

Freshwater Stingrays (Potamotrygonidae): status, conservation and management challenges

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1. Introduction

South American freshwater stingrays are included in a single family (Potamotrygonidae) and present unique but poorly known biological and ecological characteristics. Potamotrygonids represent an important part of the Neotropical ichthyofauna and belong to the only group of elasmobranchs completely restricted to freshwater habitats. Freshwater stingray species have been regularly captured for ornamental purposes for decades and are eventually used as a subsistence food source. Fishery management and conservation of freshwater stingrays is a delicate topic due to their restricted distribution and the lack of official fishery records.

This document is a brief summary of the status, conservation and management of freshwater stingrays belonging to the Potamotrygonidae family. It represents an overview of the current state of knowledge of the species, with particular emphasis on the conservation and management challenges posed by these species' biology and uses.

2. Diversity and Distribution

The Potamotrygonidae family Garman 1877 is comprised of three valid genera: *Plesiotrygon*, *Paratrygon* and *Potamotrygon*. Both *Plesiotrygon* and *Paratrygon* are monotypic and there are approximately 16-18 valid species included in the *Potamotrygon* genus (Rosa, 1985; Rosa et al., 1987; Charvet-Almeida et al., 2002; Carvalho et al., 2003). Evidence of several other undescribed species (Rosa, 1985, Araújo, 1998) and of at least one undescribed genus and species (Ishihara & Taniuchi, 1995; Compagno, 1999; Charvet-Almeida, 2001) have been observed.

Potamotrygonids should not be mistaken with other freshwater stingrays, which are included in the Dasyatidae family and possess a very different distribution such as Asia and Australia (Zorzi, 1995). Taxonomic confusion has been applied historically to potamotrygonids. One of the most important criteria in the identification of Elasmobranch fishes is the dorsal color pattern. The existence of polychromatism (diverse dorsal colour patterns within a same species) that occurs in this group (Almeida et al., 2002; Almeida et al., 2003; Almeida, 2003) almost always results in misidentifications or the use of different designations for the same species. Extreme care is recommended when using uniquely dorsal color patterns to identify these species.

Freshwater stingrays (Potamotrygonidae) are the only group among elasmobranchs that is completely adapted for living exclusively in freshwater environments (Compagno & Cook, 1995) and are widely distributed in several river basins of the Neotropical region (Rosa, 1985). The Amazon Basin contains most valid species of freshwater stingrays (approximately 13 species; Rosa, 1985) and Brazil is certainly the country with the highest concentration of species (approximately 18 species). Table 1 is a summary of the range of distribution of the species and was developed using published and author's unpublished data / observations (Rosa, 1985; Rosa et al., 1987; Araújo, 1998; Charvet-Almeida, 2001; Almeida, 2003; Carvalho et al., 2003).

Table 1 - List of species and respective summarized range of distribution.

Species	Basin or River Drainage	Countries
<i>Plesiotrygon iwamae</i>	Amazon	Brazil, Ecuador and Peru
<i>Paratrygon aiereba</i>	Amazon and Orinoco	Bolivia, Brazil, Ecuador, Peru and Venezuela
<i>Potamotrygon brachyura</i>	Paraná, de La Plata, Uruguay and Paraguay	Argentina, Brazil, Paraguay and Uruguay
<i>P. Castells</i>	Amazon, Paraná, Paraguay and Guaporé	Argentina, Bolivia, Brazil, Paraguay and Peru
<i>P. constellata</i>	Amazon	Brazil and Colombia
<i>P. dumerilii</i>	Amazon, Paraná and Paraguay	Argentina, Brazil, Paraguay and Uruguay
<i>P. falkneri</i>	Cuiabá, Paraná and Paraguay	Argentina, Brazil and Paraguay
<i>P. henlei</i>	Amazon	Brazil
<i>P. histrix</i>	Paraná and Paraguay	Argentina, Brazil, Paraguay and Uruguay
<i>P. cf hystrix</i>	Negro	Brazil

<i>P. humerosa</i>	Amazon	Brazil
<i>P. leopoldi</i>	Amazon	Brazil
<i>P. magdalenae</i>	Magdalena and Atrato	Colombia
<i>P. motoro</i>	Amazon, Orinoco and de La Plata	Argentina, Bolivia, Brazil, Colombia, French Guyana, Guyana, Paraguay, Peru, Surinam and Uruguay
<i>P. ocellata</i>	Amazon	Brazil
<i>P. orbignyi</i>	Amazon, Orinoco, Paraná and Paraguay	Argentina, Brazil, Bolivia, Colombia, French Guyana, Guyana, Paraguay, Peru, Surinam, Uruguay and Venezuela
<i>P. schroederi</i>	Amazon and Orinoco	Brazil, Colombia and Venezuela
<i>P. schuemacheri</i>	Paraná and Paraguay	Argentina, Brazil and Paraguay
<i>P. scobina</i>	Amazon	Brazil
<i>P. signata</i>	Parnaíba	Brazil
<i>P. yepezi</i>	Maracaibo	Venezuela

