International Journal of Innovative Studies in Aquatic Biology and Fisheries
Volume 4, Issue 3, 2018, PP 10-17
ISSN 2454-7662 (Print) & ISSN 2454-7670 (Online)
DOI: http://dx.doi.org/10.20431/2454-7670.0403002
www.arcjournals.org

Production Evolution, Catch Estimate and Conservation Status of the Marine Sciaenidae (Pisces, Perciformes)

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Abstract: *Marine Sciaenidae has a wide distribution, occurring in the Atlantic, Indian and Pacific oceans, and are considered one of the main fisheries resources in the world, being exploited extensively by some countries. In this context, the present work analyzed the evolution of the fishery production of the Sciaenidae between the years 1950 to 2015, considering the quantity produced, as well as the degree of vulnerability of the species, based on calculations of growth rate and variation of production, and estimated future yields. A total of 51 species belonging to 27 genera were identified, with production in 91 countries. The average annual production is 893413.5 tons, with China, India and Brazil being the countries that most capture croakers. It was observed that the production of Sciaenidae is growing at a rate of approximately 0.1% per year, but 24 species showed a negative growth rate, being Genyonemus lineatus, Atractoscion aequidens and Argyrosomus hololepidotus with-18% -16.4%, -13% respectively. Some species were noted in the catch variation, such as Pennahia argentata, which had a coefficient of variation of 149%. An aggravating exploitation of some species was observed, which may no longer be captured in the future. In 2025 a critical state is pointed out mainly for three species, and by 2050, five more are added to this worrying scenario. In this way, we need more studies on the biology, population dynamics and fisheries of Sciaenidae that will help in the sustainable management and conservation of them.*

Keywords: *World fisheries, drum, croakers, production rate.*

1. Introduction

Sciaenidae is a fish family, of the order Perciforme, and are popularly known as drum and croaker, there are currently about 280 species distributed in 90 genera scattered around the world [1]. The species of this family are mostly marine fish, only 18 species are from continental aquatic environments [2]. Croakers range from small to large fish (10-200 cm in total length), most have a silvered, elongated and compressed body, usually with a yellowish or reddish color on the lower parts [1].

This family has a wide distribution occurring in the Atlantic, Indian and Pacific Oceans [3]. They are commonly found near the bottom in coastal environments [4, 5]. Croakers are normally scattered in small groups migrating along of the coast, although a few species can be found up to 600 m depth [1]. Often found at the interface of estuaries and coastal marine and either migrate locally between flood plains and river channels, mostly use estuarine environments such as nursery areas, or move to the riverbank seasonally in the reproductive period [4].

The capture of the species of Sciaenidae is one of the main fishing resources of some parents, their production in the course of the years varied [6], some of its species are highly exploited, others lack studies to designate the status of its population. In this context, the present work analyzed the evolution of the fishery production of the Sciaenidae between the years 1950 to 2015, considering the quantity produced, as well as the degree of vulnerability of the species, based on calculations of growth rate and variation of production, and estimated future yields.

2. Materials and Methods

The data were extracted from the FishStat platform of the United Nations Food and Agriculture Organization (FAO) where all the production data of the marine fish species of the Sciaenidae, by

country, during the years 1950 to 2015, when possible. The countries of higher production of croakers were ranked from the production of the last year and the average between 1990 and 2015. Subsequently, the rates of growth or decrease (*k*) were calculated of production over the past 10 years by species, from the equation of von Genuchten & Hatton [7]:

$$k = \left(\left(\frac{P_x}{P_{x-1}} \right)^{1/n-1} - 1 \right) \times 100$$

where, *k* is the rate of growth or decrease (%), P_x is the production of the year *x*, P_{x-1} is the previous year's production *x*, and *n* = amount of years.

The species that resulted in rate of decrease were checked their categories according to the Red List of the International Union for Conservation of Nature (IUCN), which classifies the species in: not evaluated (NE), data deficient (DD), least concern (LC), near threatened (NT), vulnerable (VU), endangered (EN), critically endangered (CR), extinct in the wild (EW) and extinct (EX) [8].

