

SWORDFISH (*XIPHIAS GLADIUS*) AND BLUE SHARK (*PRIONACE GLAUCA*) FISHERY AND THE DYNAMICS OF THE FLEET OFF THE SOUTHEASTERN BRAZILIAN COAST

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SUMMARY

The swordfish (*Xiphias gladius*) is usually the main target of longliners in the southeast Brazilian coast. However, due to the increasing demand for shark meat and fins, the blue shark (*Prionace glauca*) also becomes a target of longliners. In this work, we analyzed data from 2001 to 2003 of the longline fleet based on the main harbor of the southeast coast. Three sources of information about the fishery were evaluated: interviews with fisherman, logbooks and industry production forms. The results indicated that offshore areas are exploited mainly in the 1st and 4th quarters, while fishing effort is concentrated in coastal waters in 2nd and 3rd quarters. The CPUE values of the blue shark were larger than those of the swordfish, especially in 1st quarter. The largest CPUEs of swordfish are found in 3rd quarter. The fleet dynamics seems to be guided by four factors: (a) target species, (b) favorable oceanographic and climatic conditions, (c) distance between the fishing ground and the harbor, and (d) the learning (e.g. high profitable scenario – area and quarter combination) that fisherman had in previous years.

RÉSUMÉ

L'espadon (*Xiphias gladius*) est habituellement la principale cible des palangriers qui opèrent au Sud-Est du littoral du Brésil. Toutefois, en raison de la demande croissante de chair et d'ailerons de requins, le requin peau bleue (*Prionace glauca*) est également devenu la cible des palangriers. Dans cette étude, nous avons analysé les données de 2001 à 2003 de la flottille palangrière basée au principal port de la côte du Sud-Est. Trois sources d'information sur la pêche ont été évaluées : interviews avec les pêcheurs, carnets de bord et formulaires de production du secteur industriel. Les résultats ont indiqué que les zones au large sont exploitées essentiellement pendant les 1^{er} et 4^{ème} trimestres, tandis que l'effort de pêche se concentre dans les eaux côtières aux 2^{ème} et 3^{ème} trimestres. Les valeurs de CPUE du requin peau bleue étaient supérieures à celles de l'espadon, notamment au 1^{er} trimestre. Les plus grandes CPUE d'espadon ont lieu au 3^{ème} trimestre. La dynamique de la flottille semble être guidée par quatre facteurs: (a) espèces-cibles, (b) conditions océanographiques et climatiques favorables, (c) distance entre le lieu de pêche et le port, et (d) les connaissances (p.ex. scénario hautement profitable – combinaison zone et trimestre) que possédaient les pêcheurs au cours des années antérieures.

RESUMEN

Generalmente, el pez espada (*Xiphias gladius*) es el objetivo principal de los palangreros en la costa sureste de Brasil. Sin embargo, debido a la creciente demanda de carne y aletas de tiburón, la tintorera (*Prionace glauca*) también se ha convertido en especie objetivo de los palangreros. En este trabajo, se analizan los datos de 2001 a 2003 de la flota de palangre con base en el puerto principal de la costa suroriental. Se evaluaron tres fuentes de información sobre las pesquerías: encuestas a los pescadores, cuadernos de pesca y formularios de producción de la industria. Los resultados indicaron que las zonas de alta mar se explotan sobre todo en el primer y cuarto trimestre, mientras que el esfuerzo se concentra en las aguas costeras en el segundo y tercer trimestre. Los valores de CPUE de tintorera fueron más elevados que los del pez espada, sobre todo en el primer trimestre. Los valores más elevados de la CPUE de pez espada se produjeron en el tercer trimestre. La dinámica de la flota parece estar regida por cuatro factores: (a) especie objetivo, (b) condiciones climáticas y oceanográficas favorables, (c) distancia entre los caladeros y el puerto, y (d) el aprendizaje

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(por ejemplo: escenario con alta rentabilidad – combinación de zona y trimestre) por parte de los pescadores en años anteriores.

KEY WORDS

Longlining, Swordfish, Blue shark, CPUE, Fleet dynamics

1. Introduction

The swordfish (*Xiphias gladius*) is caught in Brazilian coast all across the year by national and foreign leased longline vessels (Meneses de Lima *et al.* 2000). The catches of the swordfish represents a great proportion of longliners profit, due to its high international market price. Therefore, almost all swordfish landed in southeast Brazil is exported to other countries.

From 1972 to 1997 there were four distinct periods for the Brazilian longline fishery (see Meneses de Lima *et al.* 2000 for details). In the last period, from 1991 to 1997, the traditional multifilament nylon was replaced by the monofilament nylon and the hooks were managed to reach about 100 meters of depth. Finally, fisherman become to launch the longline at the beginning of the night, and to use light sticks and squid as bait (Arfelli 1996). All these changes were made with the intention of increase the catch of swordfish that usually feeds in surface waters during the night (Carey 1990).

Despite swordfish have been the main target of most of the boats since 1990's, some masters have been targeting sharks (mainly the blue shark - *Prionace glauca*) since early 1980's (Meneses de Lima *et al.* 2000). The interest on blue shark fishery have raised progressively due to the demand for shark meat and fins in the domestic and international market (Amorim e Arfelli 1984; Arfelli 1996).

