DRIFTNETS IN SOUTHERN BRASIL

J.E. Kotas; M. da Rocha Gamba; dos Santos, S.; V. G. Azevedo & P.C. Conolly, (1)
M. Hostim-Silva; R.C. Mazzoleni; J.Pereira (2)

(1) CEPSUL-IBAMA : Av. Ministro Victor Konder, S/Nº., CEP 88301-280, CAIXA POSTAL 86, ITAJAÍ - SC, BRASIL. E-mail : jkotas@cepsul.ibama.gov.br
(2) LABORATÓRIO DE CIÊNCIAS AMBIENTAIS - NEA/UNIVALI: CEP 88302-202, CAIXA POSTAL 360, ITAJAÍ - SC, BRASIL.

ABSTRACT

Information about driftnet fisheries directed to elasmobranchs were collected in 1993 - 1997, from fleets based in Itajaí and Navegantes harbours, Santa Catarina State, Brazil. 126 fishing-boats were identified as "drifters". Driftnets used had mesh size (stretched) between 14 and 40 cm; and total driftnet length used between 1250 and 7560 m. The hammerhead sharks (mainly *Sphyrna lewini*) were the target species and represented 76,3 % of the total catch in weight. Teleosts and other shark species represented only 2,37 % of the total catch and were commercial by-catch. The hammerhead sharks were the main target species, due its highly valuable fins in the international market. The high fishing effort (km) of 72.216 km/net during the 1995 year joined with the patchy distribution of the stock, lead to low yields and a fishery collapse the following years.

I - INTRODUCTION

The present paper has the aim to **describe** a semi-industrial driftnet fishery based in Itajaí and Navegantes harbours, Santa Catarina State, Brasil, which operated along the southeast – south Brazilian Economic Exclusive Zone during the period 1993 - 1995. After that period, the fishery colapsed due to low hammerhead sharks yields, which make the fishery an unprofitable activity.

II - METHODS

Information about driftnet fishery in southern Brasil, during the period 1993 – 1995, was obtained from boats based in Navegantes/Itajaí (26°54'S, 48°39'W, Santa Catarina State). The data-set came from interviews with shipowners and fishing masters, observations *in situ* of the boats and fishing gear, biological sampling during the harbour visits and an offshore driftnet cruise.

Weekly visits to the Navegantes and Itajaí harbours were done during the 1995 year . An observer driftnet fishing cruise was performed during july-august/95. The physical aspects of the driftnet gear were obtained: mesh size between knots (cm); panel length and height (m); number of panels carried per boat; type of material (polietylene, polipropylene, poliamyde); string diameter (mm) and construction (multifilament: braided or twisted, or monofilament) used in the buoyline, leadline and panel; distance between buoys (cm); diameter and type of buoy (polietylene, polipropylene); buoyancy (kgf); lead weight used in the leadline per panel (grams/m) and total mesh number throughout the lenght and height pannel . Net designs were obtained for several driftnets (see draws). For many driftnets, the "hanging ratio" or "E" (**Nédelec, 1975**) was also calculated i.e.:

E = length of the head rope/(number of meshes)*(mesh size)

With respect fishing boats, the main aspects obtained were the following: total length (m), main engine power (Hp), gross tonnage , net tonnage, hold storage capacity (ton), crew number, type of electronic equipment on board, shipyard year, hull type (wooden, steel), and harbour.

During 1 fishing cruise logbook was filled containing detailed information about fishing operations (set and haul) and catches, i.e., date, hour, number of panels used, position (latitude and longitude), depth (registered from the echosounder). It was also measured the surface seawater temperature and salinity for each set. The catch composition, separated by species, number and weight (kg), was also registered.

Biological sampling was also done during fishing cruise and landings. Sharks were identified using the systematic keys to genera and species from Garrick (1982), Compagno (1984, 1988), Figueiredo (1977), and Tomás & Tutui (1996). Sharks were weighted (kg) whole, gutted (without head, fins and viscera) and measured to the nearest cm. The measured obtained were total length (cm), furcal length (cm), carcass length (cm), distance between 1st dorsal origin and precaudal pit (cm). For rays, the measure used was disc with (cm). Fork length (cm) was obtained for most of the teleosts caught (i.e., tuna, billfish and dolphinfish).

Biological sampling was also performed in the landing sites. In this case, carcass length (cm) and the distance between 1st dorsal origin and precaudal pit (cm) were obtained. When possible carcasses were sexed.

III – RESULTS

III.1 - FLEET

In 1995, 47 fishing-boats were found operating with driftnets based in Itajaí and Navegantes harbours. The fleet probably was bigger than that, because many bottom gillnetters, operating along the continental shelf during autumn and winter, targetting withemouth croaker (*Micropogonias furnieri*) and angel sharks (*Squatina guggenheim* and *Squatina occulta*), change to driftnetting activity in spring and summer seasons . There are at least 34 fishing-boats using bottom gillnets, plus 49 gillnetters unknown about its modality. The total driftnet fleet in spring-summer time could reach more than 100 vessels, which means a considerable fishing effort directed to coastal and oceanic elasmobranchs . The physical aspects found in this type of boats were the following:

	Mean	Stand. Dev.	Minimum	Máximum	N
Shipyard year	1981	10,53	1949	1995	30
Boat length (m)	17,19	3,15	12,90	27,00	37
Engine power (HP)	196,17	68,57	66	360	36
Gross tonnage	37,53	22,36	10,30	128,47	35
Net tonnage	18,99	14,93	3,09	53,48	29

Driftnetters have peculiarities. Most of them are wooden boats (e.g., previous purse-seiners or trawlers adapted to driftnets) and built in 1989. The vessel's age ranged between 1949 until 1995.. Most of the driftnetters are medium size boats (17 m), but a size range can be found. An example are the "whalers" (size ranging between 13 and 17 m), used by the community of fishermen called "Araçá", in Porto Belo's county, Santa Catarina State, until bigger boats (27 m) from the industrial fleet. Fishing boats use a mean engine power of 196 Hp. Depending on the boat size, it can range between a minimum of 66 Hp to a maximum of 360 Hp. The average gross tonnage found was 37,5 * 2.83 m^3, but the values ranged between 10.3 * 2.83 m^3 to 128.5 * 2.83 m^3.

III . 2 - DRIFTNET TYPES

Driftnet parameters from Itajaí and Navegantes harbours were illustrated below:

	Mesh size (cm)	Panel high (m)	Panel length (m)	Number of panels aboard	Total net length (km)
Mean	35,6	13,5	56,6	59	3,4
Stand. Deviat.	7,2	4,5	16,7	15	1,4
Minimum	14	4,4	25	35	1,3
Maximum	40	27	118,8	120	7,6
N	43	41	41	37	36

The dimensions of the driftnets are considerable. On average they reach approximately 3,4 km , but can range between values of 1,3 and 7,6 km, depending on boat size. Driftnets are composed by units or panels, and most of the fishermen use 50 m length for each panel built (i.e., mounted with floatline and leadline). There is a range of values between 25 and 119 m length. The number of panels that a driftnetter carries on board during one fishing journey varies as well, depending on the boat size. On average 60 panels (approximately 3000 m net length) are used . One boat can transport a maximum of 120 panels per trip. Most of the fleet use polyamide, 39 – 40 cm mesh size, which is adequated to catch the adult hammerhead sharks, on average with 2 m total length. The average mesh size was 35.6 cm The nets use to work from the surface until 27 m depth, with an average height of 13.5 m. However, it doesn't mean that the genus *Sphyrna* and other species of sharks could not occur below this. Previous studies shown that hammerhead sharks (Klimley & Nelson, 1984; Klimley et al., 1988; Klimley et al., 1993) can dive until 560 m depth. Drifnet fishery explore the epipelagic stratum, visited by many shark species which came to the surface by night for feeding purposes. One of the problem with the design of this nets is the fact that the floatline operates from the surface, increasing the chance to entangle cetaceans and turtles, wich in fact use to happen. Previous experiments shown that this problem would be minimized if the mainline operated at least 2m below the surface (FAO, 1990).

Studying driftnet fishery, observations and measurements have been done about the gear, with the aim do draw detailed net plants. Attached to this paper are the net designs used by the fleet, showing its technical facts (see figures). Driftnet panels are made of polyamide (PA) braided multifilament, with hanging ratio (E) between 39 an 67 %. This ratio is important because it "wrinkles" the panels, raising the fishing power of the net, and the hammerhead sharks are entangled by head, first dorsal and pectoral fins, helped by its "cork-screw" movements . Headline is made of braided or twisted multifilament polyethylene (PE), but there are a few cases of twisted multifilament polypropylene (PP). The headline diameter ranges between 7 and 20 mm, but the usual value found was 16 mm. These ropes are strong enough to support heavy fishes like 50 - 100 Kg. Panel dimensions vary. In most of the cases the height was 14 m and the length 50 m. Panel mesh size use to be 40 cm (stretched) polyamide (PA) braided multifilament, and string diameter of 2 mm, but there are cases of smaller mesh sizes like 15 to 18 cm (stretched) made of polyamide (PA) or Nylon monofilament, with string diameters ranging between 0.7 and 1.47 mm. Fishermen claim about these smaller ones because they use to catch high quantities of *Sphyrna lewini* juveniles. The string that links headline and leadline with the netting is called "arcala" and have different sizes. Arcala's length range betwen 14 and 40 cm and use to be of polyamide (PA) braided multifilament between 1.17 and 2.5 mm diameter. Some fishermen commonly use the mesh size to the arcala's length. This device is used as a tension-absorber, avoiding that big sharks, billfishes and swordfish tear the netting easily. The netting is linked to the arcalas (i.e., in the headline and leadline) in different ways:

- 2 meshes/1mesh/2 meshes (for mesh size between 38 - 40 cm).
- 2 meshes/2 meshes/2 meshes (for mesh size between 38 - 40 cm).
- 3 meshes/3 meshes/3 meshes (for mesh size between 15 - 17 cm).
- 5 meshes/5 meshes/5 meshes (for mesh size between 15 - 17 cm).
- 3 meshes/1 mesh/3 meshes (for mesh size between 15 - 17 cm).

