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Ning L. Chao

Flávia L. Frédou

Manuel Haimovici

Monica B. Peres

Beth Polidoro

See next page for additional authors

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A popular and potentially sustainable fishery resource under pressure–extinction risk and conservation of Brazilian Sciaenidae (Teleostei: Perciformes)

Ning Labbish Chao [a,b,*], Flávia Lucena Frédou [c], Manuel Haimovici [d], Monica B. Peres [e], Beth Polidoro [f,h], Marcelo Raseira [g], Rosana Subirá [g], Kent Carpenter [h]

[a] Global Sciaenidae Conservation Network-National Museum of Marine Biology & Aquarium, Pingtung, Taiwan
[b] Bio-Amazonia Conservation International, Brookline, MA, USA
[c] Universidade Federal Rural de Pernambuco, Recife, PE, Brazil
[d] Universidade Federal do Rio Grande, Rio Grande, RS, Brazil
[e] OCEANA, Brasilia, Brazil
[f] Arizona State University, Phoenix, AZ, USA
[g] ICMBio, Instituto Chico Mendes de Conservação da Biodiversidade, Ministério do Meio Ambiente, Brazil
[h] IUCN- Global Marine Species Assessment Program, Old Dominion University, Norfolk, VA, USA

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ABSTRACT

Croakers (Sciaenidae) are major fishery resource in Brazil; constituting 22% of marine and 9% of freshwater fishery landings. Croakers are subject to heavy fishing pressure throughout Brazil, but habitat alteration is also an important threat to regional populations. In this regional Sciaenidae assessment, each species was analyzed for relative risk of extinction, including the identification and quantification of the impact of major threats and existing conservation measures, based on application of the Categories and Criteria of the IUCN Red List of Threatened Species. Of the 52 species of Sciaenid fishes (34 marine and 18 freshwater) present in Brazilian waters, the majority are at low risk of extinction, with 10 species classified as Data Deficient (DD) and 36 as Least Concern (LC). However the Southern black drum (*Pogonias cromis),* listed as Endangered (EN) is the most threatened species in the region, while three other species are classified as Near Threatened (NT). A large portion of Brazilian croakers is landed by small-scale artisanal fisheries, which are scattered along coastal and riverine communities. However, our assessments reveal that available fishery landing statistics may have greatly underestimated the artisanal fishery production and by-catch of Sciaenids. We recommend establishing, with adequate enforcement, coastal and riverine protected areas as well as strategic fishing seasons to improve and maintain the conservation status of Sciaenids and sustainable Sciaenid fisheries.

* Corresponding author at: Bio-Amazonia Conservation International, Brookline, MA, USA.
E-mail addresses: croakerchao@gmail.com (N.L. Chao), flavialucena@hotmail.com (F.L. Frédou), manuelhaimovici@gmail.com (M. Haimovici), monicabrickperes@gmail.com (M.B. Peres), beth.polidoro@asu.edu (B. Polidoro), mraseira@gmail.com (M. Raseira), rosana.subira@icmbio.gov.br (R. Subirá), kcarpent@odu.edu (K. Carpenter).

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RÉSUMÉ

Os peixes Cienídeos são os recursos mais importantes da pesca extrativa no Brasil. Constituem 22% dos desembarques marinhos e 9% dos continentais e estão sujeitos a forte pressão de pesca, embora a destruição de habitat seja considerada como uma das maiores ameaças. A avaliação regional dos Cianídeos teve como objetivo analisar o risco de extinção, identificar as principais ameaças e medidas de manejo para esse grupo no Brasil. Nós aplicamos os critérios da lista vermelha da IUCN em 52 espécies, sendo 34 marinhas e 18 de água-doce. Cianídeos estão sob baixo a moderado risco de extinção. Uma espécie marinha, a miragaia *Pogonias cromis*, está regionalmente Em Perigo (EN), enquanto uma espécie marinha e duas de água-doce estão Quase Ameaçadas (NT). Adicionalmente, 10 espécies foram categorizadas como Dados Insuficientes (DD), 36 como Menos Preocupante (LC) e duas espécies marinhas com registros incidentais como Não Aplicável (NA). Uma grande parcela dos Cianídeos no Brasil são capturados pela pesca artesanal, dispersa nas comunidades costeiras e ribeirinhas. As estatísticas de desembarque no Brasil, em geral, subestimam a pesca de pequena escala e a captura incidental dos Cianídeos. Nós recomendamos, com o cumprimento apropriado, o estabelecimento de períodos e areas protegidas nas zonas costeiras e continentais, definidas estrategicamente de forma a manter a conservação deste grupo e a atividade de pesca em níveis sustentáveis.

