Arquivos de Ciências do Mar

ASSESSMENT OF THE FISH-WEIR FISHERY OFF THE COAST OF PIAUÍ STATE, BRAZIL

Avaliação da pesca de curral na costa do Estado do Piauí, Brasil

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ABSTRACT

Fish-weirs are stationary traps set up by fishermen in places with a considerable tidal height variation. This work followed the harvesting of three fish-weirs off the coast of Piauí State, Brazil. Sampling was conducted at daytime and nighttime shifts, during six days of each month of the period from December. 2008 through November, 2009. A total of 117 fish species was registered, belonging to 41 families. There was no significant difference in mean catch weight between the dry and wet seasons, the daytime and nighttime shifts, and full moon and new moon phases. The annual catch per fish-weir was estimated as 1.2 ton, of which 79.0% were made up of commercially-important fish species for Piauí State.

Keywords: *fish-weir, artisanal fishing, species inventory, fishery statistics, Piauí State.*

RESUMO

Currais-de-pesca são armadilhas utilizadas por pescadores em locais com variação de maré. Este trabalho monitorou três currais-de-pesca na costa do Piauí, Brasil. As amostragens foram conduzidas durante seis dias por mês, durante as despescas diurnas e noturnas, entre dezembro de 2008 a novembro de 2009. Um total de 117 espécies de peixes foram registrados, pertencentes a 41 famílias. Não houve diferença significativa para o peso médio das capturas entre as estações de chuva e seca, entre os períodos diurno e noturno, e entre as fases de lua cheia e lua nova. Estimou-se que cada curral-de-pesca gera uma produção anual de 1,2 t de peixe, da qual 79,0% são constituídos por espécies de importância comercial para o Estado do Piauí.

Palavras-chaves: *curral-de-pesca, pesca artesanal, inventário de espécies, estatística pesqueira, Estado do Piauí.*

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INTRODUCTION

Fish-weirs are stationary traps for capturing fish, usually designed with stakes vertically stuck in the ground, built following the direction of the tidal currents. This artisanal fishing gear is common in Northeast and North of Brazil where tidal variation is above 2 m high. Fishing weir technique was first registered in Brazil in 1858 in the State of Ceará (Menezes 1974). Over a hundred years later, studies about this kind of fishing were developed in the States of Ceará, Maranhão and Pará (Paiva & Nomura, 1965; Paiva & Fonteles-Filho, 1968; Collyer & Aguiar, 1972; Almeida 1974; Tahim & Carvalho, 1990; Maneschy, 1993; Fonteles-Filho & Espínola, 2001; Ribeiro, 2004; Piorski *et al*., 2009).

In the State of Piauí, fishing is predominantly artisanal and the use of fishing weir traps is common in two out of the four municipalities of the coast, however, there is no published study about fishing weir for the state. Therefore, in order to cover this gap of information, we conducted the first survey of fishes from shallow water zones collected in fish-weirs at the coast of Piauí State. We compared the productivity relating diurnal versus nocturnal periods, wet versus dry seasons, and full moon versus new moon phases. In addition, we estimated the annual fish capture for each fishing weir.

MATERIAL AND METHODS

Study Area: sampling was conducted at the municipality of Cajueiro da Praia, State of Piauí (Figure 1). This region is under the influence of semi-diurnal tides up to 3.3 m of amplitude during spring tide. The climate is characterized by an average annual temperature of 27.8 degree Celsius and annual precipitation of 1,069 mm, heterogeneously distributed. Because it is located near the equator, seasons are governed by rainfall and are characterized by a dry period (July to December), and a wet period (January to June) (DIVA World Climate Data Base). For a more detailed description see Loebmann *et al.* (2010).

Description and operation of the fishing gear: fish-weirs at the State of Piauí are of the transverse type, composed by an entrance, two chambers, two small chambers and the fish trap, as it

