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Present state and perspectives for the southern Brazil shelf demersal fisheries

M. HAIMOVICI

Oceanography Department, University of Rio Grande, Rio Grande, Brazil

Abstract The demersal fish stocks in southern Brazil were assessed from landings and catch-per-unit effort data trends between 1975 and 1994, available information on the life history patterns, and population dynamics of the most important species. The fishing gears, mostly otter and pair bottom trawls in the 1970s, diversified towards double-rig trawls for fish and shrimp and bottom gill nets in the mid 1980s, and bottom longlines in the upper slope in the early 1990s. There were also some less successful attempts with traps for fish and crabs. The demersal fisheries are more intensive in winter when migratory species move northward, associated with the seasonal displacement of the western boundary of the Subtropical Convergence. Landings between 1975 and 1994 were mostly of sciaenid fishes (> 70%) and elasmobranchs (10%) and oscillated around 59 000 t. There was not a decrease in total landings but a shift from more to less exploited stocks. Since 1989, 4% of the landings came from depleted stocks of *Pagrus pagrus* (L.), *Netuma barba* (Lacépède), *Pogonias cromis* (L.) and *Rhinobatos horkelli* (Muller & Henle); 37% from overexploited stocks: *Micropogonias furnieri* (Desmarest), *Paralichthys patagonicus* Jordan, *Squatina guggenheim* Marini, and *Galeorhinus galeus* (L.); 24% from heavily exploited stocks of *Umbrina canosai* Berg, and *Macrodon ancylodon* (Bloch & Schneider); and 35% of *Cynoscion guatucupa* (Cuvier) and small stocks with unclear status. The demersal fisheries are virtually unmanaged and future landings are expected to decrease if fishing pressure remains high. Effective management will require the participation of all three countries in the region because most of the stocks fished in southern Brazil are shared with Uruguay and Argentina.

KEYWORDS: Brazil, demersal fisheries, sciaenid fishes, stock assessment.

Introduction

Until the end of the Second World War, only small-scale artisanal fishing with gillnets and beach seine occurred in southern Brazil (Fig. 1). Industrial marine fisheries started in 1947 with several otter and pair trawlers landing their catch at the port of Rio Grande (32°S). The fishery intensified in the late 1950s through pair trawlers landing in Santos (24°S) and further in 1968 when the fishing industry started to be subsidized. Up to 1974, the fishing grounds included the Uruguay and northern Argentina coastal shelf waters (Yesaki & Bager 1975). Since then, due to extension of territorial waters, all demersal fishing has been restricted to Brazilian waters, increasing greatly the fishing effort along the Rio Grande do Sul State (Haimovici, Vieira &

Correspondence: Dr M. Haimovici, Oceanography Department, University of Rio Grande, Cx. P. 474 Rio Grande, RS, 96201–900 Brazil (e-mail: docmhm@super.furg.br).

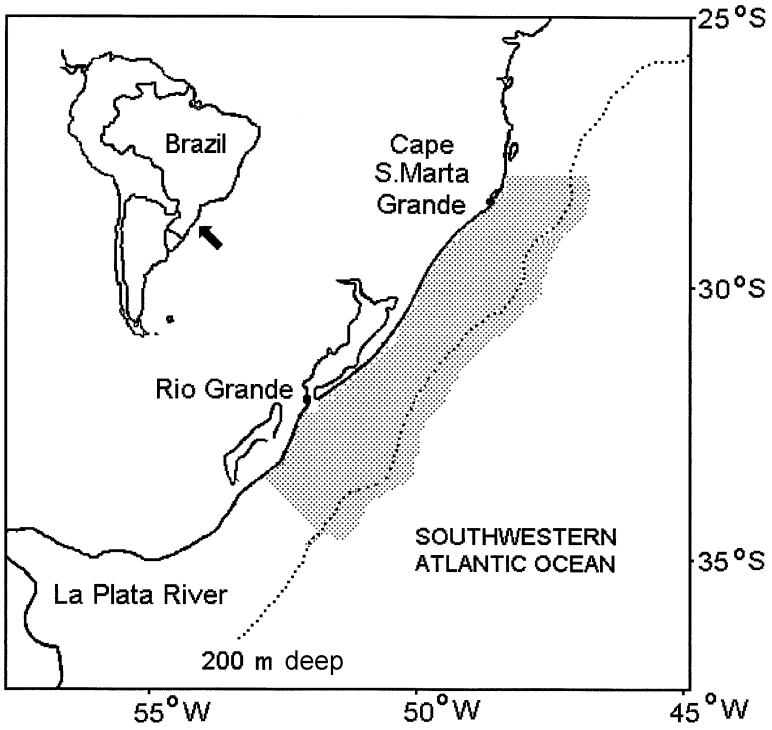

Figure 1. Demersal fishing grounds (shaded) in the continental shelf and slope of southern Brazil.