1. Introduction

Sciaenidae, also known as croakers and drums (*corvinas* e *pescadas)*, is a large family of percoid fishes with about 280 species in 90 genera worldwide (Table 1). They are primarily tropical and warm temperate coastal marine fishes; with some confined to freshwater rivers. Globally, the highest abundance of freshwater species are found in Neotropical rivers connected to the Caribbean Sea and Atlantic Ocean. Among 20 species of freshwater Neotropic Sciaenids, 18 are either endemic to Brazil or have the majority of their range of distribution in Brazil (Table 2; Casatti, 2001, 2002, 2005). Croakers range from small to large size fishes (10–200 cm total length), most with a silvery, elongate and compressed body, often with yellowish or reddish color on the lower parts of the body and fins when mature. Most croakers are found near the bottom in near-shore coastal waters, although a few are mid-water column cruisers. Croakers are often randomly scattered in small patches migrating along the shallow coast waters, although a few species can be found to 300 or 600 m depth. Sciaenids often are found at the interface of estuaries and coastal marine areas, and/or locally migrate between floodplains and river channels. Most marine Sciaenids use estuarine environments as nursery grounds, or move along the near shore and river margins seasonally for reproduction. Sciaenids often form large aggregations during spawning migration, which make them extremely vulnerable to overfishing.

Sciaenids are exploited throughout Brazil by artisanal, commercial and recreational fisheries. Brazilian fishery production, however, is comprised predominantly of local artisanal fisheries scattered along the coast and riverbanks (Vasconcellos et al., 2007; Diegues, 2008; Sanders and Hjort, 2011). Sciaenids constitute about 20% of total marine fish landings and 9% of freshwater landings (Table 3) in Brazil. Although the Brazilian Sciaenid fishery production has been relatively stable over the past decade (Fig. 1), the level of production has likely been maintained by increased fishing effort and expansion of fishing grounds. Small sized Sciaenids (<20 cm total length) also constitute a significant portion of by-catch mortality from coastal fish and shrimp trawlers (Haimovici and Mendonça, 1996; Isaac, 1998; Vieira et al., 1996). In Brazil, both freshwater and marine Sciaenid resources are considered vulnerable to over fishing; coastal habitat degradation from urbanization and aquaculture; oil exploration and dam construction.

As part of a national effort to establish baseline population information for all species and to create a national Brazilian Red List of Threatened Species, the objectives are to analyze the relative risk of extinction, to identify and quantify the impact of major threats and document existing conservation measures for Sciaenid species in Brazil, based on IUCN Red List of Threatened Species assessment methodology. Development and design a national red list of threatened species can often serve different purposes, including identification of species with elevated extinction risk, intrinsic or increased rarity, cultural importance, conservation value, or trends of population decline, while also expanding conservation priorities, international responsibility for protection, and taxonomic representation (Miller et al., 2007). Without exception, the national program to evaluate the risk of species extinction of Brazilian fauna is a combination of all of these factors.

2. Methods

The IUCN-SSC (Species Survival Commission) is comprised of 9000 volunteer experts deployed in 130 specialist groups focused on specific taxa (e.g., Shark and Ray Specialist Group) or special topics (e.g., Invasive Species Specialist Group). Each

Table 1
Global Sciaenidae assessed by IUCN Red List Criteria*.

Zoogeographic regions	Genera	Species	Assessed species	% Assessed
Indo-Pacific West	24–26	98	95	97.9%
East Atlantic & Mediterranean	6–9	20	18	90.0%
West Atlantic	22–23	64	60	100.0%
East Pacific	23–25	78	77	98.7%
Total Marine	77–85	255	250	98.0%
Freshwater (Americas & Asia)	7–8	23	20	87.0%
Total	82–90	284	270	95.1%

* Species of Sciaenidae assessed, but not all finalized.

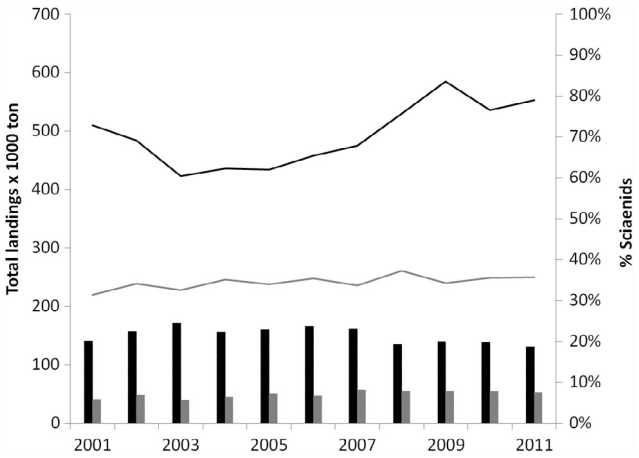

Fig. 1. Sciaenid landings (bars) as percentage of total Brazilian fisheries landings from 2001 to 2011. (Solid black-Marine fishes; Shaded-Freshwater fishes.)

specialist group is responsible for evaluating their particular group of organisms in terms of their risk of extinction based on the IUCN Red List Categories and Criteria (IUCN, 2012a, version 3.1). This first Brazilian Sciaenidae Red List Assessment (RLA) was conducted during the IUCN Global and Regional Sciaenidae Workshop, held in Manaus, Brazil in November 2009. The workshop was organized by the IUCN-SSC Sciaenidae Red List Authority, ICMBio (Instituto Chico Mendez de Conservação da Biodiversidade, Ministério do Meio Ambiente, Brazil) and the IUCN Marine Biodiversity Unit's Global Marine Species Assessment Program, Old Dominion University, USA. At the workshop, 50 specialists from 25 countries were divided in four working groups to share and synthesize species-specific data on each species taxonomy, distribution, population trends, habitat, ecology, life history, impact of major threats and conservation measures to collectively apply the IUCN Red List Categories and Criteria (version 3.1) and to assign each species a Red List Category. The regional assessment for species endemic to Brazilian waters or with the majority of their range within Brazil was determined to be equivalent to their global assessment.