There was only one case where the meshes linked to the arcalas were doubled, offering higher resistance. Buoys are attached to the headline, with distances between each other ranging from 0.82 to 4.80 m. The buoys commonly used were made of polyurethane, with buoyancy of 0.588 Kgf (mainly used on mesh size of 38 - 40 cm), but the range can be of 0.1 to 1.318 Kgf. The leadline is similar than the headline comparing the type and diameter of ropes, existing only few cases with small differences (i.e., headline diameter = 1.6 cm, leadline diameter = 1.2 cm).However,what really varies are the lead quantity in the ropes. The values ranged between 40 grams/m to 350 grams/m. The leads maintain the panels in a vertical position.

III . 3 - SPECIES COMPOSITION

Although driftnet fishery is mainly directed to the scalloped hammerhead shark (Sphyrna lewini), there are bycatches of another species of elasmobranchs, teleosts, cetaceans and turtles . (table 1).In the elasmobranch's group, 3 families are the most important: **Carcharhinidae**, **Lamnidae** and **Sphyrnidae**. Carcharhinids (requiem sharks) are represented mainly by 2 genus (Carcharhinus and Prionace), with catches of Carcharhinus brevipinna, Carcharhinus limbatus and Carcharhinus obscurus mainly over the continental shelf, and catches of Carcharhinus longimanus and Prionace glauca near the shelf border and throughout the epipelagic oceanic environment. Lamniforms are mainly represented by Isurus oxyrinchus, an oceanic species and rarely by Lamna nasus (which is more associated with temperate waters, i.e., below 18 ° C). The Sphyrnids used to be represented mainly by adults of Sphyrna lewini and sometimes by Sphyrna zygaena, the later associated with temperate waters and convergence zones (Compagno, L.J.V., 1984, Gilbert, C. R., 1967, Vooren & Britto, 1997, 1998). The highest catches of Sphyrna lewini happened during summer season, when the sea surface temperature waters are higher than 21 ° C. It is interesting to observe that Fishermen don't use thermometers to search areas of higher hammerhead shark abundance. In the neritic and oceanic environment, sometimes there were important catches of Manta rays (Mobylidae), which at the present time are not marketable, and use to be discarded death. The species is *Mobula hypostoma* and fishermen claim about that because it is an elasmobranch difficult to disentangle from the net. Notarbartolo-di-Sciara (1988), studying *Mobula thurstoni*, observed that this specie was more abundant in shallower, neritic waters, usually at depths lower than 100 m, and the greatest part of the catch was surface dwelling rays,i.e., the depth range that driftnet use to operate, which means that Manta rays are highly vulnerable to this type of gear. He also observed that the specie was solitary or in small nonpolarized groups of 2-6 fishes. In our case, during one trip done by the authors in summertime (january), It could be observed a catch of at least 30 manta rays in just one set. Bancroft (1829), Coles (1910, 1916 a), observed also schooling behaviour in *Mobula hypostoma* from the Atlantic . When operating in shallower waters (less than 100 m depth), driftnets sometimes catch Carcharias taurus .

Teleosts are only bycatches in this fishery, but most of them have economic value. Billfishes are the most important, specially Istiophorus platypterus and Xiphias gladius followed by Scombrids, particularly Auxis thazard, Thunnus albacares, Sarda sarda and Katsuwonus pelamis. Another oceanic families take place in this fisheries like Coryphaenidae and Bramidae.

Cetacean bycatches (mainly suborder odontoceti) use to happen in this fishery. Zerbini and Kotas (1998), reported at least 10 cetaceans interacting with driftnet fisheries off Southern Brazil, but the list probably can be expanded to 22 expecies. *Megaptera novaengliae*, *Physeter macrocephalus*, *Kogia simus*, *Globicephala melas*, *Delphinus spp*, *Tursiops truncatus*, *Stenella frontalis*, *Stenella longirostris*, *Stenella clymene*, *Stenella coeruleoalba*. The populational status of many of these mammals are not well defined by the IUCN (Jefferson, T.A., S. Leatherwood, and M.A. Webber, 1993). Several cetaceans species use to draught when entangled in this nets.

Marine Turtles use to be caught on driftnets. The families Chelonidae and Dermochelidae where the most importants. Green turtle (*Chelonia mydas*), Loggerhead (*Caretta caretta*) and Leatherhead (*Dermochelys coriacea*) are the species mainly caught by driftnet fishermen. In the case of *Dermochelys*, the species is mainly caught in summertime, associated with hydromedusae patches near the shelf border. Some fishermen catch between 10 and 30 leatherbacks per set, and use to have serious problems for disentangling these reptiles from the nets (fishermen, pers.comm.).

Although catches of cetaceans and marine turtles are accidental in the drifnet fishery, intentional captures of these animals are prohibited by federal law . This fact contributed that the turtles and cetaceans taken (alive or not) in the nets be discarded, which leads to a lack of information about distribution, abundance, stock identity and life history parameters of these species in Southern Brazil.

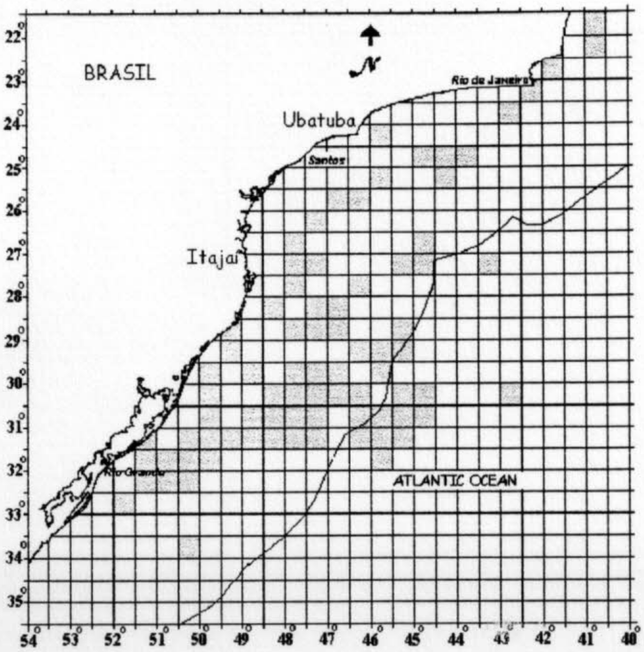
III . 4 - DRIFTNETS LANDINGS

Table 2, Figures 1, 2 & 3 shows elasmobranchs landings by driftnetters for the period 1993-1994 in Santa Catarina State (Branco, et al., 1995). Hammerhead sharks, mainly *Sphyrna lewini*, represented 76 % of total catches in weight; Carcharhinids (e.g., *Carcharhinus obscurus*, *Carcharhinus longimanus*) 7.32 % ; shortfin mako, *Isurus oxyrinchus* , 3.4 %, and the blue shark *Prionace glauca* , 0.3 % of total catches. Elasmobranchs represented 98 % of the total catches of fish, which means that this fishery was directed to sharks.

Bony fishes were a minor bycatch percentual. They represented only 1,95 % of the total driftnet catches.. Atlantic sailfish, *Istiophorus platypterus* represented 1.2 % of total catches; Bullet tuna, *Auxis thazard* , 0.35 % ; Dolphin fish, *Coryphaena hippurus*, 0.16 %; Broadbill swordfish, *Xiphias gladius*, 0.14 % ; Yellowfin tuna, *Thunnus albacares* 0.1 %; Atlantic bonito, *Sarda sarda*, 0.04 % and the Skipjack, *Katsuwonus pelamis*, 0.03 %.

III . 5 – AREAS AND FISHING EFFORT

In 1995, the fishing area was mainly located between Santos (latitude 24º00'S) and Chuí (latitude 33º45'S) in a depth range from 47 to 3600 m. There are some fishing boats that also operated northerly, i.e. until Vitória (latitude 20º00S).



Fishing areas used by drifters based in Itajaí

(Kotas et al, 1997)

A sample of fishing effort obtained from driftnet operations in southern Brazil are resumed in the following table:

Statistics	Bottom Depth (m)	Sea days	Fishing days	Begin set (time)	Set operation (hours)	Begin haul (time)	Haul operation (hours)	Soaking time (hours)
N	23	20	20	19	12	19	15	18
Minimum	47	8	5	15:00	1	4:30	2,20	12
Máximum	3600	27	18	18:00	5	6:30	7	12,20
Mean	1548	17	12	16:18	2,7	5:26	4,05	12
Std. Dev.	1226,70	4,83	3,88	0:49	1,28	0:37	1,16	0,05
Conf. Interv.	501,3	2,12	1,70	0:22	0,73	0:16	0,59	0,02

Fishing cruises ranged between 8 to 27 days, being the values affected by the target species availability, diesel consume and freshwater aboard. The average was 17 days. Fishing days, oscilated between 5 and 18 days. The average fishing days were 12. The difference between cruise and fishing days is due to the navigation time and bad weather conditions. Driftnet set begin between 3:00 and 6:00 pm. On average it occurrs within 3 hours period, depending on wind strength and net length. Strong winds help this operation, i.e. the boat positioned crossed to wind direction, while during becalmed sea driftnet is launched sideboards with the fishing boat navigating at 2-3 knots speed, a dangerous operation due to the entangling risk into the propeller. Driftnet soaking time was about 12 hours, by night, with better yields during new moon (fishermen, pers. Communication), making the nets less visible for the sharks. For the hammerhead shark, *Sphyrna lewini*, better yields are associated with temperatures higher than 21° Centigrade (Gilbert, 1967) . Driftnet haul use to be the following day, between 4:30 and 6:30 am. The average recovery time was 4 hours, which depends on net length and sea conditions.

