ARTISANALLY LANDED ELASMOBRANCHS ALONG THE COAST OF RIO DE JANEIRO, BRAZIL

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ABSTRACT

Considering the knowledge gap regarding elasmobranch species landings, this study aimed to report elasmobranch catches from artisanal fisheries to obtain baseline data in this regard. Samplings were carried out from 2016 to 2019 at three artisanal fishing colonies located in Rio de Janeiro, Tamoios, in Cabo Frio, Niterói, and Copacabana, in the metropolitan region of Rio de Janeiro. A total of twenty-three species from twelve families were identified at all sample sites, comprising 10 sharks and 12 rays. Embora Tamoios, in Cabo Frio, sofre os efeitos de um fenômeno de ressurgência, a maior riqueza relativa a elasmobrânquios oceânicos foi observada em Copacabana, que faz parte da Baía de Guanabara, reforçando a importância desse tipo de avaliação.

RESUMO

Considerando a lacuna de conhecimento em relação aos desembarques de espécies de elasmobrânquios, este estudo teve como objetivo relatar as capturas de elasmobrânquios através da pesca artesanal para obter dados de base a esse respeito. As amostragens foram realizadas de 2016 a 2019 em três colônias de pesca artesanal localizadas no Rio de Janeiro, Tamoios, em Cabo Frio, Itaipu, em Niterói e Copacabana, na região metropolitana do Rio de Janeiro. Um total de vinte e três espécies de doze famílias foi identificado em todos os locais da amostra, incluindo 10 tubarões e 12 raias. Embora Tamoios, em Cabo Frio, sofra os efeitos de um fenômeno de ressurgência, a maior riqueza relativa a elasmobrânquios oceânicos foi observada em Copacabana, que faz parte da Baía de Guanabara, reforçando a importância desse baía e a importância de sua recuperação para estratégias de manejo e conservação de elasmobrânquios. Além disso, muitos espécimes pertencentes a diferentes espécies amostradas neste local eram juvenis, como tubarões martelo (Sphyraena lewini), tigre (Galeocerdo cuvier), mako (Isurus oxyrinchus), seis fêmeas de cações frango (Rhizoprionodon lalandii) contendo embriões ou oocitos e três fêmeas de tubarão-rotador (Carcharhinus brevipinna) com oócitos maduros, indicando um possível local estratégico de reprodução e assentamento juvenil para várias espécies desembarcadas. A presença de muitas espécies apresentando diferentes graus de vulnerabilidade em relação à conservação e endemismo, especialmente para o Atlântico Sul, reforça a importância desse tipo de avaliação. Além disso, quatro de seis espécies-chave de elasmobrânquios, ou seja, espécies que apresentam um impacto extremamente alto em um ecossistema específico em relação à sua população e críticas para a estrutura e função gerais de um ecossistema, anteriormente observadas na costa sudeste do Brasil, são relatadas aqui, a saber Galeocerdo cuvier, Sphyraena lewini, S. zygaena e Zapteryx brevirostris, indicando ainda a importância de futuras avaliações sobre o monitoramento da pesca de elasmobrânquios no Brasil.

Palavras-chave: Biodiversidade; tubarões e raias; pesca artesanal.

Sphyraena lewini, Carcharinus brevipinna, Isurus oxyrinchus, Rhizoprionodon lalandii, S. zygaena, Zapteryx brevirostris.
Key-words: Biodiversity; sharks and rays; artisanal fisheries.

INTRODUCTION

Brazil is home to approximately one million registered artisanal fishers, which contribute to over 50% of the total fish produced in the country (Vasconcellos et al. 2007). However, data concerning artisanal fisheries are poor (Kalioski & Vasconcellos 2012; Previero & Gasalla 2018), making it difficult to identify and assess the effectiveness of conservation management actions (Costa et al., 2018). Elasmobranchs in particular are extremely vulnerable to artisanal fishery (Lack & Sant 2009; Bornatowski et al. 2014), either targeted or captured as bycatch (Molina & Cooke 2012; Ferrette et al. 2019), as they are long lived organisms displaying slow growth rates, delayed maturation, long gestation, and small litters (Stevens et al. 2000; Dulvy et al. 2014). Approximately 25% of this class has been reported as threatened with extinction by the International Union for Conservation of Nature (IUCN) (Dulvy et al. 2014) and, 47% of these are classified by the IUCN as data deficient, indicating absence of minimal information to be evaluated (Mace et al. 2008; Dulvy et al. 2014).

In many countries, shark and ray meat are viewed as a low-quality food item and, thus, marketed under generic designations not directly linked to these animals, in order to overcome consumer resistance (Vannuccini 1999; Bornatowski et al. 2013, 2015; Dent & Clarke 2015). This is the case in Brazil, where shark and ray meat are sold as cação fillets (Bornatowski et al. 2018). The lack of consumer knowledge regarding cação meat and what it really consists in has increasingly led to overfishing due to attractive shark and ray meat prices (Bornatowski et al. 2018) and is of significant ecological concern, as these animals play an important role in maintaining ecosystem equilibrium and health (Heupel et al. 2014). In this scenario, due to both targeted and non-targeted fisheries, Brazilian fisheries have reached critical levels for several elasmobranch species (Bornatowski et al. 2018) and 33% of all elasmobranchs are categorized as threatened, while 36% are considered data deficient (Instituto Chico Mendes de Conservação da Biodiversidade 2018), overcoming the global rate of threatened species. Most pelagic shark populations are currently depleted in Brazil while coastal species data are very poor (Bornatowski et al. 2018).