During and after the workshop, species-specific information on taxonomy, distribution, population status, habitat and ecology, major threats and conservation measures were assembled and updated based on all available fishery data, literature and personal expertise. Although long-term fishery data in Brazil are fragmented, they are systematically compiled and are publically available from IBAMA (http://www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira) from 2000 to 2007, and from 2008 to 2011 from the Ministério da Pesca e Aquacultura (http://www.mpa.gov.br/index.php/monitoramento-e-controle/informacoes-e-estatisticas). Additionally, some states-level data is available, such as from São Paulo state which provides consistent long-term fishery landing statistics (http://www.pesca.sp.gov.br/estatistica.php). From these and other annual databases, landing data for each sciaenid species were extracted and compiled (Table 3 and Fig. 1). If reliable species-specific catch statistics and population trends were not available from certain states, other indicators of population decline can be used during the Red List assessment process to support observed, antidotal or other data (IUCN, 2014). These other indicators of population decline include increasing market value, increasing effort to obtain the same catch, observations in decrease in average body-size of the catch, lack of juveniles in appropriate habitat, or the absence of older age classes in the catch (IUCN, 2014). All final Brazilian regional red list assessment results for Sciaenids were thoroughly revised, updated and reviewed through a peer-review process initiated by participating authors, with the detailed species accounts published on line (ICMBio, 2014).

The IUCN Red List categories at the regional level comprise 10 levels of extinction risk: Extinct (EX), Regionally Extinct (RE), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD) and Not-Applicable (NA). The classification criteria, application guidelines, and IUCN Red List methodology on how to apply the Criteria are publically available (IUCN, 2012a,b, 2014). A species qualifies for one of

Table 2
Red List assessment of Brazilian Sciaenidae, distribution and type of fisheries. Distribution in Brazil (E—endemic; G—over 50% Global Area of Distribution; I—Incidental). Type of fisheries: Targeted (T), By-catch or incidental (B), Industry (IN); Artisan (AR); Recreational (RE); Ornamental (OR).

	Regional category	Area of distribution	Type of fisheries
Marine Speices			
Bairdiella ronchus (Cuvier, 1830)	LC	G	B (AR)
Ctenosciaena gracilicirrhus (Metzelaar, 1919)	LC	G	B (AR)
Cynoscion acoupa (Lacepède, 1800)	NT	G	T (AR, IN, RE)
Cynoscion guatucupa (Cuvier, 1830)	LC	G	T (AR, IN, RE)
Cynoscion jamaicensis (Vaillant & Bocourt, 1915)	LC	G	T (AR, IN, RE)
Cynoscion leiarchus (Cuvier, 1830)	LC	G	T (AR, IN, RE)
Cynoscion microlepidotus (Cuvier, 1830)	LC	G	T (AR, IN, RE)
Cynoson similis Randall & Cervigon 1968	NA	I	T (AR, IN, RE)
Cynoscion steindachneri Jordan 1889	DD	I	B (AR, IN)
Cynoscion virescens (Cuvier, 1830)	LC	G	T (AR, IN, RE)
Equetus lanceolatus (Linnaeus, 1758)	LC	I	T (OR)
Equetus punctatus (Bloch & Schneider, 1801)	NA	I	B (OR)
Isopisthus parvipinnis (Cuvier, 1830)	LC	G	B (AR,IN)
Larimus breviceps Cuvier, 1830	LC	G	B (AR,IN)
Lonchurus elegans (Boeseman 1948)	DD	I	B (AR)
Lonchurus lanceolatus (Bloch, 1788)	LC	I	B (AR)
Macrodon ancylodon (Bloch and Schneider, 1801)	LC	G	T (AR, IN, RE)
Macrodon autricauda (Günther, 1880)	LC	G	T (AR, IN, RE)
Menticirrhus americanus (Linnaeus,1758)	DD	G	T (AR, IN, RE)
Menticirrhus littoralis (Holbrook, 1855)	DD	G	T (AR, IN, RE)
Micropogonias furnieri (Desmarest, 1823)	LC	G	T (AR, IN, RE)
Nebris microps Cuvier, 1830	LC	G	T (AR, IN)
Odontoscion dentex (Cuvier,1830)	LC	G	B(AR)
Ophioscion punctatissimus LC (Meek & Hildebrand, 1925)	LC	G	B (AR, IN)
Paralonchurus brasiliensis (Steindachner, 1875)	LC	G	T (AR, IN)
Pareques acuminatus (Bloch & Schneider, 1801)	DD	G	T (AR, OR)
Pogonias cromis (Linnaeus, 1766)	EN	G	T (AR, IN, RE)
Stellifer brasiliensis (Schultz, 1945)	LC	G	B (AR, IN)
Stellifer microps (Steindachner, 1864)	LC	G	B (AR, IN)
Stellifer naso (Jordan, 1889)	LC	G	B (AR, IN)
Stellifer rastrifer (Jordan, 1889)	LC	G	B (AR, IN)
Stellifer stellifer (Bloch, 1790)	LC	G	B (AR, IN)
Umbrina canosai Berg, 1895	LC	G	T (AR, IN)
Umbrina coroides Cuvier,1830	LC	G	B (AR, RE)
Freshwater species			
Pachypops fourcroi (Lacepède, 1802)	LC	G	B(AR)
Pachypops pigmaeus (Casatti, 2002)	DD	E	B(AR)
Pachypops trifilis (Müller & Troschel, 1848)	LC	G	B(AR)
Pachyurus adspersus Steindachner, 1879	DD	E	B(AR)
Pachyurus bonariensis (Steindachner, 1879)	LC	G	T(AR)
Pachyurus calhamazon (Casatti, 2001)	DD	E	B(AR)
Pachyurus francisci (Cuvier, 1830)	NT	E	B(AR)
Pachyurus gabrielensis (Casatti, 2001)	LC	E	B(AR)
Pachyurus junki Soares & Casatti 2000	LC	E	B(AR)
Pachyurus paucirastrus Aguilera,1983	NT	E	B(AR)
Pachyurus schomburgkii Günther, 1860	LC	G	B(AR)
Pachyurus squamipennis Agassiz, 1831	DD	E	T (AR, RE)
Petilipinnis grunniens Schomburgk, 1843	LC	G	B(AR)
Plagioscion auratus (Castelnau, 1855)	LC	G	T (AR, RE)
Plagioscion montei Soares & Casatti 2000	LC	E	T (AR, RE)
Plagioscion cf squamosissimus (Heckel, 1840)	LC	G	T (AR, RE)
Plagioscion cf "surinamensis" (Bleeker, 1874)	DD	G	T (AR, RE)
Plagioscion ternetzi Boulenger, 1895	LC	G	T (AR, RE)

