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ARTISANAL FISHERIES PRODUCTION IN THE COASTAL ZONE OF ITAIPU, NITERÓI, RJ, BRAZIL*

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ABSTRACT

Artisanal fisheries in the coastal zone of Itaipu-RJ play an important role in the local market, but little is known about production and productivity of the fisheries. From April 2001 to March 2003, we monitored a total of 618 landings from the beach-seine (99), the gill nets ("corvineira" - 331, "linguadeira" - 40 and "rede alta" - 25), the hook and line (98), the squid jigging (17), and the spear fishing and trap fisheries (five and three, respectively). The total monitored production was 21866 kg and the catch per unit effort (CPUE) 35.4 kg.trip^{-1}. Considering the number of effective fishing days and the average daily production per fishing gear, the annual production was estimated at 136687 kg (0.2% of the state's production in 2004). Predominant resources were: *Micropogonias furnieri*, *Trichiurus lepturus*, squids (*Loligo* spp.), clupeiform fishes (*Sardinella brasiliensis*, *Cetengraulis edentulus*, *Pellona harrowerii* and *Harengula clupeola*), *Eucinostomus* spp., *Cynoscion* spp., *Menticirrhus* spp., *Caranx crysos* and *Selene setapinnis*. The combined analysis using hierarchical and non-hierarchical classification methods, separated four fishing gears and five species groups, based on their similarity patterns, identifying gears that most effectively capture the different fish groups. The beach-seine was less selective and most productive fishery in the summer. The "corvineira" was the second most productive fishery with higher yields in the summer and fall. Catches of "linguadeira" included rays and *Paralychthys* spp., wherereas the "rede alta" caught primarily *M. furnieri*, *Mugil* spp. and sharks.

RESUMO

As pescarias artesanais na zona costeira de Itaipu-RJ desempenham um papel importante no mercado local, mas pouco se conhece sobre a produção e a produtividade da pesca. De abril-2001 a março-2003, nós monitoramos um total de 618 desembarques das pescarias de arrastos-de-praia (99), de redes de emalhe (corvineira - 331, linguadeira - 40 e rede alta - 25), de linha-e-anzol (98), de zangareio (17), e de arpão e puçá (cinco e três respectivamente). A produção monitorada total foi de 21866 kg e a captura por unidade de esforço (CPUE) de 35,4 kg.viagem^{-1}. Considerando o número de dias efetivos de pesca e a produção média diária por arte de pesca, a produção anual foi estimada em 136687 kg (0.2% da produção do estado em 2004). Os recursos predominantes foram: *Micropogonias furnieri*, *Trichiurus lepturus*, lulas (*Loligo* spp.), peixes clupeiformes (*Sardinella brasiliensis*, *Cetengraulis edentulus*, *Pellona harrowerii* e *Harengula clupeola*), *Eucinostomus* spp., *Cynoscion* spp., *Menticirrhus* spp., *Caranx crysos* e *Selene setapinnis*. A análise combinada utilizando métodos de classificação hierárquica e não-hierárquica separou quatro grupos de artes de pesca e cinco de espécies, baseada nos seus padrões de similaridade, identificando as artes de pesca que melhor capturam os diferentes grupos de recursos pesqueiros. O arrasto-de-praia foi a arte de pesca menos seletiva e mais produtiva no verão. A corvineira foi a segunda pescaria mais produtiva com rendimentos maiores no verão e outono. As capturas com linguadeira incluíram raias e *Paralychthys* spp., enquanto que a rede alta capturou principalmente *M. furnieri*, *Mugil* spp. e tubarões.

Descriptors: Artisanal fisheries, Production, CPUE, Coastal zone, Itaipu-RJ, Brazil.
Descritores: Pesca artesanal, Produção, CPUE, Zona costeira, Itaipu-RJ, Brasil.

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INTRODUCTION

Human demand for marine resources is increasing worldwide, especially in large urban centers of developing countries. Under this scenario, small scale artisanal fisheries play an important role for supporting local and regional markets. Reported small scale marine fisheries account for 40% of the marine fish taken for human food (FAO, 1998) and comprise about 50 million fishers (Berkes *et al.,* 2001). Along the Brazilian coast, the artisanal fishery sector plays an important economic, social and cultural role, responsible for a great part of the overall catches (Diegues, 1999). However, data on this sector are frequently scattered and isolated, thus limiting the possibilities for establishing catch and productivity patterns for supporting management strategies and initiatives.

Due to their dynamics and multispecies catches, artisanal fisheries use several fishing gears and affect different fish stocks. Jablonski & Silva (1996) considered that, for the most part, the fishing effort of artisanal fishers is within sustainable limits and are usually adequate for the exploitation of local resources. On the other hand, several authors (Begossi, 1992, 2006; Nehrer & Begossi, 2000; Kant de Lima & Pereira, 1997) demonstrated that most artisanal fishers have complained about the drastic decline of fish stocks, mostly due to competition with the industrial fleet, but also as a consequence of coastal environment degradation. Furthermore, competition for space and exclusion from their traditional fishing areas, also limited access to the fish stocks and reduced the artisanal production capability.

The coastal region of Itaipu (22°53’14”S, 43º22’48”W) shelters intensive artisanal fisheries, established in the area since the 18th century, and currently involving about 200 fishers. The area is located to the west of the mouth of Guanabara Bay, and forms a semi-sheltered cove protected by three coastal islands (Fig. 1). The coastal water mass is a mix of Guanabara Bay waters, contributions from the Itaipu-Piratininga lagoons, and coastal oceanic waters, seasonally influenced by weak upwelling of the South Atlantic Central Water, following the general pattern for the South Atlantic Bight (Castro-Filho *et al.*, 1987).

This study aims to identify the fisheries catch composition and provide estimates of the total fishing production and productivity. We further used a combined hierarchical and non-hierarchical classification analysis to evaluate similarities between the species composition and productivity from the different fishing gears used, to define seasonal species groups that constituted the artisanal fishery harvests in the Itaipu coastal zone.