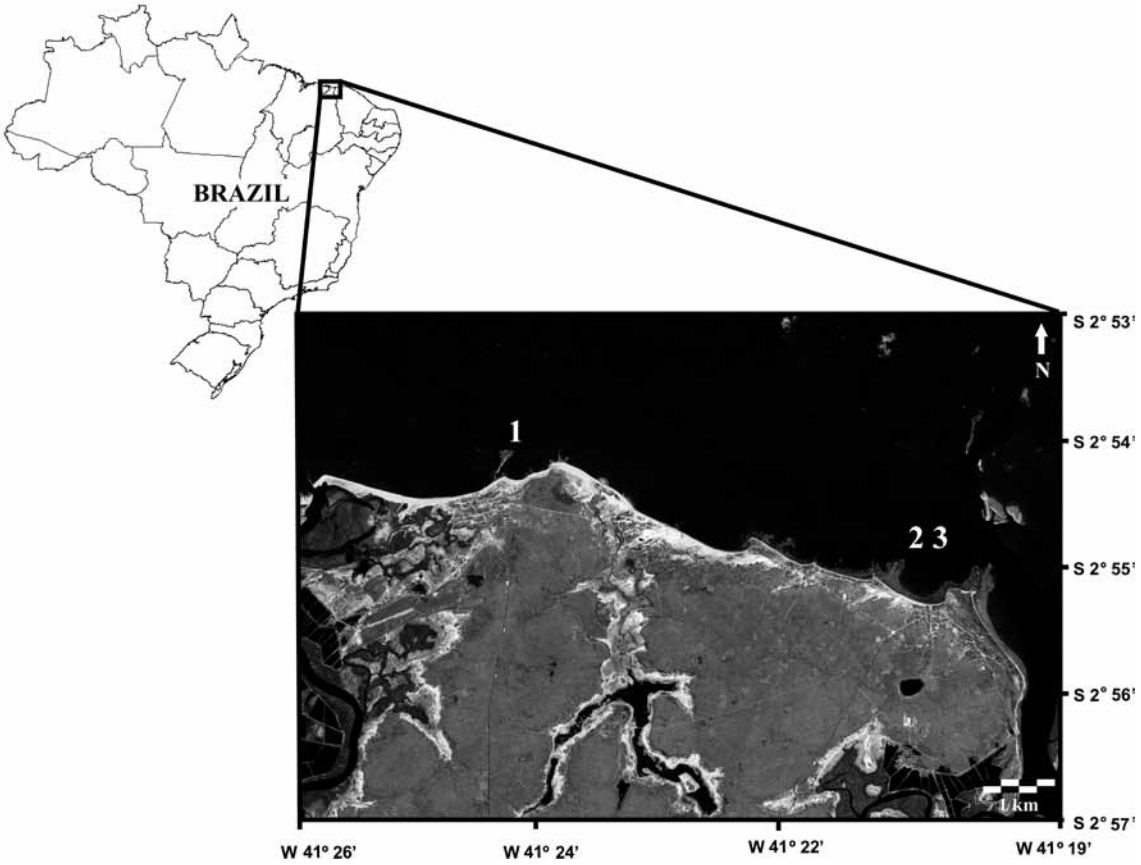

Figure 1 - Map showing the study area, city of Cajueiro da Praia, east coast of Piauí State, Brazil. Numbers 1, 2 and 3 represent the location of the sampled fish-weirs. Satellite photo was provided by Instituto Chico Mendes – Parnaíba.

is describe in (Piorski *et al.*, 2009; Mai *et al.*, 2012). The entrance is the biggest barrier, disposed perpendicularly towards tidal flow, in a way that fish are intercepted and directed to the trapping compartments (Maneschy, 1993, Piorski *et al*,. 2009). Fish-weirs are harvested twice a day during low tide and two fishermen are needed for this activity, however, in small scale fish-weirs harvesting is possible to be carried out by only one man. Details about specific gear, techniques for construction, and service life of fish-weirs are described by (Paiva & Nomura, 1965; Maneschy, 1993; Piorski *et al*,. 2009).

The fish-weirs were installed in shallow water zones, about 500 m from shoreline measured during neap tide, as the following:

Fish-weir 1: located at the village of Barra Grande, city of Cajueiro da Praia, 02°54'07"S - 41°24'18"W, 300 m distant from the lowest tidal shoreline. Its entrance measures 80 m. It is harvested by foot, by only one fisherman.

Fish-weir 2: located in city of Cajueiro da Praia, 02°55'26"S - 41°20'21"W, 400 m distant from the lowest tidal shoreline. Its entrance measures 80 m. It is always harvested by two men in a canoe.

Fish-weir 3: located in city of Cajueiro da Praia, 02°55'26"S - 41°20'24"W, 400 m distant from the lowest tidal shoreline. Its entrance measures 80 m. It is always harvested by two men in a canoe.

Sampling: samples were collected between December, 2008 and November, 2009, at the three fish-weirs in operation in the littoral zone, all of them near the coast. Sampling was conducted during six days for each month, for diurnal and nocturnal harvestings.

During harvesting, collected specimens were identified, the weight was recorded using a digital scale Rapala 25 kg RGSDS, and total length was measured by a fish measuring board with graph paper. Specimens that required a more thorough identification and the ones that were the first records for the region were taken to the Laboratory of Aquatic Resources of EMBRAPA Meio-Norte.

Specimens were fixed with 10% formalin and later preserved in 70% alcohol. Voucher specimens are deposited in the Ichthyologic Collection of Federal University of Rio Grande. Voucher codes are provided in the Appendix.

Data analysis: for each species we calculated the frequency of occurrence (FO%), which is the number of times a given species was present in the samples, the numeric frequency (NF%), and the weight frequency (WF%) calculated based on the weight of a given species in relation to the total weight obtained. In order to calculate the Index of Relative Importance (IRI) we used a formula proposed by Pinkas (1971), where IRI = FO% x (NF % + WF%). The IRI transformed in percentage is calculated considering the value for each species divided by the sum for all species.