Was realized the calculation of variation coefficient (VC) [9], by species, taking into account the scenario of catch of the species between the years 1950 and 2015. For the species that presented *VC* higher than 50%, of its total production average, the future productions for the years 2025 and 2050 were estimated by the expression:

$$P_x = \left(\frac{n \times k \times P_{2015}}{100} \right) + P_{2015}$$

where, *x* corresponding to the year, *n* amount of years between 2015 to *x*, *k* is the growth rate of the species, and P_{2015} is the year 2015 production of the species.

3. RESULTS AND DISCUSSION

A total of 51 species belonging to 27 genera were identified, more a group identified only with Sciaenidae, with production in 91 countries [6]. The average annual production is 893,413.5 tons, with China, India and Brazil being the countries that captured most croakers in 2015. In China, *Pennahia argentata* stands out, having a total of 108,461 tons in 2015, its high catch is witnessed since 2003. In the production of India the species was not specified, but its production of Sciaenidae is high, being the second country with greater production, in the last 10 years. Brazil is in third, highlighting *Micropogonias furnieri* with 41,000 tons in 2015, another highlight is the genus *Cynoscion* with 36,200 tons in 2015 (Table 1).

Table1. *Production of the ten countries with the largest capture of Sciaenidae, with indication of the main catch species. (n = numbers of species catch).*

Ranking	Country	Production in 2015 (tons)	Average 1990-2015 (tons)	n	Main species
1	China	1,033,568	696,187	6	*Pennahia argentata*
2	India	156,197	316,754	1	Sciaenidae
3	Brazil	118,557	178,475	15	*Micropogonias furnieri*
4	Indonesia	80,890	68,395	1	Sciaenidae
5	Argentina	50,738	44,022	6	*Micropogonias furnieri*
6	Republic of Korea	49,839	114,521	5	*Larimichthys polyactis*
7	Malaysia	38,776	31,446	1	Sciaenidae
8	Nigeria	26,850	23,624	2	*Pseudotolithus* spp
9	Uruguay	24,686	45,534	6	*Micropogonias furnieri*
10	Mexico	19,143	16,563	8	*Cynoscion* spp

Among the genera, those with higher productions were *Larimichthys*, *Micropogonias*, *Cynoscion*, *Miichthys* and *Pseudotolithus* (Figure 1). Of these, *Larimichthys* stands out, with a total production of 516,958 tons in 2015, the capture of this genus is witnessed in China, with 93.4% of the total production of the genus in 2015 (being captured two species), Republic of Korea with 6.6%, also with

two species, and Taiwan with only 0.03%, and only one species caught. The genus *Micropogonias*, with a production of 94,388 tons, standing out Brazil, responsible for 43.4% of the production and Argentina with 33.2%, both capture only the species *M. furnieri*, it is observed that the species has high catch in South America.

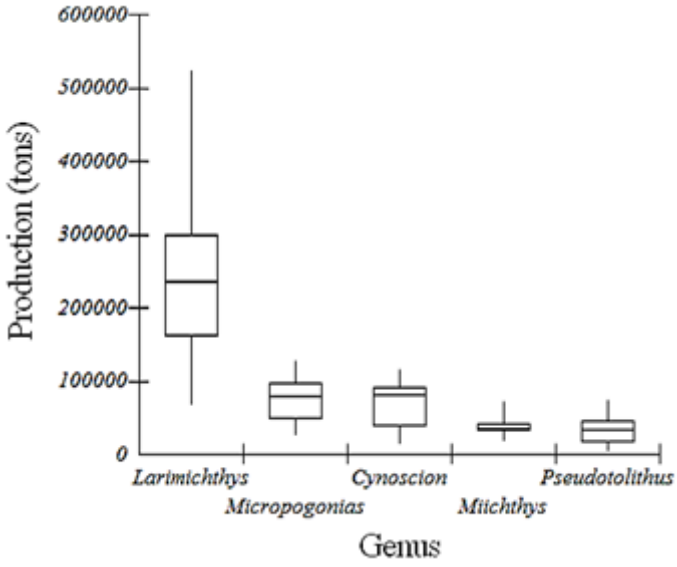

Figure1. *Production of five main genera of Sciaenidae. The bars indicate the mean values with standard deviation; horizontal lines indicate medians.*