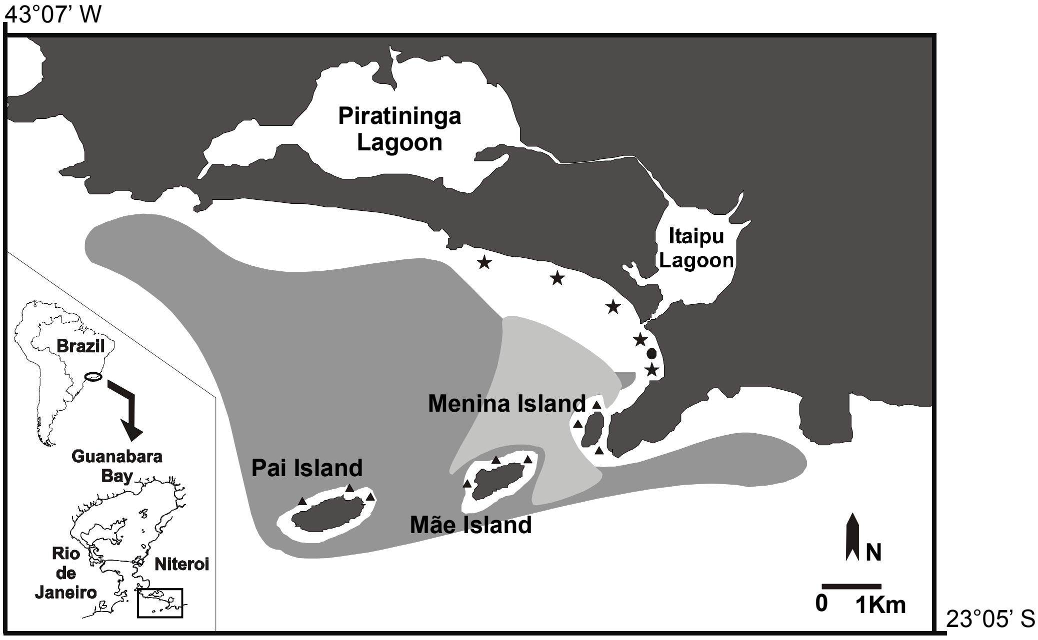

Fig. 1. Location of the fishing areas in the coastal zone of Itaipu (RJ): beach-seine (★); gill nets (■); hook and line and squid jigging (□); trap (●) and spear fishing (▲).

MATERIAL AND METHODS

We monitored the artisanal fisheries landings, one to four times a month, at Itaipu, Niterói-RJ, from April 2001 to March 2003 (618 trips in 77 days), recording data on the fishing fleet, fishing gear, catch composition and abundance for estimating fisheries effort, production, CPUE and seasonality. Sampling effort was determined mostly by the availability of the research crew.

Data regarding the catch compositon, the fishing gear used, the area where fishing occurred, and time spent fishing was gathered through interviews with the fishers. Data on fisheries production were obtained from estimates of the total number of boxes landed of a given species, taking that one box weights 22.0 kg of fish. This measure was also checked at times, by weighing randomly selected boxes with a 100 kg scale with 0.5 kg precision. We also weighed individuals of selected species for calibration and length-weight relationships using several precision scale dinamometers.

The fishing areas outlined in Figure 1, were established based in the literature (Kant de Lima & Pereira, 1997; Begossi, 2006), personal observations and fishers interviews in which they were asked to mark, in a nautical chart, fishing grounds for different gears used

Fishing opperations and gears used in the fishing area included the beach seining, the gill netting, the hook and line, squid jigging, spear fishing and a trap fisheries. In order to standardize fishing effort we considered boat trips as our effort unit. Beach seine fishing operations were also considered as boat trips. All trips were monitored at the landing site during the sampling day, by teams of two to three observers. Once a month one beach-seine operation was followed throughout in order to record the full fishing operation, fish sorting, and marketing.

To estimate annual fisheries production, separated by fishing gear and by season, we first calculated the average catch (kg) per trip (CPUE) for each gear within a season. We then estimated the average number of trips (T) based on a standard monitoring day in which we were certain that, for each particular gear, all trips were monitored within that day. To estimate the effective fishing days (DF) we subtracted from the total number of days in each season: (a) the number of cold fronts passing through the region, obtained from climate bulletins. We assumed, based on interviews and personal observations, that for each cold front fishers don't go out fishing for three days. (b) Sundays and holidays in which fishng does not occur. We then used the following empirical relationship to calculate production within a season: Production = CPUE * T * DF.

The seasonal groups considered followed approximately the conventional southern hemisphere four seasons definition: Summer – January to March; Fall – April to June; Winter – July to September; and Spring – October to December.

Species were identified according to the specialized literature (Carvalho-Filho, 1999; Figueiredo, 1977; Figueiredo & Menezes, 1978, 1980; Menezes & Figueiredo, 1980; 1985; 2000; Nelson, 1994). Species data were also checked with Fishbase website (www.fishbase.org).

To evaluate the similarity in the catch specific composition among the fishing gears, species catch data from the 610 monitored fishing operations were rearranged on a 22 column (samples – fishing gear by season) by 74 row (species) matrix. Spear fishing and trap fisheries were not considered in this analysis due to their small frequency of occurrence. The squid jigging fishery did not occur in the winter and spring. Only species that presented catches greater than 0.5 kg were included in the matrix. Values within the matrix represent the average catch of a given species, captured by one fishing gear at a certain time of the year (Table 2). Data were log transformed [ln (catch + 1)] and later standardized using the "Ranging for variables with arbitrary zero" procedure proposed by Milligan & Cooper (1988), defined as:

$$X_P = \frac{X - Min(X)}{Max(X) - Min(X)}, \text{ where:}$$

X_P = standardized value X = original value, Min(X) = smallest column value, Max(X) = largest column value. After standardization values within each column vary between 0 and 1. The transformed and standardized matrix was submitted to q-mode (grouping samples - columns) and r-mode (grouping species - rows) classification analyses (Legendre & Legendre, 1998). Q-mode classification was conducted using SHAM (Sequential Hierarchical Agglomerative Method), using the Ward method for generating hierarchical dendrograms. This method uses analysis of variance to define clusters by minimizing the sum of squares and maintaining within group variance as homogeneous as possible (Milligan & Cooper, 1987; Rossi-Wongtschowski & Paes, 1993). The analysis was accomplished using the free access software: FITOPAC1 (Shepherd, 1995).

R-mode classification was accomplished using a non hierarchical K-means algorithm that gathers similar variables in a pre-established number of groups (Legendre & Legendre, 1998). Such groups are geometrically as compact as possible around their respective centroids. The method is particularly efficient when classifying widely distributed variables with many null values without the need for establishing a relative scale of dissimilarity (Legendre *et al.,* 2002). The best number of groups present in a data set was defined by maximum value of the *C-H* index (Calinski & Harabasz, 1974) for different partitions (number of groups), where:

$$C - H = \left[\frac{R^2/(K-1)}{(1-R\ )/(n-K)} \right]$$

where, $R^2 = (SST - SSE)/SST$.

SST is the total sum of squared distances to the overall centroid and SSE is the sum of squared distances of the objects to their group's own centroids. The classification way r was accomplished with the aid of the free software K-MEANS2 (Legendre, 2001), available in: (http://www.bio.umontreal.ca/casgrain/en/labo/kmeans.html). Finally, both classifications were jointly analized to verify species groups that were strongly associated with particular fishing gear groups. This approach of combining q-mode and r-mode classifications in two-way tables is usually called nodal analysis (Rossi-Wongtschowski & Paes, 1993).