In order to compare the weight obtained in the dry versus wet seasons, day versus night periods, and full moon versus new moon phases, we calculated the catch per unit effort (CPUE) since the sampling effort of those variables was not constant. In this case, the CPUE was calculated as the total weight of species divided by the number of samples, and each harvesting was considered a sample.

When comparing dry and wet seasons, all data were included. In the comparisons of harvestings conducted during day and night periods, only the months in which samples were obtained for both periods had their CPUEs compared. When comparing full moon versus new moon, only data from the month in which there were samples available for both moon phases had their CPUEs compared. We used Student's t-test and a confidence interval of 0.95% for all analyses.

In order to gather more information on the capture of species of larger commercial interest for the region, we tabulated the data regarding catch numbers, and minimum medium and maximum length values throughout the year.

We estimated the total amount of annual capture in biomass for the fish-weirs of Piauí coast projecting the total biomass captured/fish-weir/year, based on the total harvest effort of each fish-weir (see more details in Mai *et al.*, 2012).

RESULTS

A total of 117 species belonging to 41 families were captured. The family with the higher number of representatives was Scianidae, with 17 species, and the second most diverse family was Engraulidae, with 12 species (Tab. I). The most abundant species were *Anchoa spinifer* (spicule anchovy, manjuba-vermelha), *Anchoviella lepidentostole* (broadband anchovy, manjuba-gordinha), *Cetengraulis edentulus* (atlantic anchoveta, manjuba), *Chirocentrodon bleekerianus* (dogtooth herring, sardinha), *Opisthonema oglinum* (Atlantic thread herring, sardinha-bandeira), and *Trichiurus lepturus*, 1758 (largehead hairtail, espada). Regarding the total biomass captured, species more representative were: *Chaetodipterus faber* (atlantic spadefish, parum), *Chloroscombrus chrysurus* (bumper, pelombeta), *Cynoscion microlepidotus*

(smallscale weakfish, pescada-branca), *Dasyatis guttata* (longnose stingray, raia-da-pedra), *Lobotes surinamensis* (tripletail, chancarona), *Megalops atlanticus* (tarpon, camurupim), *Opisthonema oglinum*, *Selene vomer* (lookdown, galo), and *Trichiurus lepturus* (Table I).

The ten species with higher IRI were: *Anchoa spinifer*, *Anchoviella lepidentostole*, *Cetengraulis edentulus*, *Chaetodipterus faber*, *Chirocentrodon bleekerianus*, *Chloroscombrus chrysurus*, *Lycengraulis grossidens* (Atlantic sabretooth anchovy, manjuba, arenga), *Opisthonema oglinum*, *Selene vomer*, and *Trichiurus lepturus* (Table I).

Table I - List of species, number of individuals (N), harvesting times where the species occurred (n), biomass (B) in kilograms, frequency of occurrence (FO %), numeric frequency (%NF), biomass frequency (%BF) and Index of Relative Importance (%IRI), in 146 samples of fish-weirs of Piauí State, from December, 2008 to November, 2009.

Taxa		Control			Estimates			
		N	n	B	FO %	%NF	%BF	%IRI
Chondrychthyes								
Carcharhinidae	*Carcharhinus limbatus*	1	1	2.350	0.68	0.01	0.42	0.00
Dasyatidae	*Dasyatis americana*	1	1	10.200	0.68	0.01	1.84	0.02
	Dasyatis guttata	19	16	26.600	10.96	0.10	4.79	0.80
	Dasyatis marianae	8	7	5.236	4.79	0.04	0.94	0.07
Gymnuridae	*Gymnura micrura*	1	1	3.720	0.68	0.01	0.67	0.01
Myliobatidae	*Aetobatus narinari*	1	1	0.740	0.68	0.01	0.13	0.00
	Rhinoptera bonasus	2	2	0.945	1.37	0.01	0.17	0.00
Rhinobatidae	*Rhinobatos percellens*	1	1	0.630	0.68	0.01	0.11	0.00
Osteichthyes								
Acanthuridae	*Acanthurus chirurgus*	1	1	0.230	0.68	0.01	0.04	0.00
Achiridae	*Achirus lineatus*	1	1	0.210	0.68	0.01	0.04	0.00
Ariidae	*Arius proops*	4	3	2.640	2.05	0.02	0.48	0.02
	Bagre bagre	1	1	0.015	0.68	0.01	0.00	0.00
	Cathrops spixii	29	9	4.173	6.16	0.15	0.75	0.08
	Genidens genidens	1	1	0.260	0.68	0.01	0.05	0.00
Atherinopsidae	*Atherinella brasiliensis*	3	1	0.007	0.68	0.02	0.00	0.00
Batrachoididae	*Batrachoides surinamensis*	2	2	1.270	1.37	0.01	0.23	0.00
Belonidae	*Strongylura mariana*	1	1	0.580	0.68	0.01	0.10	0.00
Carangidae	*Carangoides crysos*	1	1	0.033	0.68	0.01	0.01	0.00
	Caranx latus	15	8	1.176	5.48	0.08	0.21	0.02
	Chloroscombrus chrysurus	505	42	17.066	28.77	2.57	3.08	2.42*
	Hemicaranx amblyrhynchus	3	3	0.158	2.05	0.02	0.03	0.00
	Oligoplites palometa	86	25	5.673	17.12	0.44	1.02	0.37
	Oligoplites saurus	3	2	0.555	1.37	0.02	0.10	0.00
	Selene setapinnis	23	11	1.874	7.53	0.12	0.34	0.05
	Selene vomer	596	115	40.932	78.77	3.03	7.38	12.23*
	Trachinotus carolinus	2	2	1.243	1.37	0.01	0.22	0.00
	Trachinotus falcatus	51	33	8.803	22.60	0.26	1.59	0.62
Centropomidae	*Centropomus ensiferus*	1	1	0.180	0.68	0.01	0.03	0.00
	Centropomus parallelus	3	3	2.360	2.05	0.02	0.43	0.01
	Centropomus undecimalis	8	7	8.359	4.79	0.04	1.51	0.11
Clupeidae	*Chirocentrodon bleekerianus*	2935	43	9.581	29.45	14.92	1.73	7.32*
	Harengula clupeola	1	1	0.002	0.68	0.01	0.00	0.00
	Lile piquitinga	27	9	0.204	6.16	0.14	0.04	0.02
	Odontognathus mucronatus	4	1	0.030	0.68	0.02	0.01	0.00
	Opisthonema oglium	8770	59	52.675	40.41	44.58	9.49	32.61*
	Sardinella janeiro	25	1	0.250	0.68	0.13	0.05	0.00