With the previous information about fishing effort (i.e., boat number , average net length, fishing days), it was tried an initial estimate of the total fishing effort (km of nets) performed by the driftnet fleet based in Itajaí and Navegantes during one year. The following parameters were considered:

. (A) Average fishing days = number of sets in one cruise = 12,
. (B) Máximum number of driftnets boats operating in autumn-winter season = 47,
. (C) Máximum number of driftnets boats operating in spring-summer season = 130,
. (D)Average driftnet length = 3,4 km,
. (E) Average number of cruises a driftnet boat could do per season = 10,

Therefore, we would have,

Estimate driftnet effort (km) = (A*D*E*B) + (A*D*E*C)
During one year

Estimate driftnet effort (km) = (19.176 km autumn/winter) + (53.040 km spring/summer)
During one year

Estimate driftnet effort (km) = 72.216 km
During one year

Observing the above figures, and considering the 1995 year, when the fleet assessment was done, it seems that a huge effort was directed to a hammerhead stock during this period, stock distribuited in patches along the semi-pelagic environment, composed mainly of *S. lewini* adults, which could not support tremendous fishing pressure. Another negative aspect was the fact that the period of most intensive fishing effort was during the spring-summer season, the reproductive period the species, i.e., when pregnant females concentrations occurred (Kotas, pers. Communication). Probably all this causes allied to the fishing effort done over the *S. lewini* juveniles by bottom gillnets, contribuited to the dramatic decline of the hammerhead yields the following years, with the subsequent driftnet fishery collapse.

III . 6 - CATCH PER UNIT EFFORT (CPUE) FROM DRIFTNET FISHERY

Sphyrna lewini (Hammerhead shark)

Monthly CPUE trend (ind./km) during the period 1995 – 1997, was analysed for the hammerhead shark caught by drifters operating along the Southeast-South Brazilian coast (Figure 4). The average CPUE values ranged from a minimum of 0,4 ind./km in august/96 to a maximum of 12,5 ind./km in december/96. It was not identified a trend along the seasons, a fact that could be explained by the the high mobility of this elasmobranch resource and its distribuition in patches along the continental shelf border and even found alone free-swimming . The high catch variability probably was the main cause of collapse for this fishery, i.e. leading to the uncertainty about the catches. During sea cruises it was usual to observe net recoveries without catches. Another aspect is the fact that this nets only operates to an average depth of 4,5 m, not representing all the vertical distribution of *Sphyrna lewini* species that can reach 500 m depth (Klimley & Nelson, 1984; Klimley, 1987 ; Klimley et al., 1988, 1993 ; Galván-Magaña et al., 1989).

The horizontal CPUE distribution of *S.lewini* (number of sharks/km) during the period 1995 – 1997 was also mapped. It was observed that the fishery was mainly concentrated between latitudes 28ºS - 33ºS, and 44º W longitude (Figures 5, 6, 7, 8, 9). The best yields (i.e., between 20 to 25 sharks/km) where obtained over the slope i.e., between 1000 and 3000 m bottom depth, area where surface waters temperature were over 21º C, i.e., associated with the tropical water (T>20ºC, S>36,4 psu, Emilson, 1961), which is carried to the south-southeast direction by the Brazilian Current over the continental slope (Gama et al., 1998). The tropical water mass range from the surface to 200 m depth, building up an hypothesis that *S. Lewini* would probably follow this depth distribution.. It seems that driftnet fishery followed the migratory behaviour of *Sphyrna lewini* subadults and adults, from the neritic waters to the oceanic areas and vice versa. The driftnet fishery based in Itajaí and Navegantes , which operated in this area, was mainly responsible for this big yields, mainly during spring-summer season.

Comparing the seasonal distribution of *S. lewini* CPUE, it is possible to observe the following pattern:

. Spring-summer: The species was spreaded along coastal and offshore areas between 24º00' S - 31º00'S latitude and 51º00' W - 43º00'W longitude. In this case the horizontal distribution was very large, i.e., from litoral areas to the slope. This variability could be explained by the horizontal migratory behaviour of matured females during this seasons, moving from the oceanic to the neritic areas to give birth their pups. During spring, the species concentrated southernly, i.e., between 30º00'- 32º00'S latitude. In summer, the species was concentrated northernly, i.e., between 31º00' – 29º00'S latitude.

. Autumn-winter: The species was mainly concentrated in offshore areas, mainly between 28º00'S – 31º00'S latitude and 45º00'- 46º00'W longitude (2300 – 3500 m bottom depth, i.e., the slope). Adults were distribuited offshore, probably following and feeding on shoals of pelagic squids.

The CPUE distribution shows that the driftnet fleet follow the migratory behaviour of *S. lewini* subadults and adults, behaviour commanded by its reproductive and feeding strategy.

III.7 – BYCATCH CPUE

Another sharks species were considered bycatch in driftnet fishery (table 3). For the period march – august 1995, *Isurus oxyrinchus* a species with best flesh value in the market (U$ 0.5/Kg in Itajaí and Navegantes), showed CPUE ranging between 0.21 to 0.02 sharks/Km . *Prionace glauca* presented a CPUE between 0.23 and 0.03 sharks/Km.

Driftnets also caught teleosts, i.e billfishes, swordfishes, tunas, and dolphin fish. They are only bycatches, and it CPUE levels were low (i.e., between 0.03 and 0.06 fishes/Km).

IV – DISCUSSION

Driftnet is a primitive fishing gear and traditional in many countries. However in most of theses fisheries a pattern of quick rise and fall in catch is very comonly observed, which means an **equilibrium exploitation level very low**. During the 30's and 40's, the demand for shark liver oil estimulated driftnet and demersal gillnet activities on the continental shelves of many countries for *G. galeus* (Ripley, 1946, Olsen, 1954, 1959, Freer 1992, Peres and Vooren, 1991, de Buen, 1952, Chiaramonte and Corcuera 1995, Seabrook-Davison et al, 1985, Francis 1998). Most of these fisheries declined during the 50's as drop in the demand of liver oil. The California fishery collapsed during the 40's and a recovery was observed in New Zealand, South America and South Africa. Another directed driftnet fishery occured in California during the 70's and 80's, targetting thresher shark (*Alopias vulpinus*) (Bedford, 1987).

For most of driftnet fisheries, there is a lack of information about the ecological impact over the target and by-catch species in the epipelagic environment. Driftnets are able to catch a large variety of pelagic species, of any size, due to their high entangling capacity and efficient technology of the gear. The problem with driftnets is that non commercial species are very often caught , and catches of protected species (cetaceans and turtles) use to occur, which are not commonly reported by fishermen (Zerbini & Kotas, 1997). Di Natale et al (1994), observed that in a swordfish driftnet fishery in the Mediterranean, the entanglement frequency of a total of 85 different species caught, only 1,2 % was target species (i.e., swordfish). The rest was distribuited in the following order: 22,4 % occasional, 41,2 % incidental, 18,8 % uncommon, 8,2 % common, 4,7 % frequent and 3,5 % abundant species. The diversity of organisms ranged between fishes, cetaceans, molluscs, turtles, cnidarians, ctenophores and tunicates. In this fishery the target species (i.e., swordfish) represented 17,6 % in number and 49,71 % in weight of the total catch. The non-commercial catches represented 15,07 % in number and 25,93 % in weight. Protected species represented 1,08 % in number and 9,01 % in weight.

Many technological measures exist to minimize the ecological effects over the non target species. Di Natale et al. (1994), observed the effect of soaking time along the driftnet panels, showing that the first and second fifth of the net represented less than 20 % of the catches in number, and the median fith and the last two bands were always over 20 % . Controlling the soaking time would be an option to minimize by-catches. An entanglement reduction of protected species (cetaceans, turtles) could be also obtained by shortening the net length, and changing the net buoyancy, i.e., setting the float line a few meters below the sea surface. This suggestion is rejected by fishermen because they argue that there will be an economical reduction below the positive levels and due to true technological problems to do the modifications. Many other procedures has been done to reduce the incidental cetaceans catches by dritnets (ICCAT, SCRS/94/21). The EEC and the Italian Government funded a research program to study the possibility of avoiding or reducing the cetacean by-catch, by specific devices connected at the floating lines (e.g. simple bells). Also studying the environmetal parameters that affects driftnet yields would lead to better management of these fisheries. Di Natale et al. (1994), found a relationship between swordfish CPUE (kg/km) and the moon phases. During the years 1990, 1991, and 1992. He observed a trend of reducing swordfish CPUE during full moon phases and increasing CPUE values during new moon phases. The explanation could be related by the fact that full moon makes the driftnet more visible and detectable for the swordfish, the environment lightness affecting swordfish behaviour, and changes in the swordfish behaviour affected by vertical distribution of cephalopods induced by the full moon. This facts were also observed by de la Serna et al. (1991) on Spanish driftnet catches in the Atlantic and the Mediterranean.

United Nations through the resolution A/Res/44/225 of 1989, banned driftnets from high-seas since June 30, 1992. (Bonfil, R., 1994). After that determination, several countries are trying to control driftnet activities to minimize the ecological impact over the pelagic ecossistem. The Ad Hoc GFCM/ICCAT Working group on Stocks of Large Pelagic Fishes in the Mediterranean Sea (ICCAT, SCRS/94/21), detected a decreased in the number of countries using driftnets in the mediterranean. ICCAT, also reiterated the need for compliance with United Nations General Assembly's Resolutions 45/197 and 46/215 of December, 1990, 1991, respectively on large scale pelagic driftnet fishing and its impact on the living marine resources. The European Union limited driftnet lengths to 2,5 km, and the nets should be permanently attached to the vessels. In the Tyrrhenian sea a máximum net length of

2,5 km per boat is permitted since March/92, but the regulation is not totally enforced (Di Natali et al, 1994). In Italy, driftnets temporary bans for the period 1990 – 1991, by the Governemt produced positive effects, i.e., increasing in 1992 mean swordfish length and weight. In 1994, Italy reduced driftnet fishing effort by decreasing 30 % the net length. In the Ligurian Sea, since 1990, driftnetting is not permitted in an area of cetaceans protection. Over 600 boats are involved in this fishing activity . Japan ceased driftnet fishing operations since 1992, only maintaining this fishing activity within its economic exclusive zone. In Algeria, driftnets are regulated since 1988. The use is limited for nets with less than 2400 m length, and now only 8 – 10 vessels smaller than 10 m target swordfish with some minor by-catch. Tunisian driftnets which target Atlantic little tuna and frigate tuna always measure less than 1500 m length and its use is decreasing due economic reasons. However, with the new fisheries policy in this country, such nets will be banned (United Magreb Arabe – UMA). In Greece there was a small-scale driftnet fishery targeting *Auxis spp* in the Aegean Sea, but such fishing was prohibited by domestic regulations in 1994. In Morocco driftnet fishing effort is controlled since 1992, and the number of nets permitted is limited to one per vessel, with fishing period limited by area. Spain, since 1990, almost totally banned driftnet operations in the Mediterranean, but still maintain driftnets fleets, which targets swordfish, in the Atlantic and mediterranean waters close do Gibraltar.