Results

Monitored Landings

During the sampling period we recorded eight types of fisheries operating different fishing gears. A description of the fisheries methods is given by Kant de Lima & Pereira (1997). The beach-seine fishery operates from shore, at several stations distributed over Itaipu and Camboinhas beaches. Three types of gill net fisheries ("corvineira", "linguadeira" and "rede alta") operate within the cove and sometimes behind the islands. The hook and line and the squid jigging are conducted in more sheltered waters, off Itaipu Beach and between the Menina and Mãe Islands. Spear fishing is performed near the rocky coast and around all three islands. Traps ("Puçás") are mostly used in shallow waters at Itaipu Beach (Fig. 1).

Landings from the "corvineira" gill net fishery were the most common (53.6%) among all monitored trips, followed by the beach-seine (16.0%), hook and line (15.9%), the "linguadeira" and "rede alta" (6.5% and 4.0% respectively), squid jigging (2.5%) and spear fishing (0.8%) (Table 1).

A total of 98 species were captured in the monitored trips. Nevertheless most species occurred sporadically at low abundances. The most important species or species categories caught (>1.0% of the total) were: croaker (*Micropogonias furnieri*), largehead hairtail (*Trichiurus lepturus*), squids (*Loligo* spp.), clupeiform fishes (*Sardinella brasiliensis*, *Cetengraulis edentulus*, *Pellona harrowerii* and *Harengula clupeola*), mojarras (*Eucinostomus* spp.), weakfish (*Cynoscion jamaicensis, C. leiarchus,* and *C. guatucupa)*, kingfish (*Menticirrhus littoralis*, *M. americanus*), banded croaker (*Paralonchurus brasiliensis*), blue runner (*Caranx crysos*), atlantic moonfish (*Selene setapinnis*) and smooth puffer (*Lagocephalus laevigatus*) (Table 1).

The total monitored production was 21.8 tons with an average of 35.4 $kg.trip^{-1}$. The beach-seine was responsible for more than half of the volume caught (10793 kg) and showed the highest CPUE (109 $kg.trip^{-1}$). Gear selectivity was low capturing several species and individuals of all sizes. The largehead hairtail was the predominant fish in the beach-seine catch, contributing 18.8% of the total monitored production, followed by squids (12.0%), croaker (11.2%), clupeiform fishes (10.5%) and mojarras (9.8%) (Table 1).

Catches from the "corvineira" fishery yielded a total of 8378 kg, representing approximately 38.0% of the total monitored catch, with a CPUE of 25.3 $kg.trip^{-1}$. The fishery focuses on demersal fishes, especially croaker, which represented about 82.3% of the total "corvineira" catch (Table 1).

Hook and line was the third most important fisheries monitored in the period. The total catch was equal to 2063 kg and CPUE to 21.0 $kg.trip^{-1}$. The fishery is highly selective capturing mostly the largehead hairtail (Table 1).

Production from both "linguadeira" and "rede alta" gill nets were low (282 kg and 248 kg respectively). The yield from the "linguadeira" fishery was 7 $kg.trip^{-1}$ and the catch included flounders (*Paralychthys* spp.) and croaker, whereas for the "rede alta" CPUE was 10 $kg.trip^{-1}$, and caught mostly demersal-pelagic resources (*M. furnieri, Mugil* spp., *Rhizoprionodon* spp. and *Sphyrna lewini*) (Table 1).

The squid jigging fishery is highly seasonal and focused in a single resource. Total monitored production was equal to 48 kg and CPUE to 2.8 $kg.trip^{-1}$ (Table 1). Nevertheless, squids reach a high market value making them an important fishery resource.

The trap fisheries and the spear fishing, each targeting crabs and octopus respectively, were the least frequent fisheries. Trap monitored production was 34 kg and CPUE 11 $kg.trip^{-1}$. Spear fishing showed a total catch of 20 kg and a CPUE of 4 $kg.trip^{-1}$ (Table 1).

Table 1. Values of catch (kg), frequency of occurrence (FO - %) and total CPUE (kg.trip-1) for species categories landed from April/2001 to March/2003 at Itaipu separated by fisheries. Catch = 0 - less than 1 kg; FO = 0 - less than 1%;

