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Article

Ichthyofauna of the inner shelf of Paraná, Brazil: checklist, geographic distribution, economic importance and conservation status

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***Abstract*:** Comprehensive species checklists are essential to effectively implementing preservation and recovery measures, and should assess conservation status, vulnerability degree and anthropogenic threats. This checklist was compiled from fish species recorded in surveys conducted over the last 30 years in the shallow inner continental shelf in the State of Paraná, Brazil. Information on biogeography, conservation status, economic importance and degree of species' vulnerability are provided. A total of 272 fish species were recorded, spanning 25 orders and 88 families. The most speciose family was Sciaenidae (25 species), followed by Carangidae (23), Engraulidae (10), Carcharhinidae (9), Epinephelidae (9) and Paralichthyidae (9). Most species occurring in Paraná's shallow inner continental shelf are restricted to the West Atlantic. In terms of economic importance, 93% (253) of the species recorded were of fishery, aquaculture or aquaria interest. A notable fraction (39%) of the recorded species was classified as having moderate to very high vulnerability to extinction. In particular, 28 species (10%) were listed as globally endangered, and 34 species (12%) were listed as endangered in the Brazilian territory.

Keywords: *fish assemblage, species list, Southwest Atlantic, vulnerability*

Ictiofauna da plataforma interna do Paraná, Brasil: checklist, distribuição geográfica, importância econômica e estado de conservação

***Resumo*:** Listas abrangentes de espécies são essenciais para a implementação efetiva de medidas de preservação e devem avaliar o estado de conservação e o grau de vulnerabilidade das comunidades ecológicas. Esta lista foi compilada a partir de espécies de peixes registradas em pesquisas realizadas nos últimos 30 anos na plataforma continental interna rasa do Estado do Paraná. Foram fornecidas informações sobre biogeografia, estado de conservação, importância econômica e grau de vulnerabilidade das espécies. Um total de 272 espécies de peixes foram registradas, abrangendo 25 ordens e 88 famílias. A família com maior número de espécies foi Sciaenidae (25 espécies), seguida de Carangidae (23), Engraulidae (10), Carcharhinidae (9), Epinephelidae (9) e Paralichthyidae (9). A maioria das espécies registrada na plataforma continental interna do Paraná está limitada ao Atlântico Oeste. Em termos de importância econômica, 93% (253) das espécies incluídas nesta lista são comercialmente viáveis, seja na pesca, aquicultura ou aquariofilia. Uma fração notável (39%) das espécies registradas foi classificada como de vulnerabilidade moderada a muito alta. Em particular, 28 espécies (10%) estão listadas como ameaçadas de extinção em escala global, e 34 espécies (12%) estão listadas como ameaçadas de extinção no território brasileiro.

Palavras-chave: *assembleia de peixes, lista de espécies, Atlântico Sudoeste, vulnerabilidade.*

Introduction

The State of Paraná, in southern Brazil, has a 98 km long coastline, and is cut by two large estuarine complexes, namely, the Paranaguá Bay to the north and the Guaratuba Bay to the south. Its continental shelf extends from 175 to 190 km offshore, and is dominated by sandy bottoms, and a few rocky substrates (Brandini 2014).

Paraná's continental shelf harbors a rich fauna, particularly in its inner region which is nutrient enriched by the continental drainage system. Like the estuaries, the inner shelf functions as habitat for reproduction

and development of many fish species; therefore, it performs a vital role in their life cycles (Blaber 2000). In addition, the continental shelf contains several fish species of commercial importance.

There have been several studies on the fish fauna in the Paranaguá Estuarine Complex (Hackradt et al. 2009; Félix-Hackradt et al. 2010; Ignácio & Spach 2010; Contente et al. 2011; Passos et al. 2012; Pichler et al. 2015, 2017; Possatto et al. 2017) and in the Guaratuba Bay (Chaves & Corrêa 1998; Chaves & Vendel 2001). On the other hand, few studies have focused on the continental shelf region, especially those assessing the taxonomic composition of the ichthyofauna (Santos 2006; Carniel 2008; Schwarz-Junior 2010). Of concern is the threat to the region's fish biodiversity, most notably due to overfishing, deposition of dredged sediments, habitat loss, and deployment of new habitats, such as artificial reefs, whose impact on biodiversity is not yet fully understood. In this study, we have compiled a checklist of fish species inhabiting the shallow inner continental shelf of Paraná. Considerations about geographic distribution, conservation status, economic importance, and degree of vulnerability to extinction are provided. This checklist compiles useful information in a single document that should be of great help in devising measures of preservation and species recovery.

Material and Methods

Data on fish species inhabiting the inner continental shelf of the State of Paraná were compiled from the peer-reviewed literature (Corrêa et al. 1986; Chaves et al. 2003; Godefroid et al. 2004; Costa & Chaves 2006; Gomes & Chaves 2006; Santos et al. 2006; Félix et al. 2007a; Félix et al. 2007b; Bornatowski et al. 2009; Hackradt & Hackradt 2009; Hackradt et al. 2011; Daros et al. 2012; Bornatowski et al. 2014a; Bornatowski et al. 2014b; Rossi-Wongtschowski et al. 2014, Santos et al. 2016) as well as less accessible academic literature (Santos 2006 and Carniel 2008 - master thesis; Schwarz-Junior 2010 and Spier 2016 - PhD thesis) published over the past 30 years. The full extent of Paraná's shallow inner continental shelf was sampled down to the 20 m isobath, including areas near the mouth of the Paranaguá Estuarine Complex and the Guaratuba Bay (Figure 1). Overall, gillnetting, trawling, and underwater visual census were the main sampling methods used in the studies compiled in this work. Further details on sampling methods and sampling areas are provided in Table 1. The taxonomic classification and nomenclature follows Marceniuk (2005), Craig & Hastings (2007), Smith & Craig (2007), Figueiredo & Menezes (2009), Carvalho-Filho et al. (2010), Menezes et al. (2010) and Eschmeyer et al. (2014). Orders and families are listed according to

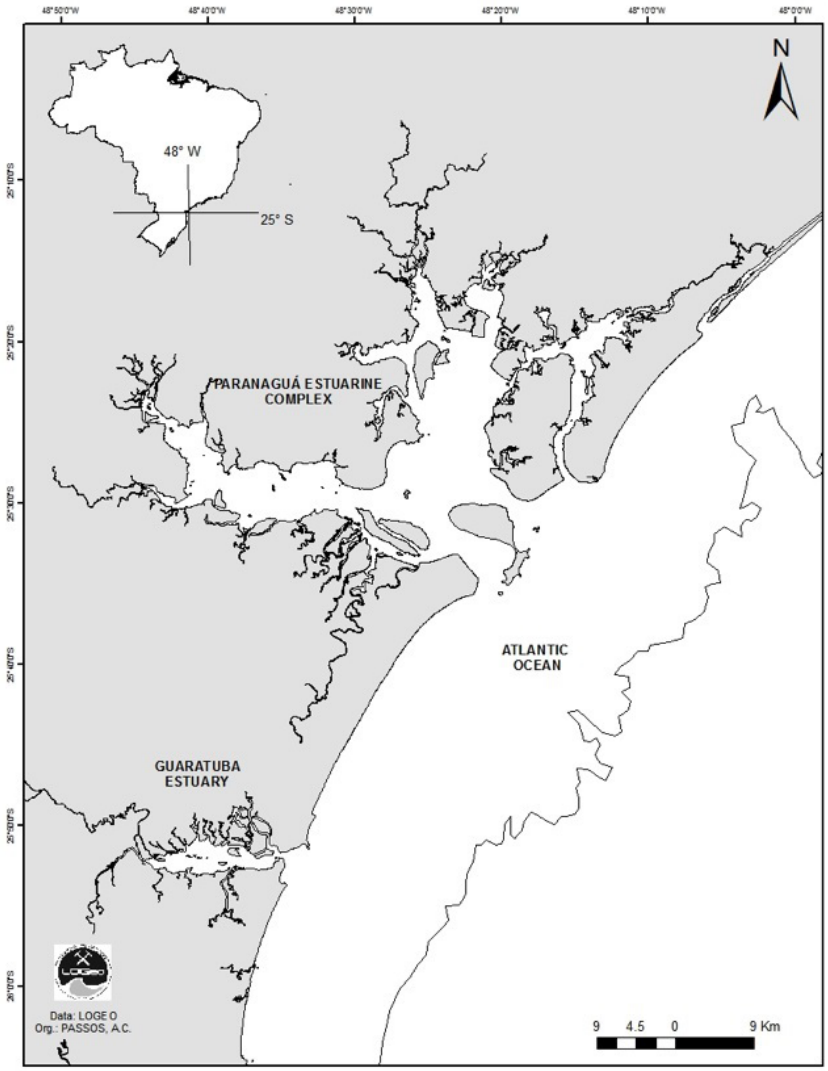

Figure 1. Map of the shallow inner continental shelf of Paraná, Brazil, showing the Paranaguá Estuarine Complex and the Guaratuba estuary. The contour represents the 20-meter isobath.