Although worlwide restrictions for driftnet use exist, another countries still continue to use this type of gear and Brazil is an example. European Union has shown a general non-compliance with the regulations by the majority of the driftnetters involved in the mediterranean, by surpassing the allowable net length limit of 2,5 km, and by not maintaining the nets permanently attached to the vessels during fishing operations. French driftnets are used mainly in the Atlantic, with very few in the Mediterranean, targeting albacore and minor by-catches of blue fin tuna. Also Ireland and U.K. are still using driftnets in the Atlantic to catch Albacore. In Italy, although occurred decreased in the fleet size and average net length, driftnet is still commonly carried on along the Mediterranean, targetting swordfish, albacores and small tunas.

The Hammerhead shark, *Sphyrna lewini* are considered target species for driftnet fishery in southern Brazil due to the high prices that their fins reach in the Asian market (i.e., Taiwan, Hong Kong, South Korea, Japan). During 1995, in Itajaí and Navegantes harbours, 1 Kg of hammerhead shark fin was paid to the fishermen U$ 50.00 (fresh fins, without processing). Undoubtedly the prices are higher in the international market. The fins are bought by a first purchaser in Itajaí and Navegantes harbours who resale the product to a Japanese company based in São Paulo, and finally they are exported to Asia from São Paulo International Airport. On the other hand, hammerhead shark fresh meat reaches only U$ 0.10 - 0.12 per Kg in Itajaí, a very low value compared with fin's price, fact that estimulated "finning" , mainly during the peak of activity for this fishery. Controlling "finning" is a very difficult task which involves economical and ethical issues (Anonymous, 1999a). Brazilian Government (IBAMA) issued a new law trying to controll gill net activities, i.e., allowing only gillnets with less than 2,5 km length to operate within brazilian EE´Z, and forbidding fins landings which represent over 5 % of the total carcasses weight (IBAMA, 1998). The exploitation of hammerhead sharks along the brazilian coast could also be managed by developing studies related to the biology and population dynamic of the hammerhead shark, *Sphyrna lewini* along the brazilian coast; Implementing a national observer's program aboard brazilian driftnetters and assessing the by-catches of *Sphyrna lewini* from another gears (i.e., trawlers, bottom gillnets, artisanal fisheries).

In brazilian waters, regulations about the use of gill nets, i.e., allowing only 2,5 km of net, length will reduce driftnet fishing to an unneconomical activity. This means that with the new legislation, most of the driftnet activity in southern Brazil will cease.

XIII - REFERENCES

ANONYMOUS, (1999 a) . Informe da sociedade brasileira para o estudo de elasmobrânquios. Informe número 4. 12 p.

BANCROFT, E.N. (1829). On the fish known in Jamaica as the sea-devil. Zool. J. 4: 444-457.

BONFIL, R. (1994) Overview of world Elasmobranch fisheries. FAO Fisheries Technical Paper, 341.

BEDFORD, D. (1987) Shark management: a case history – the California pelagic shark and swordfish fishery. In `Sharks: an Inquiry into Biology, Behaviour, Fisheries, and Use´ (Ed. S. Cook.) pp. 161 – 71. (Oregon State University Extension Service: Corvallis, Oregon.).

BRANCO, E.J., e REBELO, S. (1995) Desembarques Controlados de Pescados no Estado de Santa Catarina. Coleção Meio Ambiente. Série Estudos-Pesca, Nº 14.

CHIARAMONTE, G. E. & CORCUERA, J. (1995). Explotación comercial y biología de Galeorhinus galeus Linn. 1758 en la República Argentina. Informe Nacional 12ª reunión del Comite de Animales de CITES. Antigua, Guatemala, 11 a 14 de setiembre de 1995. Tiburones **Parte 1**, 16 pp.

COLES, R. J. (1910) Observations on the habits and distribution of certain fishes taken on the coast of North Carolina. Bull. Am. Mus. Nat. Hist. 28: 337-348.

COLES, R. J. (1916 a) Natural history notes on the devil fish, *Manta birostris* (Walbaum) and *Mobula olfersi* (Müller). Bull. Am. Mus. Nat. Hist. 35: 649 – 657.

COMPAGNO, L.J.V. (1984) FAO species catalogue. Vol 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2. Carcharhiniformes. FAO Fish. Synop., (125) Vol.4, Pt.2:251-655.

COMPAGNO, L.J.V. (1988) Sharks of the Order Carcharhiniformes. Princeton University Press. Princeton, New Jersey.

de la SERNA et al. (1991)

de BUEN, F. (1952) El tiburón vitamínico. In ´Apartado del Nº 7 de la Revista de la Facultad de Humanidades y Ciencias`. Pp. 87 – 116. (Universidad de la Republica: Montevideo.).

Di NATALE, A. , A . MANGANO. (1994) Moon phases influence on CPUE: a first analysis of swordfish driftnet catch data from the Italian fleet between 1990 and 1991. ICCAT Collective Volume of Scientific Papers. SCRS/94/86.

Di NATALE, A . , A . MANGANO, E. NAVARRA, G. SCHIMMENTI, M. VALASTRO. (1994). Albacore (*Thunnus alalunga* Bonn) Fishery in the Tyrrhenian Sea: 1990 – 1992 Report. ICCAT Collective Volume of Scientific Papers. SCRS/94/83.

Di NATALE, A. , A . MANGANO, E. NAVARRA, G. SCHIMMENTI, M. VALASTRO. (1994). Swordfish (*X. gladius*) driftnet fishery in the Tyrrhenian Sea: 1992 report. ICCAT Collective Volume of Scientific Papers. SCRS/94/82.

Di NATALE, A. ., A. MANGANO, A . MAURIZI, L. MONTALVO, E. NAVARRA, S. PINCA, G. SCHIMMENTI, G. TORCHIA, M. VALASTRO . (1994). A review of driftnet catches by the Italian fleet, species composition, observers data and distribution along the net. ICCAT Collective Volume of Scientific Papers. SCRS/94/81.

EMILSON, I. (1961). The shelf and coastal waters of southern Brazil. Bolm. Inst. Oceanogr., São Paulo, v. 11, n.2, p. 101 – 112.

FAO (1990). Report of the Expert Consultation on Large-Scale Pelagic Driftnet Fishing. Rome, 2 – 6 April 1990. Fao Fisheries Report. Nº 434. Rome, FAO. 1990. 78 p.

FAO. (1994) World review of highly migratory species and straddling stocks. FAO Fisheries Technical Paper. Nº. 337. 70 p.

FIGUEIREDO, J. L. (1977). Manual de Peixes Marinhos do Sudeste do Brasil. I . Introdução. Cações, raias e quimeras. Museu de Zoologia, Universidade de São Paulo. 105 pp

FRANCIS, M.P. (1998) New Zealand shark fisheries: development, size and management. Marine and Freshwater Research **49**, 579 – 91.

FREER, D.W.L. (1992). The commercial fishery for sharks in the South-western Cape, with an analysis of the biology of the two principal target species, *Callorhynchus capensis* Dumeril and *Galeorhinus galeus* Linnaeus. M.Sc. Thesis, University of Cape Town, Cape Town. 103 pp.

GALVÁN-MAGAÑA, F., NIENHUIS, H.J. AND KLIMLEY, A . P. (1989). Seasonal abundance and feeding habits of sharks of the lower Gulf of California, Mexico. *Calif. Fish and Game, 75(2): 74 – 84.*

GAMA, R.M.; FREITAS, A.C.; SILVA, M.P da; MÖLLER Jr., O . O . (1998). Análise comparativa das características termohalinas da plataforma continental sul do Brasil – ECOPEL I e II. Resumos da XI Semana Nacional de Oceanografia: Oceanografia e suas interfaces, de 18 a 24 de outubro de 1998.-Pelotas:Universidade/UFPel, 1998. – 709 p.

GARRICK, J. A . F. (1982). Sharks of the Genus Carcharhinus. NOAA Technical Report NMFS Circular 445. 194 pp.

GILBERT, C. R., (1967). A revision of the hammerhead sharks (family Sphyrnidae). Proceedings of the United States National Museum. Smithsonian Institution. Volume 119, number 3539. 91p.

IBAMA (1998). Portarias normativas.

JEFFERSON, T.A., S. LEATHERWOOD, and M.A. WEBBER (1993) FAO species identification guide. Marine mammals of the world. Rome, FAO. 1993. 320 p. 587 figs.

KLIMLEY, A. P., & D.R. NELSON. 1984. Diel movement patterns of the scalloped hammerhead shark (*Sphyrna lewini*) in relation to El Bajo Espiritu Santo: a refuging central-position social system. *Behav. Ecol. Sociobiol. 15: 45 – 54.*

KLIMLEY, A.P.. 1987. The determinants of sexual segregation in the scalloped hammerhead shark, *Sphyrna lewini. Environmental Biology of Fishes. Vol. 18, Nº1, pp.27-40.*

KLIMLEY, A. P. & BUTLER, S.B. 1988. Immigration and emigration of a pelagic fish assemblage to seamounts in the Gulf of California related to water mass movements using satellite imagery. *Mar. Ecol. Prog. Serv. Vol 49, nº 1-2, pp 11 – 20 .*

KLIMLEY, A.P.., CABRERA-MANCILLA, I., CASTILLO-GENIZ, J.L. 1993. Descripción de los movimientos horizontales y verticales del tiburón martillo *S. lewini*, del sur del golfo de California, Mexico. *Ciencias Marinas, 19 (1): 95 – 115.*

MIYAKE, M. (1990) Manual de Operaciones para estadísticas y muestreos de los Tunidos y especies afines en el Oceano Atlantico. Comisión Internacional Para la Conservación del Atún Atlántico.

NÉDELEC, C. (1975). FAO catalogue of small-scale fishing gear. Fishing News (Books) editors. 1991 pp.

NOTARBARTOLO-DI-SCIARA, G. (1988). Natural history of the rays of the genus Mobula in the Gulf of California. Fishery Bulletin. Vol. 86, Nº 01, pp 45 – 66.