A constant that determines the difficulty of social and ecological fishing activity management in Brazil is the lack of specific monitoring for each fishing sector, both large and small (artisanal) scale, in the long term, as, although fishery statistics are achieved regionally by some states, most of the country lacks this specificity. However, effective governance between conservation and fisheries can only be effective by filling in the gaps in fisheries data (Kolding et al., 2010). In Brazil, the latest version of the National Fisheries and Aquaculture Statistical Bulletin (Instituto Chico Mendes de Conservação da Biodiversidade, 2011) illustrates the main problem faced by sector managers, of data discontinuity, since this government document has not been updated for eight years. At the state level, the Rio de Janeiro Institute of Fisheries Foundation issues an annual report on Fisheries and Aquaculture where, in addition to unspecific fish categorization, a combination of large and scale small data is noted, making it very difficult, for example, to discern which species are vulnerable to what types of fisheries, leading to significant data deficiency, especially with regard to artisanal fishing.

However, no recent evaluation of artisanally landed sharks and rays are available for many artisanal fisheries regions, such as those located in the metropolitan region of Rio de Janeiro, and the Região dos Lagos region, which comprises over 1500 registered artisanal fishers from at least eight cities (Saquarema, Maricá, Araruama, Iguaba Grande, São Pedro da Aldeia, Cabo Frio, Búzios and Arraial do Cabo) (FIPERJ 2015).

In this context, this study aimed to assess artisanally landed sharks and rays along the coast of Rio de Janeiro, RJ, Brazil through fisheries monitoring, fisher interviews and photographs taken by the fishers and the researchers.

MATERIAL AND METHODS

The state of Rio de Janeiro (22° 54’ 13” S, 43° 12’ 35” W), is located in southeastern Brazil, occupying the 4th place in terms of economy and 3rd in population size in the national ranking (IBGE, 2019), extremely important in a socio-economic context.

A total of 28 artisanal fisher colonies are distributed throughout the state of Rio de Janeiro, from São Francisco do Itabapoana to Paraty (FIPERJ, 2019), with the main fishing ports located at Niterói, São Gonçalo, Cabo Frio and Angra dos Reis. Sampling were carried out at two artisanal fishing unions and one fisher association located in Rio de Janeiro, namely the Z-13 fishing colony/union, in Copacabana (22 ° 59 ‘10 “S, 43 ° 11’ 19” W), in the metropolitan Rio de Janeiro area, the Associação de Pesca de Tamoios (Tamoios Fishers Association), located in the Pontal de Santo Antônio, in Cabo Frio (22° 35’ 55.0” S, 41 ° 59’ 40.9” W), on the Southeastern coast of the state, and the Z-7 fishing colony/union, at
Elasmobranchs landed in Rio de Janeiro

Located in the central region of the state, artisanal fisher colonies Z-13 and Z-7, at Copacabana and Itaipu, respectively, operate in fishing areas that undergo strong influences from Guanabara Bay, an eutrophic estuarine environment, mainly in the regions most associated with oceanic waters. On the other hand, the Associação de Pesca de Tamoios, in Cabo Frio is located in an area characterized by a significant upwelling phenomenon, where deep South Atlantic Central Waters rise continuously, resulting in a high abundance of nectonic species, making this area one of the most productive fishing areas in the state of Rio de Janeiro (Valentin, 2001).

No standardized sampling effort was carried out in this study, due to logistic reasons. All specimens were caught within the fishing spectrum of the respective sites, no further that 15 km from the fishing colonies.

Samples from the Z-7 Itaipu colony, which consists of 130 associated fishers, were obtained from January to July 2016, comprising 10 visits at random. Initial visits by the researchers to this colony enabled the development of both a close relation with the fishers and elasmobranch landings, so, in the absence of the research team, fishers would send photographs of elasmobranchs whenever these animals were landed. Elasmobranch landing data for Itaipu were obtained from Brito (2016).

Concerning Tamoios, periodic visits were made every three months to the Associação de Pesca de Tamoios, from 2017 to 2018. At Tamoios, landing assessments were always performed by the research team, through sample collections and photographic records, without the aid of local fishermen.

Data collection at the Z-13 colony was carried out from September 2018 to September 2019. Observations and species identification through the scientific literature (Gomes et al. 2010) were performed through frequent visits to the colony, of at least 3 times a week, according to sea conditions, obtaining photographic records and/or tissue samples of the sampled animals. In the absence of the research team, fishers would send photographs of elasmobranchs whenever these animals were landed.

The same fishing gear, gillnets, was used in all three regions. Only the amount of cloths and mesh size differ among the fishing colonies. All nets had an average height of two meters. At Copacabana, 50 mm mesh gillnets are used for bottom and mid-column fishing, with about 8 cloths per boat, resulting in about 400 to 500m nets for each boat. At Tamoios, a mesh size between 40 and 45mm is used, with varying amounts of cloths according to boat size, of about 100m each, reaching up to 10 cloths in a single boat. At Itaipu, gillnets with mesh sizes varying from 40 to 80 mm are used for mid-column and bottom fishing. No information on net lengths are available for this colony. All elasmobranchs were captured as by-catch, due to the non-selectivity of the fishing methodology, even at different depths.