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Table 1. Details on methods and sampling areas of the different sources consulted. "x"indicates absence of depth data.

Source	Site	Year	Methods	Isobath
Corrêa et al. (1986)	Coasts of Matinhos, Pontal do Sul, Caiobá e Mel island	until 1986 (since 1942)	Museum collections	x
Chaves et al. (2003)	Matinhos shelf	March 1999 to January 2000	Bottom trawl nets (mesh of 2.5 cm)	10 and 15 m
Godefroid et al. (2004)	Shallow infralittoral of Atami Beach (25°30'S; 48°15'W)	July 1998 to June 1999	Bottom trawl nets (mesh of 1 cm)	8 and 12 m
Costa & Chaves (2006)	Paraná Continental Shelf	July 2001 to March 2003	Trawling and gillnet	8 to 20 m
Gomes & Chaves (2006)	2 km from the Guaratuba coast (25°52'S/48°39'W to 25°59'S/48°36'W)	April 2001 to March 2002	Bottom trawl nets (mesh of 3 cm)	10 m
Santos (2006)	Paraná Continental Shelf (25°26'S to 25°40'S / 48°08'W to 48°26'W)	August 2000 to July 2001	Bottom trawl nets (mesh of 3 cm)	6 to 17 m
Felix et al. (2007)	Next to the entrance of Paranaguá Bay / Pontal do Sul beach	June 2004 to May 2005	Beach seine net, 15 m long and 2.6 m height - mesh size of 5 mm.	2 m
Carniel (2008)	Paraná Continental Shelf	2005 and 2006	Trawling and gillnet	8 to 20 m
Bornatowski et al. (2009)	PR	until 2009	Museum/Literature/ field surveys	x
Hackradt & Hackradt (2009)	Currais (25°44' S, 48°22' W), Itacolomis (25°50' S, 48°24' W) and Artificial Reefs between these two islands	November 2006 to July 2007	Underwater visual census (SCUBA)	6 to 20 m
Schwarz-Junior (2009)	Paraná Continental Shelf	August 2004 to July 2005	Bottom trawl nets (mesh of 2.5 cm)	6, 9, 12 and 15 m
Hackradt et al. (2011)	Currais (25°44' S, 48°22' W), Itacolomis (25°50' S, 48°24' W) and Artificial Reefs between these two islands	January 2006 to March 2006	Underwater visual census (SCUBA)	6 to 20 m
Daros et al. (2012)	Currais Archipelago (25°44' S, 48°22' W) and Itacolomis Island (25°50' S, 48°24' W)	October 2008 to August 2009	Underwater visual census (SCUBA)	3 to 9 m
Bornatowski et al. (2014a)	20 km from the coast	April 2010 to March 2012	Gillnet of 7, 9, 11, 16, 18 and 45 cm mesh-size	20 m
Bornatowski et al. (2014b)	Itacolomis Island (15 km from the coast)	September 2011	Gillnet of 9 cm mesh-size	10 and 12 m
Rossi-Wongtschowski et al. (2014)	Paraná Continental Shelf	1995 to 2010	Mid-water trawl nets (mesh of 4 cm)	18 to 145 m
Santos et al. (2016)	Paraná Continental Shelf (25°20'S to 25°50'S / 48°08'W to 48°26'W)	August 2000 to July 2001 and August 2004 and July 2005	Bottom trawl nets (mesh of 3 cm)	6, 9, 12 and 15 m
Spier (2016)	Islands (Currais, Figueira, Galheta)	2012 to 2016	Underwater visual census (free dive)	3 to 16 m

phylogenetic order (Eschmeyer et al. 2014) and the species inside each family are organized in alphabetical order.

To analyze the zoogeographic affinities of the fauna, the species were classified in geographic distribution categories based on Floeter et al. (2008), Luiz Jr et al. (2008), Eschmeyer et al. (2014) and Froese & Pauly (2017). The categories were: CT = Circumtropical, TA = Trans-Atlantic (Western and Eastern Atlantic Ocean), WA = Western Atlantic (Northern and Southern Atlantic Ocean), SWA = Southwest Atlantic (ranging from Northern Brazil to Argentina), SSWA = Southern Southwest Atlantic (Southeastern and Southern Brazil, Uruguay and Argentina), Ca = Caribbean (ranging from Florida to Venezuela), Br = Brazilian Province [ranging from the Orinoco River Delta in Venezuela to the State of Santa Catarina in Brazil (*sensu* Briggs & Bowen 2012)], and EP = Eastern Pacific.

Regarding species' economic importance in Brazil, we defined four categories, namely, 1) food: referring to human consumption, 2) animal feed, 3) aquarium, and 4) none: referring to species without any identified commercial purpose. Categories 1, 2, and 4 were implemented based on the work of Menezes et al. (2003); Figueiredo & Menezes (2009); Froese & Pauly (2017), as well as on the authors' previous knowledge. Category 3 was implemented based on the technical and scientific bulletin of CEPENE (2005), which lists marine fish species allowed for capture in Brazil. Furthermore, we also indicate which species have economic importance specifically for the State of Paraná, based on the authors' knowledge.

Vulnerability to extinction was categorized as *low, low to moderate, moderate, moderate to high, high, high to very high,* and *very high,* following FishBase (Froese & Pauly 2017). These categories were determined based on the life history and ecological characteristics of each species (Cheung et al. 2005). Species were also classified according to the IUCN categories (IUCN 2017) and the national status of conservation proposed by the Brazilian Ministry of Environment (MMA 2014). Conservation status and vulnerability to extinction provide a rough assessment of species' endangerment.

Results

A total of 272 fish species (234 Actinopterygii and 38 Elasmobranchii) distributed over 25 orders and 88 families were recorded in the shallow inner continental shelf of Paraná (Table 2). The order richest in species was Perciformes (146), followed by Pleuronectiformes (18), Rajiformes (18), Clupeiformes (16) and Carcharhiniformes (15). Sciaenidae was the richest family with 25 species, followed by Carangidae (23), Engraulidae (10), Paralichthyidae (9), Epinephelidae (9) and Carcharhinidae (9).

Table 2. Taxonomic classification of the ichthyofauna recorded in the shallow inner shelf of Paraná, Brazil. Geographic Distribution: CT = Circuntropical, TA = Trans-Atlantic, WA = Western Atlantic, SWA = Southern West Atlantic, SSWA = Southern Southwest Atlantic, Ca = Caribbean, Br = Brazilian Province and EP = Eastern Pacific. Global conservation status according to IUCN (2010) and national conservation status according to MMA (2014): NE= not evaluated, LC= least concern, NT = near threatened, DD = data deficient, VU = vulnerable, EN= endangered, CR = critically endangered. Economic importance in Brazil. Asterisk indicate which species have economic importance specifically for the State of Paraná.