OLSEN, A . M. (1954). The biology, migration, and growth rate of the school shark, *Galeorhinus australis* (Macleay) (Carcharhinidae) in south-eastern Australian waters. Australian Journal of Marine and Freshwater Research **5**, 353 – 410.

OLSEN, A . M. (1959) . The status of the school shark fishery in south-eastern Australian waters. Australian Journal of Marine and Freshwater Research **10**, 150 – 76.

PERES, M.B., and VOOREN, C.M. (1991). Sexual development, reproductive cycle, and fecundity of the school shark *Galeorhinus galeus* off southern Brazil. *Fishery Bulletin* **89**, 655 – 67.

RIPLEY, W.E. (1946). The soupfin shark and the fishery. California Division of Fish and Game Fish Bulletin **64**, 7 – 37.

SEABROOK-DAVISON, M., PAUL, L. J., & HURST, R.J. (1985). School shark. In `Background Papers for the 1985 Total Allowable Catch´. (Eds J.A. Coleman, J.L. McKoy and G. G. Baird.) p. 259. (Fisheries Research Division, Ministry of Agriculture and Fisheries: Wellington, New Zealand.)

TOMÁS, A. R. G. & TUTUI, S. L. dos SANTOS (1996) Identificação de carcaças de cações e raias da pesca comercial no sudeste do Brasil. An . Acad. Bras. Ci., (1996) **68** (4).

VOOREN & BRITTO (1997) . Projeto ARGO. Relatório nº 01. Período: Setembro de 1996 a Abril de 1997. Fundação Universidade do Rio Grande, Departamento de Oceanografia. 113p.

VOOREN & BRITTO (1998) . Projeto ARGO. Relatório nº 02. Período: Maio de 1997 a Fevereiro de 1998. Fundação Universidade do Rio Grande, Departamento de Oceanografia. 209 p.

WOODLEY, T.H. and EARLE, M. (1991) Observation on the French Albacore Driftnet Fishery of the Northeast Atlantic. Final Report Prepared for Greenpeace International, September 1991.

ZERBINI , A . N. & KOTAS, J.E. (1998). A Note on Cetacean Bycatch in Pelagic Driftnetting off Southern Brazil. Rep. Int. Whal. Commn 48. Pp 519 – 524.

de la SERNA et al. (1991)

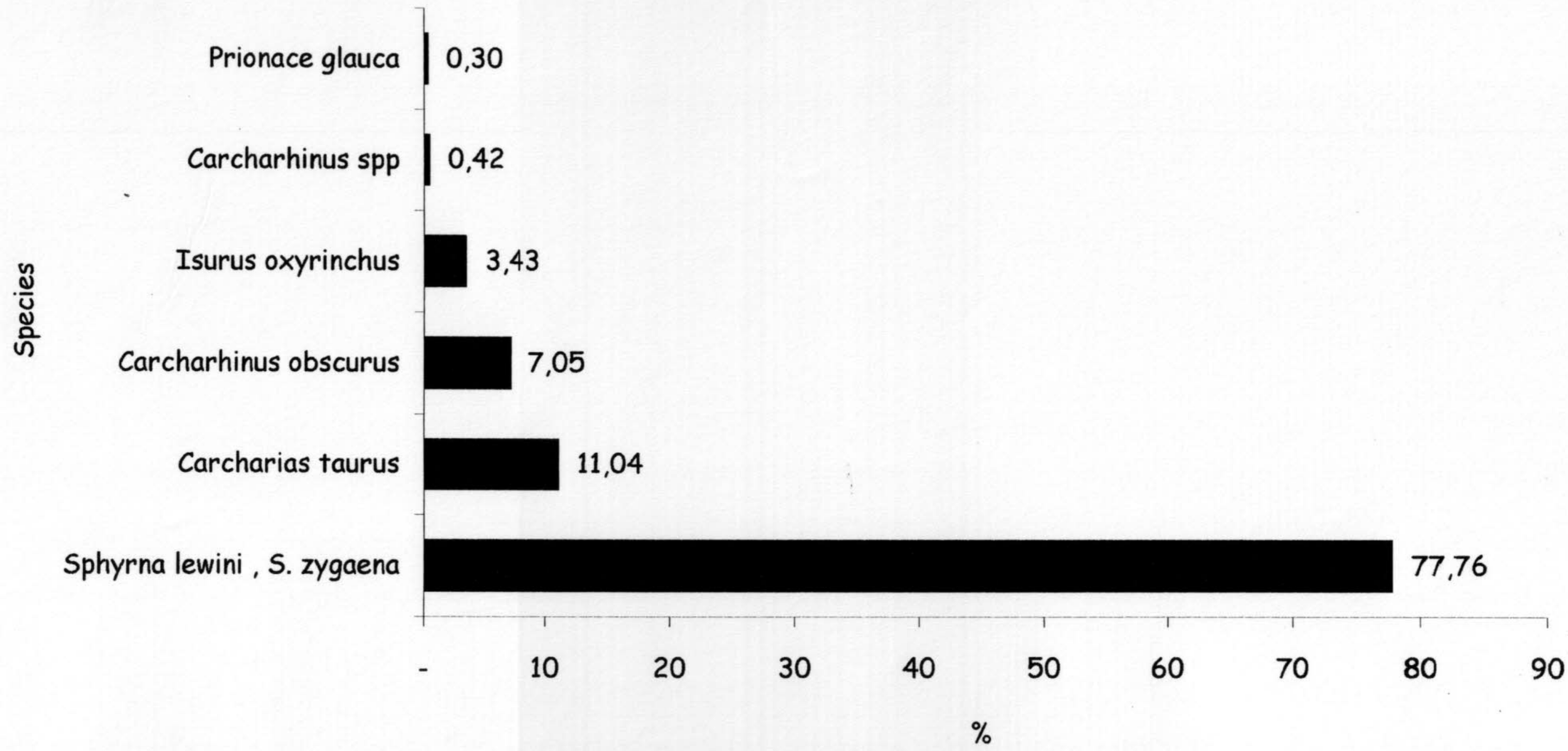
TABLE 1 - Species caught by driftnets boats based in Itajaí and Navegantes during 1995 year.

FAMILY	SPECIES	FAO NAMES	MONTH
	ELASMOBRANCHS		
Carcharhinidae	*Carcharhinus limbatus*	Blacktip shark	
Carcharhinidae	*Carcharhinus brevipinna*	Spinner shark	
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	1, 3, 4, 5
Carcharhinidae	*Carcharhinus obscurus*	Dusky shark	3, 6
Carcharhinidae	*Carcharhinus spp*	Requiem sharks	3, 4
Lamnidae	*Isurus oxyrinchus*	Shortfin mako	3, 4, 5, 6, 7, 8
Lamnidae	*Lamna nasus*	Porbeagle	8
Mobulidae	*Mobula hypostoma*	Lesser devil ray	8
Odontaspididae	*Carcharias taurus*	Sand tiger shark	7
Carcharhinidae	*Prionace glauca*	Blue shark	3, 4, 5, 7, 8
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead	3, 4, 5, 6, 7, 8
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead	7
	BONY FISHES		
Scombridae	*Auxis thazard*	Frigate tuna	8
Bramidae	*Brama brama*	Pomfret	7, 8
Coryphaenidae	*Coryphaena hippurus*	Dolphin fish	7, 8
Istiophoridae	*Istiophorus platypterus*	Atlantic sailfish	8
Scombridae	*Katsuwonus pelamis*	Skipjack	7, 8
Istiophoridae	*Makaira nigricans*	Atlantic blue marlin	4
Scombridae	*Sarda sarda*	Atlantic bonito	8
Istiophoridae	*Tetrapturus albidus*	Atlantic white marlin	3, 4, 7
Scombridae	*Thunnus albacares*	Yellowfin tuna	7
Xiphiidae	*Xiphias gladius*	Swordfish	7
	CETACEANS		
Delphinidae	*Delphinus delphis*	Common dolphin	winter
Delphinidae	*Globicephala melas*	Long-finned pilot whale	summer
Delphinidae	*Stenella coeruleoalba*	Striped dolphin	winter
Delphinidae	*Stenella frontalis*	Atlantic spotted dolphin	summer

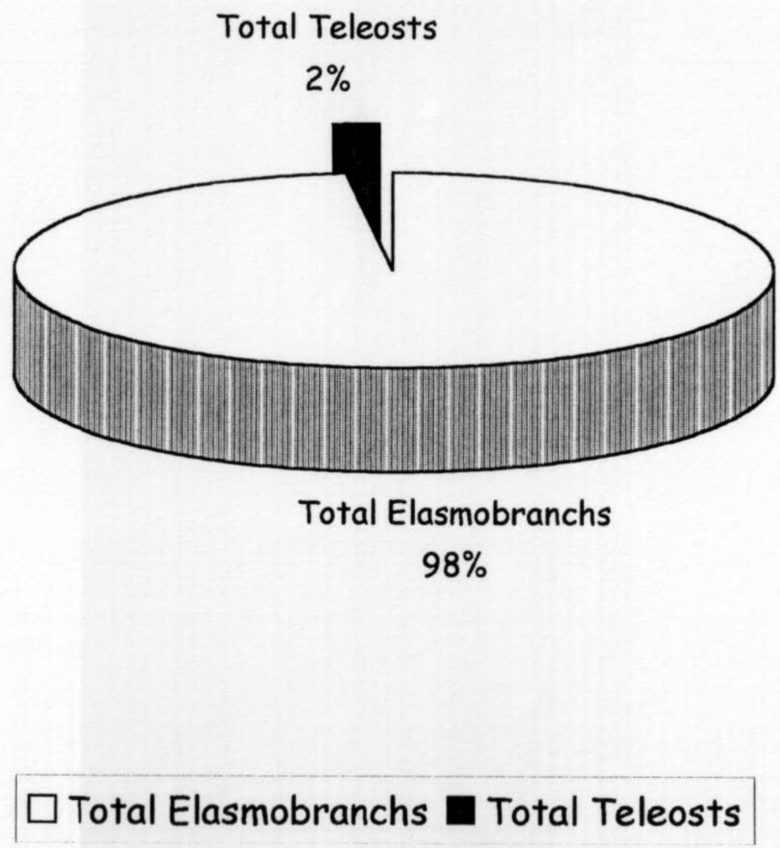
TABLE 2 - LANDING COMPOSITION FROM DRIFTNET FISHERY, IN SANTA CATARINA STATE, DURING THE YEARS 1993 AND 1994. LANDINGS IN METRIC TONNES.