Common Names		Scientific Names	Beach-seine		Gill nets						Hook and line		Squid jigging		Trap		Spear fishing		TOTAL		
					Corvineira		Linguadeira		Rede Alta												
Portuguese	English		Catch	FO	Catch	FO	Catch	FO	Catch	FO	Catch	FO	Catch	FO	Catch	FO	Catch	FO	Catch	CPUE	FO
	TELEOSTS																				
Corvina	Croaker	*Micropogonias furnieri*	1209	43.4	6899	95.2	31	17.5	42	36.0	28	7.1							8208	13.3	61.7
Espada	Largehead hairtail	*Trichiurus lepturus*	2028	50.5	204	21.1	8	7.5	21	24.0	1897	84.7							4158	6.7	34.3
SARDINHAS	Clupeiform fishes	*a	1131	33.3															1131	1.8	5.5
Carapicu	Majorra	*Eucinostomus* spp.	1062	44.4	11	0.6					0	1.0							1073	1.7	7.6
PESCADAS	Weakfish	*b	637	22.2	204	36.0	3	10.0	3	12.0	69	6.1							916	1.5	24.9
PAPA-TERRA	Kingfish	*c	579	47.5	87	24.5	3	7.5	19	48.0	1	2.0							689	1.1	23.6
Xerelete	Blue runner	*Caranx crysos*	342	24,2	10	2.4			1	12.0	34	7.1							388	0.6	6.8
Mistura	Mixed catch		354	17.2															354	0.6	2.8
Galo	Atlantic moonfish	*Selene setapinnis*	239	25.3	10	7.9	1	5.0	2	24.0									253	0.4	9.5
Baiacú-arara	Smooth puffer	*Lagocephalus laevigatus*	227	28.3	2	0.6			6	4.0	4	3.1							239	0.4	5.5
Roncador	Barred grunt	*Conodon nobilis*	183	8.1	0	0.6					0	1.0							184	0.3	1.8
Xixarro	Rough scad	*Trachurus lathami*	182	13.1															182	0.3	2.3
Tainha	Mullet	*Mugil* spp.	121	24.2	12	2.1	3	2.5	32	36.0									167	0.3	6.6
Palombeta	Atlantic bumper	*Chloroscombrus chrysurus*	153	22.2	3	6.3			5	24.0									161	0.3	7.9
BAGRE	Marine catfish	*d	96	5.1	54	15.1	3	10.0	3	12.0	2	2.0							158	0.3	10.4
Pampo	Florida pompano	*Trachinotus carolinus*	63	20.2	81	19.9	1	2.5	8	20.0									153	0.2	14.9
BICUDA	Barracuda	*Sphyraena* spp.	149	20.2	1	1.2													150	0.2	3.9
Anchova	Bluefish	*Pomatomus saltatrix*	70	14.1	61	13.0	2	2.5	12	12.0	1	2.0							145	0.2	10.2
Gordinho	Harvestfish	*Peprilus paru*	64	5.1	33	8.8	2	5.0	1	4.0									101	0.2	6.0
Linguado	Flounder	*e	9	9.1	37	11.5	32	50.0	1	4.0									79	0.1	11.0
Coió	Flying gurnard	*Dactylopterus volitans*	76	32.3	0	0.9			0	8.0	0	1.0							77	0.1	6.1
Riscadinha	Sand drum	*Umbrina coroides*	75	16.2															75	0.1	2.8
COCOROCA	Grunt	*f	51	32.3	14	14.8					7	14.2							72	0.1	15.5
Baiacú-espinho	Burrfishe	*Chilomycterus spinosus*	54	19.2							0	1.0							54	0.1	3.4
Garoupa	Grouper	*Epinephelus* spp.	2	1.0	39	6.0	2	2.5			2	1.0					5	20.0	48	0.1	3.9
Robalo	Snook	*Centropomus* sp.	3	2.0	31	7.6	7	7.5	5	20.0									45	0.1	5.7
Abrótea	Brazilian codling	*Urophycis brasiliensis*			45	11.2													45	0.1	6.0
Xixarro	Bigeye scad	*Selar crumenophthalmus*	43	10.1															43	0.1	1.6
Badejo	Black grouper	*Mycteroperca* sp.	1	1.0	36	5.4	1	2.5	3	20.0	1	1.0							41	0.1	4.2
Piraúna	Atlantic seabream	*Archosargus* sp.	27	3.0	6	1.2	2	2.5	6	4.0									41	0.1	1.5
Chinelo	Leatherjack	*Aluterus monoceros*	30	7.1	1	0.3					4	1.0							35	0.1	1.5
Trilha	Dwarf goatfish	*Upeneus parvus*	35	24.2															35	0.1	4.2
Vermelho-caranho	Snapper	*Lutjanus* sp.	19	3.0	8	2.7					1	2.0							27	0.0	2.3
Parati	Mullet	*Mugil* sp.	22	18.2	0	0.3	1	2.5											23	0.0	3.2
Manjuba	Broadband anchovy	*Anchoviella lepidentostole*	21	1.0															21	0.0	0.2
Sororoca	Spanish mackerel	*Scomberomorus brasiliensis*	4	8.1	4	1.2			11	20.0									19	0.0	2.8
Olho-de-cão	Atlantic bigeye	*Priacanthus arenatus*	7	14.1	1	1.2	0	2.5	6	24.0	1	1.0					0	20.0	15	0.0	4.4
Cherne	Snowy grouper	*Epinephelus sp.*	4	3.0	7	3.0					2	2.0							14	0.0	2.4
Faqueco	Crevalle jack	*Caranx hippos*	8	4.0	1	1.2					4	3.1							13	0.0	1.8
Linguado	Dusky flounder	*Syacium papillosum*	2	4.0			7	10.0											10	0.0	1.3
Galo-de-penacho	Lookdown	*Selene vomer*	7	6.1	2	1.2			1	4.0									9	0.0	1.8
Mamangá-liso	Toadfishe	*Porichthys porosissimus*	1	4.0	8	3.6													8	0.0	2.6
Marimbá	Silver porgy	*Diplodus argenteus argenteus*	2	10.1	4	5.4	0	5.0	2	4.0	1	3.1							8	0.0	5.5
Serra	Atlantic bonito	*Sarda sarda*			4	0.9			4	8.0									8	0.0	0.8
MICHOLE	Sand seabass	*Diplectrum* spp.	6	17.2							1	4.1							6	0.0	3.6
Bonito	Skipjack tuna	*Katsuwonus pelamis*			6	0.6													6	0.0	0.3
Enxada	Atlantic spadefish	*Chaetodipterus faber*	5	3.0															5	0.0	0.5
PARGO	Common seabream	*g	1	3.0	4	6.3													5	0.0	3.9
Sargo-de-beiço	Sheepshead	*Archosargus probatocephalus*			3	1.8	1	2.5									1	20.0	4	0.0	1.3
Peixe-porco	Planehead filefish	*Stephanolepis hispidus*	2	21.2	0	3.3			0	8.0									3	0.0	5.7
Mira-céu	Southern stargazer	*Astroscopus y-graecum*	0	1.0	0	2.1	3	7.5											3	0.0	1.8
Guaivira	Leatherjack	*Oligoplites saurus*			2	4.5					0	2.0							3	0.0	2.9
Xixarro-cobra	Round scad	*Decapterus punctatus*	2	9.1															2	0.0	1.5
Salema	Atlantic seabream	*Archosargus rhomboidalis*			1	0.3					1	1.0							2	0.0	0.3
Carapeba	Caitipa mojarra	*Diapterus rhombeus*	1	15.2	0	1.8			0	4.0	0	1.0							1	0.0	3.7
Cangulo	Grey triggerfish	*Balistes capriscus*	1	7.1	0	0.3			0	4.0									1	0.0	1.5
Pirangica	Sea chub	*Kyphosus* sp.							1	12.0									1	0.0	1.3
Carango	Bonefish	*Albula vulpes*	1	4.0	0	0.3			0	4.0									1	0.0	1.0
Pampo-galhudo	Palometa	*Trachinotus goodei*	1	2.0															1	0.0	0.6
Peixe-lagarto	Inshore lizardfish	*Synodus foetens*	0	2.0	0	0.3													0	0.0	0.5
Peixe-trombeta	Red cornetfish	*Fistularia petimba*	0	5.1															0	0.0	1.0
Peixe-pedra	Scorpionfish	*Scorpaena* sp.	0	2.0															0	0.0	0.5
Barriga-cheia	Barbel drum	*Ctenosciaena gracilicirrhus*	0	7.1															0	0.0	1.3
TOTAL			9414		7938		110		193		2059		0		0		5		19721	31.9	
	ELASMOBRANCHS																				
Tubarão-martelo	Hammerhead	*Sphyrna lewini*			150	6.0			25	12.0									175	0.3	3.7
Cação-ferro	Sharpnose shark	*Rhizoprionodon* spp.	2	1.0	129	9.7	3	2.5	30	8.0									163	0.3	5.8
Cação-anjo	Angel shark	*Squatina* spp.	5	1.0	127	9.1	10	10.0											142	0.2	5.7
Raia-manteiga	Stingray	*Dasyatis* sp.	2	1.0	19	2.7	96	17.5											116	0.2	2.8
Raia-viola	Guitarfish	*Rhinobatos* sp.			7	2.1	36	17.5											43	0.1	2.3
Raia-viola	Lesser guitarfish	*Zapteryx brevirostris*	5	5.1			10	7.5											15	0.0	1.3
Raia-santa	Shorttail fanskate	*Sympterygia* spp.					6	12.5											6	0.0	0.8
Raia-borboleta	Butterfly ray	*Gymnura altavela*	5	1.0			1	2.5											6	0.0	0.3
Galha-preta	Shark	*Carcharhinus* sp.			3	1.2													3	0.0	0.6
TOTAL			18		434		162		55		0		0		0		0		670	1.1	
	CRUSTACEANS																				
Sirís	Crabs	*Callinectes* spp., *Arenaeus* sp.	57	23.2	3	4.8	4	7.5							34	100.0	1	20.0	98	0.2	8.3
Lagosta-sapateira	Slipper lobster	Scyllaridae			2	0.9	5	7.5											7	0.0	1.0
TOTAL			57		5		9		0		0		0		34		1		104	0.2	
	MOLLUSKS																				
Lula	Squid	*Loligo* spp.	1299	54.5							3	2.0	48	100.0					1350	2.2	12.1
Polvo	Octopuses	*Octopus vulgaris*	5	8.1	1	0.3	1	2.5			1	1.0					14	100.0	22	0.0	2.6
TOTAL			1305		1		1		0		3		48		0		14		1371	2.2	
TOTAL CATCH (kg)			10793		8378		282		248		2063		48		34		20		21866	35.4	
TRIPS			99		331		40		25		98		17		3		5		618		
CPUE (Kg.trip^{-1})			109		25		7		10		21		3		11		4		35		