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Orectolobiformes						
Rhincodontidae						
Rhincodon typus Smith, 1828	Ta+EP	No	very high	VU	EN	Bornatowski et al. (2009); Spier (2016)
Carcharhiniformes						
Triakidae						
Mustelus canis (Mitchill, 1815)	WA	food*	very high	EN	NT	Bornatowski et al. (2009)
Mustelus schmitti Springer, 1939	SSWA	food*	high	CR	EN	Corrêa et al. (1986); Bornatowski et al. (2009)
Carcharhinidae						
Carcharhinus brevipinna (Müller & Henle, 1839)	CT	food*	high	DD	NT	Bornatowski et al. (2009)
Carcharhinus falciformis (Müller & Henle, 1839)	CT	food*	high	NT	NT	Costa & Chaves (2006); Bornatowski et al. (2009)
Carcharhinus limbatus (Müller & Henle, 1839)	CT	food*	high	NT	NT	Bornatowski et al. (2009); Bornatowski et al. (2014a)
Carcharhinus plumbeus (Nardo, 1827)	CT	food*	very high	CR	VU	Bornatowski et al. (2009)
Carcharhinus porosus (Ranzani, 1839)	WA+EP	food*	very high	CR	DD	Corrêa et al. (1986); Bornatowski et al. (2009)
Carcharhinus obscurus (Lesueur, 1818)	CT	food*	very high	EN	VU	Bornatowski et al. (2009), Bornatowski et al. (2014a)
Galeocerdo cuvier (Péron & Lesueur, 1822)	CT	food*	high	NT	NT	Costa & Chaves (2006); Bornatowski et al. (2009); Bornatowski et al. (2014a)
Rhizoprionodon lalandii (Müller & Henle, 1839)	Ca+SSWA+Br	food*	moderate	NT	DD	Costa & Chaves (2006); Bornatowski et al. (2009); Bornatowski et al. (2014a)
Rhizoprionodon porosus (Poey, 1861)	Ca+SSWA+Br	food*	moderate to high	DD	LC	Costa & Chaves (2006); Bornatowski et al. (2009)
Scyliorhinidae						
Schroederichthys bivius (Müller & Henle, 1838)	SSWA+Br+EP	animal feed	moderate to high	-	DD	Bornatowski et al. (2014b)
Sphyrnidae						
Sphyrna lewini (Griffith & Smith, 1834)	CT	food*	very high	CR	EN	Costa & Chaves (2006); Santos (2006); Bornatowski et al. (2009); Bornatowski et al. (2014a); Santos et al. (2016)
Sphyrna tiburo (Linnaeus, 1758)	WA+EP	food*	moderate to high	CR	LC	Bornatowski et al. (2009)
Sphyrna zygaena (Linnaeus, 1758)	CT	food*	very high	CR	VU	Costa & Chaves (2006); Bornatowski et al. (2009); Bornatowski et al. (2014a)
Lamniformes						
Odontaspididae						
Carcharias taurus Rafinesque, 1810	CT	food*	high	CR	VU	Bornatowski et al. (2009)
Squaliformes						
Squalidae						
Squalus acanthias Linnaeus, 1758	CT	food*	high to very high	CR	VU	Bornatowski et al. (2009)
Squatiniformes						
Squatinidae						
Squatina guggenheim Marini, 1936	SWA	food*	high	CR	EN	Costa & Chaves (2006); Bornatowski et al. (2009)
Squatina occulta Vooren & da Silva, 1992	SWA	food*	high to very high	CR	EN	Bornatowski et al. (2009)