RESULTS

A total of twenty-three species from twelve families were identified at all sample sites. Data concerning the Order, Family, popular names, global and national Conservation States, and geographic distribution of the artisanally landed elasmobranchs
Table 1. Details on the Order, Family, popular names, global and national conservation status, and geographic distribution of elasmobranch species landed at three artisanal fishing colonies in the state of Rio de Janeiro, Brazil, from 2016 to 2019. Conservation statuses were obtained from the IUCN and ICMBio websites, available at www.iucnredlist.org and http://www.icmbio.gov.br/.

| Order          | Family  | Species                      | Common Name                     | Conservation status | Distribution                          |
|----------------|---------|------------------------------|---------------------------------|---------------------|---------------------------------------|
| Squatiniformes | Squatinidae | Squatina guggenheim (Marini, 1936) | Angular angelshark | Caçao-anjo | Endangered | Critically endangered | (Rio de Janeiro, Brazil to Argentina) |
| Lamniformes    | Lamnidae | Isurus oxyrinchus (Rafinesque, 1810) | Shortfin mako | Tubarão-mako, Anequim | Endangered | Endangered | Global |
|               |         |                               |                                 |                     |                        |                        |                                    |
| Carcharhiniformes | Carcharhinidae | Rhizoprionodon porosus (Poey, 1861) | Caribbean sharpnose shark | Caçao-frango, Caçao-noné | Least Concern | Vulnerable | Miami, USA to Mar del Plata, Argentina |
|               |         | Rhizoprionodon lalandii (Muller & Henle 1839) | Brazilian Sharpnose shark | Caçao-frango, Caçao-noné | Data Deficient | Vulnerable | Nicargua to Florianópolis, Brazil |
|               |         | Galeocentro cuvier (Péron & LeSueur in LeSueur, 1822) | Tiger shark | Tubarão-tigre, Tinureira | Near Threatened | Near Threatened | Cosmopolitan |
|               |         | Carcarchinus falciformis (Müller & Henle 1839) | Silky shark | Tubarão-galha-preta | Vulnerable | Near Threatened | Cosmopolitan |
|               |         | Carcarchinus brevipinna (Muller & Henle, 1839) | Spinner shark | Tubarão-martelo, Panã, Panam | Near Threatened | Near Threatened | Cosmopolitan |
| Sphymidae      |         | Sphyra lewini (Griffith & Smith, 1834) | Scalloped hammerhead shark | Tubarão-martelo, Panã, Panam | Endangered | Critically endangered | Cosmopolitan |
|               |         | Sphyra zygaena (Linneaus, 1758) | Smooth hammerhead shark | Tubarão-martelo, Panã, Panam | Vulnerable | Critically endangered | Cosmopolitan |
| Rajiformes     | Arhynchobatidae | Atlantoraja castelnaui (Ribeiro, 1907) | Spotback skate | Raia-de-emplasto, Raia-chita | Endangered | Endangered | Endemic (Rio de Janeiro, Brazil to Northern Argentina) |
|               |         | Rioraja agassizi (Müller & Henle, 1841) | Rio skate | Raia-santa | Vulnerable | Endangered | Endemic (Southeastern Brazil to Northern Argentina) |
| Rajidae        |         | Gungiesiella dorsalifera (McEachran & Compagno, 1980) | Onefin skate | Raia-emplasto-de-fundo | Vulnerable | Vulnerable | Endemic (Southeastern and Southern Brazil) |
| Family                  | Species                                    | Common Name                    | Conservation status         | Distribution                                      |
|-------------------------|--------------------------------------------|--------------------------------|-----------------------------|--------------------------------------------------|
| Torpediniformes         | Narcine brasiliensis (Olfers, No. 1)       | Lesser numbfish; Brazilian electric ray | Data Deficient              | Brazil (ICMBIO)                                  |
|                         | Dasyatis hypostigma (Santos & Carvalho, 2004) | Groovebelly stingray           | Data Deficient              | Brazil (ICMBIO)                                  |
|                         | Dasyatis hypostigma (Bleek & Schneider, 1802) | Southern stingray              | Data Deficient              | Brazil (ICMBIO)                                  |
|                         | Myliobatidae                               | Pelagic stingray               | Least Concern               | Brazil (ICMBIO)                                  |
|                         | Hypanus americanus (Hildebrand & Schneider, 1926) | Southern stingray              | Data Deficient              | Brazil (ICMBIO)                                  |
|                         | Hypanus guttatus (Bloch & Schneider, 1802)  | Groovebelly stingray           | Data Deficient              | Brazil (ICMBIO)                                  |
|                         | Pteroplatytrygon violacea (Bonaparte, 1832) | Pelagic stingray               | Least Concern               | Brazil (ICMBIO)                                  |
|                         | Aetobatus narinari (Euphrasen, 1790)       | Spotted Eagle Ray              | Near Threatened             | Brazil (ICMBIO)                                  |
|                         | Myliobatis goodei (Garman, 1885)           | Southern guitarfish            | Critically endangered       | Brazil (ICMBIO)                                  |
|                         | Gymnura altavela (Linnaeus, 1758)          | Spiny butterfly ray            | Vulnerable                  | Brazil (ICMBIO)                                  |
| Rhinobatidae            | Pseudobatos horkelli (Muller & Henle, 1841) | Brazilian guitarfish           | Near Threatened             | Brazil (ICMBIO)                                  |
|                         | Pseudobatos per典雅 on (Muller & Henle, 1841) | Southern guitarfish            | Critically endangered       | Brazil (ICMBIO)                                  |
| Trygonorhinidae         | Zapteryx brevirostris (Muller & Henle, 1841) | Shovelnose guitarfish          | Vulnerable                  | Brazil (ICMBIO)                                  |
| Rhinopteriformes        | Gymnura altavela (Linnaeus, 1758)          | Spiny butterfly ray            | Vulnerable                  | Brazil (ICMBIO)                                  |