Nowadays it is well known that important modifications occurred on fishery in the last decades, but since 1997, there is not a comprehensive analysis on how these changes modified the dynamic of the fleet based in the southeast Brazilian coast. In this work the catch and effort of the swordfish and blue shark landed by the fleet in the Itajaí harbor (southeastern coast) were analyzed. We used effort and Catch-per-unit of effort (CPUE) to study the dynamic of fisherman, and of the swordfish and blue shark availability to the longline gear. We used the results to identify the factors affecting the fishermen strategy. Finally, we suggest which are the factors that should be taken into account by those interested in models of fisherman behavior and fleet dynamics.

2. Methodology

Catch and effort data from 2001 to 2003 were obtained from three sources: interview with fisherman, logbooks and industry production forms (**Table 1**). The interviews were carried out with the master of the incoming vessels by paid observers that visited the piers of Itajaí, that is one of the main fishery harbors located in the southeast Brazilian coast. In the logbooks, reports on geographical position of effort and fishing areas are more detailed than in the interviews. The industries at piers furnish the production forms when the fish caught is weighted. Data from the above three different sources were compared and those more discrepant were discarded. Therefore, only the consistent and probably realistic data were analyzed.

The data were pooled by quarter and area (5° x 5°) and maps of effort and CPUE of the swordfish and of the blue shark were built. The effort was calculated as the sum of number of hooks in each 5° x 5° block, while the catch was recorded in kilograms. The CPUE (\hat{U}) was pondered by effort in each block, following Quinn *et al.* (1982) suggestions. Therefore, the CPUE (\hat{U}) estimation in kg/1000 hooks for a given area and quarter is:

$$(1) \quad \hat{U} = \frac{\sum_{i=1}^n C_i \times 1000}{\sum_{i=1}^n f_i}$$

Where C_i stands for the catch and f_i is the effort in the i^{th} fishing event. Cochran (1963) also showed that the variance of \hat{U} is given by:

$$(2) \quad \text{vâr}(\hat{U}) = \frac{n}{n-1} \times \left(\frac{\sum_{i=1}^n (C_i - f_i \times \hat{U})^2}{\left(\sum_{i=1}^n f_i \right)^2} \right)$$

The sample size (n , the number of longline sets) for each quarter and area is shown in **Table 2**. The method to calculate CPUE is approximately unbiased, and is an alternative when complex approaches (e.g. CPUE pondered by the area occupied by the stock) can not be used (Quinn *et al.* 1982).

3. Results

3.1 Fishing effort

During the 1st quarter, fisherman often operated in offshore areas far from the home harbor, especially in 2001 (e.g. Vitória-Trindade seamount, Rio Grande rise, Uruguay/Argentina coast, Malvinas islands) (**Figures 1A, 1E and 1I**). In 2nd quarter, the efforts are distributed close to the southern Brazilian and Uruguayan coast (**Figures 1B, 1F and 1J**). In 3rd quarter the effort was concentrated also near the coast (**Figures 1C, 1G and 1K**). Finally, in 4th quarter, part of fisherman continued to fish in coastal areas, but some of them shifted to offshore regions (around Rio Grande rise) (**Figures 1D, 1H and 1L**). In the last quarter of 2003, there was an outstanding effort concentration near Itajai harbor.

Longlines were set between the isobaths of 200 and 5000 meters. The average depth of fishing operations was 1800 meters, and the standard deviation is 1100 meters.

3.2 Precision of CPUE estimations

The estimates of the coefficient of variation (CV) of \hat{U} for swordfish and blue shark are in **Table 2**. Because the CV for swordfish and blue shark were quite similar, then only one is shown.

3.3 Swordfish CPUE

In the 1st quarter, the catch rates were generally high in offshore areas (around Rio Grande rise), mainly in 2001 and 2002. In 2001, the catch rates were also high in northern areas (nearest to Vitória-Trindade seamount) (**Figures 2A, 2E and 2I**). In the 3rd quarter, relative high CPUE values were gathered near the coast, between 25°S and 35°S (**Figures 2C, 2G and 2K**). In the 2nd and 4th quarters, the CPUEs in coastal regions were not quite different from those gathered in offshore areas. During these quarters (2nd and 4th) the CPUE was generally smaller than in other periods of the year (**Figures 2B, 2F, 2J and 2D, 2H, 2L**).

3.4 Blue shark CPUE

Generally, high blue shark CPUEs in the 1st quarter are obtained in oceanic and in south areas, far from the home harbor (Itajai) (e.g. Rio Grande rise, Uruguay and Argentina, and Malvinas islands) (**Figures 3A, 3E and 3I**). During the 2nd and 3rd quarters, there was no clear trend in spatial distribution of CPUE values (**Figures 3B, 3F, 3J and 3C, 3G, 3K**). In the 4th quarter the blue shark catch rates increased again in offshore areas near to Rio Grande rise and in the far south area (**Figures 3D, 3H and 3L**). In general, blue shark catch rates were always higher from that observed for swordfish.