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Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Rajiformes						
Rhinobatidae						
Pseudobatos horkelii Müller & Henle, 1841	SWA	food*	high to very high	CR	CR	Chaves et al. (2003); Bornatowski et al. (2009)
Pseudobatos percellens (Walbaum, 1792)	TA	food*	high	DD	NT	Chaves et al. (2003); Costa & Chaves (2006); Santos (2006); Carniel (2008); Bornatowski et al. (2009); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Santos et al. (2016); Spier (2016)
Zapteryx brevirostris (Müller & Henle, 1841)	SWA	food*	moderate	VU	VU	Chaves et al. (2003); Costa & Chaves (2006); Santos (2006); Carniel (2008); Bornatowski et al. (2009); Schwarz-Junior (2009); Santos et al. (2016)
Narcinidae						
Narcine brasiliensis (Olfers, 1831)	WA	No	low to moderate	DD	DD	Chaves et al. (2003); Godefroid et al. (2004); Costa & Chaves (2006); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Bornatowski et al. (2009); Schwarz-Junior (2009); Santos et al. (2016)
Arhynchobatidae						
Atlantoraja castelnaui (Miranda Ribeiro, 1907)	SWA	food	very high	EN	EN	Bornatowski et al. (2009)
Atlantoraja cyclophora (Regan, 1903)	WA	food	high	NT	VU	Bornatowski et al. (2009)
Atlantoraja platana (Günther, 1880)	SWA	food	high	DD	VU	Bornatowski et al. (2009)
Rioraja agassizii (Müller & Henle, 1841)	SSWA	food*	high to very high	EN	VU	Costa & Chaves (2006); Bornatowski et al. (2009)
Dasyatidae						
Hypanus americanus Hildebrand & Schroeder, 1928	WA	food*	very high	DD	DD	Costa & Chaves (2006); Bornatowski et al. (2009)
Hypanus guttatus (Bloch & Schneider, 1801)	Ca+Br	food*	very high	-	DD	Costa & Chaves (2006); Bornatowski et al. (2009); Schwarz-Junior (2009); Santos et al. (2016); Spier (2016)
Dasyatis hypostigma Santos & Carvalho, 2004	SWA	food*	high to very high	DD	DD	Costa & Chaves (2006); Bornatowski et al. (2009); Spier (2016)
Gymnuridae						
Gymnura altavela (Linnaeus, 1758)	TA	food*	moderate to high	CR	VU	Costa & Chaves (2006); Santos (2006); Bornatowski et al. (2009); Santos et al. (2016); Spier (2016)
Myliobatidae						
Aetobatus narinari (Euphrasen, 1790)	CT	food*	high to very high	DD	NT	Bornatowski et al. (2009); Hackradt & Hackradt (2009); Daros et al. (2012); Spier (2016)
Mobula birostris (Walbaum, 1792)	CT	No	very high	VU	VU	Bornatowski et al. (2009); Hackradt & Hackradt (2009); Spier (2016)
Mobula hypostoma (Bancroft, 1831)	WA	No	high	VU	DD	Bornatowski et al. (2009)
Myliobatis goodei Garman, 1885	CT	food*	moderate to high	CR	DD	Costa & Chaves (2006); Bornatowski et al. (2009)
Rhinopteridae						
Rhinoptera bonasus (Mitchill, 1815)	TA	food*	high	DD	NT	Corrêa et al. (1986); Bornatowski et al. (2009); Schwarz-Junior (2009); Santos et al. (2016)
Rhinoptera brasiliensis Müller, 1836	SWA	food*	moderate to high	CR	EN	Bornatowski et al. (2009); Spier (2016)
Elopiformes						
Elopidae						
Elops saurus Linnaeus, 1766	WA	animal feed	moderate	-	LC	Carniel (2008); Spier (2016)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Anguilliformes						
Muraenidae						
Gymnothorax funebris Ranzani, 1839	WA	aquarium / food	high to very high	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Gymnothorax miliaris (Kaup, 1856)	TA	aquarium	moderate	-	LC	Spier (2016)
Gymnothorax moringa (Cuvier, 1829)	WA	aquarium / food	very high	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Gymnothorax ocellatus Agassiz, 1831	SWA+Ca	aquarium	high	DD	LC	Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Gymnothorax vicinus (Castelnau, 1855)	TA	aquarium / food	high	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Ophichthidae						
Myrichthys breviceps (Richardson, 1848)	WA	aquarium	moderate to high	-	LC	Daros et al. (2012); Spier (2016)
Ophichthus gomesii (Castelnau, 1855)	WA	No	high	-	LC	Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Muraenesocidae						
Cynoponticus savanna (Bancroft, 1831)	Ca+Br	No	high to very high	-	LC	Godefroid et al. (2004)
Clupeiformes						
Clupeidae						
Harengula clupeola (Cuvier, 1829)	WA	animal feed*	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Opisthonema oglinum (Lesueur, 1818)	WA	food*	low to moderate	-	LC	Corrêa et al. (1986); Felix et al. (2007); Schwarz Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Platanichthys platana (Regan, 1917)	SSWA	animal feed*	low	-	NE	Felix et al. (2007); Schwarz Junior (2009); Santos et al. (2016)
Sardinella brasiliensis (Steindachner, 1879)	SSWA	food*	low	DD	NE	Godefroid et al. (2004); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Engraulidae						
Anchoa filifera (Fowler, 1915)	Ca+Br	food	low	-	LC	Corrêa et al. (1986); Gomes & Chaves (2006)
Anchoa lyolepis (Evermann & Marsh, 1900)	WA	food*	low	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Anchoa parva (Meek & Hildebrand 1923)	WA	food	low	-	LC	Félix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Anchoa spinifer (Valenciennes, 1848)	Ca+Br+EP	food	low	-	LC	Santos (2006); Carniel(2008); Schwarz Junior (2009); Santos et al. (2016)
Anchoa tricolor (Spix & Agassiz, 1829)	SWA	food*	low	-	NE	Corrêa et al. (1986); Godefroid et al. (2004); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Anchovia clupeoides (Swainson, 1839)	Ca+Br	food	low	-	LC	Carniel (2008); Schwarz Junior (2009); Santos et al. (2016)
Anchoviella lepidentostole (Fowler, 1911)	Br	food	low	-	LC	Gomes & Chaves (2006); Santos (2006); Santos et al. (2016); Santos et al. (2016); Spier (2016)
Cetengraulis edentulus (Cuvier, 1829)	Ca+Br	animal feed*	moderate	-	LC	Corrêa et al. (1986); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Engraulis anchoita Hubbs & Marini, 1935	SSWA	food	moderate	-	NE	Santos (2006); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Lycengraulis grossidens (Spix & Agassiz, 1829)	SWA	food*	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Pristigasteridae						
Chirocentrodon bleekerianus (Poey, 1867)	Ca+Br	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Pellona harroweri (Fowler, 1917)	Ca+Br	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Siluriformes						
Ariidae						
Aspistor luniscutis (Valenciennes, 1840)	Br	food*	low	-	NE	Gomes & Chaves (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Bagre bagre (Linnaeus, 1766)	Ca+Br	food*	moderate to high	NT	LC	Corrêa et al. (1986); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Bagre marinus (Mitchill, 1815)	WA	food*	high	-	LC	Carniel (2008)
Cathorops spixii (Spix & Agassiz, 1829)	Ca+Br	food*	moderate	-	NE	Chaves et al. (2003); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Genidens barbus (Lacepède, 1803)	SSWA	food*	high	EN	NE	Chaves et al. (2003); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Spier (2016); Santos et al. (2016)
Genidens genidens (Cuvier, 1829)	SSWA	food*	moderate	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Notarius grandicassis (Valenciennes, 1840)	Br	food*	moderate to high	-	LC	Schwarz Junior (2009); Santos et al. (2016)
Stomiiformes						
Sternoptychidae						
Maurolicus stehmanni Parin & Kobyliansky, 1993	SWA	animal feed	low	-	NE	Rossi-Wongtschowski et al. (2014)
Aulopiformes						
Synodontidae						
Saurida brasiliensis Norman, 1935	Ta	animal feed	low	-	LC	Rossi-Wongtschowski et al. (2014)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Synodus foetens (Linnaeus, 1766)	WA	aquarium	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Felix et al. (2007); Hackradt & Hackradt (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Synodus synodus (Linnaeus, 1758)	TA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012)
Gadiformes						
Bregmacerotidae						
Bregmaceros atlanticus Goode & Bean, 1886	CT	No	low	-	LC	Rossi-Wongtschowski et al. (2014)
Bregmaceros cantori Milliken & Houde, 1984	Ca+Br	No	low	-	LC	Rossi-Wongtschowski et al. (2014)
Phycidae						
Urophycis brasiliensis (Kaup, 1858)	SSWA	food*	moderate	NT	NE	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Urophycis mystacea Miranda Ribeiro, 1903	SSWA	animal feed	low	NT	NE	Rossi-Wongtschowski et al. (2014)
Merlucciidae						
Merluccius hubbsi Marini, 1933	SSWA	food*	high	NT	NE	Rossi-Wongtschowski et al. (2014)
Batrachoidiformes						
Batrachoididae						
Porichthys porosissimus (Cuvier, 1829)	SSWA	aquarium	moderate	-	NE	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Lophiiformes						
Ogcocephalidae						
Ogcocephalus vespertilio (Linnaeus, 1758)	SWA+Ca	aquarium	moderate	-	NE	Corrêa et al. (1986); Santos (2006); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Santos et al. (2016)
Gobiesociformes						
Gobiesocidae						
Gobiesox strumosus Cope, 1870	WA+EP	aquarium	low to moderate	-	LC	Corrêa et al. (1986)
Atheriniformes						
Atherinopsidae						
Atherinella brasiliensis (Quoy & Gaimard, 1825)	WA	animal feed*	low	-	LC	Corrêa et al. (1986); Spier (2016)
Odontesthes bonariensis (Valenciennes, 1835)	SSWA	food	low to moderate	DD	NE	Félix et al. (2007)
Beloniformes						
Belonidae						
Strongylura timucu (Walbaum, 1792)	WA	animal feed	moderate	-	LC	Félix et al. (2007); Spier (2016)
Hemiramphidae						
Hemiramphus brasiliensis (Linnaeus, 1758)	TA	food*	low to moderate	-	LC	Godefroid et al. (2004); Hackradt & Hackradt (2009); Spier (2016)
Hyporhamphus unifasciatus (Ranzani, 1841)	WA+EP	food*	low	NT	LC	Godefroid et al. (2004); Félix et al. (2007); Hackradt & Hackradt (2009)
Syngnathiformes						
Syngnathidae						
Hippocampus erectus Perry, 1810	WA	aquarium	low to moderate	VU	VU	Santos (2006); Santos et al. (2016)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Microgнathus crinitus (Jenyns, 1842)	WA	No	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012)
Syngnathus folletti Herald, 1942	SWA	No	low to moderate	-	LC	Félix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Scorpaeniformes						
Scorpaenidae						
Scorpaena brasiliensis Cuvier, 1829	WA	aquarium	moderate to high	-	LC	Hackradt et al. (2011); Daros et al. (2012)
Scorpaena isthmensis Meek & Hildebrand, 1928	WA	aquarium	low to moderate	-	LC	Santos (2006); Santos et al. (2016)
Scorpaena plumieri Bloch, 1789	TA	aquarium	high	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Dactylopteridae				-		
Dactylopterus volitans (Linnaeus, 1758)	TA	aquarium	moderate	-	LC	Santos (2006); Félix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Triglidae				-		
Prionotus nudigula Ginsburg, 1950	SSWA	aquarium	moderate to high	-	NE	Gomes & Chaves (2006); Santos (2006); Félix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Prionotus punctatus (Bloch, 1793	SWA+Ca	food*	moderate to high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Perciformes						
Centropomidae						
Centropomus parallelus Poey, 1860	WA	food*	high	-	LC	Corrêa et al. (1986); Chaves et al. (2003); Felix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Centropomus undecimalis (Bloch, 1792)	WA+Ca	food*	moderate to high	-	LC	Hackradt & Hackradt (2009); Spier (2016)
Acropomatidae						
Synagrops spinosus Schultz, 1940	WA+EP	No	low	-	LC	Rossi-Wongtschowski et al. (2014)
Serranidae						
Diplectrum formosum (Linnaeus, 1766)	WA	aquarium	low	-	LC	Chaves et al. (2003); Santos (2006); Santos et al. (2016)
Diplectrum radiale (Quoy & Gaimard, 1824)	WA	aquarium	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Hackradt et al. (2011); Daros et al. (2012); Santos et al. (2016); Spier (2016)
Dules auriga Cuvier 1829	SSWA	aquarium	low	-	NE	Santos (2006); Santos et al. (2016)
Serranus flaviventris (Cuvier, 1829)	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Epinephelidae						
Epinephelus itajara (Lichtenstein, 1822)	Ta	food*	high to very high	CR	CR	Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Epinephelus marginatus (Lowe, 1834)	TA	food*	high to very high	VU	EN	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Epinephelus morio (Valenciennes, 1828)	WA	food*	high	VU	NT	Carniel (2008); Daros et al. (2012)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Hyporthodus nigritus (Holbrook, 1855)	WA	food*	high to very high	EN	CR	Santos (2006), Hackradt & Hackradt (2009); Santos et al. (2016); Spier (2016)
Hyporthodus niveatus (Valenciennes, 1828)	WA	food*	high	VU	VU	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Mycteroperca acutirostris (Valenciennes, 1828)	Ca+Br	food*	high	DD	LC	Santos (2006); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Santos et al. (2016); Spier (2016)
Mycteroperca bonaci (Poey, 1860)	WA	food*	high	VU	NT	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Mycteroperca microlepis (Goode & Bean, 1879)	WA	food*	high to very high	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Rypticus randalli Courtenay, 1967	Ca+Br	No	low	-	LC	Chaves et al. (2003); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Priacanthidae						
Heteropriacanthus cruentatus (Lacepède, 1801)	CT	aquarium	low to moderate	-	LC	Rossi-Wongtschowski et al. (2014)
Priacanthus arenatus Cuvier, 1829	TA	food*	low to moderate	-	LC	Corrêa et al. (1986); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Malacanthidae						
Malacanthus plumieri (Bloch, 1786)	WA	No	high	-	LC	Spier (2016)
Pomatomidae						
Pomatomus saltatrix (Linnaeus, 1766)	CT	food*	high	NT	VU	Godefroid et al. (2004); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Rachycentridae						
Rachycentron canadum (Linnaeus, 1766)	CT	food*	moderate	-	LC	Carniel (2008); Hackradt & Hackradt (2009); Spier (2016)
Echeneidae						
Echeneis naucrates Linnaeus, 1758	TA	aquarium	moderate to high	-	LC	Hackradt & Hackradt (2009); Spier (2016)
Remora remora (Linnaeus, 1758)	TA	food	moderate to high	-	LC	Hackradt & Hackradt (2009); Spier (2016)
Carangidae						
Alectis ciliaris (Bloch, 1787)	Ta+EP	food*	high to very high	-	LC	Spier (2016)
Carangoides bartholomaei (Cuvier, 1833)	WA	food*	high	-	LC	Godefroid et al. (2004); Carniel (2008); Schwartz-Junior (2009); Santos et al. (2016)
Caranx crysos (Mitchill, 1815)	TA	food*	low to moderate	-	LC	Santos (2006); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Santos et al. (2016); Spier (2016)
Caranx hippos (Linnaeus, 1766)	TA	food*	high	-	LC	Carniel (2008); Spier (2016)
Caranx latus Agassiz, 1831	TA	food*	high	-	LC	Corrêa et al. (1986); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Santos et al. (2016); Spier (2016)
Caranx ruber (Bloch, 1793)	WA	food*	high	-	LC	Godefroid et al. (2004); Spier (2016)