Elasmobranchs landed in Rio de Janeiro
Table 2. Elasmobranch individuals landed at three artisanal fishing colonies in the state of Rio de Janeiro, Brazil, from 2016 to 2019.

| Species                     | Sample Code | Sample Site                                      | Collection Day | Source |
|-----------------------------|-------------|--------------------------------------------------|----------------|--------|
| *Squatina guggenheim* (Marini, 1936) | SC013†      | Cais de Tamoios, Cabo Frio                       | -              | -      |
|                             | HDRG045†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 20/12/18       | Sample |
|                             | VB05*       | Colônia de Pesca Z-7, Itaipu                     | 06/03/16       | Photo  |
| *Isurus oxyrinchus* (Rafinesque, 1810) | HDRG008†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 30/09/18       | Sample |
| *Rhizoprionodon porosus* (Poey, 1861) | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 08/11/17       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 14/12/17       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 14/12/17       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 14/12/17       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 14/12/17       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 01/02/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 01/02/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 01/02/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 01/02/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 18/01/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 18/01/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 18/01/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 18/01/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
|                             | DZ-UERJ⁷     | Cais de Tamoios, Cabo Frio                       | 13/07/18       | Sample |
| Species          | Sample Code | Sample Site                  | Collection Day | Source |
|------------------|-------------|------------------------------|----------------|--------|
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| DZ-UERJ*         | Cais de Tamoios, Cabo Frio | 16/08/18                    | Sample         |
| HDRG062†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG063†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG064†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG066†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG067†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG069†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG070†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG071†         | Cais de Tamoios, Cabo Frio | 19/01/19                    | Sample         |
| HDRG084†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG085†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG086†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG087†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG088†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG089†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG090†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG091†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG092†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG093†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG094†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG095†         | Cais de Tamoios, Cabo Frio | 07/02/19                    | Sample         |
| HDRG180†         | Cais de Tamoios, Cabo Frio | 29/06/19                    | Sample         |
| *Rhizoprionodon lalandii* (Muller & Henle 1839) | DZ-UERJ* | Cais de Tamoios, Cabo Frio | 08/11/17          | Sample |
|                  | DZ-UERJ* | Cais de Tamoios, Cabo Frio | 08/11/17          | Sample |
|                  | DZ-UERJ* | Cais de Tamoios, Cabo Frio | 14/12/17          | Sample |
|                  | DZ-UERJ* | Cais de Tamoios, Cabo Frio | 14/12/17          | Sample |
|                  | DZ-UERJ* | Cais de Tamoios, Cabo Frio | 14/12/17          | Sample |
| Species       | Sample Code | Sample Site                                      | Collection Day | Source |
|--------------|-------------|-------------------------------------------------|----------------|--------|
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 14/12/17 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 01/02/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 13/07/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 13/07/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 16/08/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 16/08/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 16/08/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 16/08/18 Sample                                     |                |        |
| DZ-UERJ⁺      | Cais de Tamoios, Cabo Frio | 16/08/18 Sample                                     |                |        |
| HDRG005*      | Colônia de Pesca Z-13, Posto 6, Copacabana | 30/09/18 Photo                                     |                |        |
| HDRG006*      | Colônia de Pesca Z-13, Posto 6, Copacabana | 30/09/18 Photo                                     |                |        |
| HDRG007*      | Colônia de Pesca Z-13, Posto 6, Copacabana | 30/09/18 Photo                                     |                |        |
| HDRG011*      | Colônia de Pesca Z-13, Posto 6, Copacabana | 09/10/18 Photo                                     |                |        |
| HDRG035†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 Sample                                     |                |        |
| HDRG036†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 Sample                                     |                |        |
| HDRG037†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 Sample                                     |                |        |
| HDRG038†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 Sample                                     |                |        |
| HDRG039†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 Sample                                     |                |        |
| HDRG046†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 20/12/18 Sample                                     |                |        |
| HDRG065†      | Cais de Tamoios, Cabo Frio | 19/01/19 Sample                                     |                |        |
| HDRG068†      | Cais de Tamoios, Cabo Frio | 19/01/19 Sample                                     |                |        |
| HDRG165†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 22/06/19 Sample                                     |                |        |
| HDRG166†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 22/06/19 Sample                                     |                |        |
| HDRG167†      | Colônia de Pesca Z-13, Posto 6, Copacabana | 22/06/19 Sample                                     |                |        |
| Species                                | Sample Code | Sample Site                          | Collection Day | Source |
|----------------------------------------|-------------|--------------------------------------|----------------|--------|
| HDRG168†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 22/06/19       | Sample      |
| HDRG169†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/06/19       | Sample      |
| HDRG170†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/06/19       | Sample      |
| HDRG171†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/06/19       | Sample      |
| HDRG172†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/06/19       | Sample      |
| HDRG173†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/06/19       | Sample      |
| HDRG216†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 12/09/19       | Sample      |
| HDRG217†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 12/09/19       | Sample      |
| HDRG218†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 12/09/19       | Sample      |
| **Galeocerdo cuvier** (Péron & Le Sueur in Le Sueur, 1822) | HDRG251†   | Colônia de Pesca Z-13, Posto 6, Copacabana | 05/04/18 | Sample |
| HDRG250†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 20/09/19       | Sample      |
| **Carcharhinus falciformis** (Müller & Henle 1839) | VB17*     | Colônia de Pesca Z-7, Itaipu | 12/07/16 | Photo  |
| HDRG072†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 21/01/19       | Sample      |
| HDRG073†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 22/01/19       | Sample      |
| HDRG074†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 23/01/19       | Sample      |