Pereira 1989). Based on the analysis of the landings and effort statistics, the life history and the population dynamics of the most important species, this paper describes the development of the demersal fisheries since 1975 and discusses its present state and future development.

Study area

Rio Grande do Sul is in the southernmost region of Brazil; the coastline is a 700 km long sandy beach that runs in the north-east–south-west direction with few distinct geographical features besides the mouth of the Los Patos Lagoon at 32°S, where the port of Rio Grande is situated (Fig. 1). The continental shelf and slope is about 100 000 km^2. The region is under the influence of the western boundary of the subtropical convergence current formed by the southern-flowing, oligotrophic Brazil current, which transports tropical water (temperature 20°C, salinity 36.00), and the coastal branch of the northward-flowing nutrient-rich Malvinas (Falkland) current, transporting subantarctic water (SAW) (temperature 4–15°C, salinity 33.60–34.15). Primary production rates are highest in late winter and spring over the southern central shelf because of the influence of the SAW and freshwater run-off from the Patos Lagoon and La Plata River. Integrated chlorophyll-*a* concentrations exceed 100 mg m^{-2} (Ciotti, Odebrecht, Fillmann & Möller 1995).

The slope of the shelf increases gently and its width attains 140 km at the Rio Grande latitude and narrows to the north (Fig. 1). The bottom changes from sand to muddy at increasing depths.

Beach rock patches run parallel in the 20–30 m depth range to the south of Rio Grande and in the outer shelf to the north. Relict ahermatipic corals occur all along the shelf break (170–200 m). Macrobenthic fauna is more abundant south of Rio Grande at 50–90 m depth (Capitoli 1997). Most of the shelf in the 10–100 m depth is adequate for trawling. To the north, and along all the outer shelf and upper slope, most fishing activities are carried out with bottom gill nets, bottom long lines and hand lines.

Materials and methods

Landing statistics and the number of boats from the demersal fishery in southern Brazil were obtained from published and unpublished reports by IBAMA (Brazilian National Environment and Fisheries Agency) and the Instituto de Pesca (Fisheries Institute of the State of São Paulo). Data on effort for the industrial fisheries landed in Rio Grande were collected in a dockside sampling programme by the Department of Oceaonography of the University of Rio Grande.

Results

Mean annual landings in four, 5-year intervals for the most important species in the demersal fisheries along Rio Grande do Sul (28°30′S – 34°40′S) and landed in different harbours are shown in Table 1, and mean annual landings by fishing gears are shown in Table 2.

The fish fauna

Over 150 teleost and 57 elasmobranch species were recorded in bottom trawl surveys from 1981 to 1987 (Haimovici, Martins, Figueiredo & Vieira 1994; Haimovici, Martins & Vieira 1996; Vooren 1997). Shelf surveys showed larger standing stocks of teleosts of commercial size in winter (about 120 000 t), but total standing stock, including juveniles larger than 10 cm, was higher in early summer (340 000 t). Croakers and weakfishes of the family Sciaenidae amounted to 80% of the teleost biomass (Haimovici *et al*. 1996). Estimated biomass of elasmobranchs ranged from 43 000 t in summer to 96 000 t in winter (Vooren 1997).

Seasonal changes in composition and abundance of the demersal fish fauna are induced by alternate influence of cold subantarctic water and tropical water currents over the shelf. This seasonality is also found in the shelf fisheries, which are more intense during winter, when a variety of commercially important species immigrate from the south, including the striped croaker, *Umbrina canosai*, the weakfish, *Cynoscion guatucupa* (Cuvier) (sin. *C. striatus*) and partly the croaker, *Micropogonias furnieri* (Desmarest), the red porgy, *Pagrus pagrus* (L.) and the school shark, *Galeorhinus galeus* (L.). Northward winter migrant fishes accounted for 70% of the landings (1975–1994), while species that perform only local movements, or are associated with tropical waters, represented only 30% of total landings (Haimovici *et al*. 1989; Vooren, Araujo & Betito 1990).

