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## Conservation of freshwater turtles in Amazonia: retrospective and future prospects

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## ABSTRACT

This paper aims to discuss the current status of conservation of freshwater turtles of the Amazon and the absence of the genus *Podocnemis* the Official List of Species of Brazilian Fauna Threatened with Extinction. Amazonian turtles are used as food by indigenous people and fisherman communities. However, fishing of adult females, uncontrolled egg collecting, habitat degradation and trafficking in wildlife have caused the decline of these populations. Nevertheless, *Podocnemis expansa* and *Podocnemis unifilis* were not included in the Brazil's official list of animals threatened. Therefore, the turtles remain at great risk, due to the intense pressure that they are suffering. It is recommended that the criteria and the conservation status are reviewed including those animals in the category of vulnerable and to ensure a thorough review and modification in the current Brazilian law to be covered studies and management of turtles for subsistence, respecting and adding value to way of life of Amazonian peoples.

### 1. Introduction

In the Brazilian Amazon, the freshwater turtle fauna is rich and varied, however, very little is known about the natural history of these animals. The *Podocnemis* genus is the most widely distributed throughout the basin<sup>[1]</sup>, whose representatives are *Podocnemis expansa* (*P. expansa*), *Podocnemis unifilis* (*P. unifilis*), *Podocnemis sextuberculata* (*P. sextuberculata*) and *Podocnemis erythrocephala*. Other species are also found, such as *Peltocephalus dumerilianus*, *Chelus fimbriatus*, *Kinosternon scorpioides* (*K. scorpioides*), *Rhinoclemmys punctularia punctularia* (*R. p. punctularia*), *Phrynops nasutus* and *Mesoclemmys gibba* (*M. gibba*)<sup>[1,2]</sup>.

*P. expansa* and *P. unifilis* are economically the most important of the Amazon. Meat and eggs of these animals

provide food for local communities and their carapaces are traditionally used as ornaments and household utensils<sup>[1]</sup>. However, overexploitation, as well as uncontrolled egg collection, has caused decline substantial in their populations over time, making them rare in virtually the entire basin<sup>[3]</sup>, except for some areas where they were implemented protection and conservation programs through sustainable use.

The first actions for the protection of turtles promoted by the Federal Government began in the 60s with protecting beaches during the reproduction period<sup>[4]</sup>. In 1967, the Brazilian Institute for Forestry Development (IBDF) was created, and also the Law 5.197 de Fauna Protection which established the hunting as illegal activity and was used as a way to protect the freshwater turtles<sup>[4]</sup>. However, exploitation of these animals continued intensifying clandestinely. Thus, riverside human populations which consuming this important natural resource were marginalized<sup>[5,6]</sup>.

In 1979, the "Turtles of the Amazon Project" was created, and currently is coordinated by Brazilian Institute of Environment and Natural Resources (IBAMA, the old IBDF).

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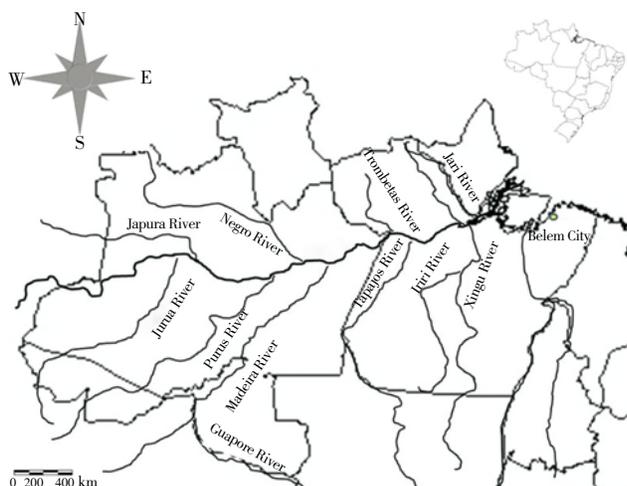
For 30 years this program has served to gradually recover natural stocks through the protection and management of key species, monitoring of reproduction areas, release of hatchlings and stimulation of business of breeding<sup>[4,7]</sup>. The legalized trade of turtles in captive and their products was regulated by IBAMA Ordinance n° 142/92 e IBAMA n° 070/96<sup>[8,9]</sup>. These measures aimed to reduce pressure on native wildlife, preserving endangered species and the cultural customs of the riverside human population who use this recourse. However, most conservation programs were focused to Podocnemididae turtles, leaving out other small species, but no less important.

This paper aims to discuss the current conservation status of turtles in the Amazon and the absence of the genus *Podocnemis*, and of *M. gibba*, *K. scorpioides* and *R. p. punctularia* of the Official List of Species of Wild Fauna Brazilian Endangered. With this, we hope to interest many researchers to search for solutions and contributions to such questions, as well as outlining programs conservation and long-term management.