The production of Sciaenidae in the world in general is increasing, having a rate of approximately 0.1% per year, according to the state from 1950 to 2015. The productions of the species has varied every year, in 2015 ranging from small productions, as *American Menticirrhus* with only 4 tons, being captured only in Argentina, to high productions, such as *Larimichthys polyactis* with 411,735 tons, with capture in the Taiwan, Republic of Korea, Chine and Japan. The catch of some species remained stable during 1990 to 2015, although they still had below-average yields and consequently had negative growth rates (Annex 1).

Among 51 species registered by FAO [6], 20 had a positive growth rate, some with more than 10% per year, growth in the last ten years, as is the case of *C. analis*, *C. nebulosus*, *M. saxatilis*, *M. miiuy*, *P. peruanus*, *S. ocellatus* e *U. cirrosa*. It stands out to *M. miiuy*, that has the fifth greater production among the species of croakers and rate of growth of 10.5%, according to the productions of 2006 to 2015 (Figure 2).

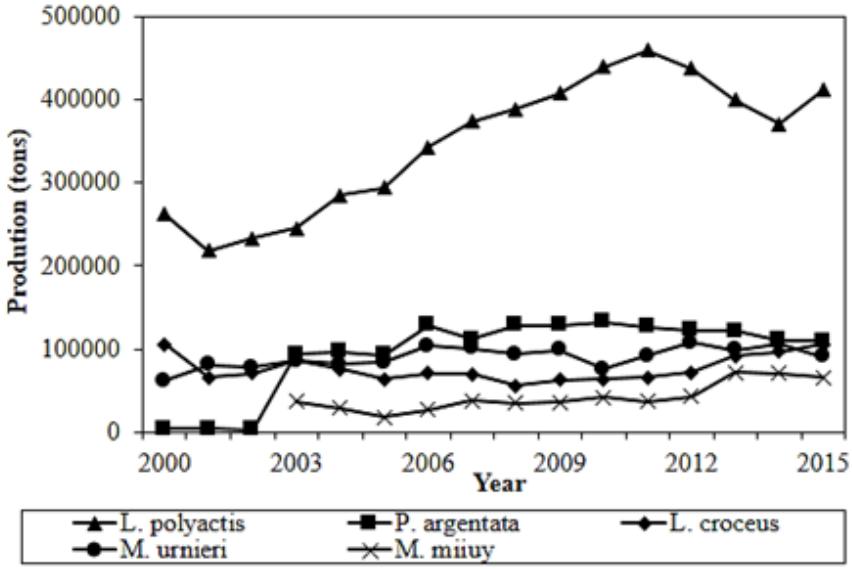

Figure2. *Sciaenidae species productions that have a positive growth rate more than 10% per year.*

However, 24 species had a negative growth rate, and seven were not evaluated by IUNC, such as C. *regalis* and *N. mitsukurii*, which urgently need to be studied and evaluated, since in the present study there were high falls in their production. Although *C. gilberti* be with data deficient, was worrisome, since its rate was -8.4 per year; 13 were classified in the category of low concern, among them *U. canariensis* and *M. undulatus* with a rate of decrease greater than 10%; *G. lineatus* was assessed in near threatened; *A. aequidens* was vulnerable and; *A. hololepidotus* endangered (Table 2).