SPECIES	1993	1994	Mean	% Total landed	% Total Elasmobranch
Sphyrna lewini , S. zygaena	422,4	538,43	480,42	76,25	77,76
Carcharias taurus	49,38	87	68,19	10,82	11,04
Carcharhinus obscurus	47,94	39,18	43,56	6,91	7,05
Isurus oxyrinchus	13,76	28,61	21,19	3,36	3,43
Carcharhinus spp	1,98	3,16	2,57	0,41	0,42
Prionace glauca	0,33	3,41	1,87	0,30	0,30
Total Elasmobranchs	535,79	699,79	617,79	98,05	
SPECIES	**1993**	**1994**	**Mean**	**% Total landed**	**% Total Teleosts**
Istiophorus platypterus	2,53	12,49	7,51	1,19	61,23
Auxis thazard	2	2,41	2,21	0,35	17,98
Coryphaena hippurus	1,31	0,66	0,99	0,16	8,03
Xiphias gladius	0,56	1,15	0,86	0,14	6,97
Thunnus albacares	0,13	1,02	0,58	0,09	4,69
Sarda sarda		0,27	0,27	0,04	2,20
Katsuwonus pelamis	0,22	0,21	0,22	0,03	1,75
Total Teleosts	6,53	18	12,27	1,95	
Total Elasm. + Teleosts	542,32	717,79	630,06		

Driftnet landing composition of sharks, Santa Catarina State 1993 - 1994



Driftnet landing composition, Santa Catarina State, 1993 -1994



Driftnet teleosts landing composition, Santa Catarina State, 1993 - 1994

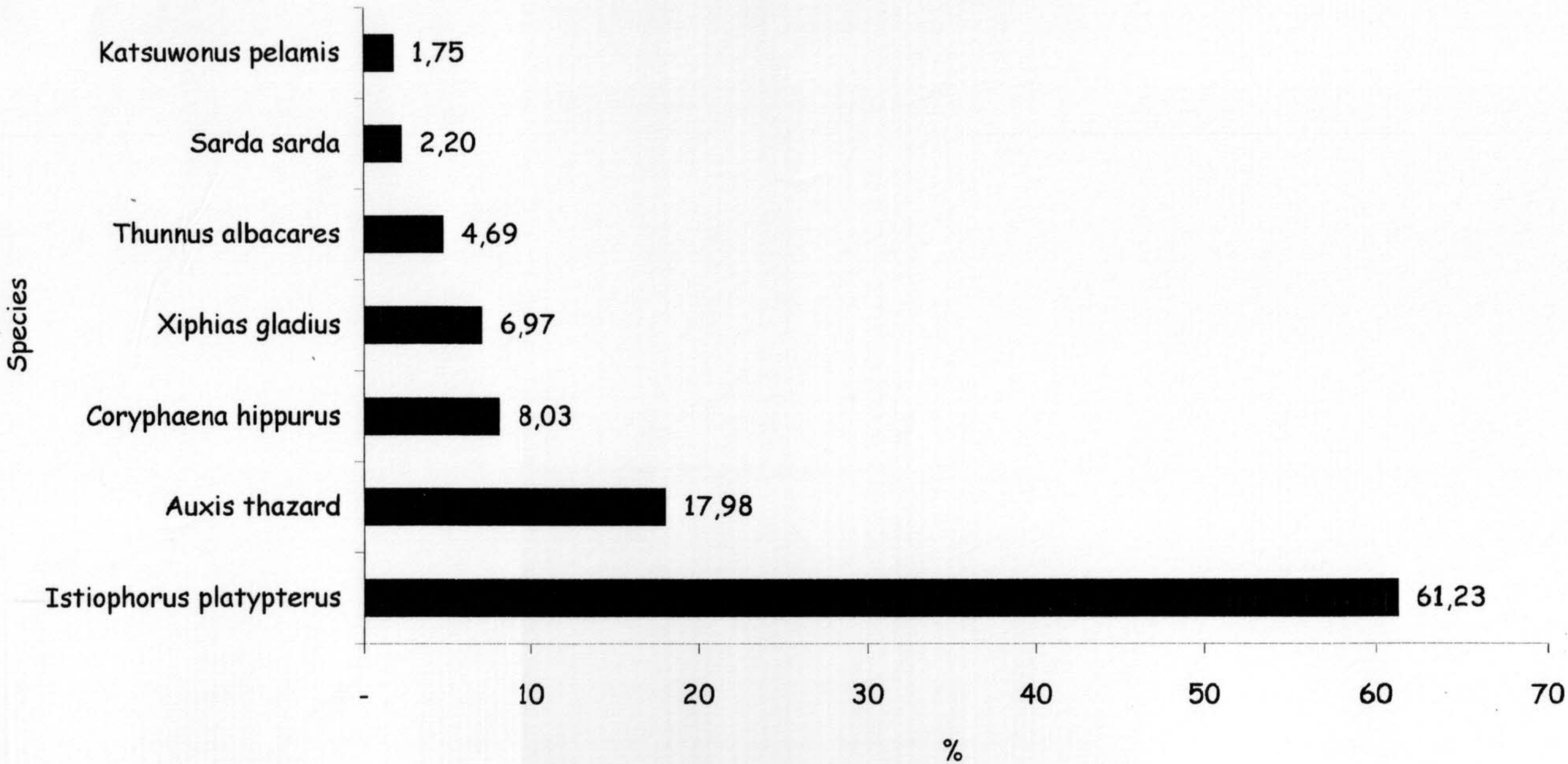


TABLE 3 - CATCH PER UNIT EFFORT (CPUE) FROM DRIFTNET FISHERY (INDIVIDUALS/KM). YEAR 1995.

MONTH	DRIFTNET LENGTH (M)	SPECIES	NUMBER OF INDIVIDUALS	CPUE (INDIV./Km)
JULY/AUGUST	7027	*Brama brama*	3	0,09
APRIL		*Carcharhinus longimanus*	1	
MARCH	1250	*Carcharhinus longimanus*	1	0,16
JULY	3000	*Carcharias taurus*	1	0,04
JULY/AUGUST	7027	*Coryphaena hippurus*	1	0,03
JULY/AUGUST	7027	*Delphinus delphis*	1	0,03
JULY/AUGUST	7027	*Istiophorus platypterus*	1	0,03
JULY	3000	*Isurus oxyrinchus*	5	0,21
MARCH	1250	*Isurus oxyrinchus*	1	0,16
JULY/AUGUST	7027	*Isurus oxyrinchus*	5	0,15
JULY	3294	*Isurus oxyrinchus*	6	0,11
JULY	3000	*Isurus oxyrinchus*	1	0,04
JULY	7027	*Isurus oxyrinchus*	2	0,02
APRIL		*Isurus oxyrinchus*	1	
JULY/AUGUST	7027	*Katsuwonus pelamis*	2	0,06
JULY/AUGUST	7027	*Lamna nasus*	1	0,03
APRIL		*Makaira nigricans*	1	
JULY/AUGUST	7027	*Mobula hypostoma*	4	0,12
JULY	3294	*Prionace glauca*	12	0,23
MARCH	1250	*Prionace glauca*	1	0,16
JULY	3000	*Prionace glauca*	3	0,13
JULY/AUGUST	7027	*Prionace glauca*	3	0,09
JULY	3000	*Prionace glauca*	1	0,04
MARCH	3920	*Prionace glauca*	1	0,03
APRIL		*Prionace glauca*	4	
JULY/AUGUST	7027	*Sarda sarda*	1	0,03
MAY	3250	*Sphyrna lewini*	270	13,85
MARCH	3920	*Sphyrna lewini*	257	6,56
MARCH	1250	*Sphyrna lewini*	36	5,76
MARCH	1800	*Sphyrna lewini*	152	5,63
MARCH	3294	*Sphyrna lewini*	206	3,91
JULY	3000	*Sphyrna lewini*	69	2,88
JULY	2862	*Sphyrna lewini*	70	2,72
MARCH	5800	*Sphyrna lewini*	140	2,01
JULY	3250	*Sphyrna lewini*	52	2,00
JULY	7027	*Sphyrna lewini*	251	1,98
JULY	2000	*Sphyrna lewini*	71	1,97
JULY	3294	*Sphyrna lewini*	93	1,76
JUNE/JULY	3294	*Sphyrna lewini*	93	1,76
MARCH	2700	*Sphyrna lewini*	51	1,57
MARCH	5000	*Sphyrna lewini*	100	1,33
JULY/AUGUST	7027	*Sphyrna lewini*	13	0,40
JULY	3000	*Sphyrna lewini*	2	0,07
APRIL		*Sphyrna lewini*	68	
JULY	3000	*Sphyrna zygaena*	30	1,25
MARCH	2700	*Tetrapturus albidus*	1	0,03
JULY/AUGUST	7027	*Thunus albacares*	1	0,03

AVERAGE (cpue)		
Sphyrna lewini	**WINTER**	**SUMMER**
indiv/Km	**1,7**	**3,82**

Figure 4 - Monthly CPUE trend (Ind./Km) for the Hammerhead Shark (*S. lewini*) caught by drifters in Southeast-South Brazilian coast. Period 1995-97