Categories composition:
*a - *Sardinella brasiliensis*, *Cetengraulis edentulus*, *Pellona harroweri* and *Harengula clupeola*
*b - *Cynoscion jamaicensis*, *C. guatucupa* and *C. leiarchus*
*c - *Menticirrus americanus*, *M. litoralis* and *Paralonchurus brasiliensis*
*d - *Netuma barba* and *Genidens genidens*
*e - *Sphyraena tome* and *S. guachancho*
*f - *Haemulon plumieri*, *Boridia grossidens* and *Orthopristis ruber*
*g - *Callamus penna* and *Pagrus pagrus*

Fisheries Cluster Analysis

The Q-mode classification analysis of fisheries resulted in four sample groups reflecting the gear type as the primary factor of dissimilarity among groups. Group 1 was characterized by beach-seine catches and the whole group was well differentiated from the rest, attaining the maximum dissimilarity value. Causes of such differences may be attributed to the low specificity of the fisheries, not targeting any specific resource, and the highest diversity of the catch. Also, the beach-seine showed the highest average catch (Table 2, Fig. 2). Group 2 aggregated the “corvineira” and “linguadeira” gill net fisheries, reflecting similarities between bottom oriented fishing gears, despite their differences in mesh size, and consequent selectivity. Group 3 was formed by the “rede alta” fisheries, which concentrated catches on highly mobile pelagic fishes including sharks, mullets (*Mugil* spp.), and bluefish (*Pomatomus saltatrix*) in the summer. Group 4 clustered together the hook and line and the squid jigging fisheries. The squid jigging is highly selective and oriented exclusively for squids, with no by-catch in the fisheries. Also, the hook and line is quite selective and captures less species than the other fishing gears monitored. Therefore, the association of the squid jigging and hook and line in group 4 probably reflected the large number of absent species or null occurrences shared by both fisheries. The clustering of group 4 could be considered as a classification artifact, yet, it allowed the aggregation of the most selective fisheries, both focused on the capture of pelagic species (Table 2, Fig. 2).

The highest partition of the C-H index in the R-mode classification yielded two groups: one included croaker and largehead hairtail, and the other the remaining species. This classification is trivial and adds very little to the understanding of fisheries patterns. Therefore we considered the second highest partition of the C-H value, which resulted in 5 groups of species or species categories, which still kept the croaker and largehead hairtail as a separate group (Table 2, Fig. 2).

The five groups (A, B, C, D and E) showed distinct species composition and catches associated with the fishing gears used by each one of the fishing methods. For instance, group A included seven species or species categories often captured by the “rede alta” gill net, including sharks *Rhyzoprionodon* spp. and *Sphyrna* spp., and bluefish as the most representative. Group B comprised 39 elements, most of them caught exclusively in beach-seines, at catches between 5 - 10 $kg.trip^{-1}$ (Table 2). Representative species were the clupeiform fishes and rough scad (*Trachurus lathami*). Group C, with 11 species, was less important in beach-seines but predominated in the “linguadeira” catches, including larger individuals such as sting rays (*Dasyatis* spp.) and angel sharks (*Squatina* spp.). Group D, had 15 species and predominated in beach-seines. Species occurred almost exclusively in this fishing gear and included squids, mojarras, Brazilian sardine (*Sardinella brasiliensis*), blue runner, false herring (*Harengula clupeola*) and stripped weakfish (*Cynoscion guatucupa*). Group E represented the two most abundant and important species, croaker and largehead hairtail, in Itaipu. Both resources were not only abundant and frequent, but were also shared by most of the fisheries conducted in the area such as beach-seine, the hook and line, and nearly all of the gill net fisheries (Table 2, Fig. 2).

Production Estimates

The annual fisheries production, considering 200 effective fishing days was equal to 136687 kg (Table 3). The beach seine fishery accounted for approximately 53.1% of this total, followed by the “corvineira” (27.8%) and the hook and line (13.4%) fisheries. The production estimate of the other fisheries together added up to a total of 7651 kg which represented approximately 5.6% of the total estimated annual production.

Seasonal production estimates revealed a consistent pattern in which summer and fall were the most productive, and winter and spring the least productive periods. Summer alone accounted for 41.9% of the total annual production (Table 3, Fig. 3).

Beach-seine and hook and line showed production peaks in the summer, whereas peak production from the “corvineira” occurred in the fall slightly different from the summer production (Table 3). The production from “rede alta” peaked in the fall and was smallest in the spring, whereas the “linguadeira” peaked in the spring and was the smallest in the winter.

The squid jigging occurs only in the summer and fall following the target species seasonality. The sporadic occurrence and low frequency of the trap fishery and spear fishing, limit the possibilities to infer any seasonal pattern from these fishing modalities (Table 3).

DISCUSSION

According with the classification suggested by Reis (1993), fisheries in the coastal region of Itaipu may be characterized as artisanal due to its small fishing capacity and low technology. Also, fishers play an important role in the marketing process, promoting the auction of the catch at their arrival on the beach.

Table 2. Average catch (kg) of the 74 most important species or species categories recorded by fishing gear per season (fa - fall; su - summer; wi - winter; sp - spring) from April/2001 to March/2003 at Itaipu-RJ. SG - species group; FGG - fishing gear group. N - trips per fishing gear per season. 0.0 = values less than 0.1.