The Patos Lagoon estuary, adjacent coastal waters and shelf provide an adequate nursery ground for demersal bony fishes. Except for the mouthbreeding ariid catfish *Netuma barba* (Lacépède), all the abundant teleosts that spawn in the region show high fecundity and are

Table 1. Fishing pressure, stock abundance, present status of exploitation and mean annual landings by species or groups of species in the demersal fisheries along the shelf, southern Brazil 1975–1994 (see text for criteria)

Genus and species	Family	Fishing pressure	Stock abundance	Present status	Mean annual landings (t)			
					1975–79	1980–84	1985–89	1990–94
Micropogonias furnieri (Desmarest)	Sciaenidae	High	Reduced	Overexploited	14 308	14 904	12 364	14 709
Cynoscion guatucupa (Cuvier)	Sciaenidae	Moderate	Unknown	Unknown	6 439	7 377	9 572	8 785
Macrodon ancylodon (Bloch & Schneider)	Sciaenidae	High	Reduced	Intensely exploited	7 941	5 865	3 659	3 966
Umbrina canosai Berg	Sciaenidae	High	Reduced	Intensely exploited	16 900	14 877	11 732	9 629
Pogonias cromis (L.)	Sciaenidae	Low	Very reduced	Depleted	1 044	359	246	63
Netuma spp.	Aaridae	Low	Very reduced	Depleted	3 983	1 536	452	615
Merluccius hubbsi Marini	Merluccidae	Low	Unknown	Unknown	760	101	200	129
Paralichthys (2 species)	Bothidae	High	Unknown	Intensely exploited	424	417	1 486	1 363
Pagrus pagrus (L.)	Sparidae	Low	Very reduced	Depleted	1 419	327	294	238
Prionotus punctatus (Bloch)	Triglidae	High	Unknown	Unknown	12	71	486	988
Urophycis brasiliensis (Kaup)	Gadidae	High	Unknown	Unknown	241	337	665	1 186
Trichiurus lepturus L.	Trichiuridae	Moderate	Unknown	Unknown	75	79	63	441
Polyprion americanus (Schneider)[1]	Polyprionidae	High	Unknown	Unknown	152	68	145	176
Squatina (3 species)	Squatinidae	High	Very reduced	Overexploited	947	1 485	2 607	2 183
Rhinobatos horkeli (Müller & Henle)	Rhinobatidae	Moderate	Very reduced	Depleted	1 010	1 253	901	460
Demersal sharks[2]		High	Very reduced	Overexploited	1 637	2 486	3 754	3 748
Rays and skates[3]		High	Unknown	Unknown	116	461	718	746
Others (including crustaceans)					5 076	4 045	10 337	8 525

[1]Landings in Rio Grande.
[2]Mostly *Galeorhinus galeus* (L.) and *Mustelus schmitti* (Springer).
[3]Mostly discarded on board.

Table 2. Mean annual landings by fishing gears in the demersal fisheries along southern Brazil between 1975 and 1994. The States in which there were landings and the periods in which each gear fished are indicated (RS, Rio Grande do Sul; SC, Santa Catarina; SP, São Paulo; RJ, Rio de Janeiro)

Fishing gear	States and periods	Mean annual landings (t)			
		1975–79	1980–84	1985–89	1990–94
Artisanal fishery	RS, since 18th century	15 007	12 760	10 685	11 425
Pair trawl	RS, SC, SP, RJ, since 1947	32 056	33 951	32 051	29 137
Otter trawl (inner shelf)	RS, SC, SP, RJ, since 1948	15 237	9 160	10 055	2 708
Otter trawl (outer shelf)	RS, 1993–1994	–	–	–	4 362
Double-rig trawl	RS, SC, since 1985	–	–	–	3 216
Bottom gill net	RS, since 1989	–	–	–	5 355
Fish traps	RS, 1988–1992	–	–	–	106
Upper slope fishery[1]	RS, SC since 1973	231	82	321	168
Total demersal fisheries		62 485	56 047	59 682	57 952

[1]Handline, vertical longline and bottom longline fisheries (incomplete, see text).

multiple spawners over several months, with intraovarian egg counts that range from 10 000 to 10 million. There is a clear spatial partitioning of the nursery habitats of the bottom-feeding croakers, *U. canosai* Beg, and *M. furnieri*, and the water-column-feeding weakfishes, *M. ancylodon* (Bloch and Schneider) and *C. guatucupa* (Table 3). These two pairs of species are the most abundant sciaenids in the region and have overlapping food habits (Vazzoler 1975).