the three threatened categories (CR, EN, or VU) by meeting quantitative thresholds for that category in one of five Criteria (A–E).

All marine Sciaenids were evaluated under Criterion A, which is generally applied to species with large or widespread populations. Criterion A measures extinction risk based on exceeding a threshold of population decline (30% for VU, 50% for EN, and 80% for CR) over the longer timeframe of 10 years or three generation lengths. Generation length is defined as the average age of parents of the current cohort, based on the natural, pre-exploitation, state of the population (IUCN, 2012a, 2014), and is meant to reflect the turnover rate of breeding individuals in a population. There are several methods

Table 3
Fishery statistics of Brazilian Sciaenidae in total fish landings from 2000 to 2011 (in metric tons).

Common names	Scientific names	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Marine sciaenidae												
Corvina	*Micropogonias furnieri*	39,598	*42,398*	39,374	36,585	36,449	45,029	44,373	41,480	45,750	43,191	43,370
Pescada-amarela	*Cynoscion acoupa*	22,235	*27,559*	26,248	21,258	20,778	20,052	20,411	20,039	22,102	20,879	21,075
Castanha	*Umbrina canosai*	13,567	14,596	11,301	12,899	11,292	12,901	11,163	11,570	16,721	12,052	12,165
Pescadinha-real*	*Macrodon atricauda*	2,641	*4,220*	3,278	2,942	3,228	3,613	3,651	10,099	11,139	10,507	7,044
Pescadinha-gó*	*Macrodon ancylodon*	6,023	*6,411*	6,278	6,092	3,772	5,522	11,252	–	–	–	–
Pescada	*Cynoscion & Macrodon spp*	1,826	*2,409*	1,948	2,454	4,293	6,701	7,987	6,185	6,822	6,435	6,504
Pescada-olhuda	*Cynoscion guatacupa*	10,377	*5,837*	9,066	6,256	9,253	5,135	3,049	5,747	6,339	6,002	6,045
Goete	*Cynoscion jamaicensis*	2,879	*1,764*	2,068	2,485	2,833	3,393	2,776	2,946	3,249	3,068	3,097
Papa-terra	*Menticirrhus spp*	2,055	*2,048*	2,037	1,649	1,852	2,114	1,948	1,934	2,134	2,015	2,034
Pescada-branca	*Cynoscion leiarchus*	716	974	884	694	1,002	1,080	692	910	1,003	948	956
Pescada-cambuçu	*Cynoscion virescens*	212	460	419	1,136	1,479	431	330	743	820	778	782
Cabeçudo, Cangoá	*Stellifer spp*	607	543	551	561	533	168	231	306	338	320	323
Oveva	*Larimus breviceps*	149	174	203	157	207	218	254	221	244	231	233
Tortinha	*Isopisthus parvipinnis*	12	*2*	2	2	104	131	16	83	91	86	87
Freshwater Sciaenidae												
Pescada	*Plagioscion spp*	10,326	13,611	10,142	12,270	12,792	12,244	12,029	13,132	12,037	14,967	13,150
Pescada-do-Piaui	*Plagioscion squamossisimus*	2,504	2,650	2,863	3,424	4,653	4,303	7,061	7,319	6,709	4,516	5,644
Curvina, Corvina**	*Pachyurus spp*	3,239	3,320	3,563	3,618	2,351	2,283	2,641	*	*	*	*