| HDRG127†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/04/19       | Sample      |
| HDRG140†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 16/04/19       | Sample      |
| HDRG190*                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 26/07/19       | Photo       |
| HDRG191*                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 26/07/19       | Photo       |
| VB06*                                  | Colônia de Pesca Z-7, Itaipu | 11/05/16 | Photo       |
| VB12*                                  | Colônia de Pesca Z-7, Itaipu | 01/06/16 | Photo       |
| VB18*                                  | Colônia de Pesca Z-7, Itaipu | 20/07/16 | Photo       |
| **Sphyrna lewini** (Griffith & Smith, 1834) | SC006†     | Cais de Tamoios, Cabo Frio | 16/01/18 | Sample |
| HDRG010†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 04/10/18       | Sample      |
| HDRG013†                               | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/10/18       | Sample      |
| Species | Sample Code | Sample Site | Collection Day | Source |
|---------|-------------|-------------|----------------|--------|
| HDRG034† | Colônia de Pesca Z-13, Posto 6, Copacabana | 06/12/18 | Sample |
| HDRG183* | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/07/19 | Photo |
| HDRG184* | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/07/19 | Photo |
| HDRG185* | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/07/19 | Photo |
| HDRG189* | Colônia de Pesca Z-13, Posto 6, Copacabana | 26/07/19 | Photo |
| HDRG220† | Colônia de Pesca Z-13, Posto 6, Copacabana | 14/09/19 | Sample |
| VB07* | Colônia de Pesca Z-7, Itaipu | 21/05/16 | Photo |
| VB08* | Colônia de Pesca Z-7, Itaipu | 21/05/16 | Photo |
| VB09* | Colônia de Pesca Z-7, Itaipu | 21/05/16 | Photo |
| VB11* | Colônia de Pesca Z-7, Itaipu | 21/05/16 | Photo |
| VB13* | Colônia de Pesca Z-7, Itaipu | 25/06/16 | Photo |
| VB16* | Colônia de Pesca Z-7, Itaipu | 12/07/16 | Photo |
| VB03* | Colônia de Pesca Z-7, Itaipu | Sem data | Photo |
| *Sphyrna zygaena* (Linnaeus, 1758) | HDRG192† | Colônia de Pesca Z-13, Posto 6, Copacabana | 16/08/19 | Sample |
| HDRG219† | Colônia de Pesca Z-13, Posto 6, Copacabana | 14/09/19 | Sample |
| VB15* | Colônia de Pesca Z-7, Itaipu | 12/07/16 | Photo |
| VB01* | Colônia de Pesca Z-7, Itaipu | Sem data | Photo |
| VB02* | Colônia de Pesca Z-7, Itaipu | Sem data | Photo |
| *Atlantoraja castelnaui* (Ribeiro, 1907) | SC007† | Cais de Tamoios, Cabo Frio | 18/01/18 | Sample |
| SC008† | Cais de Tamoios, Cabo Frio | 16/01/18 | Sample |
| HDRG009* | Colônia de Pesca Z-13, Posto 6, Copacabana | 02/10/18 | Photo |
| HDRG012* | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/10/18 | Photo |
| HDRG040† | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/12/18 | Sample |
| HDRG041† | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/12/18 | Sample |
| HDRG048† | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/01/19 | Sample |
| HDRG200* | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/09/19 | Photo |
| HDRG232* | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/09/19 | Photo |
| HDRG233* | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/09/19 | Photo |
| Species                        | Sample Code | Sample Site                                           | Collection Day | Source |
|-------------------------------|-------------|------------------------------------------------------|----------------|--------|
| **Rioraja agassizi** (Müller & Henle, 1841) | HDRG234*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 17/09/19       | Photo  |
|                               | HDRG235*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 17/09/19       | Photo  |
|                               | HDRG236*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 17/09/19       | Photo  |
|                               | HDRG237*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 17/09/19       | Photo  |
|                               | HDRG238*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 17/09/19       | Photo  |
|                               | VB14*       | Colônia de Pesca Z-7, Itaipu                        | 06/07/16       | Photo  |
|                               | SC009†      | Cais de Tamoios, Cabo Frio                          | 16/01/18       | Sample |
|                               | SC010†      | Cais de Tamoios, Cabo Frio                          | 16/01/18       | Sample |
|                               | SC011†      | Cais de Tamoios, Cabo Frio                          | 16/01/18       | Sample |
|                               | HDRG077†    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 23/01/19       | Sample |
| **Gurgesiella dorsalifera** (McEachran & Compagno, 1980) | SC014†      | Cais de Tamoios, Cabo Frio                          | 16/01/18       | Sample |
| **Narcine brasiliensis** (Ofers, 1831) | HDRG221†    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 15/09/19       | Sample |
| **Dasyatis hypostigma** (Santos & Carvalho, 2004) | HDRG001*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 22/09/18       | Photo  |
|                               | HDRG019*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG020*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG021*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG022*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG023*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG024*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG025*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG026*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 03/11/18       | Photo  |
|                               | HDRG027*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 10/11/18       | Photo  |
|                               | HDRG028*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 10/11/18       | Photo  |
|                               | HDRG029*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 18/11/18       | Photo  |
|                               | HDRG030*    | Colônia de Pesca Z-13, Posto 6, Copacabana          | 18/11/18       | Photo  |
| Species       | Sample Code | Sample Site                                      | Collection Day | Source |
|--------------|-------------|--------------------------------------------------|----------------|--------|
|              | HDRG128†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/04/19       | Sample |
|              | HDRG141†    | Cais de Tamoios, Cabo Frio                       | 18/05/19       | Sample |
|              | HDRG142†    | Cais de Tamoios, Cabo Frio                       | 18/05/19       | Sample |
|              | HDRG186*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/07/19       | Photo  |
|              | HDRG187*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/07/19       | Photo  |
|              | HDRG188*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/07/19       | Photo  |
|              | HDRG193*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/08/19       | Photo  |
|              | HDRG196*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 25/08/19       | Photo  |
|              | HDRG197*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 25/08/19       | Photo  |
|              | HDRG201†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 09/09/19       | Sample |
|              | HDRG205†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/09/19       | Sample |
|              | HDRG206†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/09/19       | Sample |
|              | HDRG212†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 12/09/19       | Sample |
|              | HDRG213†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 12/09/19       | Sample |
|              | HDRG214†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 12/09/19       | Sample |
|              | HDRG215*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 12/09/19       | Photo  |
|              | HDRG239*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/09/19       | Photo  |
|              | HDRG240*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/09/19       | Photo  |
|              | HDRG241*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/09/19       | Photo  |
|              | HDRG242*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/09/19       | Photo  |
|              | HDRG243*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 17/09/19       | Photo  |
|              | HDRG246*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 18/09/19       | Photo  |