	Sardinella sp.	1	1	0.010	0.68	0.01	0.00	0.00
Dactylopteridae	*Dactylopterus volitans*	4	3	0.800	2.05	0.02	0.14	0.01
Diodontidae	*Cyclichthys spinosus*	14	12	3.205	8.22	0.07	0.58	0.08
Echeneididae	*Echeneis naucrates*	24	22	1.615	15.07	0.12	0.29	0.09
Engraulidae	*Anchoa cayorum*	3	1	0.014	0.68	0.02	0.00	0.00
	Anchoa filifera	303	1	0.774	0.68	1.54	0.14	0.02
	Anchoa januaria	18	7	0.047	4.79	0.09	0.01	0.01
	Anchoa spinifer	866	36	9.040	24.66	4.40	1.63	2.22*
	Anchoa tricolor	2	2	0.009	1.37	0.01	0.00	0.00
	Anchovia clupeoides	99	6	0.814	4.11	0.50	0.15	0.04
	Anchovia surinamensis	1	1	0.005	0.68	0.01	0.00	0.00
	Anchoviella brevirostris	7	3	0.025	2.05	0.04	0.00	0.00
	Anchoviella lepidentostole	943	40	8.662	27.40	4.79	1.56	2.60*
	Cetengraulis edentulus	1254	26	7.347	17.81	6.37	1.32	2.05*
	Engraulis eurystole	189	7	0.428	4.79	0.96	0.08	0.07
	Lycengraulis grossidens	630	35	7.609	23.97	3.20	1.37	1.64*
Ephippiodae	*Chaetodipterus faber*	436	72	104.321	49.32	2.22	18.80	15.47*
Gerreidae	*Diapterus alisthostomus*	1	1	0.031	0.68	0.01	0.01	0.00
	Diapterus auratus	1	1	0.120	0.68	0.01	0.02	0.00
	Diapterus rhombeus	127	46	10.253	31.51	0.65	1.85	1.17
	Eucinostomus argenteus	23	8	0.130	5.48	0.12	0.02	0.01
	Eucinostomus brasiliensis	5	1	0.004	0.68	0.03	0.00	0.00
	Eucinostomus gula	5	2	0.018	1.37	0.03	0.00	0.00
	Eucinostomus havana	2	1	0.006	0.68	0.01	0.00	0.00
	Eucinostomus melanopterus	5	2	0.004	1.37	0.03	0.00	0.00
	Eugeres brasiliensis	2	2	0.401	1.37	0.01	0.07	0.00
Gobiidae	*Ctenogobius boleosoma*	1	1	0.007	0.68	0.01	0.00	0.00
Grammistidae	*Rypticus randalli*	5	5	0.080	3.42	0.03	0.01	0.00
Haemulidae	*Anisostremus moricandi*	1	1	0.001	0.68	0.01	0.00	0.00
	Anisostremus virginicus	31	15	1.197	10.27	0.16	0.22	0.06
	Conodon nobillis	1	1	0.240	0.68	0.01	0.04	0.00
	Haemulon aurolineatum	1	1	0.060	0.68	0.01	0.01	0.00
	Haemulon steindacneri	3	3	0.114	2.05	0.02	0.02	0.00
	Genyatremus luteus	79	35	9.683	23.97	0.40	1.74	0.77
	Orthopristis ruber	1	1	0.009	0.68	0.01	0.00	0.00
	Pomadasys corviaeformes	164	17	0.927	11.64	0.83	0.17	0.17
Hemirhamphidae	*Hemirhamphus brasiliensis*	1	1	0.019	0.68	0.01	0.00	0.00
Lobotidae	*Lobotes surinamensis*	5	4	2.084	2.74	0.03	0.38	0.02
Lutjanidae	*Lutjanus analis*	2	2	0.070	1.37	0.01	0.01	0.00
	Lutjanus apodus	4	4	0.520	2.74	0.02	0.09	0.00
Megalopidae	*Megalops atlanticus*	3	3	31.600	2.05	0.02	5.69	0.18
Mugilidae	*Mugil curema*	4	3	1.960	2.05	0.02	0.35	0.01
	Mugil liza	2	2	1.150	1.37	0.01	0.21	0.00
Ogcocephalidae	*Ogcocephalus vespertilio*	4	4	0.540	2.74	0.02	0.10	0.00
Ostraciidae	*Acanthostracion polygonius*	2	2	0.453	1.37	0.01	0.08	0.00
	Lactophrys trigonus	3	3	0.395	2.05	0.02	0.07	0.00
Paralichthyidae	*Paralichthys brasilienses*	2	1	2.180	0.68	0.01	0.39	0.00
Polynemidae	*Polydactylus oligodon*	2	2	0.132	1.37	0.01	0.02	0.00
	Polydactylus virginicus	8	3	1.200	2.05	0.04	0.22	0.01
Pomacentridae	*Abudefduf saxatilis*	4	2	0.170	1.37	0.02	0.03	0.00
Pristigasteridae	*Pellona harroweri*	129	34	2.289	23.29	0.66	0.41	0.37
Scianidae	*Bairdiella ronchus*	7	5	0.266	3.42	0.04	0.05	0.00
	Cynoscion acoupa	15	13	12.767	8.90	0.08	2.30	0.32

