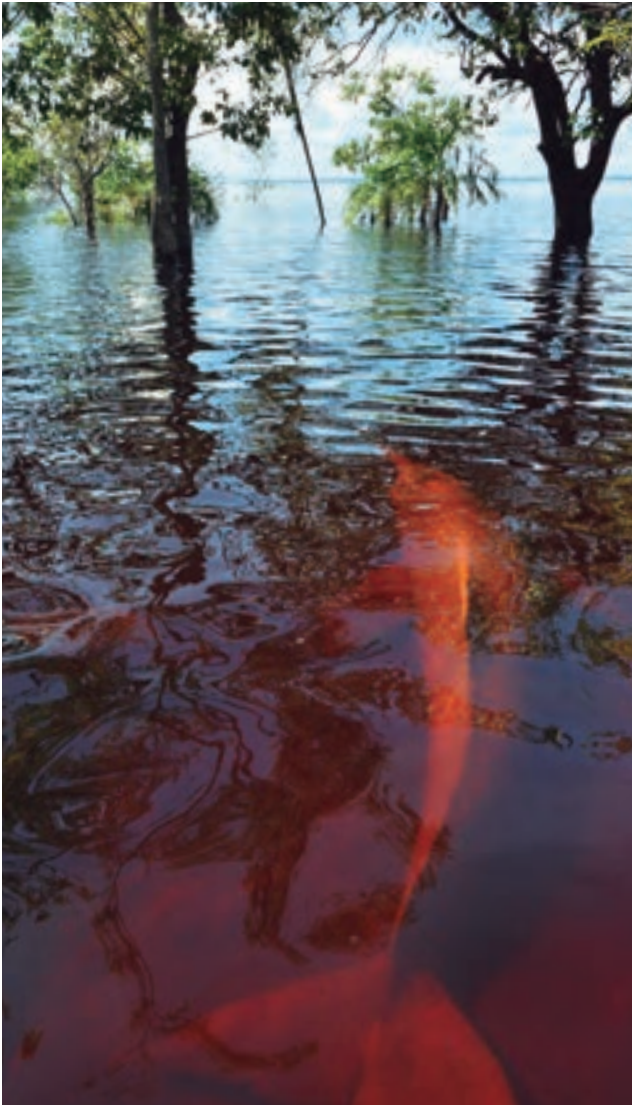
Habitat rehabilitation (Pepeaderos)

In response to the processes of deforestation of the flooded forest, we have initiated an initiative to recover these areas. The natives call them "pepeaderos", which correspond to areas with trees that provide a large amount of seeds or "pepas" that are consumed by the fish. It is the equivalent of a supermarket in the jungle, as fishermen paddle inside the flooded forest looking for trees with certain seeds, and that is where they put their hooks to fish. Each species of fish consumes a certain seed, so for them it is very important to have these areas in good condition. The recovery work consists of collecting seedlings during the summer (low water) of key species for the fish, taking them to a nursery and having them there for several months, while the flood passes, and then planting them again in forest areas where they can thrive.

To finance these processes in Colombia, we have gotten companies to pay for the planting of native trees in the flooded forest as a form of compensation and mitigation of carbon emissions. The cativity is carried out by the fishermen themselves around the lakes in Tarapoto.

I believe that this is an important initiative that must be carried out in lake systems where many species of fish reproduce and search for food. Already in Brazil and Peru there are similar initiatives where positive results are reported.





A healthy flooded forest produces large numbers of seeds, which are the food of many species of fish, which in turn support dolphin populations.



During the period of low waters, the botos form more numerous groups with colorful behaviors in surface, associated so much to feed as to reproduce.







8 Education and awareness





Environmental education
is a **powerful** tool to promote
conservation processes.

However, it requires adequate planning and specialized professionals to carry it out. At the beginning, when I started working with dolphins in the Amazon, I gave a lot of talks in schools, distributed posters, and wrote leaflets and booklets thinking that that would be enough. Over time I realized that we had to work more closely with local school teachers to understand basic cultural aspects first, and secondly, the need for educational material for the classroom. With this, and with the participation of educators, we began to build a long-term process that, after more than 20 years of work, has achieved positive results. In this, it was key to integrate biological and cultural information around the dolphins. This in turn became a differential element in the tourism activity around these species, because in addition to the guides have basic aspects of biology and behavior, incorporate indigenous stories of dolphins.