Table2. *Conservation state of Sciaenidae species in Red List of the International Union for Conservation of Nature, which have a negative growth rate.*

Species	Growth rate (%)	Conservation state by IUCN
Aplodinotus grunniens	-0.7	LC
Argyrosomus hololepidotus	-13.0	EM
Atractoscion aequidens	-16.4	VU
Atractoscion nobilis	-7.9	LC
Cilus Gilberti	-8.4	DD
Cynoscion acoupa	-1.0	LC
Cynoscion arenarius	-9.0	LC
Cynoscion jamaicensis	-1.7	LC
Cynoscion leiarchus	-2.0	LC
Cynoscion regalis	-19.0	NA
Cynoscion striatus	-10.8	NA
Genyonemus lineatus	-18.0	NT
Isopisthus parvipinnis	-5.1	LC
Leiostomus xanthurus	-4.5	LC
Menticirrhus littoralis	-2.5	LC
Micropogonias undulatus	-11.5	LC
Micropogonias furnieri	-1.4	NA
Nibea mitsukurii	-50.0	NA
Otolithes ruber	-2.1	NA
Pennahia argentata	-1.8	NA
Pseudotolithus elongatus	-2.4	LC
Pteroscion peli	-4.8	LC
Umbrina canariensis	-12.1	LC
Umbrina canosai	-3.5	NA

According to Chao & Starnes [10], *G. lineatus* reaches the vulnerable criteria based on the fisheries data of the population in California. Still according to authors, the impact of fisheries on the rest of its reach is unknown. *A. aequidens* its category in IUCN is due to the reductions of approximately 95% of its stock in South Africa and due to dramatic increase in recreational fisheries in Australia in the last 15 years [11]. Some measures have already been taken, in South Africa, catch restrictions limit the amount of fisheries and the minimum catch size, 60cm Total Length (LT), in Australia the minimum length is 38 cm TL [12, 13].

Argyrosomus hololepidotus, evaluated as endangered, is endemic to the Madagascar's southeastern coast, existing in only five locations across the globe. Even with few existing data such of life, growth, population and fishing studies, the species is pointed to danger level, it is estimated that their mature population is less than 10,000, in which they are part of a single subpopulation that is undergoing continuous decrease. Even so, there are still no management measures that see the safety of the species [14].

In view of the high oscillations, some species stood out in this scenario, as can be observed in table 3, which are the species that had a sweating coefficient of greater than 50%. Some of them have varied in the range of about 150% of their average production, 18 species with high oscillation, have a negative growth rate, that is, there is a decrease in their production evolution. This may be related to the population structure of the species, since they have a high rate of exploitation, causing the population to become imbalanced, thus decreasing their fish stocks.

Table3. *Estimates of the productions for the years 2025 and 2050, of Sciaenidae species that have variation coefficient (VC) superior to 50% of their average production.*

Species	Average production (tons)	VC (%)	k (%)	2025 (tons)	2050 (tons)
Aplodinotus grunniens	1000	118.5	-0.7	476	396
Argyrosomus hololepidotus	3845	142.6	-3.0	3376	1561
Atractoscion aequidens	355	54.7	-6.4	122	23
Atractoscion nobilis	376	103.5	-7.9	39	5
Atrobucca nibe	3482	94.7	3.7	741	1846
Cynoscion analis	4378	51.6	18.5	27415	1902288
Cynoscion arenarius	273	102.7	-9.0	5	0
Cynoscion guatucupa	9308	82.3	1.1	25254	33343
Cynoscion regalis	4113	87.0	-19.4	8	0
Cynoscion striatus	6305	73.7	-10.8	1130	64
Genyonemus lineatus	193	84.9	-18.8	1	0
Isopisthus parvipinnis	67	63.7	-5.1	49	13
Larimichthys polyactis	156921	78.5	2.1	505418	843788
Macrodon ancylodon	3967	116.7	8.9	28895	246208
Menticirrhus americanos	2	54.8	26.0	32	40.3
Menticirrhus littoralis	1200	64.1	-2.5	449	237
Menticirrhus saxatilis	53	85.6	24.8	946	241754
Menticirrhus spp	1076	78.4	-1.1	1716	1295
Micropogonias spp	3291	61.8	-32.6	3	0
Micropogonias undulatus	7451	68.0	-11.5	937	45
Paralonchurus peruanus	4025	96.1	13.6	9851	236463
Pennahia anea	2932	59.2	13.9	22397	583041
Pennahia argentata	29288	148.9	-1.8	91312	58233
Pogonias cromis	2445	52.4	4.4	5899	17424
Pseudotolithus elongatus	8113	91.8	-2.4	14346	7837
Pseudotolithus senegallus	1074	91.1	6.0	4729	20182
Pteroscion peli	1910	60.1	-4.8	883	258
Sciaena umbra	143	89.0	7.6	534	3365
Sciaenops ocellatus	570	120.2	27.8	852	395878
Umbrina canariensis	1300	100.4	-12.1	493	20
Umbrina canosai	8816	77.6	-3.5	9896	4009
Umbrina cirrosa	477	99.1	14.0	1156	30536