Demersal fisheries

Between 1975 and 1994, total annual landed catches along southern Brazil averaged 72 200 t. Most fishing was in coastal and shelf waters on demersal teleosts (71%), demersal elasmobranchs (8%) and crustaceans (5.3%), while pelagic shelf teleosts (10%), and pelagic oceanic fish (4%) were far less important. Trawl net (61%) and gill net (19%) fishing accounted for most of the catch, whilst the rest was caught by purse seines (10%), traps (4.5%), and hooks (4%) (Haimovici, Castello & Vooren 1997).

Fisheries along southern Brazil involve about 9000 participants, two thirds in estuarine and small-scale coastal fisheries and the remainder in the industrial fisheries. The number of boats fishing demersal marine fisheries was estimated, in recent years, at around 400. Of these, 150 are wood fishing boats measuring up to 15 m long, powered by 150 hp engines, in the small-scale artisanal fleet, that fish mostly with gill nets in coastal waters at depths of less than 40 m (Reis, Vieira & Duarte 1994). The rest belong to the industrial fleet, are larger wood or steel boats, between 20 and 35 m long, with 250 to 650 hp (usually under 450 hp). Most fishing on the continental shelfs is with otter, pair and double-rig trawls and bottom gillnets (Table 2). A few boats fish along the shelf break and upper slope with bottom longlines, vertical longlines and handlines (IBAMA 1995). In all these boats, the catch is held in holds between layers of crushed ice (Haimovici *et al*. 1989).

Pair and otter trawlers fish mainly the sciaenids, *U. canosai*, *C. guatucupa*, *M. ancylodon*, and *M. furnieri*, which represent about 80% of total demersal landing. Catch and effort data

Table 3. Reproductive characteristics of commercially important demersal fish stocks in southern Brazil. Sources summarized in Haimovici (1997; teleosts) and Vooren (1992, 1997; elasmobranchs). First maturity (1°mat), fecundity in number of intraovarian maturing eggs or mean number of intrauterine developing embryos

Genus and species	Ages (years)		Total length (cm)		Annual fecundity	Reproduction season	Habitat of juveniles
	1°mat	max	1°mat	max			
Micropogonias furnieri (Desmarest)	2 to 3	> 35	35	70	$> 10^6$	Spring to summer	Estuarine and coastal
Cynoscion guatucupa (Cuvier)	3 to 4	> 15	32	55	$> 10^5$	Autumn and spring	Shelf 25–180 m
Macrodon ancylodon (Bloch & Schneider)	1 to 2	> 10	23	45	$> 10^5$	Spring to summer	Coastal
Umbrina canosai Berg	1 to 2	> 20	18	40	$> 10^5$	Winter to spring	Shelf 40–180 m
Netuma barba (Lacépède)	> 7	> 30	45	80	$< 10^2$	Spring	Estuarine
Pogonias cromis (L.)	> 5	> 50	80	140	$> 10^7$	Spring to summer	Estuarine
Paralichthys patagonicus Jordan			35	65	$> 10^5$	Spring to summer	Estuarine
Pagrus pagrus (L.)	> 3	> 15	25	50	$> 10^5$	Spring	Shelf
Trichiurus lepturus L.			70	130	$> 10^4$	Year round	Shelf
Polyprion americanus (Schneider)			80	140	$> 10^6$	Winter to spring	Unknown
Galeorhinus galeus (L.)	> 15	> 26	120	150	7.23	Summer	Lat. 35°S
Mustelus schmitti (Springer)	> 6	> 11	60	> 90	6.00	Summer	Lat. 35°S
Squatina occulta (Vooren & Silva)			110	129	3.50	Summer	Unknown
Squatina guggenheim Marini			75	87	2.80	Summer	Coastal
Rhinobatos horkeli (Müller & Henle)	> 7	> 11	110	127	6.00	Summer	Coastal