In the first years of work in the Colombian Amazon, we found that the photo identification of dolphins could also be an environmental education tool. In that sense, in the nineties we showed the pictures of the dolphins in activities with teachers and children in Puerto Nariño, and they gave them names and accompanied us to the lakes to observe them. In a relatively short time, we were able to get these children to ask their fishermen parents not to use fishing nets in the prohibited places so as not to generate accidental entanglements of the dolphins that they already knew and that they were particularly interested in.



One strategy that we have been using to reach more schools in the Amazon and Orinoquia is the generation of a traveling exhibition with information about the dolphins. For this we designed eight panels with biological, ecological, cultural and threat data, and we made adjustments for each region and each country where it was used. In this we work in coordination with organizations and researchers in Colombia, Ecuador, Peru, Bolivia and Venezuela in schools and public places. In total more than 35,000 children have seen this exhibition over the past four years.



Photo: Tony Tirado



Environmental education has been a very valuable tool in the conservation of dolphins. In recent years children have been protagonists in this, with multiple activities in local community colleges, and also in rivers and lakes when they accompany their parents to fish.











9 The politic level





In addition to all the scientific and social work we have done for many years in the Amazon and Orinoco.

In addition to all the scientific and social work we have done for many years in the Amazon and Orinoco, we showed that without the political support of the governments and decision-makers, what we could achieve for the conservation of the dolphins and their habitats was not very effective. The main incentive was to see the conservation plans of the IUCN around many threatened species on the planet. In the case of the cetaceans several of these plans existed but they mentioned very briefly the river dolphins, and in many cases, they corresponded to looks and interpretations of researchers from other countries that had worked for a short time in South America. I myself participated in several meetings at the international level, and since 1998 I joined the group of cetacean specialists of the IUCN and later I worked on the elaboration of the red books of threatened mammals in Colombia.

Having started the estimate program of abundance of river dolphins in 2001, I thought it was time to make a South American action plan by collecting the experience of researchers from the region. With this in mind, in 2008 we organized with Omacha Foundation, WWF, Whale and Dolphin Conservation and the South American Marine Mammal Society (SOLAMAC), a workshop in Santa Cruz de la Sierra in Bolivia with 45 experts. Within these experts, apart from the dolphin specialists, there was the participation of ichthyologists and conservation biologists. Bolivia was chosen because it was one of the countries



Dolphin conservation plans have opened a door between regions and governments to implement actions that preserve river health.



where there was less information about dolphins, and the workshop as such could be a mechanism to encourage local groups to work with these species in a more regular way.

The Plan was finally published in 2010 and distributed massively in all countries with the presence of river dolphins. The document included diagnostic chapters on the status of these species in each country, and a prioritization of actions to be developed in a time lapse of 10 years. The document was published in English despite the fact that the two languages of the region are Spanish and Portuguese, and it was done in this way because it was fundamental to have recognition from the international community, and in particular from the IUCN. Later, a summary version was made in Spanish.

The publication had the desired impact, and the media began to echo in each country and make the importance of river dolphins relevant. So the next step that we set out to do was to promote national action plans in each country, which were endorsed by governments and turned into management instruments. At that time, only Brazil had an action plan for all cetaceans, and included river dolphins.



Currently, all the countries where river dolphins live have action plans supported by each Government.



The best way to ensure dolphin survival is to protect aquatic ecosystems and the forest.



In a very satisfactory way, the first country to react was Bolivia, a country that, having no access to the sea, only had these dolphins as the only cetaceans. Additionally, at that time, genetic information was presented suggesting that it was a different species, *Inia boliviensis*. This generated a sense of belonging and pride in Bolivia that led the president of that country to declare the dolphins as national heritage. Likewise, tourism initiatives focused on dolphins were consolidated in several regions of Bolivia. Even an airline painted its planes with the image of Bolivian bufeos. Subsequently, action plans were built in Colombia, Peru and Ecuador, and more recently in Venezuela. In the case of Colombia, a plan was generated with all the cetaceans as in Brazil, in Peru it included dolphins and manatees, and in Ecuador dolphins, manatees and otters. All these plans were ratified by the respective governments. In the case of Venezuela, the plan included dolphins, manatees and otters but was endorsed by the Academy of Sciences of that country.

Dolphin emerging on the Bita river in the Orinoquia.