3. Biology

Potamotrygonids exhibit some features similar to marine Elasmobranchs: low fecundity, late maturation and slow growth. In addition, the constraint of a freshwater environment (habitat reduction during low water periods) make the potamotrygonids species, more vulnerable than their marine counterparts. Some freshwater stingrays are endemic, and apparently require very specific habitat conditions such as acid and poor oxygen water. They exhibit a very small range of tolerance to both natural and anthropogenic impacts (Compagno & Cook, 1995; Marques, 1996).

Freshwater stingrays are restricted to water where the salinity is less than 3 ppt. (Brooks et al, 1981). They exhibit unique physiological features such as the inability to retain urea, due to the absence of salt excretion by the rectal gland (Thorson et al, 1978) and modifications in the Lorenzini's ampullae (Raschi and Mackanos, 1989). Analysis of plasma concentration components in some species of potamotrygonids has shown a typical teleostean blood chemistry and very different from other euryhaline elasmobranchs such as the dasyatid species (Wood et al, 2002).

This group explores diverse habitats in freshwater environments, including beach sands, flooded forest, small creeks with mud or stone bottoms and lakes. In all habitats in which they are found freshwater stingrays are predators on top of the food web. The adult forms of different species eat mainly fishes, worms and small crustaceans (Charvet-Almeida, 2001; Lasso et al, 1996), and the juveniles eat small crustacean and aquatic insects.

All species of freshwater stingrays studied so far presented a reproductive mode described as matrotrophic viviparity with development of *villi* uterine named *trophonemata*, which nourish the embryo during the gestation time. The reproductive cycle in the potamotrygonid species observed shows a direct relation to the hydrologic cycle (Charvet-Almeida et al, in press). The average uterine fecundity range observed was from 1 to 8. The gestation period varied and lasted between 3 to 12 months. The birth season also presented variations and can last from 3 to 4 months. A resting interval was observed in the reproductive cycle of most species studied in the Brazilian Amazon.

Potamotrygonidae developed at least two interesting adaptations to freshwater environments: the first is the ability to floating on the surface when the bottom water was poor in oxygen and the second is maternal care. These adaptations are unique among Elasmobranch species (Achenbach & Achenbach, 1976; Araújo, 1998).

4. Threats

The following threats to Potamotrygonidae were identified (not all apply in all river basins):

- Subsistence/artisanal fisheries for food purposes;
- Artisanal fisheries for ornamental purposes;
- Commercial fisheries as bycatch;
- Recreational fisheries;
- Ecotourism (negative fisheries);
- Habitat deterioration and destruction (including dragging, dams and gold mines).

Ornamental fishing for more than two decades in Brazilian Amazon catches Potamotrygonidae. Until 1989 there was no regulations in Brazil, and any data exist before this time. In 1990 the Brazilian Environmental Agency (IBAMA) prohibited the exportation of freshwater stingrays for ornamental purpose. This reinforced the antagonism between stingray and riverine people (Araújo, 1998). At the end of ninety's, a partnership between IBAMA and scientific institutions, led to the development of new regulations, which determine a quota system for a specific list of species of freshwater stingrays that could be export in (regulation No 022/98). Recently, this regulation was reviewed and more species were included in the list (regulation No.036/2003). Official statistics of freshwater stingrays exportation are available disposable since 1998 in Brazil. However, they only represent a percentage of freshwater stingrays in the ornamental trade captured at Brazilian Amazon. In Table 2 it shows a list of species use for ornamental purposes.

Table 2: List of valid species and status in International Trade.