It is noted the aggravating exploitation of some fishery resources, which may no longer be captured in the future. In 2025, a critical state is pointed out mainly for the species, *C. arenarius*, *C. regalis* and *G. lineatus*. Moreover, in 2050, species are added, *A. aequidens*, *A. nobilis*,*I. parvipinnis*, *M. undulatus* e *U. canariensis*, to this worrying state.

Thus, we need more studies on the biology, population dynamics and fisheries of Sciaenidae, especially on the aforementioned species, which will help in the sustainable management and conservation of these species.

4. Conclusions

It was noted that Sciaenidae is an important fishing resource worldwide, being captured in 51 different countries, even if its production is showing increasing, the capture of some species are in declines, and others have already been found in a worrying state, including included in the red list of threatened species of IUCN. This is linked to high fisheries rates, resulting in a decrease in fish stocks and consequently bringing incalculable damage to fish populations. Therefore, the urgency of studies, from biology to Sciaenidae fisheries, is striking so that plausible measures can be taken for the continuity of species, together with fishing.

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ANNEX1. Annual and average yield and growth rate (k), of the last 10 years, by species

Species	1990	1995	2000	2005	2010	2015	Average production 1950-2015	K
Aplodinotus grunniens (Rafinesque, 1819)	439	470	577	503	702	512	1001	-0.7
Argyrosomus hololepidotus (Lacepède, 1801)	2285	1501	1486	5956	17722	4595	3845	-13.0
Argyrosomus regius (Asso, 1801)	2717	2040	2353	4852	5675	6606	3547	2.2
Atractoscion aequidens (Cuvier, 1830)	590	397	412	688	439	238	355	-16.4
Atractoscion nobilis (Ayres, 1860)	56	33	101	139	258	88	376	-7.9
Atrobucca nibe (Jordan & Thompson, 1911)	2719	197	450	335	364	514	3482	3.7
Cilus Gilberti (Abbott, 1899)	8543	5592	4744	6773	10571	2149	8476	-8.4
Cynoscion acoupa (Lacepède, 1801)	-	-	-	20778	20879	19800	21427	-1.0
Cynoscion analis (Jenyns, 1842)	5248	9406	6326	3011	4326	5029	4378	18.5
Cynoscion arenarius (Ginsburg, 1930)	123	91	74	29	33	12	273	-9.0
Cynoscion guatucupa	9488	19218	9433	19386	18774	22598	9308	1.1