Data extracted from annual statistics of Brazilain Ministery of Fisheries and Aquaculture (www.mpa.gov.br).
* From 2008 two species of Macrodon have been combined under one common name "pescadinha real" or *M. atricauda*, however majority landings belong to northern species *M. ancylodon*.
** From 2008 on freshwater "curvina" was eleiminated from the landing statistics.

to calculate generation length depending on available data. In the absence of specific age class data, generation length can be calculated as the median age between the age at first maturity, or reproduction, and the species longevity (IUCN, 2014).

The majority of freshwater Sciaenids were evaluated under Criterion B, which is based on meeting geographic area thresholds and other factors that indicate decline. Specifically, Criterion B measures extinction risk based on a small geographic range size (extent of occurrence $<20,000$ km^2 or area of occupancy <2000 km^2 to meet the lowest threshold for VU) combined with evidence of continued decline, a small number of locations, and/or evidence of extreme fragmentation.

The category Near Threatened (NT) is assigned to species that come close to but do not fully meet all the thresholds or conditions required for a threatened category under any Criterion, and the category Least Concern (LC) is assigned if a species does not meet or come close to meeting any of the thresholds required of a threatened category. A species is listed as DD if there are insufficient data to apply the Red List Criteria. This can apply to species that need taxonomic clarification, or that are only known from a few specimens. In some cases, relatively well-known species are listed as DD when significant threats are known but cannot be adequately quantified.

For a regional red list assessment the criteria are the same as the global assessments but with additional considerations to account for immigration or emigration of individuals to and from the region that could impact regional population trends (IUCN, 2012b). However, additional filters were developed by the Brazilian Red List specialists group (CEPSUL-ICMBio, accessed on May 5, 2015 http://www.icmbio.gov.br/cepsul/destaques-e-eventos/215-avaliacao-do-estado-de-conservacao-de-peixes-osseos-marinhos.html) including three justifications for assigning a species to the Least Concern (LC) category:

1. A species is widely distributed, frequently encountered (common) and abundant. No significant (specific) threats are known to put the population at risk.
2. A species is naturally uncommon and less abundant, but no significant (specific) threats are known to put the population at risk.
3. A species complex can be assessed as a single taxon, and as such, is widely distributed, abundant and frequently encountered. No significant (specific) threats are known to put the population(s) at risk. However, taxonomic research is required to clarify the status of the species. For example, the widely distributed and taxonomically poorly-defined freshwater Sciaenid, *Plagioscion cf. "squamossisimus"* and *P. cf. "surinamensis"*, were each treated as a species complex, which may include additional cryptic species and populations (Casatti, 2005; Cooke et al., 2011).

Based on these filters and the thresholds of the IUCN Red List Criteria, the category of Least Concern (LC) was assigned to (1) a well-known commercially exploited species that has long-term fishery statistics, but do not meet the thresholds for a threatened category under IUCN criteria (e.g. *Micropogonias furnieri*, Table 2), (2) small and non-target species that are common and abundant along Brazilian coast or rivers, even without specific data on population trend (e.g. species of *Stellifer*); and (3) rare and uncommon species, not targeted by fisheries or known to be impacted by a significant threat, even though population data may be lacking (e.g. species of *Pachypos* and *Pachyurus*, Table 2).

For the Brazilian Red List Assessment, species assigned to the Data Deficient (DD) category included: (1) those caught sporadically due to incidental distribution in Brazilian waters (e.g. *Cynoscion steindachneri, Lonchurus elegans*); (2) freshwater

Table 4
Total number of Brazilian Sciaenidae assessed and percentage distribution by categories compared to IUCN global bony fish assessment.

Category	Brazilain Sciaenidae Assessed						Global Bony Fish Assessed*	
	Marine species		Freshwater species		Total			
	No.	%	No.	%	No.	%	No.	%
EN	1	2.9%	0	0.0%	1	1.9%	171*	12%
NT	1	2.9%	2	11.1%	3	5.8%	34	2%
LC	25	70.5%	11	61.1%	36	69.2%	934	65%
DD	5	14.7%	5	27.7%	10	19.2%	297	21%
NA	2	5.9%	0	0.0%	2	3.8%		
Total	34		18		52		1,436	

* Hoffmann et al. (2010): with 171 species in threatened categories (CR + EN + VU).

species where significant threats are known, but difficult to quantify, and more research is required to determine if the species meets the thresholds for a threatened category (e.g. *Pachyurus squamipennis*); and (3) co-generic pools of common species which may include undescribed species (e.g. *Plagioscion cf surinamensis* complex). Marine Sciaenids with their principal range of distribution outside of Brazil with only ambiguous records in Brazilian waters were assessed as Not-Applicable (NA, e.g. *Equetus punctatus*).