Species	Legal status	In international trade
<i>Plesiotrygon iwamae</i>	Illegal to be exported from Brazil	Yes
<i>Paratrygon aiereba</i>	Illegal to be exported from Brazil	Yes
<i>Potamotrygon brachyura</i>	Illegal to be exported from Brazil	Yes
<i>P. castexi</i>	Illegal to be exported from Brazil	Yes
<i>P. constellata</i>	Illegal to be exported from Brazil	Yes
<i>P. dumerilii</i>	Illegal to be exported from Brazil	Yes
<i>P. falkneri</i>	Illegal to be exported from Brazil	Yes
<i>P. henlei</i>	Legal to be exported from Brazil, quota 1000 units/year	Yes
<i>P. hystrix</i>	Illegal to be exported from Brazil	No information
<i>P. cf. hystrix</i>	Legal to be exported from Brazil, quota 5000 units/year.	Yes
<i>P. humerosa</i>	Illegal to be exported from Brazil	Yes
<i>P. leopoldi</i>	Legal to be exported from Brazil, quota 1000 units/year	Yes
<i>P. magdalenae</i>	No information available	Yes
<i>P. motoro</i>	Legal to be exported from Brazil, quota 5000 units/year.	Yes
<i>P. ocellata</i>	Illegal to be exported from Brazil	No information
<i>P. orbignyi</i>	Legal to be exported from Brazil, quota 2000 units/year.	Yes
<i>P. schroederi</i>	Legal to be exported from Brazil, quota 1500 units/year.	Yes
<i>P. schuemacheri</i>	Illegal to be exported from Brazil	No information
<i>P. scobina</i>	Illegal to be exported from Brazil	Yes
<i>P. signata</i>	Illegal to be exported from Brazil	Yes
<i>P. yepezi</i>	No information	Yes

Artisanal fisheries for food purposes also capture potamotrygonids. This type of fishing is restricted to some areas where commercial fishing with hook and line takes place such as mouth Amazon River. Fishery records included dasyatid and potamotrygonid in a unique category. This was not monitored until recently. Charvet-Almeida (2001), Almeida (2003) and Charvet-Almeida & Almeida (2003) work has shown that at least three species of Potamotrygonidae are caught in this fishery: *Potamotrygon orbignyi*, *Potamotrygon scobina* and *Plesiotrygon iwamae*.

Commercial fisheries with trawl nets are used along the Solimões-Amazonas River, and where freshwater stingrays are fished as bycatch. There is no scientific information and no records of the amount of stingrays released from the gear in these fisheries.

Though the effects of disturbance from ecotourism have been noted at least in two species of Potamotrygonidae (*Potamotrygon orbignyi* and *Paratrygon aiereba*) in the Rio Negro Basin, the data are uncertain. Araújo, (2001), has estimated 21.000 individuals removed from the population by negative fishery. This kind of fishing is developed by some ecotourism companies to avoid accidents with freshwater stingrays. This activity is unregulated because it is not considered "fishery" by Brazilian Environmental Agency (IBAMA).

Habitat damage or destruction can also deplete freshwater stingray populations more severely than fisheries. However only the future will kinds tell how activities as gold mines and dams interfere with the life cycle of freshwater stingrays species. In the sites where large dams and gold mining are located, no research is available before 1999.

5. Population Trends and Conservation Status

Data on fishing practices and conservation efforts of Potamotrygonidae for ornamental trade have only recently begun to be collected. In the State of Amazonas, Brazil, where 10.000 units of stingrays are exported annually, the fishery effort is concentrated on *Potamotrygon cf. hystrix* stocks. This species is one of the smallest species of freshwater stingrays, with maximum disc width of fifty centimetres, endemic from the Rio Negro Basin, and shows a high density of individuals around islands and flooded forests. The reproduction cycle of this species is directly dependent of duration of the dry season. In years with long dry seasons, this species can produce twice the amount of newborns. Sixty per cent of captures of this species is concentrated in only one tributary of the Rio Negro. The CPUE data for this species in this area do not show a direct relationship with fishery effort or exportation data. The pressure of effort on the stocks depends on the level of the river. In those fishing seasons where the river is very low (1996-1997 season- El Niño effect) the vulnerability of the species is higher, but the species' habitat is not accessible to the

fishermen. In very dry years, the water quality is very poor and natural mortality rate is higher. In those fishing seasons where the dry season is short (1998-1999) the species was vulnerable and accessible for shorter period of time. The reduction of exportation data confirmed this trend.

In the fishing seasons where the river level were not so low and dry periods are not as short, the amount of fishing double. The main cause of this is that species' vulnerability associated with habitat accessibility to traditional ornamental fishermen, and occasional fishermen from commercial fisheries (edible fish). This phenomenon was especially observed during the fishing seasons of 2001-2002 and 2002-2003. The CPUE in these years was directly proportional to the effort, but the export data did not demonstrate this pattern. The average mortality post-capture rate of this species is between 2 %- 5 %.

During the fishing seasons 2001–2002 and 2002-2003 the mortality post-capture rate was 4-8 %. The reason for this rise mortality rates was due the commercial fishermen (edible fish) do not have the same practice as ornamental fishermen handling and caring the stingrays after their capture.

Freshwater stingrays are not the principal fish used in the ornamental industry in the State of Amazonas, however they are important in helping to improve the sales of cardinal tetra *Paracheirodon axelrodi*.