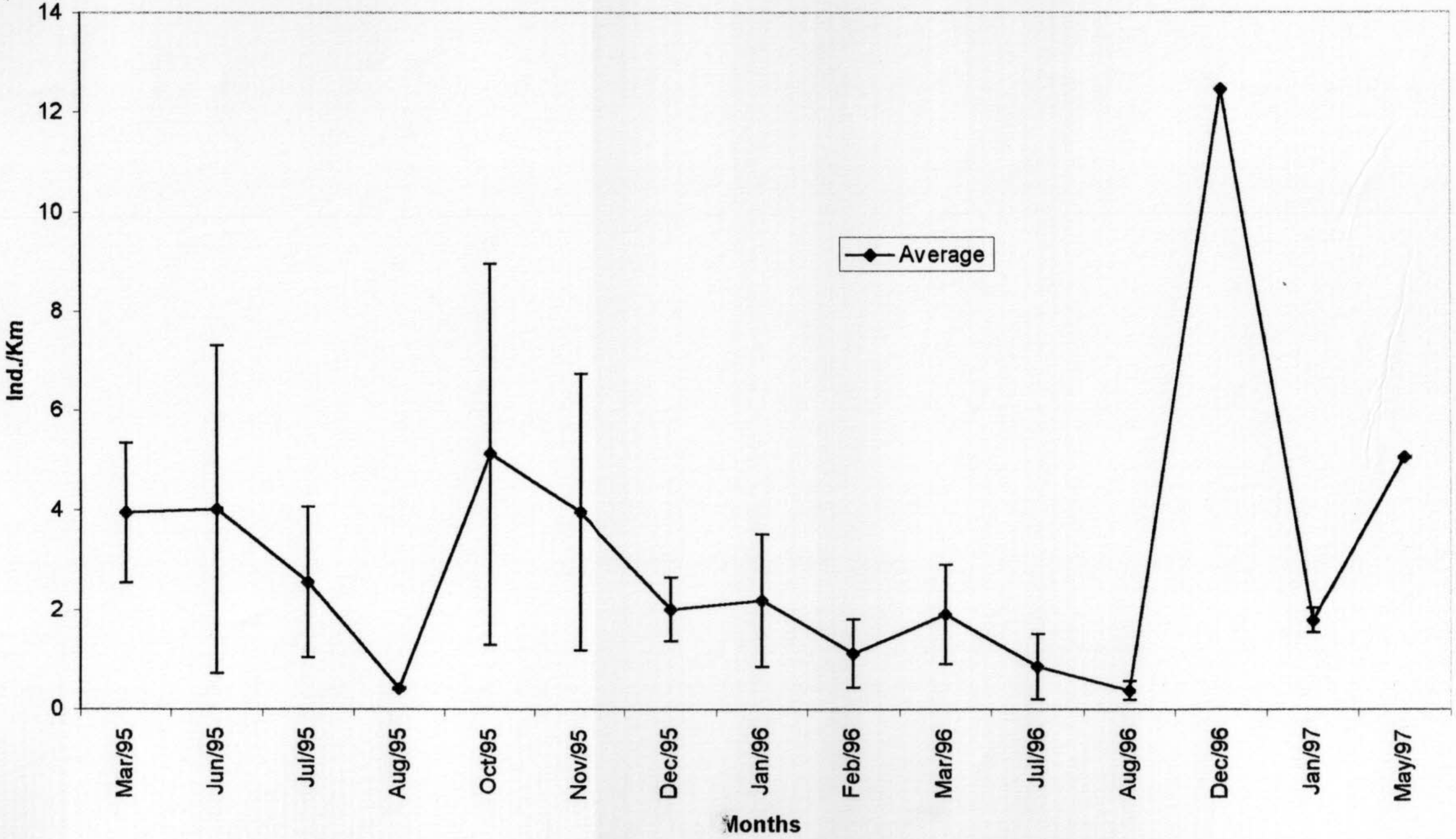
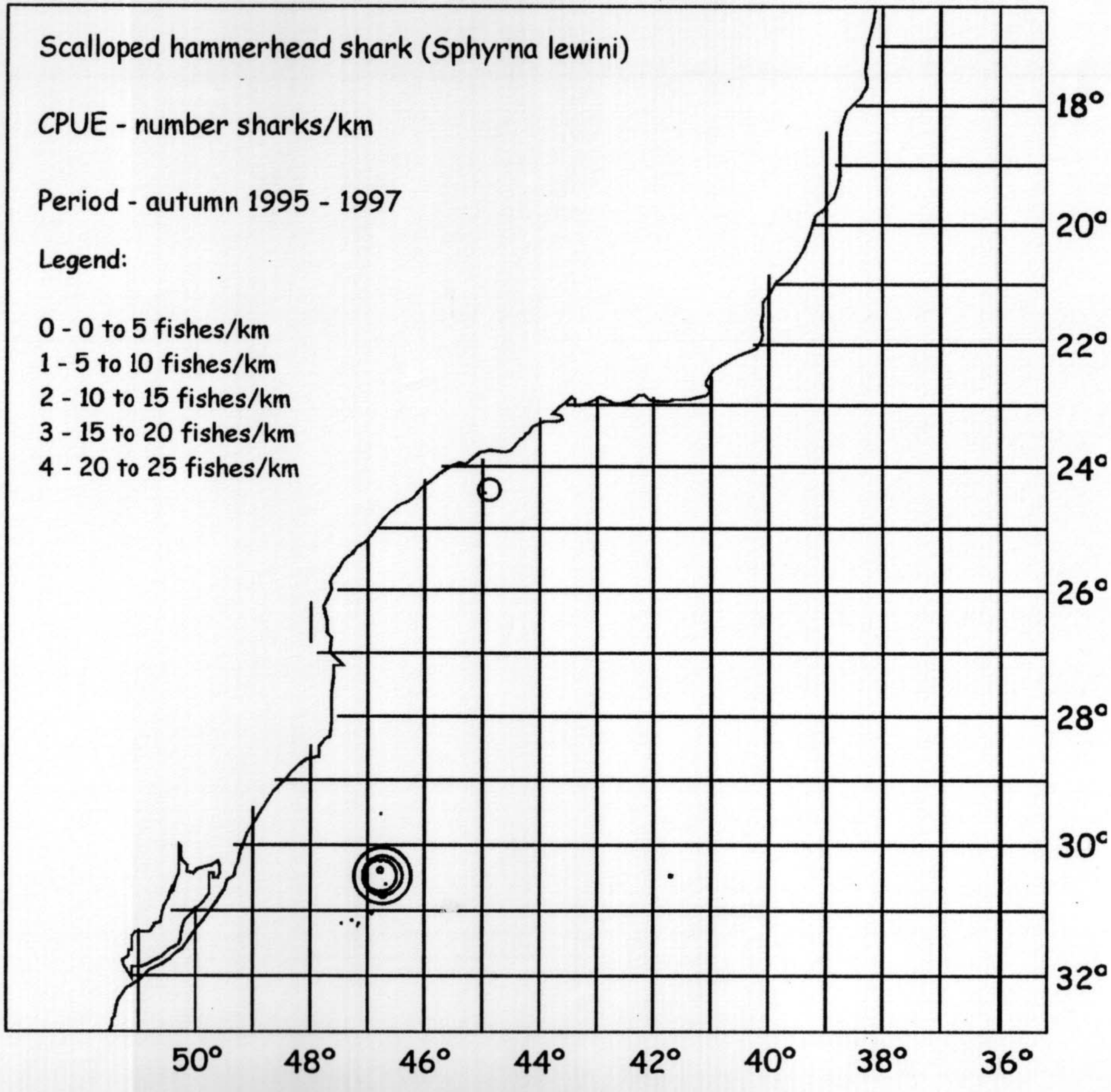


FIGURE 5



Scalloped hammerhead shark (Sphyrna lewini)
CPUE - number sharks/km
Period - autumn 1995 - 1997
Legend:
0 - 0 to 5 fishes/km
1 - 5 to 10 fishes/km
2 - 10 to 15 fishes/km
3 - 15 to 20 fishes/km
4 - 20 to 25 fishes/km
18°
20°
22°
24°
26°
28°
30°
32°
50°
48°
46°
44°
42°
40°
38°
36°

FIGURE 6

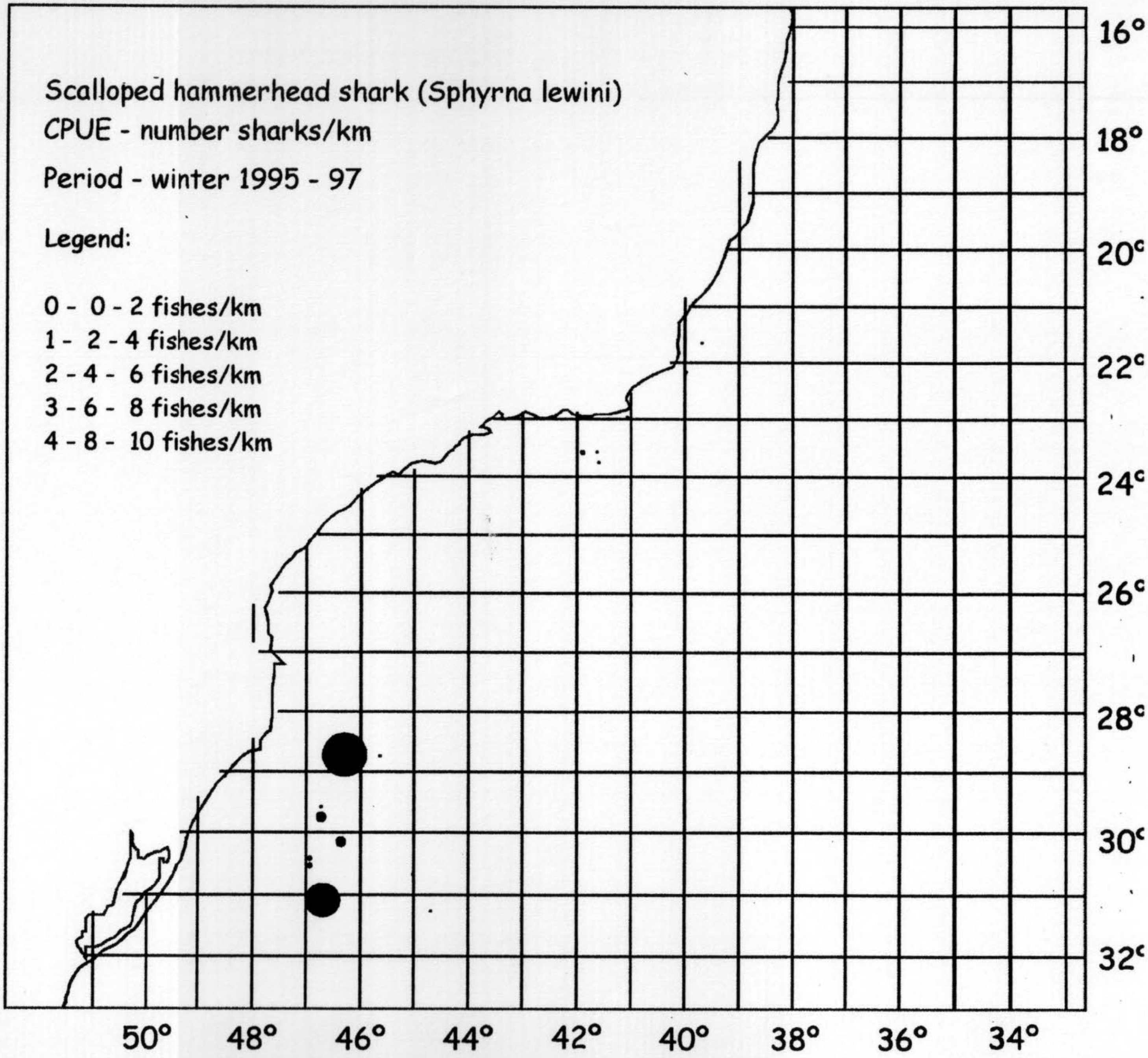

Scalloped hammerhead shark (Sphyrna lewini)
CPUE - number sharks/km
Period - winter 1995 - 97
Legend:
0 - 0 - 2 fishes/km
1 - 2 - 4 fishes/km
2 - 4 - 6 fishes/km
3 - 6 - 8 fishes/km
4 - 8 - 10 fishes/km
16°
18°
20°
22°
24°
26°
28°
30°
32°
50°
48°
46°
44°
42°
40°
38°
36°
34°