The common name "pescada branca" is used in fishery statistics for *Plagioscion squamosissimus* (Table 3), but likely includes multiple species of *Plagioscion*. For this reason, we assessed "pescada branca" as a species complex comprised of *Plagioscion* cf. *squamossisimus* and *Plagioscion* cf. *surinamensis*; the former of which includes similar species with thin and shorter second anal spine, while the later includes species that have a thicker and longer second anal spine.

3. Results and discussion

There are 34 marine and 18 freshwater Sciaenidae species found in Brazilian waters, with several additional undescribed species. Of the 52 species assessed, 5 marine and 5 freshwater species (19.2%) lacked adequate data to quantify any known threats or to calculate population trends, and were therefore classified as Data Deficient; 25 marine and 11 freshwater species (69.2%) were classified as Least Concern (LC). Overall, the proportion of Brazilian LC and DD species is similar to those for all bony fishes global assessed to date in LC or DD categories, although a lower proportion of Brazilian Sciaenids are listed in threatened categories (~2%) compared to 12% of bony fishes globally assessed to date (Table 4; Hoffmann et al., 2010).

Only the Southern black drum, *Pogonias cromis*, from southern Brazil, met the thresholds of decline for a threatened category, with the Brazilian stock classified as Endangered (EN). One marine acoupa weakfish, *Cynoscion acoupa*, from northern Brazil, along with two freshwater endemic croakers, *Pachyurus francisci* from Rio São Francisco basin and *Pachyurus pauciratrus* from Rio Tocantins, were classified as Near Threatened (NT).

Of all the Sciaenid species assessed, the most concern is the now endangered Southern black drum (*Pogonias cromis*). Over 99% of registered commercial landings of this species in Brazil are from the southern most state of Rio Grande do Sul, where landings have reduced from 1450 tons in 1976 to an average of 81 tons since 1990 (Table 5). In northern states, landing in São Paulo peaked to 12.5 tons in 1992, but have been less than one ton per year since. In Santa Catarina State, the last recorded landings for this species were 40 tons in 1994 and 2.5 ton in 1995. South of Brazil, average landings from 2000–2011 were 517.3 tons in Uruguay and 36.8 tons in Argentina. Despite reports of decreasing commercial catches in the Rio de la Plata estuary, this species was not assessed as threatened in Argentina (Baigún et al., 2012). Although the Brazilian stock of the species may interact with populations in Uruguay and Argentina, there is no evidence that southern Brazil is a source for stocks or populations further south. Southern black drum can reach a maximum size of 150 cm (TL), live as long as 45–55 years, and mature around 4–5 years of age in the La Plata River estuary (Urtrega and Perrotia, 2001) and 3–4 years in southern Brazil (Haimovici, unpublished data). For these reasons, even with drastic decreases in fishing effort, this species will be very slow to recover from overfishing. It is important to note that the completely separated North Atlantic black drum, which is a minor commercial and recreational species and is not considered to be overfished or classified in a threatened catalog (Adlerstein and Zollett, 2011).

The acoupa Weakfish or "pescada amarela", *Cynoscion acoupa*, was initially classified as Least Concern on the 2010 IUCN Red List (http://www.iucnredlist.org). From 2001 to 2011, *C. acoupa* landings in Brazil fluctuated between 20,050 and 27,559 tons (Table 3), with an overall decline in landings of approximately 27% over the past 10 years. As this decline is slightly less than the 30% threshold for a threatened category, this species qualifies for a category of Near Threatened (NT). The state of Pará represents 80% of total Brazilian landings for this species, which is considered fully exploited, with the 2005 biomass estimated around 87,500 t (Frédou and Asano Filho, 2006). However, due to the differences in sampling methods, divergent landing statistics are common throughout Brazil, which may explain why the total catch from Port Bragança, Pará is four times less than the official statistics (Isaac et al., 2008).

Pachyurus francisci is endemic to Rio São Francisco basin and has been classified as Near Threatened (NT) due to its limited area of occurrence and continue loss of habitat. This species has become very rare in the lower reaches of the São Francisco

Table 5
Southern Brazil, Uruguay and Argentina recorded landing of southern black drum, *Pogonias cromis*, in metric tons.
Source: see text.