*Hypanus guttatus* (Bloch & Schneider, 1801)

| Species       | Sample Code | Sample Site                                      | Collection Day | Source |
|--------------|-------------|--------------------------------------------------|----------------|--------|
|              | HDRG202†    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 10/09/19       | Sample |
|              | HDRG208*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/09/19       | Photo  |
|              | HDRG209*    | Colônia de Pesca Z-13, Posto 6, Copacabana       | 11/09/19       | Photo  |
| Species                          | Sample Code | Sample Site                                      | Collection Day | Source   |
|---------------------------------|-------------|-------------------------------------------------|----------------|----------|
| Hypanus americanus              | HDRG198†    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 08/09/19       | Sample   |
| (Hildebrand and Schroeder, 1928)| HDRG199†    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 08/09/19       | Sample   |
|                                 | HDRG203†    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 10/09/19       | Sample   |
|                                 | HDRG204†    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 10/09/19       | Sample   |
|                                 | HDRG230*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 17/09/19       | Photo    |
|                                 | HDRG231*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 17/09/19       | Photo    |
|                                 | HDRG244*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 18/09/19       | Photo    |
|                                 | HDRG245*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 18/09/19       | Photo    |
| Pteroplatytrygon violacea       | HDRG123*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 08/04/19       | Photo    |
| (Bonaparte, 1832)               | HDRG003*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 27/09/18       | Photo    |
| Gymnura altavela                | HDRG004*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 27/09/18       | Photo    |
| (Linnaeus, 1758)                | HDRG015*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 19/10/18       | Photo    |
|                                 | HDRG016*    | Colônia de Pesca Z-13, Posto 6, Copacabana      | 19/10/18       | Photo    |
| Species                        | Sample Code | Sample Site                               | Collection Day | Source |
|-------------------------------|-------------|-------------------------------------------|----------------|--------|
| *Aetobatus narinari*           | HDRG017*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 19/10/18       | Photo  |
|                               | HDRG047†    | Colônia de Pesca Z-13, Posto 6, Copacabana | 20/12/18       | Sample |
|                               | HDRG096*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 02/04/19       | Photo  |
|                               | HDRG147*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 31/05/19       | Photo  |
|                               | HDRG161*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 12/06/19       | Photo  |
|                               | HDRG162*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 12/06/19       | Photo  |
| *Myliobatis goodei*           | HDRG181†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | HDRG194*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/08/19       | Photo  |
|                               | HDRG195*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/08/19       | Photo  |
|                               | HDRG248*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 19/09/19       | Photo  |
|                               | HDRG253*    | Cais de Tamoios, Cabo Frio                | 19/01/19       | Photo  |
| *Pseudobatos horkelii*        | HDRG25†     | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
| (Muller & Henle, 1841)        | SC001†      | Cais de Tamoios, Cabo Frio                | 18/01/18       | Sample |
|                               | SC002†      | Cais de Tamoios, Cabo Frio                | 18/01/18       | Sample |
|                               | SC003†      | Cais de Tamoios, Cabo Frio                | 01/02/18       | Sample |
|                               | SC004†      | Cais de Tamoios, Cabo Frio                | 01/02/18       | Sample |
|                               | SC005†      | Cais de Tamoios, Cabo Frio                | 01/02/18       | Sample |
|                               | HDRG044†    | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/12/18       | Sample |
|                               | HDRG056†    | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
|                               | HDRG057†    | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
|                               | HDRG058†    | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
|                               | HDRG174†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | HDRG175†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | HDRG176†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | HDRG177†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | HDRG178†    | Cais de Tamoios, Cabo Frio                | 29/06/19       | Sample |
|                               | VB10*       | Colônia de Pesca Z-7, Itaipu              | 21/05/16       | Photo  |
| *Pseudobatos percellens*      | HDRG014*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/10/18       | Photo  |
| Species            | Sample Code | Sample Site                        | Collection Day | Source |
|--------------------|-------------|------------------------------------|----------------|--------|
| (Muller & Henle, 1841) | HDRG018*    | Colônia de Pesca Z-13, Posto 6, Copacabana | 25/10/18       | Photo  |
| HDRG031*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 29/11/18       | Photo  |
| HDRG032*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 29/11/18       | Photo  |
| HDRG033*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 29/11/18       | Photo  |
| HDRG042†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/12/18       | Sample |
| HDRG043†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 13/12/18       | Sample |
| HDRG049†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/01/19       | Sample |
| HDRG050†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 08/01/19       | Sample |
| HDRG051†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/01/19       | Sample |
| HDRG052†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/01/19       | Sample |
| HDRG059†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
| HDRG060†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
| HDRG061†           | Colônia de Pesca Z-13, Posto 6, Copacabana | 17/01/19       | Sample |
| HDRG082*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 01/02/19       | Photo  |
| HDRG083*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 01/02/19       | Photo  |
| HDRG124*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/04/19       | Photo  |
| HDRG125*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/04/19       | Photo  |
| HDRG126*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 11/04/19       | Photo  |
| HDRG129*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
| HDRG130*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
| HDRG131*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
| HDRG132*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
| HDRG133*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
| HDRG134*           | Colônia de Pesca Z-13, Posto 6, Copacabana | 15/04/19       | Photo  |
are presented in Table 1, while data concerning elasmobranch individuals landed at three artisanal fishing colonies in the state of Rio de Janeiro, Brazil, from 2016 to 2019 are presented in Table 2.