	Cynoscion leiarchus	2	2	0.425	1.37	0.01	0.08	0.00
	Cynoscion microlepidotus	21	17	19.430	11.64	0.11	3.50	0.63
	Cynoscion sp.	24	7	0.550	4.79	0.12	0.10	0.02
	Cynoscion virescens	1	1	1.900	0.68	0.01	0.34	0.00
	Isopisthus parvipinnis	4	4	0.067	2.74	0.02	0.01	0.00
	Larimus breviceps	19	13	2.016	8.90	0.10	0.36	0.06
	Macrodon ancylodon	2	2	0.315	1.37	0.01	0.06	0.00
	Menticirrhus americanos	3	3	0.815	2.05	0.02	0.15	0.00
	Menticirrhus littoralis	2	2	0.016	1.37	0.01	0.00	0.00
	Micropogonias furnieri	2	2	0.346	1.37	0.01	0.06	0.00
	Ophioscion punctatissimus	3	2	0.005	1.37	0.02	0.00	0.00
	Parenques acuminatus	1	1	0.010	0.68	0.01	0.00	0.00
	Stellifer brasilienses	4	3	0.019	2.05	0.02	0.00	0.00
	Stellifer rastrifer	12	4	0.162	2.74	0.06	0.03	0.00
	Stellifer stellifer	2	1	0.070	0.68	0.01	0.01	0.00
	Steliffer sp.	5	1	0.180	0.68	0.03	0.03	0.00
Scombridae	*Scomberomorus brasiliensis*	17	5	0.475	3.42	0.09	0.09	0.01
	Scomberomorus cavalla	1	1	0.018	0.68	0.01	0.00	0.00
Sparidae	*Archosargus probatocephalus*	2	2	0.140	1.37	0.01	0.03	0.00
	Archosargus rhomboidalis	2	2	0.410	1.37	0.01	0.07	0.00
Stromateidae	*Peprilus paru*	50	20	6.690	13.70	0.25	1.21	0.30
Tetraodontidae	*Colomesus psittacus*	35	25	13.874	17.12	0.18	2.50	0.68
	Lagocephalus laevigatus	4	3	2.670	2.05	0.02	0.48	0.02
	Sphoeroides greeleyi	2	1	0.250	0.68	0.01	0.05	0.00
	Sphoeroides testudineus	56	23	6.898	15.75	0.28	1.24	0.36
	Sphoeroides tyleri	5	4	1.254	2.74	0.03	0.23	0.01
Trichiuridae	*Trichiurus lepturus*	803	91	58.894	62.33	4.08	10.61	13.67*
Triglidae	*Prionotus punctatus*	3	2	0.280	1.37	0.02	0.05	0.00
TOTAL		19672	146	555		100	100	100

* Ten species with the highest IRI.