The process of working together with several organizations and researchers at both the academic and political levels was generating a network that has shown its effectiveness over time. We have been able to build joint training processes, prioritized publications, standardized sampling methodologies and even regionally incorporated technological tools. In 2017 several of the technical meetings led by WWF and Omacha led to the creation of the South American River Dolphin Initiative (SARDI).

Although in all the South American countries the river dolphins were in threat category, the action plans have allowed to identify concrete actions to increase their knowledge and try to reduce threats. In Colombia, for example, in addition to the national plan, several regional plans have been jointly built between Omacha and autonomous government corporations.

One of the most important aspects of the management plans is that in addition to concentrating efforts on the dolphins, the need to protect the habitats is identified. Healthy rivers are required to sustain not only the conservation of dolphins, but also aquatic biodiversity and food security of the riverine communities in the region. The dolphins have then become ambassadors of aquatic ecosystems in the Amazon and Orinoquia.

Through the political lobby it is possible to work on critical issues such as the dolphin killings in Brazil for piracatinga fishing, and the mercury toxicity problems of this species of fish. In Brazil, the ban on fishing for piracatinga

We can't lose river dolphins. Its conservation is connected with that of the great rivers and wetlands of the Amazon.



PAUL VAM DAMME

Director Faunagua

Bolivia

The first Bolivian Action Plan for the Conservation of *Inia geoffrensis boliviensis*



The year 2009 was important for aquatic mammal conservation in Bolivia. In that year the Red Book for the Bolivian fauna was drafted and published. The Red Book identified the threats for several aquatic and riparian species, and categorized them. *Pteronura brasiliensis* was identified as being in danger of extinction, whereas the Bolivian river dolphin was considered to be vulnerable to extinction. This new listing was a strong impulse for undertaking conservation actions for these species.

At the time of the Red Book drafting, in 2009, a meeting organized during a field trip on the Mamoré River had already generated the inputs for a conservation plan of the Bolivian river dolphin. Decision makers, bolivian biologists, foreign invitees, representants of civil society, and fishers participated in this historic meeting. After returning from the field trip, the Action Plan for the Conservation of *Inia geoffrensis boliviensis* was drafted as a joint undertaking by the Ministry of Environment and academic institutions. The Plan had five strategic lines: protection, non-extractive sustainable use, knowledge sharing, communication and environmental education, and finally, legislation and institutional management.

The Action Plan proposed more than 80 actions, of which ten were assigned high priority. Without doubt, the most important progress during the implementation stage of the plan, between 2012 and 2016, was the promulgation of the National Law No. 284 on the 18th of September 2012, which declared the "bufeo boliviano", as the Bolivian Dolphin is called locally, as National Patrimonium. This milestone in dolphin conservation was thereafter followed by a set of other protective regulations at a more regional scale. Another milestone was the election of the bufeo as bio-indicator in the System for the Monitoring of the impacts of the Jirau and Santo Antonio dams (MRE-MMAyA, 2014). The Action Plan resulted in the transforming of the species in true ambassador for aquatic conservation in Bolivia. At the end of the Action Plan, the Bolivian river Dolphin occupied a prominent position as flagship species for the conservation of aquatic ecosystems in the entire



Bolivian Amazon. The species is nowadays “used” in promotional campaigns of sustainable tourism, environmental education programs and publications on Amazon aquatic diversity. The bufeo also has passed from one of the least mammal species studied in Bolivia to one of those which now attracts uttermost interest by scientists and biology students. The (pending) recognition of the species as being unique, separated genetically from *I. geoffrensis*, has probably helped in improving its “public” image in Bolivia.

Progress in the Action Plan implementation was monitored during meetings held every two years. These meetings were organized by the members of the Coordinative Group, which consisted of members of scientific collections, universities, together with national and regional authorities. During one of these meetings, new priority actions were proposed, such as the “Evaluation of the use of bufeo as bait in the fisheries of scavenger species (blanquillo)”, and “Study the interaction between commercial fishing and the bufeo and reduce accidental capture of the species”. As such, the plan was converted to an “adaptive action plan”, introducing new actions to protect the species facing new threats. During these meetings, there were proposals to extend the duration of the Action Plan, but this proposal was not withheld by the national government. Finally, the Action Plan played its historic role and was concluded in 2016. The Bolivian Ministry for Environment is drafting now a new Action Plan, which should be finishing in 2019.

was enacted for five years, and in Colombia the commercialization of this fish was banned based on its impact on public health. Likewise, the Colombian authority has issued important normativity that prohibit the use of dolphins as bait in any type of fishery, and has endorsed fishing agreements in places such as Tarapoto. The designation of Ramsar sites has also had the participation of governments, headed by the Presidents, who make the formal request to the Ramsar Secretariat in Switzerland.