Fishing Gear Groups		FGG 1				FGG 2								FGG 3				FGG 4					
		Beach-seine				Corvineira				Linguadeira				Rede Alta				Hook and line				Squid jigging	
SG	Species/Categories — Season	fa	su	wi	sp	fa	wi	sp	su	wi	fa	sp	su	fa	sp	su	wi	fa	wi	sp	su	fa	su
	N =	28	24	19	28	105	98	79	49	11	10	15	4	3	8	2	12	23	28	25	22	6	11
A	*Mugil platanus*	0.5	0.1	3.3	1.5	0.0	0.1			0.2				2.1	0.3	1.9	1.3						
A	*Rhyzoprionodon* spp.				0.1	0.4	0.8	0.1	0.1		0.3			9.0	0.4								
A	*Pomatomus saltatrix*	0.0	2.8	0.1		0.1	0.2	0.2	0.4	0.2				0.5	0.1	4.8		0.0		0.0			
A	*Cynoscion acoupa*		6.2		0.1	0.0	0.0	0.5	0.5			0.1		0.3	0.1		0.1			0.3			
A	*Sphyrna* spp.					0.5	1.0							5.0			0.6						
A	*Centropomus* spp.	0.1				0.1	0.1		0.3	0.1		0.4		0.2	0.2	0.3	0.3						
A	*Mycteroperca* spp.		0.0			0.0	0.1	0.1	0.4	0.1				0.3	0.3	0.3	0.1		0.0				
	Total SG A	**0.6**	**9.2**	**3.4**	**1.6**	**1.2**	**2.2**	**0.9**	**1.7**	**0.6**	**0.3**	**0.4**		**17.5**	**1.4**	**7.2**	**2.4**	**0.0**	**0.0**	**0.3**			
B	*Trachurus lathami*	2.7	4.4		0.0																		
B	*Pellona harrowerii*	3.8																					
B	*Umbrina coroides*	1.1	1.8		0.0					0.0													
B	Herring			1.2	1.5																		
B	*Cetengraulis edentulus*		0.0	2.6																			
B	*Chilomocterus spinosus*	1.8	0.0		0.1										0.1					0.0			
B	*Archosargus* sp.				1.0	0.0	0.1				0.2				0.8								
B	*Selar crumenophtalmus*		1.8																				
B	Marine catfish				1.1		0.0		0.2	0.1							0.0						
B	*Aluteros* spp.	0.0		0.2	0.9	0.0												0.2					
B	*Upneus parvus*	0.8	0.5		0.1			0.0										0.0					
B	*Scomberomus brasiliensis*	0.1	0.0	0.1			0.0							0.3			0.7						
B	*Lutjanus* sp.	0.0	0.8			0.0	0.0		0.1												0.0		
B	*Diplodus argenteus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0				0.8		0.0	0.0				
B	*Mugil curema*	0.2		0.1	0.5			0.0		0.1													
B	*Scomberomorus* spp.		0.2														0.7						
B	*Anchoviella lepidentostole*	0.8																					
B	*Urophicis brasiliensis*					0.2	0.0	0.1	0.4														
B	*Selene vomer*	0.1	0.0	0.3		0.0	0.0									0.3							
B	*Kyphosus* sp.															0.6							
B	*Sympterigia* spp.									0.4		0.2	0.1										
B	*Genidens genidens*	0.0					0.0	0.0	0.0							0.6							
B	*Caranx hippos*	0.2		0.2		0.0	0.0											0.0	0.1				
B	*Sarda sarda*					0.0	0.0	0.0							0.3		0.1						
B	*Cynoscion jamaicensis*	0.1				0.1														0.3			
B	*Boridia grossidens*		0.0		0.4					0.0													
B	Slipper lobster										0.4												
B	*Epinephelus* sp.	0.1		0.1		0.0	0.0	0.0	0.1									0.1		0.0			
B	*Cynoscion leiarchus*	0.1				0.1	0.1		0.0											0.1			
B	*Octopus vulgaris*	0.1		0.1	0.1				0.0			0.1							0.0				
B	*Astrocopus ygraecum*				0.0		0.0				0.3												
B	*Sphyraena* sp.	0.0		0.2		0.0																	
B	*Gymnura altavela*				0.2					0.1													
B	*Chaetodipterus faber*		0.2																				
B	*Diplectrum formosum*	0.0	0.0	0.1	0.1													0.0	0.0				
B	*Porichthis porosissimus*	0.0	0.0						0.2														
B	*Katswuomus pelamis*								0.1														
B	*Haemulon* sp.			0.0	0.1			0.0												0.0			
B	*Stephanolepis hispidus*	0.0		0.0	0.1		0.0										0.0						
	Total SG B	**12.0**	**9.7**	**5.1**	**6.1**	**0.4**	**0.3**	**0.2**	**1.1**	**0.7**	**0.8**	**0.2**	**0.1**	**0.3**	**1.1**	**2.2**	**1.5**	**0.3**	**0.2**	**0.5**	**0.0**		
C	*Dasyatis* sp.				0.1	0.1	0.1			0.3	1.2	4.0	5.3										
C	*Cynoscion* spp.	0.1	0.0	1.1		0.5	0.1	0.3	0.2	0.1		0.1									2.3		
C	*Netuma barba*	0.0		3.4		0.2	0.1	0.1	0.2		0.1	0.0		0.6				0.1		0.0			
C	*Linguados*	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.8	1.2	1.1	0.2	0.2									
C	*Peprilus paru*			3.6		0.2	0.1	0.0	0.0	0.1	0.1						0.1						
C	*Rhynobatos* sp.					0.0		0.0	0.1	0.2	2.4	0.6	0.3										
C	Crabs	0.0	1.5	0.2	0.6		0,0	0.0	0.0	0.1	0.3												
C	*Squatina* sp.				0.2	0.5	0.2	0.7	0.2	0.2		0.5											
C	*Ortopristes ruber*	0.2	0.0	0.4	0.8	0.0	0.0	0.0	0.1	0.1	0.1	0.0						0.1	0.0	0.1	0.0		
C	*Zapteryx brevirostris*	0.1		0.2						0.2	0.8												
C	*Epinephelus* sp.			0.1		0.1	0.2	0.2	0.1	0.1									0.1				
	Total SG C	**0.6**	**1.7**	**9.0**	**1.8**	**1.7**	**0.9**	**1.4**	**0.9**	**2.1**	**6.1**	**6.4**	**5.7**	**0.8**			**0.1**	**0.1**	**0.1**	**0.1**	**2.3**		
D	*Loligo* spp.	14.4	23.1	1.2	11.4				0.0				1.3								0.1	4.2	2.0
D	*Eucinostomus argenteus*	14.0	17.9	1.1	7.8	0.1			0.0											0.0			
D	*Harengula clupeola*	2.3	12.4	3.4	2.3																		
D	*Cynoscion guatucupa*	1.5		5.6	11.1		0.0	0.0	0.0					0.1						0.1			
D	*Sardinella brasiliensis*	8.4	4.4	3.7	0.2																		
D	*Caranx crysos*	5.4	3.5	5.7	0.0	0.0	0.0	0.1							0.2	0.1		1.3	0.2				
D	Mixed catch	65.0	5.1	2.8	1.9																		
D	*Selene setapinnis*	0.0	0.5	8.7	2.2	0.0	0.1	0.0	0.0	0.1				0.0	0.0		0.1						
D	*Lagocephalus laevigatus*	1.8	0.6	8.1	0.3		0.0										0.4	0.1		0.1			
D	*Conodon nobilis*	0.4	1.8	5.7	0.8		0.0	0.0										0.0					
D	*Chloroscombrus chrisurus*	3.4		2.5	0.4	0.0	0.0	0.0							0.0		0.4						
D	*Sphyraena tome*	0.0	1.8	1.9	2.3	0.0	0.0	0.0															
D	*Trachinotus carolineus*	0.5	0.0	0.3	1.5	0.1	0.7		0.0	0.1				0.2			1.0						
D	*Dactylopterus volitans*	1.0	1.0	0.1	0.9		0.0								0.0		0.0	0.0					
D	*Priacanthus arenatus*	0.0	0.1	0.1	0.1	0.0	0.0	0.0			0.0				0.7	0.1	0.0	0.0					
	Total SG D	**57.6**	**72.3**	**50.9**	**43.2**	**0.3**	**0.9**	**0.1**	**0,0**	**0.1**	**0,0**		**1.3**	**0.3**	**0.9**	**0.2**	**1.9**	**1.4**	**0.2**	**0.2**	**0.1**	**4.2**	**2.0**
E	*Trichiurus lepturus*	4.5	3.6	16.8	53.5	0.3	0.8	0.7	0.8	0.5	0.1	0.1			0.1	2.3	1.3	15.7	15.2	23.8	23.5		
E	*Micropogonias furnieri*	12.3	19.2	4.5	11.4	25.8	14.1	15.6	32.1	1.5	0.6	0.5	0.2	9.1	1.3		0.5	0.4	0.0	0.7			
	Total SG E	**16.8**	**22.8**	**21.3**	**64.9**	**26.2**	**14.9**	**16.3**	**32.9**	**2.0**	**0.7**	**0.6**	**0.2**	**9.1**	**1.4**	**2.3**	**1.8**	**16.1**	**15.2**	**24.6**	**23.5**		
	TOTAL	**87.5**	**115.6**	**89.6**	**117.5**	**29.8**	**19.1**	**18.7**	**36.6**	**5.6**	**7.9**	**7.6**	**7.3**	**27.9**	**4.8**	**11.8**	**7.7**	**17.9**	**15.6**	**25.6**	**25.9**	**4.2**	**2.0**