3.5 Catch compositions

Blue shark catches are always larger than catches of any other species. The percentage of the blue shark in the catches is about 65% in 1st quarter, but it decreases progressively until the 4th quarter (**Figure 4**). Swordfish is the second species in total catch landed (10% to 20% across the year). The proportion of swordfish in the catches is usually higher in 3rd, than in other quarters (**Figure 4**). Besides swordfish and blue shark, the longline fleet based at Itajai often catches other species like yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*) and albacore (*Thunnus alalunga*). The variations of tuna catches across the years are similar. Catches were relatively high in the 2nd, and mainly in the 3rd quarters. Among tuna species, yellowfin catch is the largest, while bigeye catch is small. In general, catches of blue shark, swordfish and tunas decreased in the 4th quarter, especially in 2003 (**Figure 4**).

Average annual catch landed by longline fleet in Itajaí was about 1600 MT for the period from 2001 to 2003. Swordfish and blue shark contributed, respectively, with 18% and 40% for the total catch landed. Together, the catches of the three species of genera *Thunnus* added up to 27% of the total catch.

4. Discussion

The swordfish have been a target because of its high value at the market. On the other hand, the blue shark price is not so high, but the catches are large and the fins are very valuable. The amount of blue shark landed is usually larger than that of swordfish (650 MT against 300 MT – CTTMar/UNIVALI 2003). Once the price for swordfish meat is about three times the price for the blue shark meat, similar profits are obtained with both species. Therefore, the fisherman strategy (effort distribution) is clearly influenced by both blue shark and swordfish catch rates. The national fleet based in southern Brazil has a different strategy from that of the fleet based in the northeastern region. This later fleet has only swordfish as target and operates mainly in the equatorial areas. The proportion of swordfish in the catches of northeast fleet is about 45%, while blue shark catches are small (5.7%) (Travassos *et al.* 2002), in contrast with the results we found for the southeastern fleet (18% for swordfish and 40% for blue shark). Thus, this confirms the importance of the identification of the target species, once the northeastern and the southeastern fleet can sometimes operate in the same areas, but the catch compositions are quite different. If the target species is not taken into account, it is difficult to analyze catch data and biases are introduced when the CPUE is used as an index of abundance.

Most of CV values are smaller than 0.4, hence in these cases the precision of CPUE estimates are reasonable. The following discussion was based mainly in those more confident estimates (*e.g.* CV < 0.4) (**Table 2**).

Usually the fishermen go to offshore areas far from the harbor in few occasions, especially during the austral summer and spring (1st and 4th quarters). Coastal and shallower areas are visited regularly, but mainly in autumn and winter (2nd and 3rd quarters). Most of fishing sets were carried out between 25°S and 35°S (**Figure 1**). The movements of the fleet are related to the resource (swordfish and blue shark) displacement and vulnerability. The vulnerability and movements of these fishing targets are probably associated with the mid-scale seasonal variability of oceanographic variables, since environmental conditions (*e.g.* temperature, salinity, colour and turbidity) affect fishing success of large pelagic species fisheries (*e.g.* Podestá *et al.* 1993). In summer, fisherman search for cold waters offshore because the warm waters of Brazil Current dominate the coastal area near the continental shelf (see temperature charts in Matsuura 1986). In winter, the influence of cold waters on south Brazilian coast increase, then fisherman concentrates effort in these areas. The preference for coastal areas in the winter is also due to the security and to economic advantages. Obviously, the costs of operations near the home harbor are relatively small. In the 2nd and 4th quarters similar catch rates are gathered in coastal and offshore areas, because intermediate features between the extreme conditions occurring in austral winter and summer are found (**Figures 2 and 3**).

A Subtropical Convergence zone results from the meeting of the Brazil Current flowing southward with the Malvinas Current flowing northward. The north portion of the front of the convergence influences the continental shelf and the slope of the south coast of Brazil (between 30°S and 35°S) during the winter (Garcia 1997). The mixture of warm tropical waters (Brazil Current), of cold sub-Antarctic waters (Malvinas Current), of freshwater outflows (Prata river and Patos lagoon), results in a seasonal, but extremely high phytoplanktonic productivity all over the south Brazil/Uruguay (30°S to 40°S) shelf and slope (Odebrecht and Garcia 1997). The presence of nutrient rich sub-Antarctic waters (Malvinas Current) during the lately autumn, winter and early spring, results in high levels of primary (Odebrecht and Garcia 1997) and secondary production (Montú *et al.* 1997) in the south of Brazil. Consequently, this area supports great prey-species biomass for pelagic predators (Castello *et al.* 1997). Therefore, the movements of the fleet (**Figure 1**) seems to be appropriate, since fisherman doesn't need to go to offshore areas in autumn and winter to find cold and productive waters, because squids are abundant in the Malvinas Current (Haimovici and Perez 1990). The oceanographic dynamics result in a concentration of cephalopods (*e.g.* squid) that are the main food components for swordfish in the southwestern Atlantic (Zavala-Camin 1987). In fact, Arfelli (1996) argues that migration of swordfish along Brazilian coast is probably related to squid distribution in the south of Brazil.