Frequency data for each elasmobranch species landed at the Tamoios, Z-7 and Z-13 artisanal colonies is displayed in Figure 2. It is important to note that no standardized sampling effort was carried out in this study, so no frequency proportion extrapolation is possible for the analyzed areas.

**Table 1.** Elasmobranch species landed at three artisanal fishing colonies in the state of Rio de Janeiro, Brazil, from 2016 to 2019.

| Species | Sample Code | Sample Site | Collection Day | Source |
|---------|-------------|-------------|----------------|--------|
| *Zapteryx brevirostris* | HDRG075† | Colônia de Pesca Z-13, Posto 6, Copacabana | 23/01/19 | Sample |
| (Muller & Henle, 1841) | HDRG076† | Colônia de Pesca Z-13, Posto 6, Copacabana | 23/01/19 | Sample |
| | HDRG247* | Colônia de Pesca Z-13, Posto 6, Copacabana | 19/09/19 | Photo |
| | HDRG249† | Colônia de Pesca Z-13, Posto 6, Copacabana | 20/09/19 | Sample |
| | SC012† | Cais de Tamoios, Cabo Frio | 18/01/18 | Sample |

* indicates a photo source; † indicates a sample source.; # UERJ Ichthyological Collection.

**Figure 2.** Frequency data for each elasmobranch species landed at the Tamoios, Z-7 and Z-13 artisanal colonies.
Elasmobranchs landed in Rio de Janeiro 49

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Figure 3. Ray species identified during this study. (A) Dasyatis hypostigma; (B) Hypanus americanus; (C) Aetobatus narinari; (D) Hypanus guttatus; (E) Pteroplatrygon violacea; (F) Atlantoraja castelnaui.

Figure 4. Shark species identified during this study. (A) Isurus oxyrinchus; (B) Carcharhinus brevipinna; (C) Rhizoprionodon lalandii; (D) Galeocerdo cuvier; (E) Eye detail - Carcharhinus brevipinna; (F) Sphyrna lewini.; (G) Eye detail - Isurus oxyrinchus; (H) Eye detail - Rhizoprionodon lalandii.
Figure 3 illustrates elasmobranch landings and weighing by artisanal fishers for marketing, while Figures 4 and 5 illustrate some of the rays and sharks, respectively, identified during this study.

DISCUSSION

The present study reports a preliminary assessment carried out during three years regarding artisanal fishing elasmobranch landing at three locations throughout the coast of Rio de Janeiro. Although the Associação de Pesca de Tamoios, in Cabo Frio is home to the previously described upwelling phenomenon, the highest richness concerning oceanic elasmobranchs was recorded at the Z-13 colony, in Copacabana, located in the metropolitan region of Rio de Janeiro. This sampling site is a part of Guanabara Bay, and the results presented herein reinforce the significant biodiversity of the bay and the importance of its recovery for elasmobranch management and conservation strategies.

In addition, many specimens belonging to different species sampled from this site (Sphyraena zygaena, Sphyraena lewini, Carcharhinus brevipinna, Isurus oxyrinchus and Galeocerdo cuvier) were juvenile (Araujo, pers. obs.), while three spinner shark females (Carcharhinus brevipinna) with mature oocytes were also noted (Araujo, pers. obs.), indicating that this may be a strategic reproduction and juvenile settlement site for several of the landed species. This is further supported by the record of six females of Rhizoprionodon lalandii, a coastal species, containing embryos and/or oocytes, as well as the high presence of juvenile hammerhead sharks (Sphyraena lewini), indicating potential development area (Motta et al., 2005). It is noteworthy both Itaipu and Copacabana are inserted in the estuarine Guanabara Bay, while Tamoios is located the São João River, both a strong indication of an elasmobranch breeding area, as reported by Plumlee et al. (2018) and Parsons and Hoffmayer (2007). In addition to species that are more commonly caught by gillnets, more pelagic and cosmopolitan species such as Tiger (Galeocerdo cuvier) and Mako (Isurus oxyrinchus) sharks were also caught by the same fishing methodology, all juveniles, once again indicating potential elasmobranch breeding and development areas.