The topic of the deliberate illegal killing of dolphins was included in the agenda of the International Whaling Commission (IWC) in recent years, and Brazil and Colombia were asked to take action to stop this threat. In 2018, a specific workshop on this topic was held in the city of Santos (Brazil) and subsequently the results were presented to the Scientific Committee of the IWC in Slovenia.

The threat situation for these dolphins has been increasing regionally, to the point that the IUCN updated its categorization to endangered (EN) both for *Inia geoffrensis* and for *Sotalia fluviatilis*, and within the Commission it has been recommended to address a Conservation Management Plan (CMP) for these species. This figure is important, since it links and commits the governments where these species are present to address specific conservation strategies that must be reported annually. In principle, the Government of Colombia will lead the initiative with Brazil, Peru and Ecuador.

MIRIAM MARMONTEL

Mamirauá Institute (Brazil)

Perspectives from scientists in the region

In Brazil, we still have a lot to evaluate of the dolphins, but I believe that one of the main problems they are currently suffering is the accidental deaths in fishing nets. For me, that is the biggest problem of all. We have big problems with hydroelectric plants, there are many of them being planned and built and we are already seeing the consequences of the isolation of the populations. I think the mercury problem can also be a big threat, and as more research is done, more important things will be found. In Brazil, there really is not a group doing mercury analysis on dolphins.

One of the most publicized problems in Brazil has been the illegal capture of dolphins to use them as bait for piracatinga fishing. However, I believe that the problem with nets (bycatch) is much larger. The work we have done in the Mamirauá Reserve shows that alligators are caught up to three times more as bait than dolphins. I think dolphins are not going to end in ten or twenty years, and I do not agree that the population has been reduced by 50% as some scientists have pointed out. It is important to look at this on a larger scale and see if the



dolphins are moving to other areas with less pressure.

There is a great challenge in filling gaps in knowledge, and to address this process, we are already making alliances and collaborative processes with researchers within Brazil and other countries to focus on more concrete issues that seek to answer the questions we have. From this has emerged an initiative called South American River Dolphins Initiative (SARDI), which brings together institutions from several countries (Brazil, Colombia, Bolivia, Ecuador and Peru).

We already have more estimates of abundance in different rivers, and what we have to plan are monitoring in some of them in the long term in order to detect population changes. Likewise, our team, with the support of WWF Brazil, has begun to incorporate technology for dolphin studies, such as the use of drones, thermal cameras and isotope analysis.





10 The communication estrategy



Photo: Julio García Robles



Something that has been fundamental in the whole process of working with river dolphins has been the consolidation of a communication strategy.

Something that has been fundamental in the whole process of working with river dolphins has been the consolidation of a communication strategy that has taken scientific information about threats and opportunities to the general public and policy makers.

I remember my first attempts in the nineties to draw people's attention to the importance of dolphins, in which the reactions were cold and uninterested. They were animals in distant regions, of which we did not have many photos and that many people thought were ugly. They were other species in the great caillodscope of conservation as tigers, pandas, rhinoceronts, elephants and even some charismatic whales. However, I had a pleasant surprise when the largest publisher company in Colombia decided to make notebooks with emblematic species on their covers. After consulting with schools and children across the country, the Amazon dolphins were chosen as the first species. From one moment to the next, commercials on TV and radio positioned the dolphins nationally, and a good part of the school population had their notebooks and their messages of conservation in their hands.