Due to the presence of the Subtropical Convergence in winter, the larger swordfish catch rates has been historically observed in the favorable scenario highlighted above (3rd quarter in the square 30°S-35°S/45°W-55°W) (Arfelli 1996; Meneses de Lima *et al.* 2000; Travassos *et al.* 2002). Due to these high catch rates obtained in the past, the effort in the beginning of 2000's was in that block and quarter (**Figure 1C, 1G and 1K**). However, in the period we analyzed (2001 to 2003), the CPUE values were not especially large in that fishing

spot (**Figure 2C, 2G and 2K**). Probably the CPUE values in the theoretical more favorable fishing scenario were disappointing because of the high effort focused there. That old “gold mine” (3rd quarter in 25°S-30°S/45°W-50°W) is shared by many fishermen, hence the CPUE there is now ordinary.

Most of the outstanding large effort close to the Itajaí coast (25°S-30°S/45°W-50°W) in the 4th quarter of 2003 (**Figure 2L**), were from boats originally sited in other harbors (*e.g.* Espírito Santo) and not in Itajaí. These boats have fished mainly the dolphin fish (*Coryphaena hippurus*). This fishery was motivated by the opening of a new economic market (exportation). Even though it is too early to make considerations, we believe that a new fishery is starting. The harvest of dolphin fish in the end of the year and in coastal waters will probably occur in the next years.

It is clear that the knowledge the fisherman acquired in previous years is readily used when they have to decide where to fish in the next year. For instance, in the 1st quarter of 2001 fisherman concentrated effort in coastal waters, but the CPUE was higher offshore (near Rio Grande rise) for both swordfish and blue shark. Consequently, in the 1st quarter of 2002, fisherman concentrated effort in offshore areas, due to the “learning” process (**Figures 2A and 2E**). However, the CPUE naturally decreased where the effort was focused. Therefore, offshore areas in 2002 were no more profitable as it were in 2001. Hence, the fishing effort in the 1st quarter of 2003 was no more focused near Rio Grande rise (**Figure 2I**). If the CPUE is large in a fishing scene, fishermen fishes intensively there. When the CPUE decreases, the fishermen distribute the effort mainly near the home harbor.

Summarizing, the dynamic of the fleet can be associated with four factors: (a) target species, (b) cyclic oscillations of environmental variables, (c) distance between the fishing ground and the harbor, and (d) the “learning” the fisherman had in previous years. Therefore, it is reasonable to suppose that the effort f in the quarter q , in the area a , in the year y is a function of three terms at least:

$$(3) \quad f_{qay} \approx f(\hat{U}_{qay-1}, D_{qa}, E_{qa})$$

where \hat{U} is the CPUE of target species, D is the distance from the home harbor, E is an index of oceanographic conditions (*e.g.* temperature), and $f(\)$ denotes the function. If the above conceptual model proves to be reasonable in the future, we could forecast fishermen behavior. The importance of understanding how the predator (*i.e.* fisherman) confronts the prey dynamics can help in the analysis of catch and effort data, and maybe in the management of tuna fisheries.

5. References

- AMORIM, A.F. and C.A. Arfelli. 1984. Estudo biológico-pesqueiro do espadarte, *Xiphias gladius* Linnaeus, 1758, no sudeste e sul do Brasil (1971 a 1981). Bol. Inst. Pesca. 11: 35-62.
- ARFELLI, C.A. 1996. Estudo da Pesca e Aspectos da Dinâmica Populacional de Espadarte, *Xiphias Gladius* L. 1758, no Atlântico Sul. Rio Claro (SP). Ph. D. Thesis - Instituto de Biociências, Universidade Estadual Paulista.
- CAREY, F.G. 1990. Further acoustic telemetry observations of swordfish. In: *Proc. Second. Int. Billfish Symp., Part 2: Contributed Papers*. Stroud, R. H. (ed.). Savannah, Georgia: National Coalition for Marine Conservation, Inc., p. 103-122.
- CASTELLO, J.P., M. Haimovici, C. Odebrecht and C.M. Vooren. 1997. The continental shelf and slope. In: Seeliger, U. Odebrecht, C. and J. P. Castello (eds.). 1997. Subtropical Convergence environments. The coast and sea in the southwestern Atlantic. Springer: Germany. 308 p.
- COCHRAN, W.G. 1963. Sampling techniques. 2nd ed. Wiley and Sons. New York. 413 p.
- CTTMar/UNIVALI. 2003. Boletim estatístico da pesca industrial de Santa Catarina – ano 2002. Ações Prioritárias ao Desenvolvimento da Pesca e Aquicultura no Sul do Brasil. Convênio Secretaria Especial de Aquicultura e Pesca da Presidência da República (SEAP/PR), Universidade do Vale do Itajaí (UNIVALI). SEAP/PR/001/2003. Pezzuto, P. R. (coord.). 93 p.

