PREFACE

This National Report is based on the results of the study completed by the UNEP/GEF consultant into *Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand*, with the title "*Fish Stocks and Habitats of Regional, Global and Transboundary Significance in the South China Sea - Indonesia*".

The review is based on previous studies, secondary data, and information gained from a number of linked institutions as previously agreed by the RWG-F.

The Editorial Team would like to thank: (i) the Director of Fisheries Resources, Directorate General of Capture Fisheries as the Fisheries Focal Point for his support to the team in finishing the report; (ii) the National Committee of Fisheries and other linked institutions that have provided valuable inputs and other assistance so that we could complete this National Profile on fisheries together.

Finally, we hope that this report may be useful as a source of information regarding Indonesian fisheries for interested parties.

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1. BACKGROUND

1.1 Overview of the Fisheries Sector

The objectives of capture fisheries management in Indonesia are to improve the welfare of the fishers, conserve fisheries resources and their environments, and increase foreign exchange earnings. The fisheries sector not only plays an important role in providing food for the nation, it also serves as a source of employment, income, and foreign exchange.

Small-scale fisheries play a dominant role in contributing fish for the domestic market or local consumption. On the other hand, landings for export are mostly derived from semi-industrial fisheries. Most inshore fish resources have been more intensively exploited than those offshore have.

Accordingly, fisheries in the South China Sea waters of Indonesia require sound management aimed at rebuilding resources and sustaining marine and coastal ecosystem integrity. The central and provincial governments have established a number of fisheries regulations, although they need to be implemented more vigorously. In managing the country's fisheries, the Code of Conduct for Responsible Fisheries has been used as a prime reference by government.

Over the 10-year period from 1991 to 2001, Indonesian fisheries have demonstrated slight increases in landings and their contribution to the national economy. Fish production from both capture fisheries and aquaculture in the South China Sea area increased at an average of 4.47% per annum during the period. Marine capture fisheries increased as much as 2.05% per annum. Fish landings for export of tunas and shrimps increased by an average of 8.49% and 5.48% per annum, respectively. During the same period, the contribution of fisheries to GDP increased at an average of 4.27% per annum.

1.1.1 Total catch by fishing area, port of landing or province (by species/species group)

During the last 10 years, Indonesia's landings of marine fishes from the South China Sea and its adjacent waters, as part of the Sunda Shelf, have increased at an average of 2.05% per annum. It is surprising that during the same period, landings of skipjack tuna increased by more than 20%. So far, landings of other tunas have been variable, decreasing slightly from 1997 to 1998, followed by slight increases in recent times.

There are a number of landing places for the fleet fishing in the South China Sea, namely those located on the Island of Sumatra (Provinces of Riau, Jambi, South Sumatra and Bangka Belitung) and Kalimantan (Province of West Kalimantan). Figures 1 provides a map of Indonesian waters, whilst Figure 2 shows the Indonesian provinces that border the South China Sea. On average, fish landings in each province are approximately 200,000 tonnes per year, except in Jambi where landings are rarely more than 50,000 tonnes in a year.

Growth in total marine landings from the South China Sea accelerated from 1991 to 2000, although declined to approximately 0.5 million tonnes in 2001. In 2001, the total marine landings of 516,671 tonnes consisted of 40.27% (208,080 tonnes) demersal fishes, 31.15% (160,944 tonnes) pelagic fishes, 18.73% (96,783 tonnes) crustaceans, 6.13% (31,653 tonnes) molluscs, and 0.24% (1,237 tonnes) miscellaneous species or groups. Table 1 presents the landings of each group from the South China Sea from 1991 to 2001. Note that the catch of demersal fish levelled off since 1996. Similarly, the catch of pelagic fishes was stable from 1996 to 1999. Landings of demersal fish declined from 2000 to 2001. In light of increased levels of fishing effort, these catch trends indicate overfishing, especially for demersal fish stocks.