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Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Chloroscombrus chrysurus (Linnaeus, 1766)	TA	food*	moderate to high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Hemicaranx amblyrhynchus (Cuvier, 1833)	WA	food*	low to moderate	-	LC	Chaves et al. (2003); Carniel (2008); Spier (2016)
Oligoplites palometa (Cuvier, 1832)	Ca+Br	food*	low to moderate	-	LC	Santos (2006); Santos et al. (2016); Spier (2016)
Oligoplites saliens (Bloch, 1793)	SWA+Ca	aquarium*	moderate	-	LC	Corrêa et al. (1986); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Oligoplites saurus (Bloch & Schneider, 1801)	WA	food*	low to moderate	-	LC	Godefroid et al. (2004)
Pseudocaranx dentex (Bloch & Schneider, 1801)	CT	food*	high to very high	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Selene setapinnis (Mitchill, 1815)	WA	food*	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Selene vomer (Linnaeus, 1758)	WA	aquarium*	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Seriola dumerili (Risso, 1810)	CT	food*	moderate to high	-	LC	Santos (2006); Hackradt & Hackradt (2009); Santos et al. (2016)
Seriola lalandi Valenciennes, 1833	TA+EP	food*	high to very high	-	LC	Spier (2016)
Seriola rivoliana Valenciennes, 1833	WA+EP	food*	high to very high	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Trachinotus carolinus (Linnaeus, 1766)	WA	food*	moderate to high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016); Spier (2016)
Trachinotus falcatus (Linnaeus, 1758)	WA	food*	moderate	-	LC	Corrêa et al. (1986); Felix et al. (2007); Hackradt & Hackradt (2009); Spier (2016)
Trachinotus goodei Jordan & Evermann, 1896	WA	food*	low to moderate	-	LC	Félix et al. (2007); Spier (2016)
Trachinotus marginatus Cuvier, 1832	SSWA	food*	moderate to high	-	NE	Godefroid et al. (2004); Félix et al. (2007); Spier (2016)
Trachurus lathami Nichols, 1920	WA	food	moderate	-	LC	Rossi-Wongtschowski et al. (2014)
Uraspis secunda (Poey, 1860)	CT	No	low to moderate	-	LC	Godefroid et al. (2004)
Coryphaenidae						
Coryphaena hippurus Linnaeus, 1758	CT	food*	moderate	-	LC	Rossi-Wongtschowski et al. (2014); Spier (2016)
Lutjanidae						

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Lutjanus analis (Cuvier, 1828)	WA+Ca	food*	moderate to high	NT	NT	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Lutjanus cyanopterus (Cuvier, 1828)	WA	food*	high	VU	VU	Hackradt & Hackradt (2009); Spier (2016)
Lutjanus griseus (Linnaeus, 1758)	WA+Ca	food*	moderate	-	LC	Spier (2016)
Lutjanus jocu (Bloch & Schneider, 1801)	Ta	food*	high to very high	NT	DD	Spier (2016)
Lutjanus synagris (Linnaeus, 1758)	WA+Ca	food*	moderate	NT	NT	Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Rhomboplites aurorubens (Cuvier, 1829)	WA+Ca	food	moderate to high	NT	VU	Hackradt & Hackradt (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014)
Lobotidae						
Lobotes surinamensis (Bloch, 1790)	CT	food*	low to moderate	-	LC	Carniel (2008); Spier (2016)
Gerreidae						
Diapterus auratus Ranzani, 1842	WA	food*	low to moderate	-	LC	Corrêa et al. (1986); Spier (2016)
Diapterus rhombeus (Cuvier, 1829)	Ca+Br	food*	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Eucinostomus argenteus Baird & Girard, 1855	WA+EP	food*	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Eucinostomus gula (Quoy & Gaimard, 1824)	WA	food*	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Ulaema lefroyi (Goode, 1874)	Ca+Br	food*	low	-	LC	Félix et al. (2007)
Eucinostomus melanopterus (Bleeker, 1863)	TA	food*	low to moderate	-	LC	Gomes & Chaves (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Eugerres brasilianus (Cuvier, 1830)	WA	food*	moderate	-	LC	Corrêa et al. (1986), Carniel (2008)
Haemulidae						
Anisotremus surinamensis (Bloch, 1791)	WA	aquarium / food*	high	DD	DD	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Anisotremus virginicus (Linnaeus, 1758)	WA	aquarium	moderate	-	LC	Carniel (2008); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Conodon nobilis (Linnaeus, 1758)	WA	aquarium	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Genyatremus luteus (Bloch, 1790)	Ca+Br	food*	low to moderate	-	DD	Corrêa et al. (1986), Carniel (2008)
Haemulon aurolineatum Cuvier, 1830	WA	food*	moderate	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Haemulopsis corvinaeformis (Steindachner 1868)	WA	aquarium	low to moderate	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Haemulon steindachneri (Jordan & Gilbert, 1882)	SWA+Ca	aquarium	low to moderate	-	LC	Godefroid et al. (2004); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Orthopristis ruber (Cuvier, 1830)	SWA+Ca	aquarium	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Santos (2006); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Sparidae						
Archosargus probatocephalus (Walbaum, 1792)	WA	food*	moderate	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Archosargus rhomboidalis (Linnaeus, 1758)	WA	aquarium*	moderate	-	LC	Carniel (2008); Spier (2016)
Diplodus argenteus argenteus (Valenciennes, 1830)	WA	food*	low to moderate	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Sciaenidae						
Bairdiella ronchus (Cuvier, 1830)	Ca+Br	animal feed	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Ctenosciaena gracilicirrhus (Metzelaar, 1919)	Ca+Br	animal feed	low	-	LC	Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Cynoscion acoupa (Lacepède, 1801)	SWA+Ca	food*	high	NT	LC	Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016); Spier (2016)
Cynoscion jamaicensis (Vaillant & Bocourt, 1883)	SWA+Ca	food*	moderate	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Cynoscion leiarchus (Cuvier, 1830)	Ca+Br	food*	high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Cynoscion microlepidotus (Cuvier, 1830)	Br	food*	high	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Cynoscion striatus (Cuvier, 1829)	SSWA	food*	moderate to high	-	NE	Carniel (2008)
Cynoscion virescens (Cuvier, 1830)	Ca+Br	food*	high	-	LC	Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Isopisthus parvipinnis (Cuvier, 1830)	Ca+Br	food*	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Larimus breviceps Cuvier, 1830	Ca+Br	food*	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Macrodon ancylodon (Bloch & Schneider 1801)	WA	food*	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Menticirrhus americanus (Linnaeus, 1758)	WA	aquarium / food*	high	DD	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Menticirrhus littoralis (Holbrook, 1847)	WA	food*	low to moderate	DD	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Santos et al. (2016)
Micropogonias furnieri (Desmarest, 1823)	SWA+Ca	food*	moderate	-	LC	Chaves et al. (2003); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Nebris microps Cuvier, 1830	Br	food*	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Odontoscion dentex (Cuvier, 1830)	WA	aquarium*	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Ophioscion punctatissimus Meek & Hildebrand, 1925	Ca+Br	food*	low to moderate	DD	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Felix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Paralonchurus brasiliensis (Steindachner, 1875)	SWA+Ca	aquarium	low	-	LC	Corrêa et al. (1986); Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Pareques acuminatus (Bloch & Schneider, 1801)	WA	aquarium	low	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Pogonias cromis (Linnaeus, 1766)	WA	food*	high	EN	LC	Godefroid et al. (2004); Santos (2006); Santos et al. (2016)
Stellifer brasiliensis (Schultz, 1945)	Br	animal feed	low	-	NE	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Stellifer rastrifer (Jordan, 1889)	SSWA+Br	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Stellifer stellifer (Bloch, 1790)	Br	animal feed	low	-	DD	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Umbrina canosai Berg, 1895	SSWA	food*	low to moderate	-	NE	Godefroid et al. (2004)
Umbrina coroides Cuvier, 1830	WA	food*	low	-	LC	Felix et al. (2007); Schwarz Junior (2009); Santos et al. (2016)
Polynemidae						
Polydactylus oligodon (Günther, 1860)	WA	food*	low	-	LC	Godefroid et al. (2004); Schwarz Junior (2009); Santos et al. (2016)