- GARCIA, C.A. E. 1997. Physical Oceanography. *In*: Seeliger, U; Odebrecht, C. and J. P. Castello (eds.). 1997. Subtropical Convergence environments. The coast and sea in the southwestern Atlantic. Springer: Germany. 308 p.
- HAIMOVICI, M. and J.A.A. Perez. 1990. Observaciones sobre la distribución y maduración sexual del calamar argentino, *Illex argentinus* (Castellanos, 1960) (Cephalopoda: Ommastrephidae), en el sur del Brasil. *Scient. Mar.* 54 (2): 179-185.
- MATSUURA, Y. 1986. Contribuição ao estudo da estrutura oceanográfica da região sudeste entre Cabo Frio (RJ) e Cabo de Santa Marta Grande (SC). *Ciência e Cultura.* 38 (8): 1439-1450.
- MENESES DE LIMA, J. H. J.E. Kotas, and C.F. Lin. 2000. A historical review of the brazilian long-line fishery and catch of swordfish. *Col. Vol. Sci. Pap. ICCAT.* 51 (36): 1329-1358.
- MONTÚ, M., I.M. Gloeden, A.K. Duarte, and C. Resgalla, Jr. 1997. Zooplankton. *In*: Seeliger, U; Odebrecht, C. and J. P. Castello (eds.). 1997. Subtropical Convergence environments. The coast and sea in the southwestern Atlantic. Springer: Germany. 308 p.
- ODEBRECHT, C. and V.M.T. Garcia. 1997. Phytoplankton. *In*: Seeliger, U; Odebrecht, C. and J. P. Castello (eds.). 1997. Subtropical Convergence environments. The coast and sea in the southwestern Atlantic. Springer: Germany. 308 p.
- PODESTÁ, G. P., J.A. Browder, and J.J. Hoey. 1993. Exploring the association between swordfish catch rates and thermal fronts on U.S. longline grounds in the western north Atlantic. *Cont. Shelf Res.* 13: 253-277.
- QUINN, T. J., S.H. Hoag, and G. M. Southward. 1982. Comparison of two methods of combining Catch-Per-Unit-Effort data from geographic regions. *Can. J. Fish. Aquat. Sci.* 39: 837-846.
- TRAVASSOS, P., H. Hazin, F. Hazin, and S. Mattos. 2002. Distribution et abondance relative de l'espadon (*Xiphias gladius*, Linnaeus 1758) capturé dans l'Atlantique sud-ouest équatorial. *Col. Vol. Sci. Pap. ICCAT.* 54 (5): 1570-1578.
- ZAVALA-CAMIN, L.A. 1987. Ocorrência de peixes, cefalópodos e crustáceos em estômagos de atuns e espécies afins, capturadas com espinhel no Brasil (23°S-34°S) 1972-1985. *Bol. Inst. Pesca.* 14: 93-102.

Table 1. Number of documents obtained from the pelagic longline industry fleet based at Itajaí harbor. INTERVIEW: paid observers which meet the incoming vessels and interview the fisherman. LOGBOOK: provided by fisherman. IPF (Industry Production Form): records of fish landed and weighted-furnished by industry.

<i>Year</i>	<i>Quarter</i>	<i>Interview</i>	<i>Logbook</i>	<i>IPF</i>	<i>Total</i>
2001	I	15	8	13	36
	II	19	9	11	39
	III	20	19	13	52
	IV	20	11	33	64
2002	I	14	13	16	43
	II	18	18	20	56
	III	22	25	22	69
	IV	21	11	24	56
2003	I	8	14	21	43
	II	10	14	22	46
	III	19	14	33	66
	IV	31	12	128	171
TOTAL		217	168	356	741

Table 2. Number of fishing operations (*n*) and the coefficient of variation (CV) of the CPUEs of swordfish (*Xiphias gladius*) and blue shark (*Prionace glauca*) for each area (5° x 5°) and quarter.

Quarter	LAT (°S)	LON (°W)	2001		2002		2003	
			<i>n</i>	CV	<i>n</i>	CV	<i>n</i>	CV
I	20	25	8	0.512	-	-	-	-
		30	4	0.577	-	-	-	-
	25	30	4	0.577	3	0.706	-	-
		35	-	-	2	-	-	-
		40	-	-	9	0.354	-	-
	30	45	-	-	15	0.372	21	0.242
		25	-	-	89	0.338	1	-
		30	5	0.500	117	0.192	9	0.354
		35	7	0.408	27	0.196	4	0.578
		40	18	0.630	9	0.353	9	0.354
		45	77	0.378	8	0.442	16	0.259
	35	50	11	0.895	15	1.034	28	0.193
		30	-	-	8	1.068	1	-
		40	-	-	-	-	3	0.707
		45	15	0.268	-	-	44	0.427
		50	18	0.462	-	-	4	0.583
40	55	1	-	-	-	-		
45	50	28	0.603	-	-	-	-	
II	25	35	-	-	7	0.412	-	-
		40	2	-	1	-	-	-
		45	48	0.202	47	0.228	55	0.247
	30	30	-	-	4	0.577	-	-
		35	21	0.224	2	-	-	-
		40	19	0.625	7	0.410	1	-
	35	45	74	0.339	111	0.178	78	0.159
		50	80	0.307	140	0.154	79	0.176
45		-	-	-	-	2	0.999	
	50	5	-	1	-	1	-	
III	15	35	9	0.353	-	-	-	-
		20	3	0.706	-	-	-	-
	25	45	-	-	1	-	-	-
		35	4	0.578	2	-	-	-
		40	13	0.289	8	0.378	30	0.203
	30	45	92	0.161	71	0.120	81	0.177
		35	8	0.378	1	-	-	-
		40	2	-	2	-	-	-
		45	98	0.102	181	0.179	106	0.231
	35	50	87	0.160	134	0.104	85	0.263
		45	2	-	7	1.079	-	-
		50	2	-	10	0.828	-	-
40	50	10	1.053	-	-	-	-	
IV	20	40	-	-	-	-	7	-
	20	45	1	-	2	-	-	-
	25	30	-	-	-	-	6	0.447
		35	-	-	-	-	7	0.408
	30	40	13	0.783	2	-	7	0.408
		45	23	0.297	55	0.282	166	0.214
		25	-	-	18	0.917	10	0.334
		30	21	0.223	42	0.579	19	0.237
		35	17	0.250	1	-	2	1
		40	11	0.316	13	0.984	7	0.408
	35	45	79	0.278	60	0.395	71	0.161
		50	49	0.246	37	0.170	33	0.449
		45	-	-	14	0.610	14	0.845
		50	-	-	8	1.068	-	-