There was no significant difference for the mean weight of captures between dry and the wet seasons (Student's test, df = 9, p = 0.57; n.s.), between day and night periods (Student's test, df = 16, p = 0.78; n.s.), and between full moon and new moon phases (Student's test, df = 16, p = 0.75; n.s.) (Table III).

The species *Anchoviella lepidentostole* presented seasonality, being captured between January and September, with a higher peak of captures from March to May; its total length varied from 5 to 13 cm. *Opisthonema oglinum* also presented seasonality, being captured between December and July, with the highest peak of captures from March to July; its total length varied from 3 to 23 cm (Tab. II). Other species were captured throughout the year like *Selene vomer* and *Trichiurus lepturus* (Table II).

By the extrapolation of the weight captured data we obtained an estimate of 1.2 ton per fish-weir per year for the fish-weirs of Piauí coast. Seventy four percent of the total weight captured accounted for fishes with commercial interest for the region.

Table II - Number of sampled individuals (N), mean length in cm (L), and minimum and maximum length (min-max) of species of commercial interest captured in the fish-weirs off Piauí coast, during samplings conducted from December, 2008 to November, 2009.

Espécies	December 2008		January 2009		February 2009		March 2009		April 2009		May 2009	
	N	L (min-max)	N	L (min-max)	N	L (min-max)	N	L (min-max)	N	L (min-max)	N	L (min-max)
Anchoviella lepidentostole			7	8.7 (7-13)	6	9.88 (8-11)	393	8.75 (7-11)	126	9.74 (9-11)	272	9.11 (7-11)
Archosargus probatocephalus			1	21								
Archosargus rhomboidalis			1	18	1	25						
Batrachoides surinamensis									1	43		
Cathorops spixii			2	33.5 (25-42)	1	21	3	46.23 (36-59)			5	18.08 (15-27)
Centropomus ensiferus												
Centropomus parallelus							2	38.5 (38-39)				
Centropomus undecimalis							1	52				
Chaetodipterus faber	3	36.17 (34-39)	80	19.92 (4-35)	2	21.9 (12-32)	35	19.68 (10-34)			51	13.6 (5-34)
Cynoscion acoupa			3	42.37 (39-47)							4	39.5 (33-45)
Cynoscion leiarchus									1	36		
Cynoscion microlepidotus			4	38.98 (32-46)					2	42.5 (42-43)	2	57.75 (55-61)
*Dasyatis guttata**			1	32	1	50	1	45	3	28.03 (20-44)	1	40
Genyatremus luteus			1	23	1	16			1	19	51	15.13 (4-28)
Lobotes surinamensis							3	73.67 (73-75)			1	8
Megalops atlanticus			1	150			1	92			1	63
Mugil curema											1	40
Mugil liza					1	48					1	34
Opisthonema oglinum	2	7 (7-8)	10	4	2	9.95 (8-12)	2742	6.62 (5-9)	1210	9.78 (5-14)	2580	7.78 (3-17)
Peprilus paru	12	19.28 (17-22)	4	19.63 (19-20)	2	20.9 (20-22)			27	18.46 (16-22)		
Sciades proops	1	47							1	53	2	44.8 (37-53)
Selene setapinnis	3	17.67 (16-19)			1	20						
Selene vomer	25	17.98 (11-28)	39	15.39 (6-23)	29	19.5 (12-26)	53	18.2 (11-26)	20	16.95 (9-28)	135	14.65 (3-27)
Trichiurus lepturus	21	65.63 (33-87)	12	61.5 (36-82)	42	62.13 (33-93)	152	35.5 (8-91)	417	36.82 (25-84)	40	39.1 (5-71)

Espécies	June 2009		July 2009		August 2009		September 2009		November 2009	
	N	L (min-max)	N	L (min-max)	N	L (min-max)	N	L (min-max)	N	L (min-max)
Anchoviella lepidentostole	21	10.12 (9-11)	94	7.44 (5-11)			24	11.68 (9-13)		
Archosargus probatocephalus			1	38						
Archosargus rhomboidalis										
Batrachoides surinamensis					1	31				
Cathorops spixii	1	24			17	15.23 (10-32)				
Centropomus ensiferus			1	27						
Centropomus parallelus					1	33				
Centropomus undecimalis	2	42.75 (36-50)	5	46.7 (36-61)						
Chaetodipterus faber	1	8	247	19.36 (6-37)	8	19.01 (14-22)	2	12.25 (11-14)	7	23.11 (12-30)
Cynoscion acoupa			1	53	3	52.7 (39-70)	3	42.57 (22-54)	1	70
Cynoscion leiarchus							1	68		
Cynoscion microlepidotus	7	40 (35-52)	3	57.13 (56-59)	1	66	1	48	1	54
*Dasyatis guttata**	2	26.15 (20-32)	4	28.55 (18-53)	6	38.33 (18-69)				
Genyatremus luteus	10	19.97 (15-25)	11	19.81 (8-28)	2	19.1 (9-29)	1	14	1	16
Lobotes surinamensis			1	18						
Megalops atlanticus										
Mugil curema	1	37			2	36 (35-37)				
Mugil liza										
Opisthonema oglium	1021	11.82 (9-15)	1203	8.38 (4-23)						
Peprilus paru	2	19.8 (19-21)	2	17.25 (16-19)	1	19				
Sciades proops										
Selene setapinnis	14	15.28 (13-22)	2	15.05 (14-16)	2	16	1	18		
Selene vomer	49	15.66 (9-22)	229	15.71 (5-25)	6	15.38 (14-17)	9	17.2 (14-19)	2	19.2 (17-22)
Trichiurus lepturus	41	54.55 (32-92)	33	64.91 (53-80)	12	64.88 (39-76)	26	68.99 (34-82)	7	62.9 (43-79)