Potamotrygon cf. hystrix represents 50 % of all freshwater stingrays legally exported from Brazil. Despite the fact that any decline of abundance was observed in this species, its capture must be monitored and the number of individuals exported annually must be controlled to avoid decrease in the stocks.

Other endemic species such as *Potamotrygon leopoldi* and *Potamotrygon henlei* must follow the same model, monitoring captures and controlling the number of exported individuals. However collecting data pertaining to the capture and effort has just begun in this past year. *Potamotrygon motoro* is the most fecund stingray and is located in a wide area of Neotropical region. Its capture and exportation are monitored There is no evidence of reduction in the abundance in this species, but a strict control must applied in their exportation because some confusion can occur between this species and the endemics *P. leopoldi* and *P. henlei*.

Potamotrygon orbignyi is widely distributed species through the Amazon Basin. It is a high polychromatic stingray and sometimes difficult to be recognized. The evaluation of CPUE for this species did not show reduction in abundance. *Potamotrygon schroederi* is a rare stingray at export data. This partly due to the fact that, the species has the highest mortality rates post-capture (10 –12 %) in stingrays groups. The species demands special care, and for the fishermen the profit ratio cost/benefit at *P. schroederi* fisheries is not advantageous. Despite this, the capture and the exportation of this species is somewhat controlled, because some aquariums can export *Potamotrygon cf. hystrix* as *Potamotrygon schroederi*.

Data of exportation of freshwater stingray to ornamental fishing trade from other countries or species are not available or does not exist.

6. Legal and Management Status

Many species of freshwater stingrays are found in more than one country. The collection of some species such as *Paratrygon aiereba* for ornamental trade is prohibited in Brazil, but is legally exported from Peru.

Brazil seems to be the only country that has any specific regulation to control the export of species freshwater stingrays for ornamental trade. The regulation only allows the exportation of seven species of *Potamotrygon* genus (Table 2), based on a quota system. At least three species are endemic species, and two of them *Potamotrygon henlei* and *P. leopoldi* are in basins where dam projects are to be developed in the next few years. The other endemic species, *Potamotrygon cf. hystrix*, will need soon protection of its habitat by the federal government because ecotourism projects and dragging activities of the Rio Negro will endanger their numbers. The other species, *P. motoro*, *P. orbignyi* and *P. schroederi*, exist in other countries, but there are no shared stocks.

The species *Potamotrygon yepesi* is listed as a vulnerable species in the Red Book of Fishes from Colombia. No information or conservation records are available concerning the species and their protection (Mojica, et al, 2002).

No regulations exist in South America to regulate the capture of Potamotrygonidae from commercial vessels; the same is true of the practice of negative fishery. Moreover, there is no real effort being made to protect freshwater stingrays from negative fishery.

National Regulation of Fisheries -Brazil's perspective

- Regulation N° 036/2003 which was signed on June 25, 2003, is a federal regulation that determines the exportation of seven species of freshwater stingrays and a quota system. The appendix number 03 of this regulation obligates the ornamental fishing industry to present scientific data about the impact of fisheries on the freshwater stingrays populations. Furthermore, these regulations will update according to the research results.
- The regulation prohibits the exportation of adult specimens and unknown scientific species.
- In case of infractions by any industry a fine is applied and the loss of exportation rights is recommended.

7. Economic Importance

Freshwater stingrays are not the main species in the South American ornamental fish trade. The ornamental fish industry seems to be highly concerned in maintaining the freshwater stingray populations in order to meet the demands of the market. None often, fisheries choose to raise other traditional species for exportation, such as *Paracheirodon axelrodi*.

Moreover, the money generated by freshwater stingray fisheries helps riverine people to buy school materials for their children, and can provide a precious supplementary income for several months of the year to sustain the a large number of families. This is the importance of this trade for the riparian communities.

8. Management Challenges

The control of international trade is one of more difficult steps in a freshwater stingrays conservation program. Part of this problem, is that some species are found near the border of Brazil and Colombia, or Brazil and Peru. Local people on Brazilian borders complain that the stingrays captured in the Brazilian side are exported from Colombia or Peru. They argue that these species are being exported illegally. In this sense, an international program to regulate the exportation of freshwater stingrays in ornamental fishing trade is necessary. However, one must keep in mind that many species on the market are still unknown to science. Information is currently available on only a very few species.

The Brazilian Government has only permitted the use of national resources according to available of scientific data. In addition the regulation of freshwater stingrays uses this criterion. That is why more scientific data and research with stingrays as well their management and conservation needs is required.

In some places like Barcelos, the State of Amazonas, the municipality created a green stamp, which recognizes the ornamental fishing companies that respect the Brazilian fishing and environmental regulations.

In many places, stingrays are found in small creeks areas controlled by drug traffickers where environmental conditions have not been studied and described.

9. Literature

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