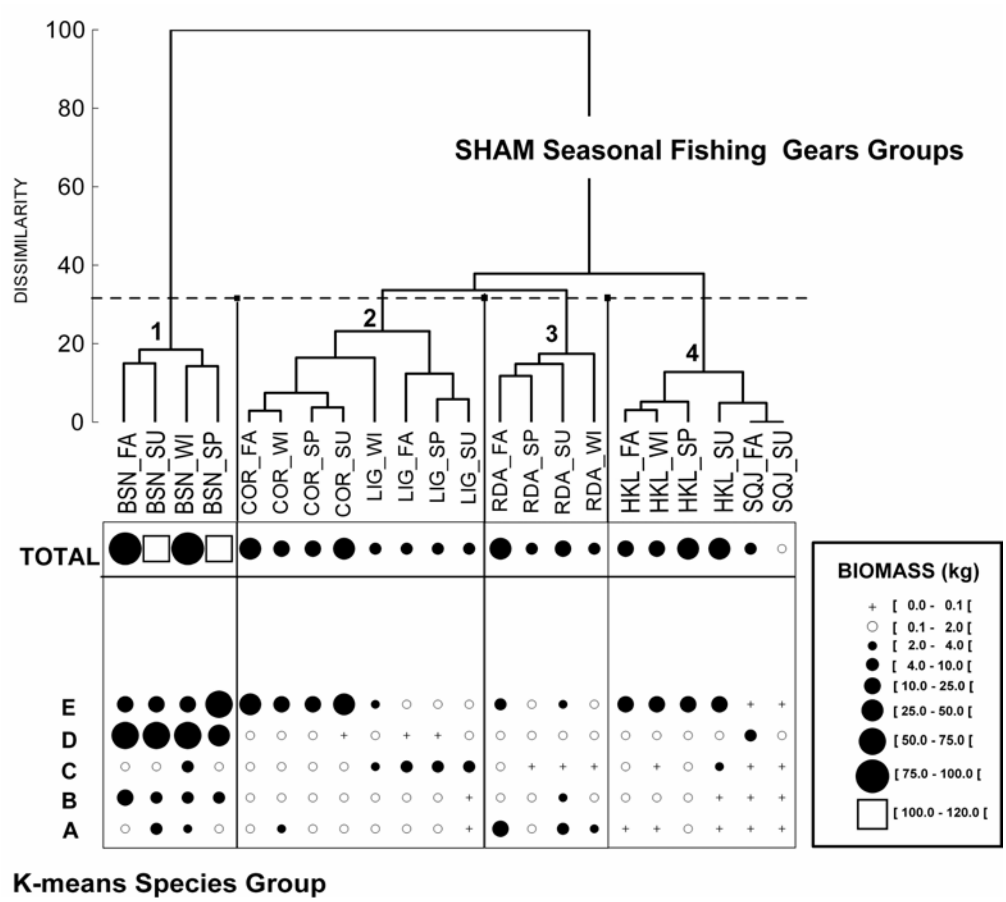

Fig. 2. Comparison among the grouping of the fishing gears for seasons (mode-Q) using analysis of grouping type SHAM and grouping of species (mode-R) using analysis of grouping type K-means. Fishing gears: BSN – beach-seine, COR – corvineira, LIG – linguadeira, RDA – rede alta, HKL – hook and line and SQJ – squid jigging. Seasons: FA – fall, SU – summer, SP – spring and WI – winter.

Table 3. Estimates of annual and seasonal fisheries production (kg), by fishing gear at Itaipu-RJ, Brazil. T = average number of trips per day; CPUE = $kg.trips^{-1}$.