	Rio Grande do Sul (RS)	Santa Catarina (SC)	São Paulo (SP)	Brasil	Argentina	Uruguay	Total region
1975	598			598	5		603
1976	1324			1324	11		1335
1977	1450			1450	30	121	1601
1978	1093			1093	26	147	1266
1979	756			756	3	99	858
1980	611			611			611
1981	511			511	3		514
1982	228			228	28		256
1983	205			205	7	265	477
1984	240			240	1	333	574
1985	181			181	1		182
1986	295	39	0	335	11	619	965
1987	284		2	286	6	315	607
1988	316	3.2	0.8	320	33	150	502
1989	154	3.2	0.6	158	13	303	474
1990	30	5.2	1.1	36	1	46	82
1991	60	13.4	1.5	74	14	229	318
1992	18	7.8	12.9	39	52	281	372
1993	62	36.6	0.0	98	95	273	466
1994	63	40.0	0.9	104	10	220	334
1995	23	2.1	0.2	26	40	574	640
1996	10		1	11	158	172	340
1997	179	0		179	81	83	343
1998	256	0	0.2	257	271	678	1206
1999	1	0	0.1	1	95	100	196
2000	51	0	0.4	51	12	344	407
2001	4	0	0.2	5	51	325	381
2002	109	0	0.7	109	33	504	646
2003	37	0	0.6	38	152	701	890
2004	5	0	0.5	6	55	578	638
2005	380	0	1.1	381	92	611	1083
2006	110	0	0.6	111	10	559	680
2007	1	0	0.6	1	19	683	704
2008	192	0	0.7	193	68	436	697
2009	0	0	0.5	1	67	272	339
2010	0		0.7	1	341		
2011			1.6	2	17		

river due to siltation, pollution, and dam development. It may also be impacted by introduced species, such as tilapias, peacock bass (*Cichla)* and *Plagioscion squamossisimus* (Alves et al., 2008; SoaresdaLuz et al., 2009). More research is urgently needed to determine if this species is already locally extinct in the Rio das Velhas, located in the upper reach of Rio Sao Francisco basin. The Rio das Velhas basin is a heavily populated region with high levels of pollution and frequent fish kills (Alves and Pompeu, 2005).

The freshwater *Pachyurus paucirastrus* from the Rio Tocantins basin is also listed as Near Threatened (NT) due to its small number of locations and evidence of continuing decline in habitat. This species is primarily threatened by habitat loss due to the construction of dams for hydroelectric power. After extensive sampling, Pacheco et al. (2008) declared that *Pachyurus paucirastrus* has completely disappeared from the lower reaches of the Rio Tocantins just four years after the closure of Serra da Mesa dam. It is not known if this species may still exist in other areas of the Rio Tocantins basin, or other river systems.

3.1. Missing species and taxonomy

In addition to 52 species assessed for the Brazilian national Red List, there are several species or varieties have not been formally described, including species of the genera *Cynoscion*, *Pachyurus*, *Plagioscion*, *Ophioscion* and *Stellifer* (Chao, unpublished data). Marine species of *Ophioscion* and *Stellifer* species are relatively rich in diversity and abundance, especially in the North and Northeast regions of Brazil. They are small-sized fishes (<25 cm TL), which are common in by-catch from coast shrimp trawls (Isaac, 1998; Rodrigues Filho, 2008), and have similar external appearances which makes them difficult to identify correctly (Chao, 2003). Well-defined species taxonomy and reliable population data are fundamental for red list assessment, but they are still missing among a few Sciaenidae.

In this assessment the freshwater "pescada branca" was assessed as two species complex comprised of *Plagioscion* cf. *squamossisimus* and *Plagioscion* cf. *surinamensis*. Casatti (2005) placed *Plagioscion surinamensis* (Bleeker 1873) as a junior synonym of *Plagioscion squamosissimus* Heckel (1840), and then assigned *Plagioscion surinamensis* (Steindachner 1878, non Bleeker) as a junior synonym of *P. magdalenae* (Steindachner 1878). *Plagioscion magdalenae* is a valid species endemic to Magdalene River, Colombia. Applying the name *P. magdelenae* to *Plagioscion* species of the Amazon estuary is not correct

(e.g. Santos et al., 2010). Due to the vast area covered by river basins in the Neotropics, new records from distantly separated species are common and cryptic or new species may still be discovered (Cooke et al., 2011).

3.2. Sciaenid Fisheries in Brazil

Of the 34 marine sciaenids assessed, 18 are targeted by commercial, artisanal or ornamental fisheries, and 9 species are abundant in the by-catch of industrial shrimp trawlers (Table 2). Seven freshwater sciaenids are targeted in seasonal artisanal fisheries, while others are uncommon and only captured incidentally. In Brazil, fisheries have distinct regional characteristics. Artisanal fisheries account for a higher proportion of marine fish landings in the North and Northeast regions, while industrial fisheries sustain the largest part of marine fisheries in the Southeast and South regions (Vasconcellos et al., 2007). From 1980 to 2007, there was an increase in artisanal fishery landings in the North (from 82.0 to 91.1%), Northeast (70.4 to 96.3%) and Southeast (12.8 to 38%), accompanied by a decrease in the South (25.9% to 15.5%) (Sanders and Hjort, 2011).

Since 2001 Brazilian marine fisheries statistics have been more consistently sampled and reported (Ruffino, 2008), including 13–14 taxa of sciaenids with a total landing from 97 to 150 thousand tons, which constitute 18%–25% of near one half million tons total marine fish landings (Fig. 1). Freshwater sciaenid landings are comprised of three groups of multiple (aggregated) species with total landings between 12,000 and 20,000 tons (Table 3). However, Brazilian fishery landing statistics have not been reported since 2012.