After this point, I must recognize that the interaction with WWF and Conservation International allowed me to assess the role of communication and dissemination that they do in their programs. In this way, we started in 2006 a collaborative work between Omacha and WWF where initially, the focus of the communication strategy was on the expeditions to estimate the abundance of

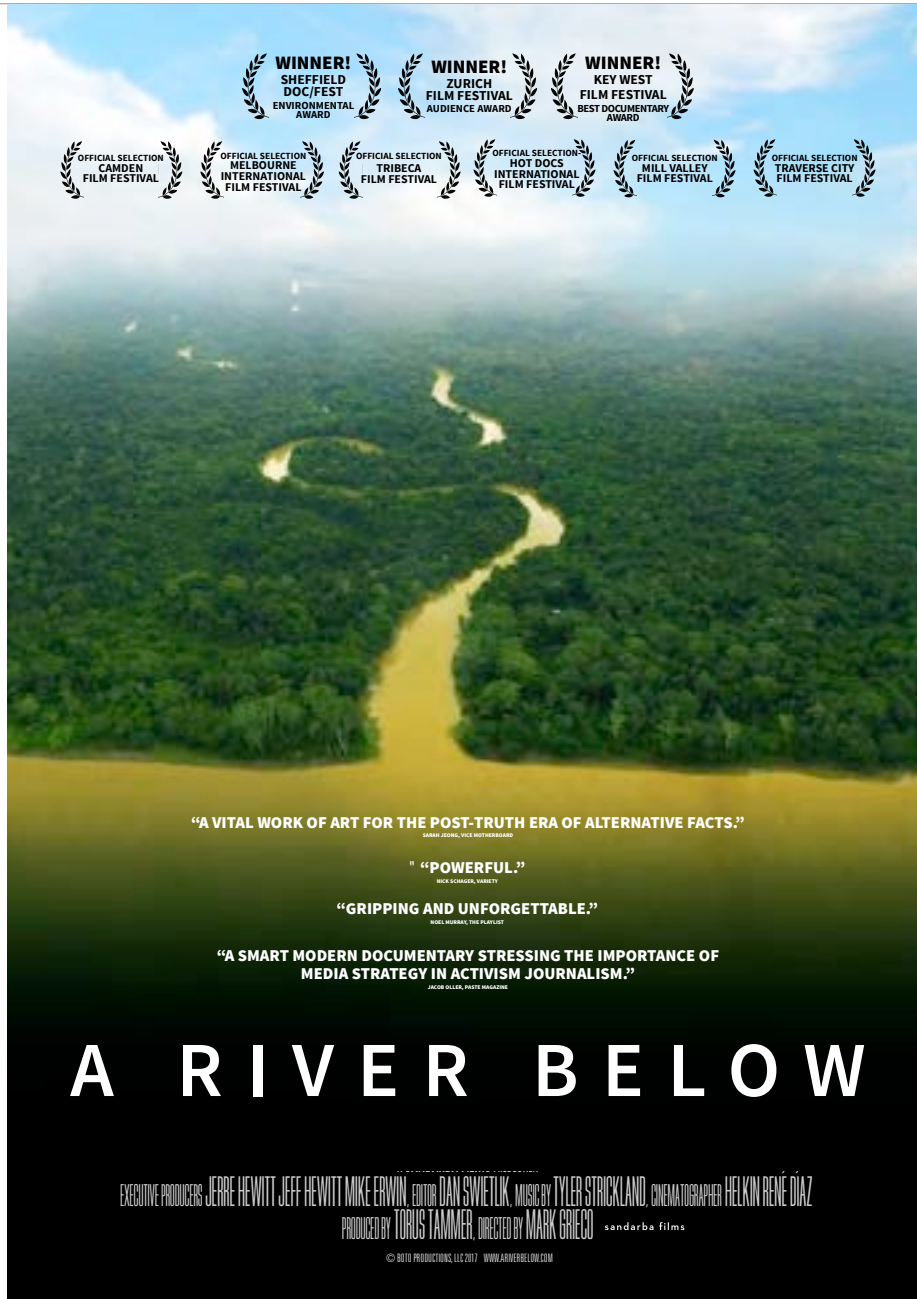


the river dolphins. Each expedition constituted a human and scientific history where besides counting dolphins, we evaluated the threats in the rivers and interacted with local communities. It was the first door to start connecting the people of the cities with these species.

One of the key aspects is that we start to get better pictures and videos of the species, even underwater. This also served to generate a connection with the public and with the media. Likewise, in addition to the dolphins, WWF began to highlight the scientists behind the research as "conservation champions", creating greater interest for the press. I have been one of these characters. In the beginning, I must confess that I did not feel very comfortable with this, but later I assumed the role as a strategy to be able to make these dolphins really be taken into account and that conservation actions could be promoted.