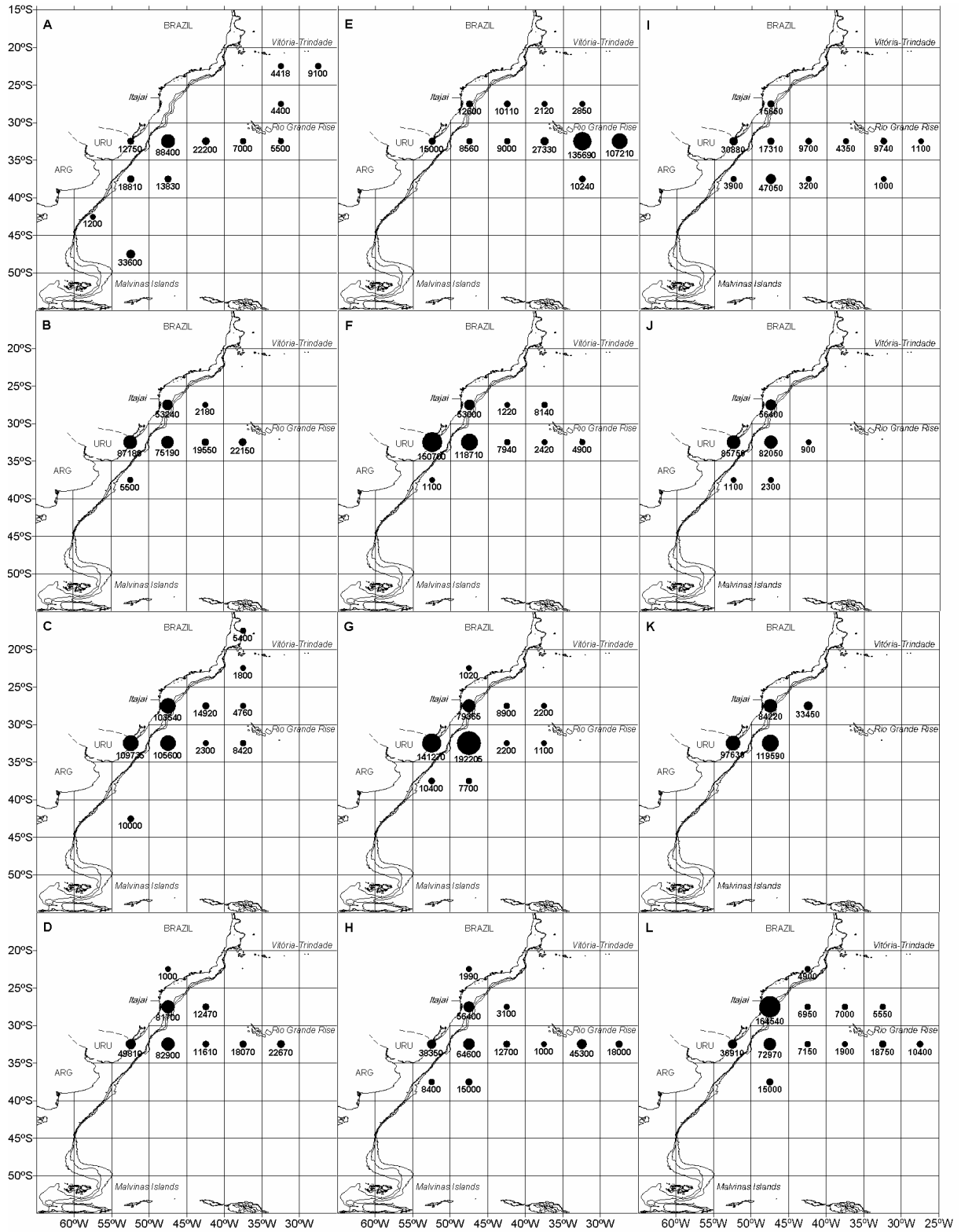


Figure 1. Geographical distribution of total fishing effort (number of hooks) per quarter, from the pelagic longline fleet based at Itajai harbor. 1st column: 2001; 2nd column: 2002; 3rd column: 2003. The lines along the coast represent 200, 500 and 1000 meters of depth. URU-Uruguay; ARG-Argentina.