(Cuvier, 1830)								
Cynoscion jamaicensis (Vaillant & Bocourt, 1883)	-	-	-	2731	3068	2900	2804	-1.7
Cynoscion leiarchus (Cuvier, 1830)	-	-	-	1002	948	900	911	-2.0
Cynoscion nebulosus (Cuvier, 1830)	3208	3950	6486	513	314	1576	3026	11.3
Cynoscion regalis (Bloch & Schneider, 1801)	4482	3095	2438	587	123	69	4113	-19.4
Cynoscion spp (Gill, 1861)	50361	49600	58818	23146	26440	28583	37358	1.8
Cynoscion striatus (Cuvier, 1829)	5665	13417	13440	8559	5480	3551	6305	-10.8
Cynoscion virescens (Cuvier, 1830)	-	-	-	1488	778	740	740	6.2
Genyonemus lineatus (Ayres, 1855)	278	256	105	38	6	6	193	-18.8
Isopisthus parvipinnis (Cuvier, 1830)	-	-	-	104	86	82	67	-5.1
Larimichthys croceus (Richardson, 1846)	40534	89630	105805	64157	63550	105223	92763	4.5
Larimichthys polyactis (Bleeker, 1877)	52895	181553	262090	293674	438837	411735	156921	2.1
Larimus breviceps (Cuvier, 1830)	-	-	-	207	231	220	217	0.1
Leiostomus xanthurus (Lacepède, 1802)	3101	3521	3141	2321	1675	958	3417	-4.5
Macrodon ancylodon (Bloch & Schneider, 1801)	117	5345	6642	4476	12575	12264	3967	8.9
Menticirrhus americanos (Linnaeus, 1758)	-	-	-	-	-	4	2	-
Menticirrhus littoralis (Holbrook, 1847)	652	968	961	851	281	580	1200	-2.5
Menticirrhus saxatilis (Bloch & Schneider, 1801)	25	34	28	129	24	103	53	24.8
Menticirrhus spp	-	1330	1352	2186	2036	1921	1076	-1.1
Micropogonias spp	5876	4352	4998	4219	5372	155	3291	-32.6
Micropogonias undulatus (Linnaeus, 1766)	3078	7013	12138	10945	6524	3164	7451	-11.5
Micropogonias furnieri (Desmarest, 1823)	59308	88569	61501	83942	75992	91069	65149	-1.4
Miichthys miiuy (Basilewsky, 1855)	-	-	-	17943	42236	65597	42128	10.5
Nibea mitsukurii (Jordan & Snyder, 1900)	2391	2164	1999	1302	-	-	2058	-50
Otolithes ruber (Bloch & Schneider, 1801)	-	-	9963	6869	6487	7945	7807	-2.1
Paralonchurus peruanus (Steindachner, 1875)	8704	5543	5729	854	2159	2763	4025	13.6

Pennahia anea (Bloch, 1793)	-	-	1310	1717	5186	6081	2932	13.9
Pennahia argentata (Houttuyn, 1782)	7584	7369	4180	93010	132708	109313	29288	-1.8
Plagioscion squamosissimus (Heckel, 1840)	-	-	10335	12792	-	18917	12815	5.0
Pogonias cromis (Linnaeus, 1766)	1109	850	2876	2900	2910	3825	2445	4.4
Pseudotolithus elongatus (Bowdich, 1825)	3630	13092	13532	20223	20959	18270	8114	-2.4
Pseudotolithus senegallus (Cuvier, 1830)	468	813	811	1250	2555	2647	1074	6.0
Pseudotolithus spp	30882	21876	31706	47420	42267	34677	27350	-3.9
Pteroscion peli (Bleeker, 1863)	2341	7820	1126	1966	2298	1445	1910	-4.8
Sciaena umbra (Linnaeus, 1758)	247	277	24	161	335	256	143	7.6
Sciaenops ocellatus (Linnaeus, 1766)	1	2	6	25	7	73	571	27.8
Totoaba macdonaldi (Gilbert, 1890)	-	-	-	-	-	-	1343	-
Umbrina canariensis (Valenciennes, 1843)	52	6	1082	2328	1158	1794	1300	-12.1
Umbrina canosai (Berg, 1895)	19644	14537	9221	9313	17230	14205	8817	-3.5
Umbrina cirrosa (Linnaeus, 1758)	850	270	224	140	128	312	477	14.0
Total	741836	1203270	1180533	1570648	1780039	1750750	893414	0.1

Citation: *Cícero Diogo Lins de Oliveira & Carlos Yure Barbosa de Oliveira (2018). "Production Evolution, Catch Estimate and Conservation Status of the Marine Sciaenidae (Pisces, Perciformes)". International Journal of Innovative Studies in Aquatic Biology and Fisheries, 4(3),pp.10-17. http://dx.doi.org/10.20431/2454-7670.0403002*