In the consolidation of this process, it also served the international recognition that our work has had and the awards received. In 2007, when I won the prestigious Whitley Gold Award, other doors were opened to make the conservation efforts of these species more visible, as well as being able to have important funds from the Whitley Fund for Nature and WWF that made it possible to connect the work to a regional level and on a larger scale. We were not only talking about the conservation of dolphins, but the aquatic ecosystems of the Amazon and Orinoquia. This dimension has allowed us to be thinking on a global scale, and we can share experiences and expectations with our colleagues working with dolphins in Asia, aiming to build a global strategy, accompanied by the subject of communications.

Also, over the years we have supported several documentaries that show the dolphins and the threats they face in the region. In that process, I participated in a different documentary called "A River Below" that was filmed for three years between Brazil, Colombia and Peru and that addressed in a more universal way the problem of the conservation of the Amazon through the dolphins, showing the economic, political and even ethical conflicts associated with this. The documentary managed to reach a much wider audience globally thanks to all the prizes won and to be shown on a massive platform like Netflix.



The movie *A River Below* exposed internationally the complexity of the conservation of dolphins and the Amazon. This made her deserving of several awards.



With all the efforts made to connect the people of the cities with the river dolphins, recently, I was surprised when a young and talented fashion designer decided to launch a collection of clothes inspired by the Amazon dolphins, calling it "Pink River", connecting the world of fashion with the conservation of these species and their habitats. This is highly relevant if we take into account that the fashion world can be very polluting, especially from water sources. For this reason, it is very positive that a designer is inspired by nature, promotes sustainable practices in the creation of her creations, and finally contributes resources from these collections to the conservation of dolphins.



The interest in the conservation of river dolphins was also reflected in fashion as in the case of a very creative collection of designer Ana Lucía Bermúdez.



Currently many more people know the enigmatic pink dolphins, and that definitely helps to implement actions for their conservation.



The flooded forest is one of the favorite habitats of the botos.

On the other hand, it is also very important that the communication strategy be done at the local level, where sometimes the dolphins are part of negative perceptions. In this sense, the positioning of these species as a tourist attraction has played a fundamental role in turning dolphins into local icons. This can be seen well in the crafts, in murals and designs in the main Amazonian cities. This again is an evidence of the importance of working on the conservation of species from a more holistic perspective and that includes the human dimension of the communities that inhabit them.

The subject of communications was built from the local to the national, and from there to the international. The results are seen in that more people around the planet know these charismatic species, governments are aware of their importance, and donors have begun to approach to see how they can help these species and their habitats not disappear.







11 The Future





The future of the dolphins is **completely linked** to the management and planning of the rivers in the Amazon, Orinoco and Tocantins.

Without healthy habitats these species will disappear and may become another statistic of extinction processes. For the moment, we see how in certain areas when human pressure increases and the habitat deteriorates, the animals move and look for new areas. But what will happen when there are fewer and fewer available areas where they can find food and living conditions? This would seem a very distant scenario in a basin like the one of the Amazons with more than 7 million km², but really, as we already presented it, the aquatic ecosystems really add up to less than one million km² and with enormous anthropogenic pressures.

For those of us who have lived in the Amazon and Orinoquia for many years, we see dramatic changes driven by population growth and unsustainable economic agendas. There are already many studies in the region that clearly show the problems and threats, so it is time to take concrete actions based on political will. This is a great challenge since these regions are mostly filled by governments, which has led to the development of illicit activities associated with mining, deforestation, agricultural expansion, overfishing and drug trafficking. The construction of large infrastructure projects does not generally consider environmental impacts, but is based on economic profit scenarios.



Tucuxi emerging
in the lakes of
Tarapoto, in
the Colombian
Amazon.



Indigenous peoples in some countries see their territories threatened and their cultural values are diluted in response to the pressure of contact with capitalist economies.

Our countries have signed important international agreements focused on key issues such as biodiversity and climate change but it seems that the agendas remain in the cities and do not move to the remote regions such as the Amazon and Orinoquia. We still do not have clear policies for the management of rivers and aquatic ecosystems; they are commonly used goods and are seen as means of transport and communication, but not as key ecosystems. The outlook is not encouraging, and in a couple of decades the region could be undergoing a dramatic transformation as has occurred in other basins where there are also dolphins such as the Ganges, the Indus and the Yangtze. In these places, there are many lessons to learn, they constitute a mirror of what can come if decisions are not made on time.