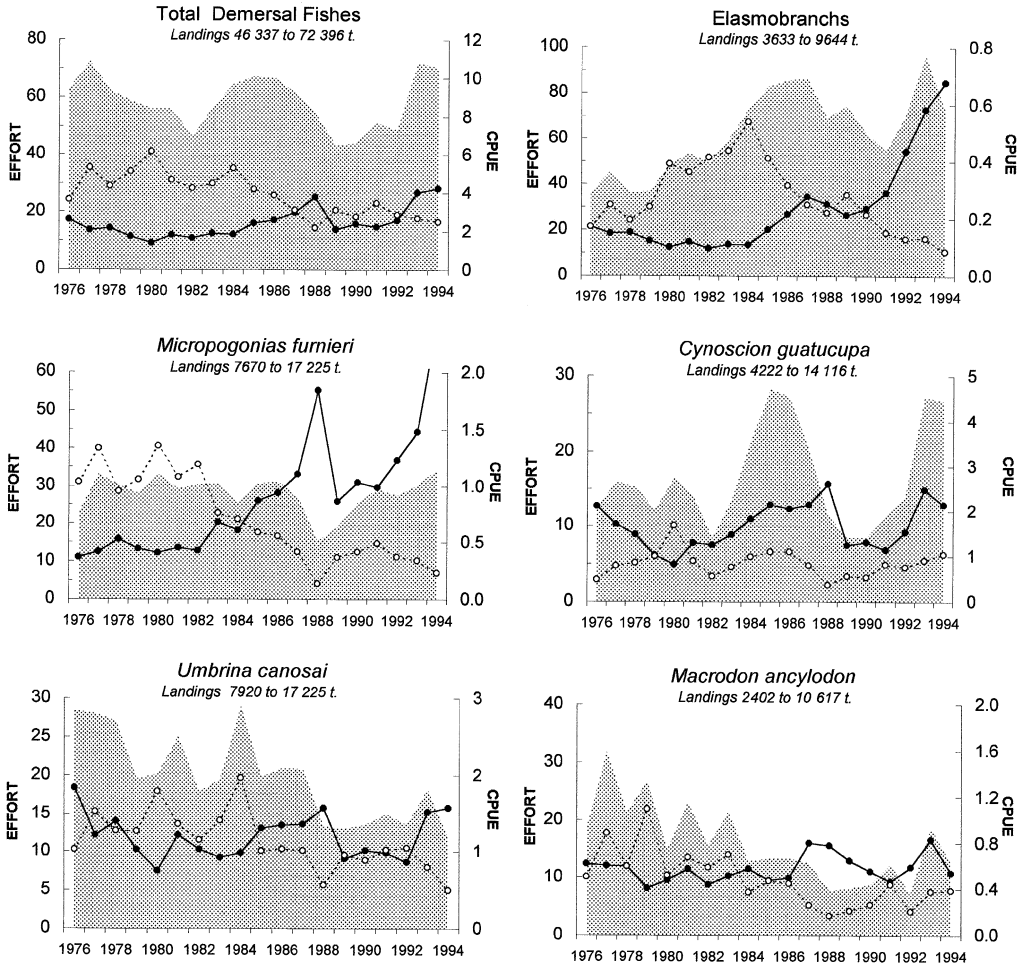

Figure 2. Annual landings (shaded areas), catch-per-unit-effort (CPUE, tonnes per day at sea) of pair trawlers (open circles, right-side scale) and total effort in thousands of days at sea of pair trawlers (filled circles, left-side scale) of all species, elasmobranchs and the most important bony fishes in the demersal fisheries on the continental shelf of southern Brazil.

from this fishery are available for 1975–1994 (Fig. 2) and show a decrease in total catches per day at sea. This is a minimum estimate for the decrease because, despite little changes in the sizes, engines and gear, the fishing power has increased to an unknown degree owing to developments in navigation and fish-finding equipment.