## 2. Materials and methods

### 2.1. Study area

The Amazon basin has an area of approximately 7 million km<sup>2</sup>, constituting a huge complex of rivers, streams, lakes and canals<sup>[10]</sup>. This basin covers Brazilian states and also neighboring countries of South America. Due to very rich in water volume, the Amazonian rivers have great potential for the production of electricity and waterway transportation. Some of the main tributaries of the Amazon River are: Negro River, Purus River, Madeira River (State of Amazonas), Trombetas River, Tapajós River and Xingu River in State of Pará (Figure 1).



**Figure 1.** Geographic plan of the region of distribution of freshwater turtles in the Brazilian Amazonia showing the access by river.

### 2.2. Procedures

During a period of three months, an extensive review was made on freshwater turtles undertaken in Brazilian Amazonia, using different kinds of data sources including online library sources, ScienceDirect, Scielo, Periódico Capes, as well as governmental and environmental organizations website. Books, technical publications, systematic reviews and academic thesis were included in this review paper, focusing on the practice of conservation of turtles in Amazonian, consumption of meat, eggs, illegal trade of turtles, hunting pressure and sustainable management published until the year 2013.

## 3. Historic on the consumption

For centuries, it has been reported that Amazonian turtles are consumed as food by indigenous peoples of the region, and this habit is extended to riverside communities<sup>[3,11–14]</sup>. Currently, it is known that the flesh of turtle is an important source of protein, higher than that found in beef and pork<sup>[14]</sup>. However, consumption of turtles is also an important part in the culture of Amazonian people<sup>[3,12]</sup>.

In Brazil, reports on the exploitation of turtles in the Amazon since the Colonial period were written by naturalist. However, it is known that the turtles were already consumed by indigenous peoples long before European arrival in the Brazilian Amazon. The available records, dating from the late 16th century, reported that eggs, meat, viscera, fat and carapace turtles were intensively used by local populations<sup>[15]</sup>. The eggs of the turtle produced the “oil” or “butter” that were widely used in lamps for illumination. The fat was used in the production of food or to preserve meats<sup>[15]</sup>.

In the 17th century, there were many nesting beaches of *P. expansa*, which drew attention of many Portuguese traders<sup>[15]</sup>, by possibility of marketing the meat and eggs for the production of butter, much valued in national and international markets<sup>[16]</sup>. Some of these beaches have been selected and inspected by the Portuguese crown that regulated and oversaw the collection of eggs<sup>[15,17,18]</sup>. However, the continued exploitation occurring and for many years several turtles were sold, and thousands of eggs and adult animals were collected<sup>[15,19]</sup>.

The whole process of intense exploitation, mass capture of these animals continued persisting, leading to almost total depletion of populations, especially of *P. expansa*, and as a consequence, there was the need for people to seek smaller species such as *P. unifilis* and *P. sextuberculata*<sup>[15,16,20–22]</sup>, which with the passage of time also began to show signs of

population decline<sup>[21]</sup>.

Currently, the Amazonian turtles are still being captured, traded and consumed systematically<sup>[18,22]</sup>. In the late 1970s, there were reports that small species as *K. scorpioides* and *R. p. punctularia* were clandestinely sold in great amount through the streets of Belém city<sup>[15]</sup>. The illegal trade in *K. scorpioides* is still a reality, being sold in restaurants and during the religious festivities in Belém city<sup>[23]</sup>. Despite not reaching more than 1 kg, this species is considered an important local food<sup>[15]</sup> and well appreciated in Northern Brazil.

In the estuarine region of the state of Pará, there are register of *R. p. punctularia* populations, founds in igapós (literally, flooded forest), coastal plain lakes, and occasionally, in temporary pools<sup>[24]</sup>, but little is known about its biology and ecology, as well as the level of exploitation and the impacts that these populations have suffered over the years<sup>[24,25]</sup>. Thus, the intensity of capture of *K. scorpioides* and *R. p. punctularia* is not yet known<sup>[25]</sup>. However, there are reports that one of the ways to capture *K. scorpioides* in Marajó Island is burning large tracts of land, forcing these animals to evacuate to out the camps<sup>[12]</sup>.

*K. scorpioides* has great importance in the history, customs and economy of the rural and urban communities in the state of Pará and in Amazon region as a whole<sup>[23]</sup>. However, despite being protected by environmental legislation, these animals also continue to be commercially exploited intense and disorderly manner with the removal of many specimens of natural populations<sup>[23]</sup>. Thus, in the state of Pará, because of unawareness of the ecology and conservation status of populations *R. p. punctularia*, *K. scorpioides* and *M. gibba*, these species have not yet been priority targets for conservation initiatives of government agencies.