* Data of disc width, instead of total length.

Table III - Student's t-test values for the mean catch weight between wet and dry seasons, daytime and night-time shifts, and full moon and new moon phases. Data from fish-weirs off Piauí State's coast, from December, 2008 to November, 2009.

Comparisons	Mean 1	Mean 2	t value	df	P
Wet x dry seasons	59.875	44.904	0.59	9	0.57
Day x night shifts	4.599	5.115	-0.28	16	0.78
Full moon x new moon	4.288	3.821	0.32	16	0.75

DISCUSSION

Because of the fact that the fish-weirs of Piauí are operating in shallow waters (up to 3 meters depth in the high tide), comparisons between our results with the captures taken by this fishing gear in the neighboring States of Maranhão and Ceará should be carefully interpreted. That is, due to distinct depths of operation in each State, it is expected that species composition changes and the total catch be higher with the increase of depth, even by comparison of samples with same effort. In fact, this pattern was previously observed by Paiva & Nomura (1965) which obtained higher capture indexes in fish-weirs installed far from the coast. On the other hand, although there is an expected tendency of higher catch in deeper zones, it is important to underscore that continuous studies of fisheries are essential to monitoring if the fish stocks in the region are overexploited and catch has decreased as observed in several regions worldwide.

Another factor that is important to clarify is that estimates of total capture from the fish-weirs are considered an estimative of fish production only when all the scheduled harvests occur. During our study, we witnessed several periods in which harvesting did not occur. This absence of harvesting at irregular intervals was also observed by Maneschy (1993) and Piorski *et al.(*2009).

The comparison between species richness shows that Piauí fish-weirs present the higher values in relation to studies of other States in Brazil. Earlier researchers (Paiva & Nomura, 1965; Paiva & Fonteles-Filho, 1968; Collyer & Aguiar, 1972) have not provided a full list of captured species, listing only the eight most abundant species. Jacinto (1982) reported 78 species from Ceará fish-weirs between 1978 and 1981, and Piorski *et al.* (2009) presented a list of 42 species captured by fish-weirs in the State of Maranhão from April to September, 2004. The higher richness observed here may be related to the location of the fish-weirs in the State of Piauí, near the coast in shallow waters.

Data from 1962 to 1970 listed *Megalops atlanticus*, *Trichiurus lepturus*, *Caranx* sp., *Chloroscombrus chrysurus*, *Opisthonema oglinum*, and *Scomberomorus maculatus* as the most abundant species captured in fish-weirs of Ceará State (Paiva & Nomura, 1965; Paiva & Fonteles-Filho, 1968; Collyer & Aguiar, 1972). Likewise, Almeida (1974) listed *Euthynnus alleteratus* and *Elops saurus* as the major species for Ceará. Piorski *et al.* (2009) reported *C. edentulus*, *T. lepturus*, *C. crysos*, *O. saurus*, *M. ancylodon, Notarius grandicassis*, *P. harroweri*, *G. luteus*, *C. chrysurus*, *S. vomer*, *C. psittacus*, *C. acoupa*, *B. bagre*, and *Aspistor quadriscutis* as the most common species in the fish-weirs of Maranhão in 2004.

The major difference between data from the most important fishing species from the states of Ceará, Piauí and Maranhão, is the fact that some families with great commercial interest such as Carangidae and Scombridae end up not being accounted for the captures of Piauí State because of the location of the fish-weirs in shallow waters.

Historically, official data of fish landing from open sea in the State of Piauí indicate a fish annual capture lower than 3,000 ton, as it was recorded in 2009 when 2,959.7 tons of fish were registered (MPA 2010) and in 2010, when the value was 3.019,4 t (MPA, 2012). It is worth mentioning that the 1.2 ton annual catch accounts only for 0.05% of Piauí State's total annual fish production.

Acknowledgments - We are thankful to ICMBio (Parnaíba) for the collaboration. We also would like to thank fishermen: Adécio, Antônio, Charles and Pedro, and helpers: Diniz, Davi and Davilson Soares, Obelix, Gabriel, Natelson, and Fernando.