Seasons	Fall				Winter				Spring				Summer				Annual Production
Fishing Gear			Production				Production				Production				Production		
	T	CPUE	Daily	Total	T	CPUE	Daily	Total	T	CPUE	Daily	Total	T	CPUE	Daily	Total	
Beach-seine	4	96	384	20349	2	95	190	9143	2	121	243	11176	5	121	603	31966	72633
Corvineira	8	30	240	12729	8	20	159	7631	7	19	131	6038	6	37	220	11663	38060
Linguadeira	1	8	8	437	1	6	6	272	3	8	23	1060	2	7	15	772	2541
Rede alta	1	28	28	1487	1	8	8	404	1	5	5	226	1	12	12	632	2749
Hook and line	2	18	36	1909	1	16	16	750	4	26	102	4707	8	26	207	10977	18343
Trap					1	5	5	255					1	14	14	749	1005
Squid jigging	2	4	8	441									3	2	6	315	756
Spear fishing					1	4	4	173	1	5	5	207	1	4	4	220	600
Total		37	705	37352		26	388	18628		36	509	23414		47	1081	57293	136687
Total Days	91				92				92				90				
Cold Fronts	25				31				33				25				
Sundays, Holidays	13				14				13				12				
Effective Fishing Days	53				48				46				53				

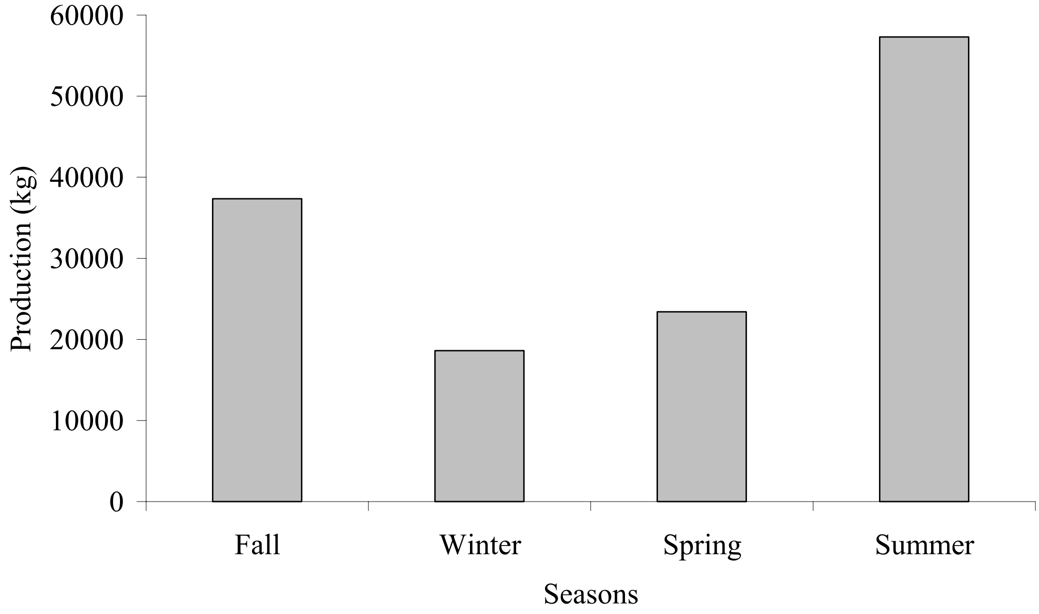

Fig. 3. Seasonal variation of estimated production (kg) of the fisheries in the coastal zone at Itaipu (RJ), from April/01 to March/03.

The classification analysis provided an important tool for identifying species groups associated with the different fishing modalities used in the area on a seasonal basis. Also, the classification suggests a strong association between the different fisheries and their catch. This partition is quite clear as we look at the three different gill net fisheries. The large diversity in the types of fishing gears and specific equipments used towards the exploitation of certain fish resources (e.g. "corvineira" - croaker; "linguadeira" - flounders and angel shark; and "rede alta" – pelagic sharks, mullets and bluefish) result in a multi-specific fisheries showing high overlap regarding the use of the most important fish resources such as the croaker, the largehead hairtail and squids.

The use of several fishing gears and the exploitation of different fishing areas amplify the access to resources, increasing total production. However, Kant de Lima & Pereira (1997) observed that in the early 60's the introduction of the gill net fisheries raised conflicts with the traditional beach-seiners, which suggested that many of the migrating stocks would not come into the beach-seining area due to gill nets set offshore in neighboring waters. For instance, the mullet beach-seine fishery disappeared from the area in the mid 80's, and fishers blamed it on the gill nets. Whether this hypothesis is true, still remains to be tested.

The estimated total annual production for the area represents approximately 0.7% of the Guanabara Bay fisheries production, following Jablonski *et al.* (2006), and 0.2% of the Rio de Janeiro total production in 2004 (0.8% from artisanal production) - (IBAMA, 2005). In spite of its small contribution, the fisheries production at Itaipu is locally significant, supplying restaurants and kiosks, but also attracting buyers from the Niterói fish market, when large catches are made or special resources are captured.

The largest yields found during the summer may be related to two major factors: a) the period of more favorable oceanographic conditions for conducting fishing operations, and b) the arrival of many different species near the coast, such as croaker (Vazzoler, 1991; Vazzoler *et al.,* 1999), several species of clupeiform fishes (Saccardo & Rossi-Wongtschowski, 1991), mojarras and squids (Costa & Haimovici, 1990; Perez & Pezzuto, 1998; Perez, 2002). The winter months are significantly less productive. Two possible hypotheses may explain this difference. Unfavorable oceanographic conditions and cold fronts affecting all types of fishing may prevent fishers to go out at sea, two to three days at a time. Such conditions may happen mostly in the winter and spring. Also, artisanal fish marketing in the winter may be less favorable due to cold weather and less buyers on the beach.

In spite of the low yields presented from “linguadeira”, “rede alta”, squid jigging, traps and spear fishing, their catches included flounders, guittarfish, mullets, squids, crabs, octopus and groupers, usually reaching high price in the local market, representing important alternative resources compared, for instance, with the beach-seine catches.

Magro (2005), indicated that, in spite of the lack of information about the artisanal and sport fishing, catches of largehead hairtail with hook and line are considerable in the State of Rio de Janeiro, and peak abundance in the spring and summer seems to be linked to recruitment periods (Bellini, 1980). Still, the harvest of this species appears to be resilient and conservative over time, as Kant de Lima & Pereira (1997) observed in the late 70’s, local fishers harvesting similar large catches in January.

The high squid yields in the fall and summer were associated with persistent and abundant spawning groups near the islands. A similar fact had been previously observed near the Arvoredo Island in the State of Santa Catarina (Perez *et al.*, 1997). According to local fishers, the squid harvest occurs from December to February, associated with the occurrence of cold and clear waters near the coast (Lima & Pereira, 1997).

The clupeiform fishes constitute an exclusive fishing resource of the beach-seine. In spite of their low economic value, they represent a resource of interest, for instance, when the Brazilian sardine occurs in great volumes. The production peak in the fall, matches the highest frequency of sardine schools in coastal waters of Rio de Janeiro State, after reproduction (Paiva & Motta, 2000).

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