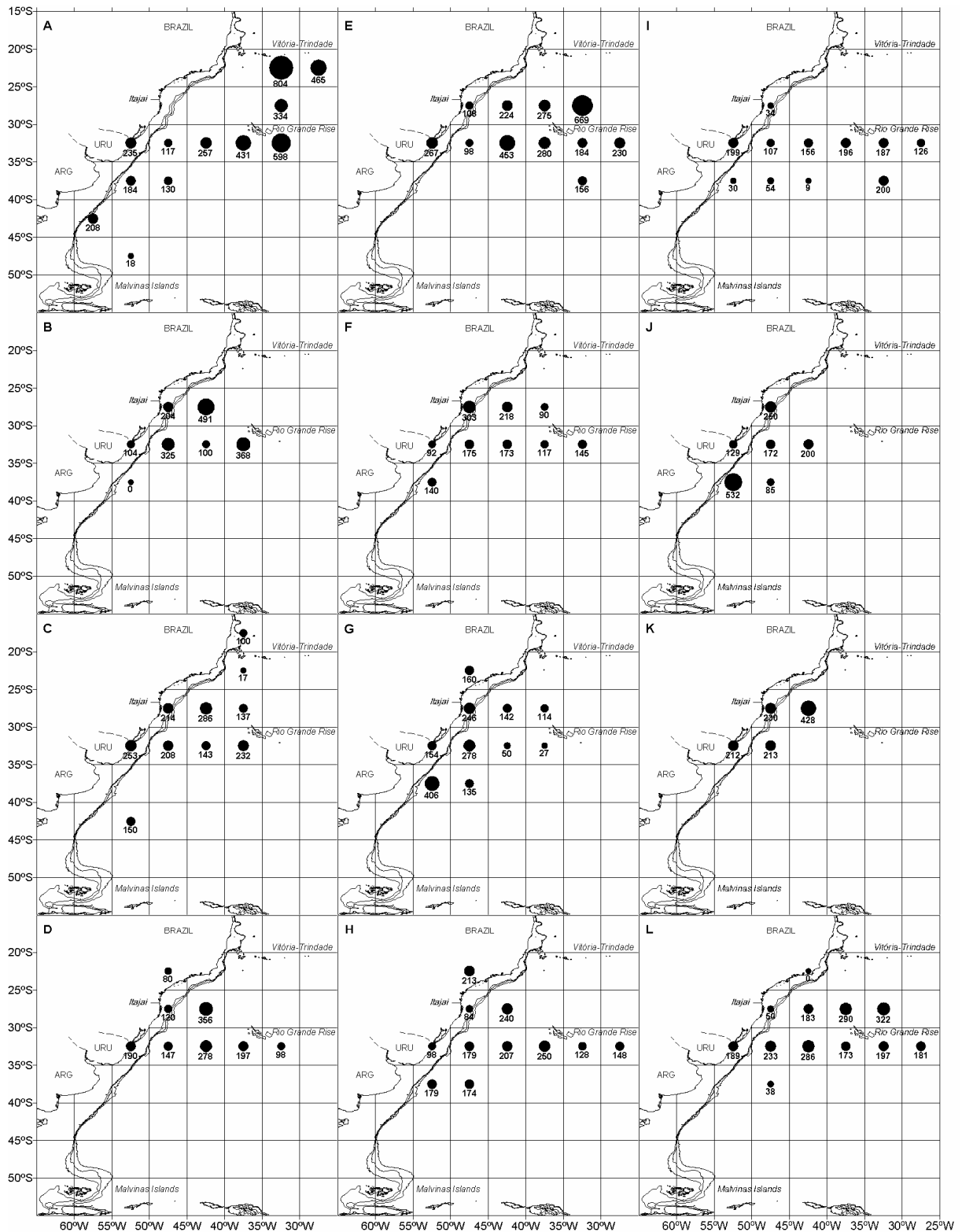


Figure 2. Geographical distribution of swordfish (*Xiphias gladius*) CPUE (kg/1000 hooks) per quarter, obtained from the pelagic longline fleet based at Itajaí harbor. 1st column: 2001; 2nd column: 2002; 3rd column: 2003. The lines along the coast represent 200, 500 and 1000 meters of depth. URU-Uruguay; ARG-Argentina.