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Appendix

Voucher list of specimens deposited in the Ichthyologic Collection of Federal University of Rio Grande:

Acanthostracion polygonius Poey, 1876 n°2634; *Achirus lineatus* (Linnaeus, 1758) n°2611; *Anchoa cayorum* (Fowler, 1906) n°2589; *Anchoa januaria* (Steindachner, 1879) n°2602; *Anchoa spinifer* (Valenciennes, 1848) n°2628; *Anchoa tricolor* (Spix & Agassiz, 1829) n°2631; *Anchovia clupeoides* (Swainson, 1839) n°2593; *Anchovia surinamensis* (Bleeker, 1865) n°2622; *Anchoviella brevirostris* (Günther, 1868) n°2607; *Anchoviella lepidentostole* (Fowler, 1911) n°2626; *Anisotremus virginicus* (Linnaeus, 1758) n°2574; *Atherinella brasiliensis* (Quoy & Gaimard, 1825) n°2624; *Bagre bagre* (Linnaeus, 1766) n°2556; *Bairdiella ronchus* (Cuvier, 1830) n°2597 and 2620; *Carangoides crysos* (Mitchill, 1815) 2633; *Caranx latus* Agassiz, 1831 n°2565; *Cathorops spixii* (Agassiz, 1829) n°2552; *Cetengraulis edentulus* (Cuvier, 1829) n°2598; *Chaetodipterus faber* (Broussonet, 1782) n°2619; *Chirocentrodon bleekerianus* (Poey, 1867) n°2618; *Chloroscombrus chrysurus* (Linnaeus, 1766) n°2587; *Conodon nobilis* (Linnaeus, 1758) n°2563; *Cynoscion leiarchus* (Cuvier, 1830) n°2621; *Cynoscion virescens* (Cuvier, 1830) n°2569; *Dactylopterus volitans* (Linnaeus, 1758) n°2561; *Diapterus rhombeus* (Cuvier, 1829) n°2627; *Echeneis naucrates* Linnaeus, 1758 n°2551; *Engraulis eurystole* (Swain & Meek, 1884) n°2572; *Eucinostomus argenteus* Baird & Girard, 1855 n°2614; *Eucinostomus gula* (Quoy & Gaimard, 1824) n°2617; *Eucinostomus havana* (Nichols, 1912) n°2609; *Eucinostomus melanopterus* (Bleeker, 1863) n°2594; *Genyatremus luteus* (Bloch, 1790) 2550; *Haemulon aurolineatum* Cuvier, 1830 n°2600; *Haemulon steindachneri* (Jordan & Gilbert, 1882) n°2608; *Hemicaranx amblyrhynchus* (Cuvier, 1833) n°2559; *Hemiramphus brasiliensis* (Linnaeus, 1758) n°2568; *Isopisthus parvipinnis* (Cuvier, 1830) n°2554; *Larimus breviceps* Cuvier, 1830 n°2553; *Lile piquitinga* (Schreiner & Miranda Ribeiro, 1903) n°2629; *Lutjanus apodus* (Walbaum, 1792) n°2567; *Lycengraulis grossidens* (Agassiz, 1829) n°2573; *Menticirrhus americanus* (Linnaeus, 1758) n°2603; *Micropogonias furnieri* (Desmarest, 1823) n°2592; *Odontognathus mucronatus* Lacepède, 1800 n°2562; *Ogcocephalus vespertilio* (Linnaeus, 1758) n°2635; *Oligoplites palometa* (Cuvier, 1832) n°2549; *Oligoplites saurus* (Bloch & Schneider, 1801) n°2571; *Ophioscion punctatissimus* (Fowler, 1917) n°2590; *Opisthonema oglium* (Lesueur, 1818) n°2555; *Orthopristis ruber* (Cuvier, 1830) n°2596; *Pellona harroweri* (Fowler, 1917) n°2586; *Polydactylus oligodon* (Günther, 1860) n°2560; *Polydactylus virginicus* (Linnaeus, 1758) n°2564; *Pomadasys corvinaeformes* (Steindachner, 1868) n°2612; *Prionotus punctatus* (Bloch, 1793) n°2605; *Rypticus randalli* Courtenay, 1967 n°2625; *Sardinella* sp. n°2595; *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camin, 1978 n°2623; *Selene setapinnis* (Mitchill, 1815) n°2585; *Selene vomer* (Linnaeus, 1758) n°2570; *Sphoeroides greeleyi* Gilbert, 1900 n°2588; *Sphoeroides tyleri* Shipp, 1972 n°2606; *Steliffer* sp. n°2604; *Stellifer brasilienses* (Schultz, 1945) n°2630 and 2599; *Stellifer rastrifer* n°2601 and 2632; *Stellifer stellifer* (Bloch, 1790) n°2613; *Trachinotus falcatus* (Linnaeus, 1758) n°2636.