In its most recent report, the Rio de Janeiro Institute for Fisheries Foundation (FIPERJ) reported that, in 2016, the species identified as cacação-frango (Sharpmose shark, Rhizoprionodon sp.) was the most representative species regarding total landings, with a production of 5,212.8 kg, followed by cacação-anjo (angelfish, Squatina sp.), at 2,661.5 kg and, finally, cacação-martelo (hammerhead shark, Sphyra sp.), totaling 1,004kgs (Fundação Instituto de Pesca do Estado do Rio de Janeiro 2016). However, the data reported herein cannot be quantitatively compared to FIPERJ data, as FIPERJ provides mixed and generalized information containing artisanal, semi-industrial and industrial fishing data, where artisanal fishing represents only a portion of the catch. In addition, the different range of fishing fleets should also be taken into account, as a limiting factor for the habitat range of certain species, such as hammerhead sharks and angelfish, due to depths and distance from the shore. It is also noteworthy that FIPERJ accounts for the weight of a certain species and data per individual, which may overestimate the data, as an adult fish may weigh more than 10 juvenile individuals.

Concerning species vulnerability, Squatina occulta and Squatina guggenheim, are classified as critically endangered and endangered, respectively, according to the IUCN. In addition, Squatina guggenheim, was reported as reaching critically low levels and populational declines during the 1990s (Boeckman & Vooren, 1997; Vooren 1997; Lessa et al. 1999), indicating significant vulnerability for this species. In turn, all six hammerhead shark species distributed along the Brazilian coast are currently nationally listed as threatened (Instituto Chico Mendes de Conservação da Biodiversidade 2018). Given that the present study identified several Squatina guggenheim, Sphyraena lewini and Sphyraena zygaena individuals, it is clear that environmental education actions, measures to avoid the capture of this species or release actions alongside fishers at these locations are required, in order to sensitize them to the inherent impact of capturing these species and avoid further damage.

A significant amount of landed elasmobranch species is unidentified, or identified solely by their common names by the fishers, which also change according to fishery region (FIPERJ, 2016). For example, many unidentified species may belong to the cacação category, the Brazilian generic name for most shark species, representing a significant amount of the 3.1 tons landed in 2016 for which no scientific identification was carried out. The same is probably true for rays, as these animals are distributed into categories with popular names such as raia-pintada (stingrays) (about 1 ton) or raia-manteiga (spotted rays) (3 tons) (FIPERJ, 2016). Thus, many species may be easily confused, making it difficult to create an elasmobranch management plan, and species identification is paramount. In addition, it is important to note the significant elasmobranch role as a fishing resource in Brazil, attributed to the current market incentive for the consumption of shark meat, due to, mainly, low costs, leading to social and economic.
as well as ecological, concerns (Bornatowski et al. 2018).

Rio de Janeiro extractive marine fisheries represent about 2.5% of total shark landings caught per year in Brazil (Ministério da Pesca e Aquicultura 2014). However, in 2010 alone, in the Southwest Atlantic region, about 33% more sharks were fished in reality compared to lower figures reported by Southwest Atlantic governments to the Food and Agriculture Organization of the United Nations (FAO), attributed to artisanal, illegal and discarded fisheries (Pauly & Zeller, 2016). Allied to the lack of knowledge on the commercial and artisanal exploitation of these animals, the lack of information on the occurrence of shark species makes it difficult to employ conservation strategies aiming at the preservation and management of this resource. One way to circumvent the reported difficulties is the scientific monitoring of the artisanal fishermen colonies and performing a scientific approach towards the ecological knowledge of these fishermen, which, besides contributing to landing monitoring, enables taxonomic, physiological and genetic elasmobranch studies, furthering knowledge concerning the population ecology and geographical distribution of the group. In recent years, several studies have been conducted in Brazil addressing these issues (Palmeira et al. 2013; Barbosa-Filho et al. 2014, 2016, 2017; Bornatowski et al. 2015; Gemaque et al. 2017; Feitosa et al. 2018), denoting the relevance of information of this nature to the management and conservation of this threatened zoological group.

Dulvy et al. (2014) estimated that about a quarter of the world’s shark and ray species are threatened by overfishing, and although the state of Rio de Janeiro is flagged as one of the world’s priority shark conservation areas (Lucifora et al. 2011), the results presented herein indicate high amounts of threatened species being caught as by-catch. From an ecosystem perspective, it is well known that the presence of top predators and mesopredators as trophic regulators is essential for the functioning of ecosystem interaction webs (Stevens et al. 2000). Thus, declines in shark and ray population stocks may lead detrimental effects on marine communities (Myers et al. 2007; Bornatowski et al. 2014). The main documented phenomenon implies in the deregulation of lower trophic level maintenance exerted by top predator pressure, known as the top-down effect, thus affecting not only the ecosystem in question, but also the fishing industry itself (Ferretti et al. 2010).

In this regard, it is important to take into account the presence of keystone species. Keystone species are defined as species which “have an extremely high impact on a particular ecosystem relative to its population, and are also critical for the overall structure and function of an ecosystem, and influence which other types of organisms make up that ecosystem” (Humphries et al., 2017). Six keystone elasmobranch species have been previously observed throughout the Southeastern coast of Brazil (Bornatowski et al. 2014), and the present study reports four of them, namely Galeocerdo cuvier, Sphyrna lewini, S. zygaena and Zapteryx brevirostris, further indicating the importance of future assessments concerning elasmobranch fisheries monitoring in Brazil. In addition, due to the continuity of oceanographic conditions between the Brazilian Southeast and South, it is probable that the species reported herein display an extended ecosystem importance to the South, implicating in further social and economic concerns.

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