Dolphins are the
last symbol of the
conservation of
the aquatic world
in the Amazon.

There are other species of cetaceans more threatened on the planet, as is the case of the Vaquita (*Phocoena sinus*), which about 20 years ago had more than 500 specimens, and today less than 30. It is an endemic species of the northern part of the Gulf of California in Mexico, and due to accidental





entanglement, their populations have been reduced dramatically and very fast despite the gigantic effort that many organizations have developed. Here again, the main engine of affectation is the economic one, since the fisheries of the area have focused on the totoaba fish (*Totoaba macdonaldi*), and specifically on the commercialization of its swim bladder towards China, in a multi-million dollar market.

The question is how to guarantee the survival of many threatened species if they are in an economic circuit that has no kind of consideration for the environmental issue? Most river dolphins just face this type of scenario, whether in China, India, Pakistan or the Amazon, where government policies promote the fragmentation of rivers with hydroelectric plants and where deforestation and pollution are not controlled.

For situations like these, the IUCN recently coordinated a workshop in Nuremberg with specialists to evaluate the possibility of doing conservation ex situ of seven of the most endangered dolphin species on the planet, among which were *Inia geoffrensis* and *Sotalia fluviatilis*. At first, with our South American colleagues, we considered that this scenario was very distant in the case of the Amazon and Orinoco species, because although there is evidence of population decline and increased threats, the availability of habitats seems to be still great. However, when listening to experiences in other parts of the world, with species such as the Vaquita in Mexico or the finless porpoise (*Neophocaena asiaeorientalis*) in China, we realized that it is important to think about this scenario and be prepared if it is needed.

The challenges we face in the future if we want to conserve these species are enormous. We must continue working in a coordinated manner among organizations from all the countries where these species live, particularly in scientific, social, economic, political and communication lines of action. For this, it will be essential to count on the support of governments and to use the existing management plans as a legal instrument to advance the actions. The construction of the Conservation Management Plan for river dolphins in South America before the International Whaling Commission should be a short-term goal, since it would be the best tool to coordinate actions between governments.

From the scientific point of view, it is a priority to generate population trend studies in regions where data is already available, such as the Amazon River in Colombia and the Mamirauá Sustainable Reserve in Brazil. Some of these areas could be the Tapajos and Tocantins rivers in Brazil, the Putumayo (Colombia, Ecuador, Peru), the Meta (Colombia, Venezuela) and the Samiria (Peru). Additionally, it is important to spatialize and quantify the threats to dolphins in aquatic ecosystems to identify where efforts should be concentrated urgently. Within the issue of threats, it is essential to establish the impact of bycatch on dolphin populations, since it is suspected that it is high but there are no concrete figures.

From the social and economic point of view, it is important to continue working with local communities at various levels: strengthening environmental management capacities, generation of conservation agreements, responsible dolphin watching, fluvial tourism and other initiatives that reinforce biodiversity conservation, and at the same time improve the quality of life of the inhabitants. Environmental education is also a fundamental tool in this process, which is why the inclusion of specialists in the subject should be promoted in dolphin conservation programs and biodiversity in general. It is important to create generations of Amazonian inhabitants with a sense of belonging and clear and concrete capacities to develop sustainable productive activities. They must be aware of the transformation of the region and the environmental and climatic challenges they will face.

In the political sphere, it is essential to continue and update dolphin management plans of a national nature and to seek legal instruments to guarantee the conservation of these species. In addition to the CMP, it is important to raise the issue of river dolphins in other international agendas such as the Convention on Migratory Species (CMS), the Biodiversity Convention, and very specifically in the Amazon Cooperation Treaty, which articulates the countries of the region and that could play a very important role in facilitating cooperation and coordination between governments.







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Photo: Julio García Robles

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RIVER DOLPHINS



CONNECTING SCIENCE AND CONSERVATION
IN THE AMAZON AND ORINOCO BASINS

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This book presents a testimony of the author's life providing relevant information on the conservation of river dolphins in the Amazon and Orinoco basins, through the accumulated experience of 32 years of work with these species. It also includes the voice of scientists, park rangers and indigenous leaders about dolphins. It evaluates not only threats, but also many of the actions that are carried out in research, generation of economic alternatives, work with government authorities, promotion of protected areas and communication strategies.