Double-rig trawling with twin nets targeting shrimp and demersal fishes was introduced in southern Brazil in 1985. The shrimps, *Artemesia longinaris* Bate and *Pleoticus muelleri* (Bate), are fished in shallow waters in spring and summer, the flatfish, *Paralichthys patagonicus* Jordan, is fished at 20–80 m depth between autumn and spring and three species of angel shark of the genus *Squatina* are fished on the outer shelf at down to 140 m depth. Double-rig trawlers landed about 30% of the total elasmobranch catches in 1989–1990, but their contribution has decreased to less than 5% since 1992 (Haimovici & Mendonça 1996a).

Onboard discards by pair and otter trawling of small demersal fishes and elasmobranchs, in a series of trips monitored from 1978 to 1980, varied between 26 and 46% (Haimovici & Palacios Maciera 1981). In 1992 and 1993, discards from double-rig trawling for fish were around 50%, and from shrimp fishing around 20% (Haimovici & Mendonça 1996b). Projection of these rates led to estimates of total annual discards ranging from 17 000 to 25 000 t in recent years.

Two licensed Japanese vessels, fishing with traps, caught 1471 t of red crab, *Chaceon notialis* Manning & Holthuis, at depths greater than 400 m from December 1984 to June 1985, but the fishery was abandoned owing to a marked decrease in yields (Lima & Branco 1991). Fishing with traps along the outer shelf was also intended for red porgy, *Pagrus pagrus*, between 1987 and 1992, but mean annual yields of 106 t were too low to sustain the fishery.

Four larger trawlers (49–52 m, 1200 hp) were licensed to fish over the outer shelf and upper slope and landed 3947 t in 1993 and 4777 t in 1994. Catches included sharks and rays (31%) and sciaenids (20%), which were already intensely exploited, and the cutlassfish, *Trichiurus lepturus* (L.) (24%), which was discarded by the inner shelf trawl fishery.

Since 1973, a handline fishery for the wreckfish, *Polyprion americanus* (Schneider), from rowing boats operating during daytime from larger fishing boats, developed over hard bottoms of the upper slope. In the early 1990s this fishing technique was gradually substituted by vertical longlines, bottom gill nets, and bottom longlines. Statistics for this fishery are incomplete, but landings amounted to over 1000 t annually. Individual fishing grounds were abandoned after intense fishing and recovered only after several years.

Gill netting at depths between 50 and 200 m has developed since 1989 and has become the main fishing method for demersal shark (IBAMA 1995). Between 1990 and 1994, mean annual catches were 5354 t (Table 2).

Demersal fish stocks

Micropogonias furnieri. The white croaker is the most important coastal demersal fish in the region (Table 1). Although annual catches reached over 14 000 t in recent years, the species is considered to be overfished in southern Brazil. Two spawning groups co-occur in the region, one near the Patos Lagoon inlet (32°S) and another that spawns further south (> 34°S) (Haimovici & Umpierre 1996). The first has been heavily exploited by gill net and trawl fisheries for more than two decades (Reis *et al*. 1992). Declining CPUE and sharply increasing fishing effort (Fig. 2), changes in the age structure (Schwingel & Castello 1990; Haimovici & Umpierre 1996) and a drastic decrease in the density of juveniles in coastal waters between 1980 and 1990 (Ruffino & Castello 1992) are evidence that catches are not sustainable at the present level.

Umbrina canosai. The striped croaker rarely attains more than 40 cm total length and has a slow growth and low natural mortality (Haimovici 1988a). It is heavily fished along the southern Brazil coast and to a lesser extent along Uruguay and northern Argentina. Landings of this species reached 19 000 t in the late 1970s, but have gradually decreased to round 10 000 t since 1987 (Fig. 2, Table 2). Biomass, estimated from cohort analysis, decreased from 75 000 t in 1976 to about 37 000 in 1983 (Haimovici 1988a). In contrast to the white croaker, the age

structure of the striped croaker has not changed in recent years (Haimovici, unpublished data). Fishing effort of otter and pair trawlers did not increase in the last decade (IBAMA 1995; Fig. 2). Landings are not expected to decrease if fishing effort remains at the same level.

Cynoscion guatucupa. Following the shift of the subtropical convergence current, adults of a single stock of striped weakfish migrate northward during the colder months from Uruguay and Argentina to the southern Brazil shelf. Landings from local catches represented only 30% of the total catches from the stock and fluctuated between 4000 t (1975 and 1988) and 14 000 t (1986 and 1994). These variations probably reflect inter-annual differences in availability to Brazilian trawlers, because the CPUE displays similar oscillations (Fig. 2).