3.3. Market value and exploitation

Croakers are popular food fishes in Brazil with moderate pricing in local markets, and exploitation was concentrated in a few high value or very abundant species. Medium to large weakfishes (*Cynoscion acoupa, C. virescense)* and the King weakfish (*Macrodon ancylodon)* are the most targeted species in northern Brazil states (Maranhão, Pará and Amapá). Most of these catches are shipped to metropolitan markets in the South. Although *C. acoupa* has been fully exploited Frédou and Asano Filho (2006), its current risk of extinction is low to moderate as declines are estimated to be 10%–25% over the past 10 years. As drift gill nets are the principal gear used to capture larger fish; fishes over 70 cm (TL) are still common in landings and local markets.

Smaller-sized and juvenile Sciaenids constitute a large portion of the by-catch in coastal industrial shrimp trawlers and artisanal fisheries. Relatively few, scattered quantitative data are available for sciaenids in the by-catch, such as for *Ophioscion* and *Stellifer* species in the north (Isaac, 1998; Rodrigues Filho, 2008), juveniles of *Macrodon attricauda*, *Cynoscion guatucupa*, *Paralonchurus brasilienis* and *Umbrina canosai* in the south (Haimovici and Mendonça, 1996).

Recently, several previously non-targeted or low quality Sciaenid species have been processed or made available for popular consumption, such as *Bardiella ronchus, Ctenosciana gracilicirrhus, Nebris microps, Paralonchurus brasiliensis, Stellifer and Ophioscion* (Chao, personal observations). Supplementing consumer markets with these species may indicate a general decline of traditional sought species.

3.4. Conservation concerns

Brazilian Sciaenids are at low to moderate risk of extinction; with the exception of the Endangered Southern black drum (*Pogonias cromis)* and two Near Threatened freshwater croakers (Tables 2 and 4). Fishery landings for targeted Sciaenid species have been relatively stable over the past decade, although at lower levels (Table 3; Fig. 1). However, to evaluate population trends in Red List Assessments differ in methodology from those of fisheries management organizations, as the Red List assessment methodology focuses on quantifying the impacts of threats to a regional or global species population rather than the calculating parameters required for management of a particular stock (Collette et al., 2011). Sciaenids are major fishery target in Brazil, but the lack of consistent state and national level landing statistics and few independent studies on population trends makes it extremely difficult to quantify the fishery impact on species and populations. Given the large size of Brazil, its rich biodiversity and strong regional differences, a weak fisheries management system and institutional framework is a significant challenge to fisheries assessment, management, monitoring and enforcement. To improve Brazil's ocean health, we agree to Elfes et al. (2014) that future actions should focus on: enhancing fisheries management, expanding marine protected areas, and monitoring coastal habitats.

For freshwater species, habitat losses due to damming of rivers, deforestation, water pollution, mining, poor agricultural practices or inadequate management practices Barletta et al. (2010) are of major concern. For the two freshwater croakers recently assessed, there are specific concerns about the high level of environmental degradation in the Rio San Francisco basin, including coastal development adjacent to mangrove and reef habitats in the northeast region of Brazil; the impacts of introduced freshwater silver croaker (*Plagioscion* spp.) on native species; and the impact of hydroelectric dams and reservoirs in the northeastern and southern regions (Alves et al., 2008; Torres, 2006). For these species, efficient conservation strategies to conserve highly exploited aquatic resources are needed, including establishing marine protected areas and land based natural parks and reserves in Brazil (Diegues, 2008; Sanders and Hjort, 2011). However, it is encouraging that the Brazilian Minister of the Environment has completed the first step toward implementing effective conservation strategies

by releasing a new national "red lists" identifying 3286 species of plants and animals threatened with extinction (ICMBio, 2014 & Portarias Nos. 443, 444, 445).

Among fishes and aquatic invertebrates, 83 species are commercially exploited, mainly as by-catch. The industrial fisheries sector has been using its political influence to persuade the government to change the contents of the red list of aquatic animals or revoke it entirely (Dario et al., 2015). Unfortunately, the portarias (ordinance) have been canceled on June 12, 2015. Colleagues participated in the Red List Assessment since 2009 and scientific communities are making efforts to reach out to stack holders and government agencies.

3.5. Conclusions

Results and recommendations of the first Brazilian Sciaenidae Red List Assessment are summarized below:

1. With a few exceptions, Brazilian sciaenids are at low to moderate risk of extinction.
2. Threats from habitat degradation are likely to be more severe than fishery pressure on Brazilian freshwater sciaenids, but overfishing and by-catch are the main threats to estuarine and marine species.
3. The taxonomic status of several Brazilian Sciaenid taxa is not well-defined, which limits the reliability of fisheries landing statistics.
4. As IUCN recommends that Red List assessments are updated every 10 years; actions are needed to improve the availability and quality of data for future re-assessments.

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