#### 4. Main threats

Approximately 99% of the modern era extinctions are attributed to human action through the destruction, habitat degradation and over-exploitation of wildlife, due to increased human population density<sup>[26]</sup>. As a consequence of deforestation occurs high erosion and siltation that destroys margins of rivers, beaches and thermal niches where many turtles usually breed and feed<sup>[27]</sup>. However, habitat loss has a secondary role because the overfishing of adult females and uncontrolled egg collection are the main threats for populations of turtles<sup>[22,28–31]</sup>.

The construction of dams for hydroelectric power station

in the Amazon may also cause profound changes in the hydrological cycle, in aquatic biodiversity, in social and economic cycle of the region<sup>[32]</sup>, because the habitat in the reservoir area is completely lost<sup>[27]</sup>. The interruption of the natural course of rivers alter feeding grounds of turtle, transforming environments that were originally lentic in lotic environments<sup>[31,33]</sup>, flooding reproduction areas in the reservoir. These impacts, however, may not be immediately obvious, but the long-term effects need to be monitored in order to outline appropriate conservation strategies<sup>[27]</sup>.

Moreover, due to the occupation of beaches for tourism and intense human predation, it occurs a significant reduction of nests in some parts of the rivers of the Amazon basin<sup>[7]</sup>, such as using the beaches as balneary, contributing to environmental degradation because people often seek nests and collect the eggs<sup>[29,30]</sup>. Thus, in the beaches that suffer excessive pressures of collection of eggs, the females leave these reproduction sites<sup>[16]</sup>.

In this context, studies conducted in Brazil and Bolivia found that fishing pressure has a negative effect on the abundance of *P. unifilis* and *P. expansa*, an effect that was more intense with proximity to urban centers<sup>[22,34,35]</sup>.

The trafficking of wild animals is a strong activity in Brazil which also contributes fairly to the population decline of turtles<sup>[5]</sup>. The capture of adults of reproductive age, the removal of hatchlings from their habitat, and the death of many individuals in transport may exceed the capacity of natural populations to recompose<sup>[36]</sup>. This activity generates large profits for enterprises that use the products of wildlife and also for traffickers who recruit a significant proportion of the rural population for practicing this illegal trade as alternative source of income by selling animals at minimal prices. With that the country loses economically and the poor population do not have any return at their benefit, further increasing social inequality.

In this context with the creation of Law N° 5,197 of Wildlife Protection, which considered illegal hunting for all species in the country, the rural population were the most affected, since they were launched in illegality and marginalized due to the repressive interpretation of this Law<sup>[5,18]</sup>. Although Article 37 of Decree 3179/99, which regulates Law 9605/98 Environmental Crimes not to consider as crime the wild animal that is slaughtered “to satisfy the hunger of the agent or his family,” many fiscals interprets this law equivocally or purposely ignore. Many riverside residents reported cases of abuses committed by authoritarian fiscals who seized and acted out hunting products as the sole source of food for

families which had nothing to eat.

A rational interpretation of the law is very important for which the riverside population are not marginalized for being seeking sustenance for their families, to the detriment of the real culprits who illegally trade in animals and eggs. In other words, it is necessary to make the difference between people who work and use natural resources as food to provide a living for his family and the traffickers who act irresponsibly seeking only profit from illegal trade of wildlife. Therefore, it is suggested that the Brazilian legislation on fauna should be revised and modified, because it is prohibitive and not opens possibilities for rural community management[22].

## 5. Status of conservation and Brazil's official list of endangered species

The current conservation status of species of freshwater turtles that occur in the Amazon Basin is very varied and reflects the historical use of this resource and conservation actions implemented by the government and local communities[21]. In areas where protection measures and management were implemented, the stocks of turtles are very different from other regions where there is any kind of protection or conservation project[21]. Thus, the Podocnemididae turtles can be considered potentially vulnerable due to its intense exploitation by the human population[22].

During the 1960s, at the initiative of the International Union for Conservation of Nature (IUCN), it emerged the interest for the preparation of the first list of endangered species in the world. Currently, *P. expansa* lies in the category of low risk of extinction, however it may become vulnerable if human impacts continue intensifying[37]. *P. unifilis* and *P. sextuberculata* are in the category of vulnerable species and may undergo a high risk of extinction in the wild[37]. In addition, since 1975, *P. expansa* and *P. unifilis* are classified in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora in Endangered Species, by the Federal Decree Federal n° 76.623/75[7,38].