Macrodon ancylodon. A single stock of royal weakfish occurs between 29°S and 34°S (Yamaguti 1979) and has been exploited since the 1950s, with a maximum catch of 10 617 t in 1977. Landings decreased to less than 3000 t in 1992 but showed an increase over the last 2 years (Fig. 2). Although maximum age may reach 12 years (Yamaguti 1968), age classes above 6 years have been absent since the 1970s (Haimovici 1988b). Landings, effort and CPUE fluctuated in the last decade (Fig. 2) and mean exploitation rate was estimated to be around 0.5 (J. Kotas, unpublished data). Thus future yields are expected to be maintained if the effort is kept at the same level.

Pagrus pagrus. The red porgy was overexploited by trawl fishing in the outer shelf during the 1970s (Haimovici *et al*. 1989) and the fishery did not recover despite the fishing effort in that area being reduced for the following 15 years (Table 1).

Paralichthys spp. Double-rig trawling in recent years resulted in considerable total landings of the flatfishes *P. patagonicus* and *P. orbignyianus* (Valenciennes). They reached a maximum of 2157 t in 1990 but decreased thereafter.

Prionotus punctatus (Bloch) and *Urophycis brasiliensis* (Kaup). Double-rig trawling increased annual mean landings of these species to 986 t and 1186 t respectively since 1990. As they were not found to be abundant in bottom-trawl surveys (Haimovici *et al*. 1996), their fishing potential seems to be limited.

Pogonias cromis. The black croaker is a large, long-lived sciaenid that migrates in spring into coastal lagoons and was heavily exploited by the artisanal gillnet fishery during the 1970s in the Patos Lagoon estuary. The stock was gradually reduced, and mean annual landings decreased from 1044 to 63 t (Table 1).

Netuma barba and *N. planifrons* (Higuchi, Reis & Araujo). These two catfishes are long-lived mouthbrooders which use the Patos Lagoon estuary along their annual reproductive migrations (Reis 1986). They have been heavily exploited by the artisanal gillnet fishery during the 1970s and almost collapsed after 1980 (Reis *et al*. 1994). Both species suffered severe recruitment overfishing as a result of their very low fecundity.

Elasmobranchs. Landing statistics of elasmobranchs are recorded in four categories: sharks, angel sharks, guitar fish and rays (Vooren *et al*. 1990) (Table 1). Demersal shark landings include mainly school shark, *Galeorhinus galeus*, which were less frequent in recent years, and the smaller *Mustelus schmitti* (Springer) that was formerly discarded. Both are northward winter migrants that spawn somewhere southward in summer (Vooren 1992). Catches of angel sharks consist mainly of *Squatina guggenheim* Marini, which inhabits the inner shelf at depths down to 80 m, and *S. occulta* (Vooren & Silva), which is more abundant on the outer shelf and

the slope down to 350 m. Since the mid 1980s, angel sharks have been intensely fished by double-rig trawlers and industrial gillnetting. Annual catches reached over 2000 t. The stock of the guitar fish, *Rhinobatos horkeli*, was much reduced in the 1980s by beach seining and pair trawling over its breeding grounds in inshore shallow waters in the summer months where it concentrates to breed. Pooled landings of elasmobranchs showed an increasing trend up to 1987 and after some years of smaller landings, a sharp increase was observed in 1992 and 1993, owing to intense gillnet fishing. Despite increasing landings, the catches per day at sea by pair trawlers have decreased since 1985 (Fig. 2). Catches of long-lived and low-fecundity elasmobranchs are not sustainable. The school shark and the guitar shark already show severe recruitment overfishing and the angel sharks are expected to follow. As fishing pressure was very high in recent years (Fig. 2), even with a decrease in the fishing, yields are expected to decrease in the near future (IBAMA 1995).

Discussion

Over the last 20 years, total landings of the demersal fisheries in southern Brazil fluctuated between 46 000 t and 75 000 t (mean 59 000 t). Part of this inter-annual variability may be explained by changes in the accessibility of the Brazilian fleet to the winter northward migrant fishes. This is well illustrated by *Cynoscion guatucupa*, for which landings and CPUE follow the same oscillations as total landings (Fig. 2).