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Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Polydactylus virginicus (Linnaeus, 1758)	WA	food*	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016); Spier (2016)
Mullidae						
Mullus argentinae Hubbs & Marini, 1933	SSWA	aquarium	low	-	NE	Santos (2006); Schwarz Junior (2009); Santos et al. (2016)
Pseudupeneus maculatus (Bloch, 1793)	WA	food*	moderate	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Mugilidae						
Mugil curema Valenciennes, 1836	TA+EP	food*	high	DD	LC	Corrêa et al. (1986); Carniel (2008); Spier (2016)
Mugil liza Valenciennes, 1836	WA	food*	moderate	NT	DD	Carniel (2008); Spier (2016)
Pomacentridae						
Abudefduf saxatilis (Linnaeus, 1758)	TA	aquarium	low to moderate	-	LC	Corrêa et al. (1986); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Chromis multilineata (Guichenot, 1853)	TA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Stegastes fuscus (Cuvier, 1830)	Br	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Stegastes pictus (Castelnau, 1855)	Ca+Br	aquarium	low	-	NE	Daros et al. (2012)
Stegastes variabilis (Castelnau, 1855)	WA	aquarium	low	-	NE	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Uranoscopidae						
Astroscopus y-graecum (Cuvier, 1829)	WA	food*	high	-	LC	Santos (2006); Felix et al. (2007); Schwarz Junior (2009); Santos et al. (2016)
Pinguipedidae						
Pseudopercis semifasciata (Cuvier, 1829)	SSWA	food	high	DD	NE	Godefroid et al. (2004)
Blenniidae						
Hypleurochilus fissicornis (Quoy & Gaimard, 1824)	SSWA+Br	No	low	-	LC	Schwarz Junior (2009); Santos et al. (2016); Spier (2016)
Hypsoblennius invemar Smith-Vaniz & Acero P., 1980	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012)
Ophioblennius trinitatis Miranda Ribeiro, 1919	Br	aquarium	low	-	LC	Daros et al. (2012)
Parablennius marmoreus (Poey, 1876)	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Parablennius pilicornis (Cuvier, 1829)	TA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Scartella cristata (Linnaeus, 1758)	CT	aquarium	low	-	LC	Hackradt & Hackradt (2009); Daros et al. (2012); Spier (2016)
Gobiidae						
Bathygobius soporator (Valenciennes, 1837)	TA	aquarium	low to moderate	-	LC	Corrêa et al. (1986); Carniel (2008); Hackradt & Hackradt (2009)
Coryphopterus glaucofraenum Gill, 1863	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Microgobius meeki Evermann & Marsh, 1899	Ca+Br	No	low	-	LC	Santos (2006); Santos et al. (2016)
Ephippidae						

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Chaetodipterus faber (Broussonet, 1782)	WA	aquarium / food*	high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Acanthuridae						
Acanthurus bahianus Castelnau, 1855	WA	aquarium	low to moderate	-	LC	Corrêa et al. (1986); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012)
Acanthurus chirurgus (Bloch, 1787)	TA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Acanthurus coeruleus Bloch & Schneider, 1801	WA	aquarium	high	-	LC	Daros et al. (2012); Spier (2016)
Sphyraenidae						
Sphyraena barracuda (Edwards, 1771)	TA	food*	very high	-	LC	Spier (2016)
Sphyraena guachancho Cuvier, 1829	TA	food*	very high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Sphyraena picudilla Poey, 1860	WA	food*	moderate to high	DD	NE	Chaves et al. (2003)
Sphyraena tome Fowler, 1903	SSWA	food*	low to moderate	DD	NE	Santos (2006); Felix et al. (2007); Hackradt & Hackradt (2009); Santos et al. (2016)
Gempylidae						
Thyrsitops lepidopoides (Cuvier, 1832)	SSWA	food*	moderate	-	NE	Rossi-Wongtschowski et al. (2014)
Trichiuridae						
Trichiurus lepturus Linnaeus, 1758	CT	food*	high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Scombridae						
Scomber colias Gmelin, 1789	Ta	food*	moderate	-	LC	Rossi-Wongtschowski et al. (2014)
Scomberomorus brasiliensis Collette, Russo & Zavala-Camin, 1978	WA	food*	high to very high	-	LC	Felix et al. (2007); Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Spier (2016)
Scomberomorus cavalla (Cuvier, 1829)	WA	food*	high to very high	-	LC	Carniel (2008); Hackradt & Hackradt (2009); Hackradt et al. (2011); Spier (2016)
Stromateidae						
Peprilus paru (Linnaeus, 1758)	WA	food*	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)
Pempheridae						

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Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Pempheris schomburgkii Müller & Troschel, 1848	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Chaetodontidae						
Chaetodon striatus Linnaeus, 1758	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Pomacanthidae						
Pomacanthus paru (Bloch, 1787)	WA	aquarium	moderate	DD	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Labridae						
Bodianus rufus (Linnaeus, 1758)	WA	aquarium	low	-	LC	Daros et al. (2012); Spier (2016)
Halichoeres brasiliensis (Bloch, 1791)	SWA	aquarium	moderate to high	-	DD	Spier (2016)
Halichoeres poeyi (Steindachner, 1867)	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Scaridae						
Sparisoma amplum (Ranzani, 1841)	Br	aquarium	moderate	NT	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012)
Sparisoma axillare (Steindachner, 1878)	Br	aquarium	moderate	VU	DD	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Sparisoma frondosum (Agassiz, 1831)	Ca+Br	aquarium	low to moderate	VU	DD	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Sparisoma radians (Valenciennes, 1840)	WA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Daros et al. (2012)
Labrisomidae						
Labrisomus nuchipinnis (Quoy & Gaimard, 1824)	TA	aquarium	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Malacoctenus delalandii (Valenciennes, 1836)	WA	No	low	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Paraclinus spectator Guimarães & Bacellar, 2002	Br	No	low	-	LC	Daros et al. (2012)
Pleuronectiformes						
Paralichthyidae						
Citharichthys arenaceus Evermann & Marsh, 1900	WA	animal feed	low	-	LC	Chaves et al. (2003); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Citharichthys macrops Dresel, 1885	WA	animal feed	low	-	LC	Santos (2006); Felix et al. (2007); Schwarz-Junior (2009); Santos et al. (2016)
Citharichthys spilopterus Günther, 1862	WA	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Etropus crossotus Jordan & Gilbert, 1882	WA+EP	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Paralichthys brasiliensis (Ranzani, 1842)	SWA	food	moderate to high	-	NE	Godefroid et al. (2004)
Paralichthys orbignyanus (Valenciennes, 1839)	SSWA	food	moderate to high	DD	NE	Carniel (2008)

Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Paralichthys patagonicus Jordan, 1889	SSWA+EP	food	low to moderate	NT	NE	Santos (2006); Santos et al. (2016)
Syacium micrurum Ranzani, 1842	Ca+Br	food	moderate	-	LC	Schwarz Junior (2009); Santos et al. (2016)
Syacium papillosum (Linnaeus, 1758)	WA	animal feed	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Felix et al. (2007); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Bothidae						
Bothus robinsi Topp & Hoff, 1972	WA	animal feed	low to moderate	-	LC	Chaves et al. (2003)
Pleuronectidae						
Oncopterus darwinii Steindachner, 1874	SSWA	animal feed	moderate	-	NE	Godefroid et al. (2004); Santos (2006); Felix et al. (2007); Santos et al. (2016)
Achiridae						
Achirus declivis Chabanaud, 1940	WA	animal feed	low	-	LC	Gomes & Chaves (2006); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Achirus lineatus (Linnaeus, 1758)	WA	aquarium	low to moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Schwarz-Junior (2009); Santos et al. (2016)
Trinectes microphthalmus (Chabanaud, 1928)	Ca+Br	animal feed	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Trinectes paulistanus (Miranda Ribeiro, 1915)	Ca+Br	animal feed	low	-	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Cynoglossidae						
Symphurus diomedeanus (Goode & Bean, 1885)	WA	animal feed	low to moderate	-	LC	Corrêa et al. (1986)
Symphurus plagusia (Bloch & Schneider, 1801)	Ca+Br	animal feed	low to moderate	-	LC	Godefroid et al. (2004)
Symphurus tessellatus (Quoy & Gaimard, 1824)	Ca+SSWA+Br	animal feed	moderate	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Tetraodontiformes						
Balistidae						
Balistes capriscus Gmelin, 1789	TA	food*	low to moderate	NT	VU	Chaves et al. (2003); Hackradt & Hackradt (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Spier (2016)
Monacanthidae						
Aluterus monoceros (Linnaeus, 1758)	CT	food*	high	NT	LC	Hackradt & Hackradt (2009); Spier (2016)
Monacanthus ciliatus (Mitchill, 1818)	TA	food	low to moderate	-	LC	Godefroid et al. (2004)
Stephanolepis hispidus (Linnaeus, 1766)	TA	aquarium*	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Daros et al. (2012); Rossi-Wongtschowski et al. (2014); Santos et al. (2016); Spier (2016)

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Table 2. Continued...

Orders/Families/Species	Geographic Distribution	Economic Importance	Vulnerability FishBase	Conservation status MMA - 445	Conservation status IUCN	Source
Tetraodontidae						
Lagocephalus laevigatus (Linnaeus, 1766)	TA	aquarium*	high	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Carniel (2008); Schwarz-Junior (2009); Santos et al. (2016)
Sphoeroides greeleyi Gilbert, 1900	Ca+Br	aquarium	low	-	LC	Chaves et al. (2003); Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Hackradt & Hackradt (2009); Hackradt et al. (2011); Santos et al. (2016)
Sphoeroides spengleri (Bloch, 1785)	TA	aquarium	low to moderate	-	LC	Santos (2006); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Daros et al. (2012); Santos et al. (2016); Spier (2016)
Sphoeroides testudineus (Linnaeus, 1758)	WA	aquarium / food*	low	DD	LC	Godefroid et al. (2004); Gomes & Chaves (2006); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Santos et al. (2016)
Diodontidae						
Chilomycterus spinosus spinosus (Linnaeus, 1758)	SWA	aquarium	low to moderate	-	LC	Chaves et al. (2003); Santos (2006); Felix et al. (2007); Carniel (2008); Hackradt & Hackradt (2009); Schwarz-Junior (2009); Hackradt et al. (2011); Rossi-Wongtschowski et al. (2014); Santos et al. (2016)
Molidae						
Ranzania laevis (Pennant, 1776)	TA+EP	No	moderate to high	-	LC	Spier (2016)
Beryciformes						
Holocentridae						
Holocentrus adscensionis (Osbeck, 1765)	TA	aquarium	low to moderate	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)
Gasterosteiformes						
Fistulariidae						
Fistularia tabacaria Linnaeus, 1758	TA	aquarium	high to very high	-	LC	Hackradt & Hackradt (2009); Hackradt et al. (2011); Daros et al. (2012); Spier (2016)

Cynoscion (6) and *Carcharhinus* (6) were the dominant genus in number of species, followed by *Anchoa* (5), *Gymnothorax* (5) and *Lutjanus* (5).

The geographic distribution of species across the different categories defined in the previous section are illustrated in Figure 2. Many of the recorded species are widely distributed over the Western Atlantic, and can be further separated into two groups with distinct distribution: the first, characteristic of the Caribbean fauna, is also found in the Caribbean and Brazilian Province; and the second, with temperate affinities, is characteristic of the Southern Southwest Atlantic, including Argentina and Uruguay.

In terms of Brazilian economic importance, 156 species (57%) are used for human consumption, 74 species (27%) for aquaria and 30 species (11%) for animal feed. Only 19 species (7%) have no commercial importance in Brazil. In the State of Paraná, on the other hand, only 57% of species of economic interest in Brazil are exploited. In particular, 21 species used for human consumption in other parts of Brazil have no economic importance in Paraná. Moreover, the aquaria and animal feed industries are relatively underdeveloped, with only 9 of 74 potentially viable species used in aquaria, and 4 of 30 potentially viable species commercialized for animal feed. In short, of 253 species of economic interest in Brazil, only 144 are exploited in the State of Paraná (Figure 3).

A total of 61% of species were categorized as having low to moderate vulnerability to extinction, and 39% ranged from moderate to very high vulnerability (Table 2). Most Elasmobranchii (29 species) were highly or very highly vulnerable. Among the Perciformes, 50 of the 146 species were classified as having moderate to very high vulnerability. Considering both red lists, 82% of catalogued species in Paraná's inner shelf were assessed for their risk of extinction. Two hundred and forty-two species occurring in the shallow inner continental shelf of Paraná appear in the red list of the International Union for Conservation of Nature (IUCN 2017), where 185 are listed as least concern, 17 as data deficient, 12 as near threatened, 17 as vulnerable, 8 as endangered, and 3 as critically endangered. The Brazilian Ministry of Environment (MMA 2014) classified substantially less species in the area (85 species), however with higher risk of extinction (12 vulnerable, 7 endangered, 15 critically endangered) (Figure 4).

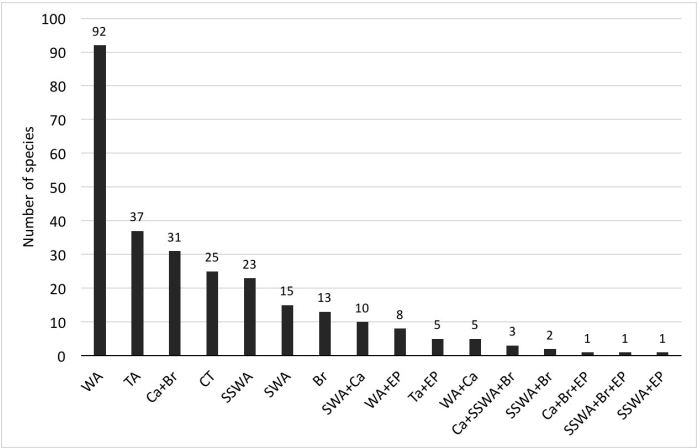

Figure 2. Geographic distribution of the species recorded in the shallow inner continental shelf of Paraná. CT = Circumtropical, TA = Trans-Atlantic, WA = Western Atlantic, SWA = Southwest Atlantic, SSWA = Southern Southwest Atlantic, Ca = Caribbean, Br = Brazilian Province, EP = Eastern Pacific.