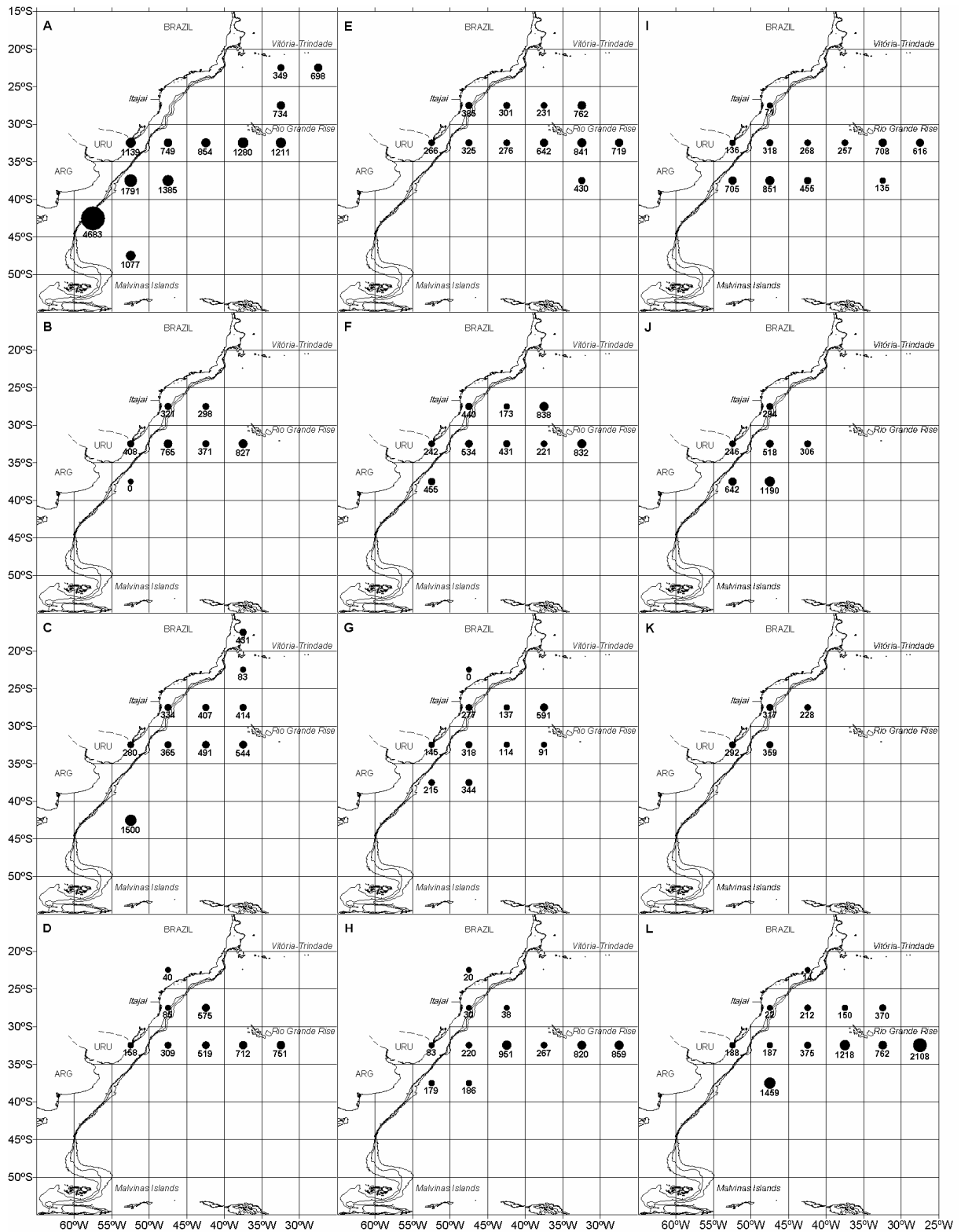


Figure 3. Geographical distribution of blue shark (*Prionace glauca*) CPUE (kg/1000 hooks) per quarter, obtained from the pelagic longline fleet based at Itajaí harbor. 1st column: 2001; 2nd column: 2002; 3rd column: 2003. The lines along the coast represent 200, 500 and 1000 meters of depth. URU-Uruguay; ARG-Argentina.

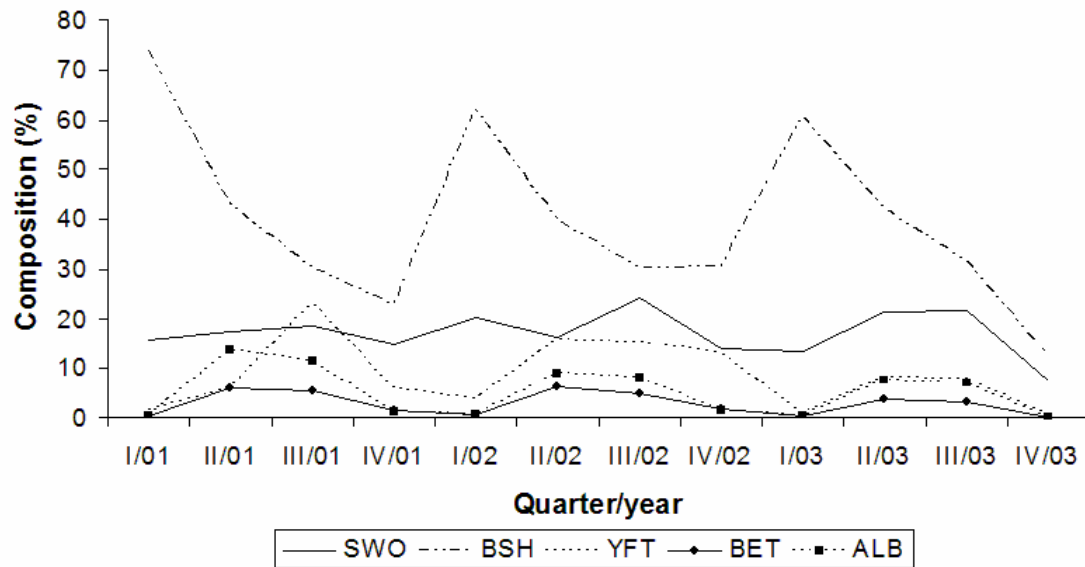


Figure 4. Catch composition (%) of the pelagic longline fleet landings at Itajaí harbor. SWO-swordfish (*Xiphias gladius*), BSH-blue shark (*Prionace glauca*), YFT-yellowfin tuna (*Thunnus albacares*), BET-bigeye tuna (*T. obesus*), ALB-albacore (*T. alalunga*).