Between 1976 and 1994, recorded landings remained relatively high, despite the stocks that contribute more to the demersal fishery showing a decreasing trend (Fig. 2). This may be explained by a combination of factors: (1) continued intensive fishing on the stocks of the most abundant sciaenids; (2) landing of formerly discarded sizes and species; (3) the development of the marine shrimp fishery and more efficient methods to catch flatfishes with double-rig trawls; and (4) expansion of the gillnet fishery to the outer shelf targeting elasmobranchs, a region formerly subjected to little fishing effort.

By 1995, the shelf and upper slope were subjected to a high level of fishing pressure by diverse gears. Stocks were grouped in four categories according to the trends in the landings, CPUE and the present knowledge of their life history and population dynamics summarized in Tables 1 and 3.

Stocks of *Netuma barba*, *Rhinobatos horkeli*, *Galeorhinus galeus*, *Pogonias cromis* and *Pagrus pagrus* are considered to be depleted. Annual landings of these five species reached 9000 t in the late 1970s and decreased to less than 1500 t in the 1990s. All these are long-lived species and the first three have very low fecundity. These stocks have no chances of recovery in the near future.

The stocks of *Micropogonias furnieri*, *Paralichthys patagonicus*, elasmobranchs (*Squatina* spp.) and *Mustelus schmitti* still yielded high landings: 21 500 t annually between 1990 and 1994, but falling CPUE are signals of rapid decrease of the abundance and a possible near future sharp decrease in the landings.

Umbrina canosai and *Macrodon ancylodon* yielded 24 800 t annually in the late 1970s and around 13 600 t in the last years. Despite intense exploitation, both landings and the age structure of the catches have not changed much in the last decade. Landings are expected to

remain at the same level if pair trawlers' fishing effort does not increase, unless the Uruguayan and Argentinian trawlers start targeting the striped croaker.

All other demersal species yielded around 20 000 t in recent years. These include *Cynoscion guatucupa*, *Urophycis brasiliensis*, *Prionotus punctatus*, *Trichiurus lepturus* and marine shrimp for which no consistent trends in CPUE were observed. No important increase in the landings of these species is foreseen, with the possible exception of the cutlassfish, *T. lepturus*, if on board preservation problems are resolved.

Early estimates of a potential yield of demersal fishes of over 100 000 t based on bottom-trawl surveys in the early 1970s off southern Brazil (28°S–34°S) by Yesaki, Rahn & Silva (1976) were optimistic. More recently, in 1986 and 1987, Vooren, Haimovici, Vieira, Duarte & Ferreira (1988) did not find important fishing stocks between 120 and 500 m in bottom-trawl surveys. Therefore, except for small stocks lightly exploited on irregular sea bottoms, there are no unexplored demersal resources that could enhance the landings. This analysis suggests that yields will decrease in the near future, independent of the management strategy that may be adopted in southern Brazil. The recovery of the demersal stocks will require fishing effort to be kept low for several years. This is particularly difficult for migratory stocks shared with Uruguay and Argentina, as there is no international fishery management forum involving the three countries.

Studies emphasizing the high level of discards, small mesh sizes and excessive effort were available to the managers (Haimovici & Palacios Maciera 1981; Vooren 1983; Haimovici *et al*. 1989; IBAMA 1995) and scientific advice resulted in the regulation of larger mesh sizes in the cod ends of the nets and the suspension of licences for new boats in the trawl fishery. These regulations were not enforced and the fishery may be considered to be virtually unmanaged.

Diverse factors may explain the lack of social pressure for effective management of the southern Brazil demersal fisheries, among them the low degree of organization, the conflicting interests involved in the fishery (fishermen, fishing boat owners, processing industry, etc.), and the relatively small importance of the fishing industry, compared with other sectors of the economy. This situation is unlikely to change in the near future, thus, only a marked reduction in the catch-per-unit effort can lead to a decrease in the total effort.

Effective management requires a control on the number of fishing boats with each gear, minimum cod end mesh sizes for the trawl nets and seasons or areas closed to fishing. Detailed landing and effort statistics and a better knowledge of stocks boundaries are necessary. International cooperation in research and management between the three countries in the region is essential because many of the stocks fished in southern Brazil are shared with Uruguay and Argentina.

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