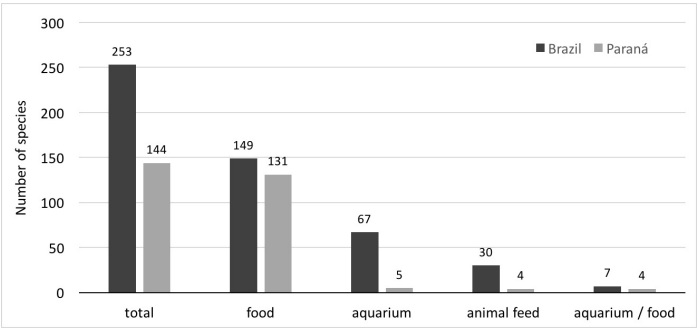

Figure 3. Number of catalogued species with economic importance in the State of Paraná only, versus the number with economic importance in Brazil overall.

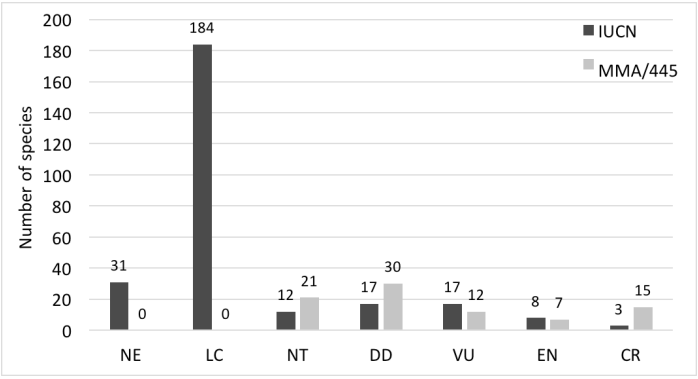

Figure 4. Global conservation status according to IUCN (2017) and National conservation status according to MMA (2014): NE= not evaluated, LC= least concern, NT = near threatened, DD = data deficient, VU = vulnerable, EN= endangered, CR = critically endangered.

Discussion

The vastness of the Brazilian coast and its large ecosystem and biodiversity contributed to a false perception of inexhaustible fishing resources, and the misguided adoption of policies that neglected resource sustainability and focused primarily on species of commercial importance (Nahum et al. 2009). A necessary step towards implementing better informed policies is to obtain an accurate assessment of species occurrence, and their respective economic importance and vulnerability to extinction. Such comprehensive assessment is still lacking for Paraná's shallow inner continental shelf, in Southern Brazil, home to several threatened species. In an attempt to remedy this situation, this study compiled the results of surveys of Paraná's shallow inner continental shelf performed over the past 30 years, providing a comprehensive checklist of fish species, along with information on biogeography, conservation status, economic importance and degree of species' vulnerability.

Extracting correlations between the various factors that could influence species vulnerability to extinction, and hence pinpointing its causes, is beyond the scope if this work. Nonetheless, we believe that our checklist provides valuable information for future studies on the ecology and conservation of the fish fauna of the area.

In our study, we have confirmed a rich fauna of Elasmobranchii in the continental shelf of Paraná, comprising 24% of Brazilian's elasmobranch fauna (Rosa & Gadig 2014). Several elasmobranchs that occur in Paraná seem to use the southern coast of Brazil for reproduction (Bornatowski & Abilhoa 2012). Vooren et al. (2005) recorded 21 species that use areas on the southern continental shelf for reproduction. It is suspected that several species also use Paraná's coast as parturition and nursery grounds, such as *Carcharhinus limbatus, Rhizoprionodon lalandii, Sphyrna lewini, Narcine brasiliensis, Rioraja agassizi, Pseudobatos percellens* and *Zapteryx brevirostris*.

According to Castello (1994), the coastal fish fauna in Southeastern and Southern Brazil is composed of a mixture of species with tropical to subantarctic affinities, explaining the richness of the fish fauna in Paraná's inner shelf. Among the Actinopterygii, Sciaenidae was the most representative family in other continental shelves of Brazil (Rocha & Rossi-Wongtschowski 1998; Muto et al. 2000; Moraes et al. 2009) and its occurrence in Paraná's inner continental shelf is associated with Coastal Water (Muto et al. 2000). Sciaenidae and Carangidae were also the most speciose families in both estuaries of the region: the PEC (Passos et al. 2012) and the Guaratuba Bay (Chaves & Corrêa 1998; Chaves & Vendel 2001). In Brazilian waters, there are 37 species of Sciaenidae and 25 species of *Cynoscion*, with 25 species of Sciaenidae and 9 of *Cynoscion* occurring in Paraná (Nelson et al. 2016). That means that only three species of *Cynoscion* do not occur, or were not registered, in the State of Paraná. *Cynoscion guatucupa,* for instance, is not listed in this checklist, but its range of occurrence goes from southeastern Brazil to Uruguay. The other two *Cynoscion* species (*C. similis* and *C. steindachneri*) only occur in the Northern Brazilian coast (Nelson et al. 2016).

Fishery activities on the coast of Paraná are mostly artisanal or small-scale commercial operations, mainly utilizing two basic types of gear, gillnets and bottom trawl-nets (IPARDES 1981; Andriguetto-Filho 2002; Chaves & Robert 2003; Robert & Chaves 2006; Andriguetto-Filho et al. 2009). They target different resources over the year based on seasonal changes in species abundance and tourism (Robert & Chaves 2006). Trawling targets shrimp, *Xiphopenaus kroyeri* (Heller, 1862), *Litopenaeus schmitti* (Burkenroad 1936) and *Farfantepenaeus* sp. (Branco & Verani 2006; Robert et al. 2007), while gillnetting targets mainly teleosts and elasmobranchs such as Carcharhiniformes and Rhinobatidae (Costa & Chaves 2006; Robert & Chaves 2006; Bornatowski & Abilhoa 2012). A considerable number of species (109) with economic importance in Brazil are not commercialized in Paraná. These species can be considered as bycatch in the region, following Guanais et al. (2015) who define bycatch as the portion of the total catch that is effectively discarded. Sciaenidae, such as *Ctenosciaena gracilicirrhus*, *Isopisthus parvipinnis*, *Larimus breviceps*, *Menticirrhus americanus*, *Paralonchurus brasiliensis*, *Stellifer brasiliensis* and *Stellifer rastrifer*, although reported as shrimp bycatch in other studies (Cattani et al. 2011; Santos et al. 2016), have some economic importance in the region.

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The lack of risk assessment for 18% of the species catalogued in this study under global lists can be attributed to the lack of studies on basic biology, habitat requirement, abundance, and distribution (Lamas et al. 2016), as well as lacking fishery statistics (discontinued in 2012) (Dario et al. 2015; Barreto et al. 2017). Therefore, is imperative that fishery monitoring programs be reinstated in Brazil to allow for science-based management (Dario et al. 2015).

We conclude with a few cautionary comments. First of all, the sampling methods and sampling efforts varied across the different studies compiled in this checklist, and therefore comparisons of their results, or statistical inferences based on combined results, are not straightforward to make. Hard conclusions should not be drawn before taking such systematic differences into account. Secondly, the sampling areas also differed across studies, so it was not possible to draw conclusions regarding temporal variations of species' occurrence. Nonetheless, our results, combined with effective monitoring of fishing activities, deposition of dredged sediments, and deployment of artificial habitats, could inform policy making regarding management and administration of the fishery resources of the Brazilian continental shelf.

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Authors' Contributions

Substantial contribution in the concept and design of the study: Daphne Spier, Henry Spach

Contribution to data collection: Daphne Spier, Humberto Gerum, Natalia Mattos, Hugo Bornatowski

Contribution to data analysis and interpretation: Daphne Spier, Humberto Gerum, Riguel Contente, Hugo Bornatowski

Contribution to manuscript preparation: All authors

Contribution to critical revision, adding intelectual content: All authors

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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