Species such as *M. gibba*, *R. p. punctularia* and *K. scordioides*, due to not having known their conservation status and not being widely studied, are not classified by IUCN and neither are the primary focus of conservation efforts of government agencies, and therefore may be in threat. In view of this, in order to prevent the threat, these species can be included in the official Brazilian list whose conservation status remains uncertain to ensure its preservation.

The Official List of Species of the Brazilian Fauna Threatened with Extinction is one of the most important tools used by the Brazilian government for the conservation of biodiversity, where species that are pointed, somehow, are threatened as to their existence[39]. The first list was drawn up in 1968 by José Cândido de Mello Carvalho and officialized by IBDF Ordinance n°. 303/68, in which there were two species of sea turtles[40,41] (Table 1). The Brazilian list does not list the degree of threat of each species, as in most of the existing lists in the world, the species are just classified as threatened[41,42]. With the publication of the Red Book of the Brazilian Fauna Threatened with Extinction, IUCN categories were presented as a recommendation to use, but not included in the official list[41], because the Brazilian environmental legislation does not recognize threat categories, making it impractical to use this as a tool for public politics official[43].

Despite there was consensus among experts and institutes of research that Podocnemididae turtles are at risk, these animals were not included in the Official List of Species of the Brazilian Fauna Threatened with Extinction (Table 1), because government agencies considered that their populations had recovered due to conservation programs have been directed to monitoring the beaches and transplanted eggs[4], during the nesting period.

The practice of transplanting eggs, in conservation programs, is currently widely questioned and criticized[44,45]. It is known that sex determination in turtles depends on the temperature of egg incubation[46], in which high thermal amplitude favors the birth of females and low temperatures produce males[47,48]. Thus, the improper handling of the eggs can result in alterations of sex ratio with risk of

**Table 1**

Species of turtle included in the official list Brazilian.

List	Date	Turtle	Source
IBDF Ordinance n° 303/68	29/05/1968	<i>Chelonia imbricata</i> *, <i>Dermochelys coriacea</i>	[40,41]
IBDF Ordinance n° 3.481/73	31/05/1973	<i>Chelonia imbricata</i> , <i>Dermochelys coriacea</i>	[41,55]
IBAMA Ordinance n° 1522/89	19/12/1989	<i>Phrynops hogeï</i> , <i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Eretmochelys imbricata</i> , <i>Lepidochelys olivacea</i> , <i>Dermochelys coriacea</i>	[41,56]
Normative Statement MMA n° 003/2003	26/05/2003	<i>Phrynops hogeï</i> , <i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Eretmochelys imbricata</i> , <i>Lepidochelys olivacea</i> , <i>Dermochelys coriacea</i>	[39,41]

\* *Chelonia imbricata* (Synonym: *Eretmochelys imbricata*).

masculinization of the hatchlings or cause an hatching rate very low, due to embryonic death, compared with nests left intact[13,29,49–51].

Through actions of adequate protection and management in nature, it is possible to ensure the survival of turtles[52]. It is important not only to maintain biological diversity, but also to be an important food resource for rural communities[6,20]. Thus, community participation provides greater satisfaction thereof[6], allowing a discussion about preservation with fishermen, women and students of communities, serving as a solid basis for establishing management plans, reliable data collection and awareness of the importance of using resources efficiently, and minimizing conflicts between rural communities and IBAMA[6,21,44,53].

Community management based on sustainable use of eggs collected from beaches subject to flooding is a successful alternative that should be considered to develop conservation strategies[22,38,46]. It has also been suggested that the reproduction beaches are divided into two sections: one part (50%) for the total protection and the other part (50%) for the use and management[44]. Moreover, it is recommended that environmental reserves are established in large areas of lowland forest and flooded forest of the Amazon, allowing feed and reproduce turtles, increasing the reproductive success of the same[15].

Conservation biology is very important to attack the problem from several angles, working on economic, social and managerial issues that threaten the species[26]. The sustainable development is the key to achieving conserve natural resources because it takes income, adding value and new techniques to rural families[6,54]. Therefore, it is essential that one must have vision to achieve success in the conservation of turtles of Amazonia.

## 6. Conclusion

The Amazon turtles continue to be threatened and at great risk. In medium and long term, their populations have greatly reduced because of the intense pressure that has suffered due to the illegal traffic, capture of adult females and uncontrolled egg collection. It is recommended, therefore, that the conservation status of these animals are reevaluated by including them on the Official List of Species of the Brazilian Fauna Threatened with Extinction in the category of vulnerable and there is a thorough revision and modification in the current Brazilian legislation.

Managements programs turtles for subsistence purposes are contemplated, respecting and adding value to the way of life of traditional peoples of the Brazilian Amazon.

## Conflict of interest statement

We declare that we have no conflict of interest.

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