FIGURA 7

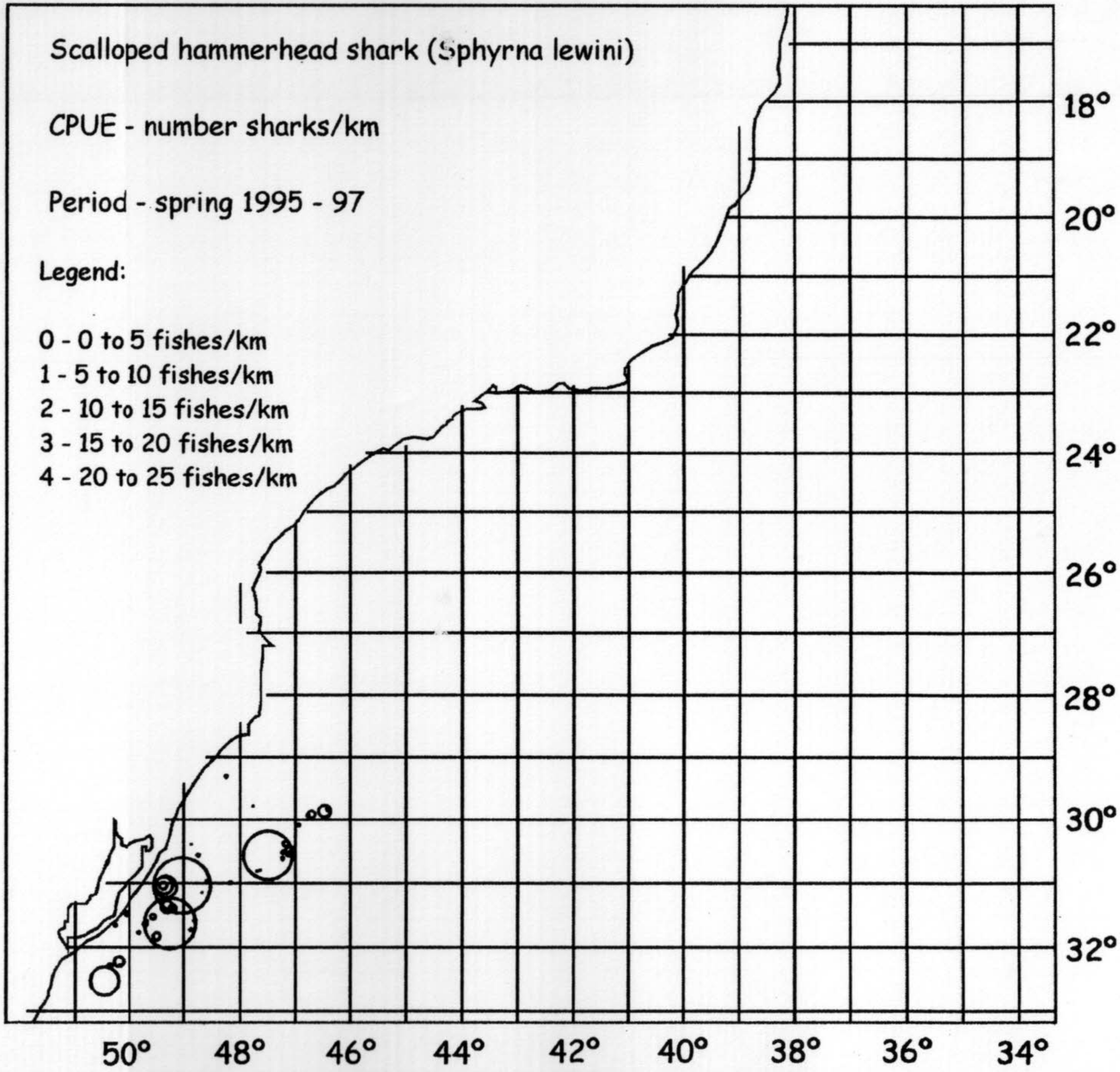
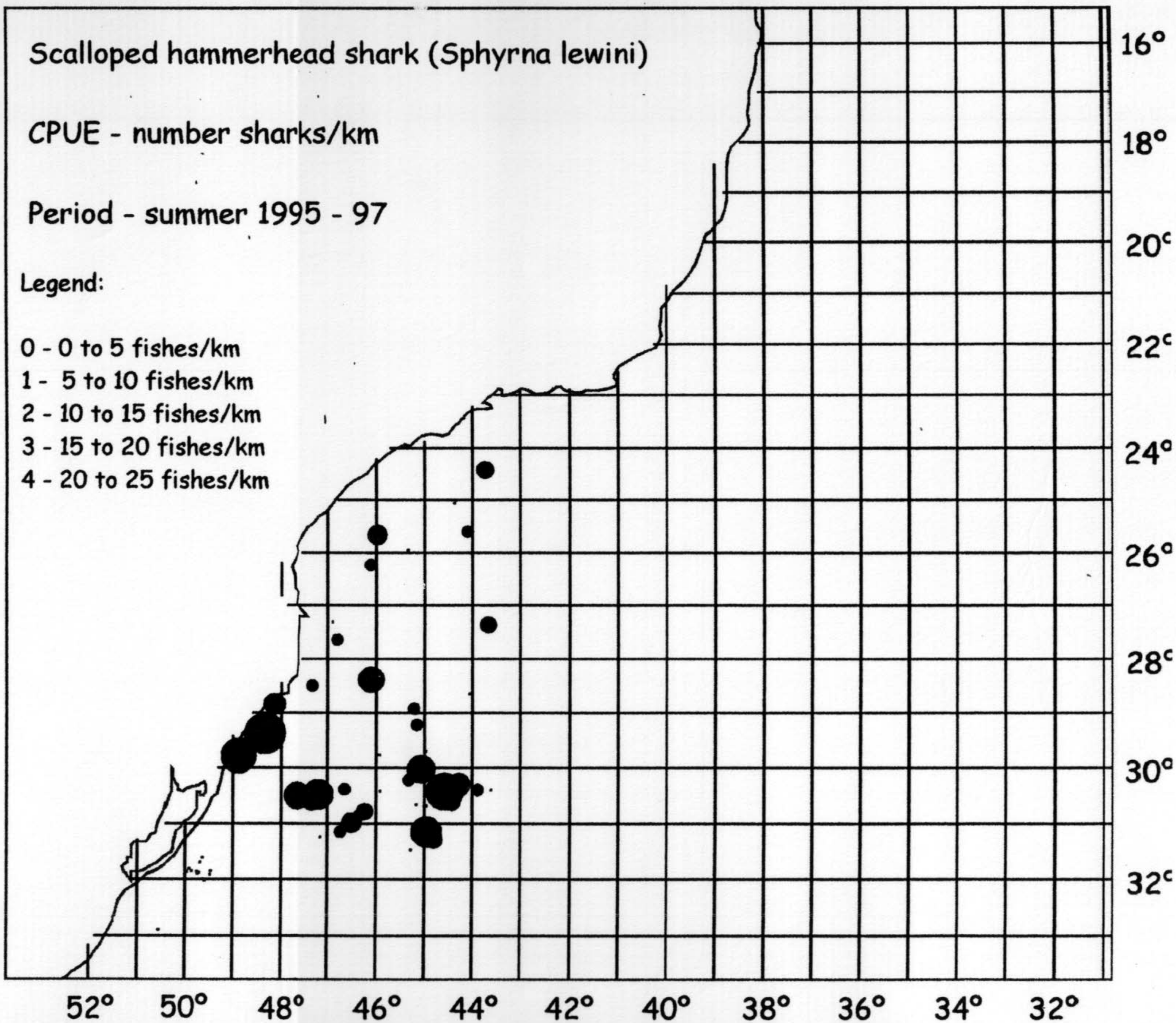

Scalloped hammerhead shark (Sphyrna lewini)
CPUE - number sharks/km
Period - spring 1995 - 97
Legend:
0 - 0 to 5 fishes/km
1 - 5 to 10 fishes/km
2 - 10 to 15 fishes/km
3 - 15 to 20 fishes/km
4 - 20 to 25 fishes/km
18°
20°
22°
24°
26°
28°
30°
32°
50°
48°
46°
44°
42°
40°
38°
36°
34°

FIGURE 8



Scalloped hammerhead shark (Sphyrna lewini)
CPUE - number sharks/km
Period - summer 1995 - 97
Legend:
0 - 0 to 5 fishes/km
1 - 5 to 10 fishes/km
2 - 10 to 15 fishes/km
3 - 15 to 20 fishes/km
4 - 20 to 25 fishes/km
16°
18°
20°
22°
24°
26°
28°
30°
32°
52°
50°
48°
46°
44°
42°
40°
38°
36°
34°
32°

FIGURE 9

Legend:

0 - 0 to 5 fishes/km
1 - 5 to 10 fishes/km
2 - 10 to 15 fishes/km
3 - 15 to 20 fishes/km
4 - 20 to 25 fishes/km