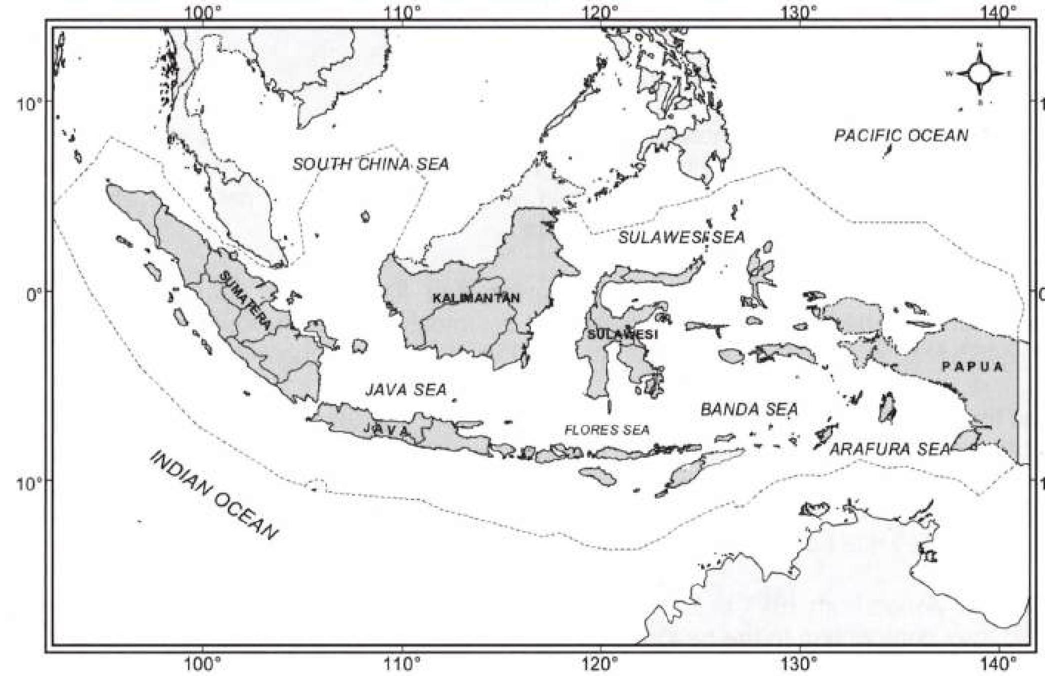

Figure 1 Map of Indonesian Waters, including the South China Sea, Java Sea, Flores Sea, Sulawesi Sea, Pacific Ocean, Banda Sea, Arafura Sea, and Indian Ocean.

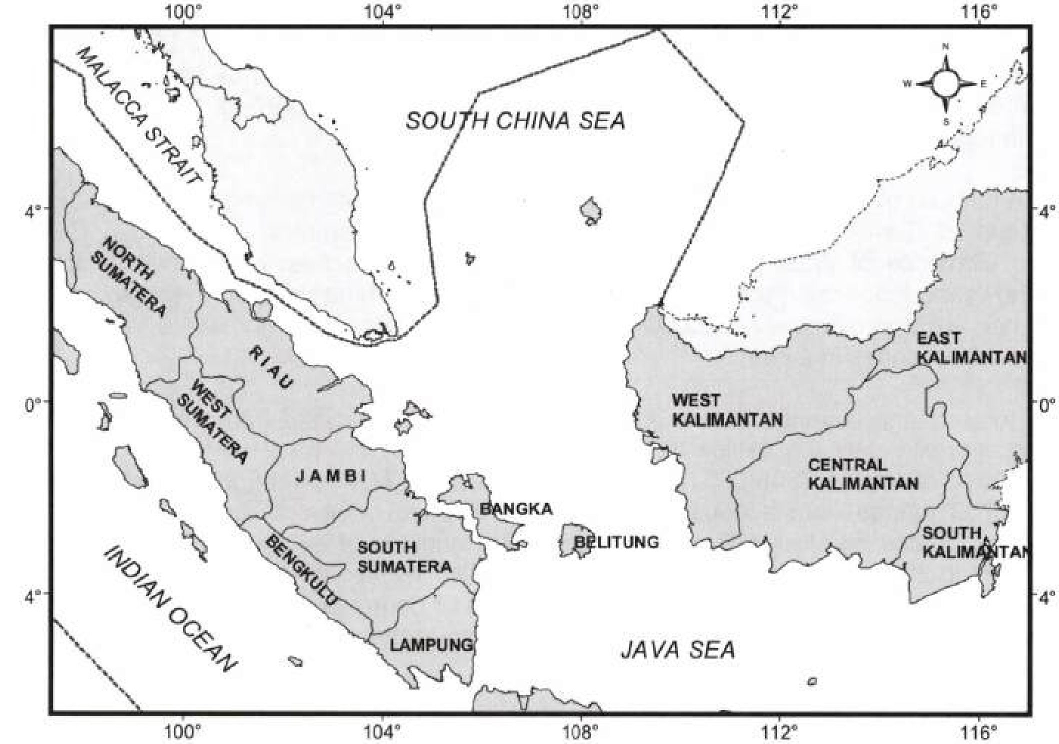

Figure 2 Indonesian provinces bordering the South China Sea, including the provinces of Riau, Jambi, South Sumatra, Bangka-Belitung, and West Kalimantan.

Table 1 Total landings of fish groups in the South China Sea from 1991 to 2001 (tonnes).

Category	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Demersal	377,760	404,995	417,069	426,244	462,487	510,777	529,461	526,491	566,019	668,992	208,080
Pelagic	749,593	803,873	827,928	846,208	918,877	1,014,588	1,050,817	1,044,774	1,123,784	1,332,128	160,944
Crustaceans	27,907	29,257	29,237	30,966	30,640	32,487	41,865	51,704	45,800	51,224	96,783
Molluscs	11,679	12,566	15,597	14,687	18,494	16,626	20,231	15,797	22,432	25,793	31,653
Other	0	3,280	2,361	472	1,261	1,334	262	0	0	23	1,237
Total	**1,166,939**	**1,253,971**	**1,292,192**	**1,318,577**	**1,431,759**	**1,575,812**	**1,642,636**	**1,638,766**	**1,758,035**	**2,078,160**	**498,697**

Source: Directorate General of Fisheries (DGF) (1993; 2003).

The bag gillnet (a gillnet fitted with a bag and pulled by a fishing boat) and fish net are commonly used by the commercial sector to exploit demersal fishes. Whilst set gillnets, hook and lines, and tidal-traps are most commonly used by fishers to catch demersal fish, especially in the eastern areas of Sumatra, including Riau, Jambi, South Sumatra, and Bangka-Belitung provinces. Sumiono *et al.* (2003) provide a review of the demersal fishery in the South China Sea, particularly the assessment of the distribution and abundance of demersal fish resources. Assessment of the status of currently fished demersal stocks indicates that these resources are biologically fully-exploited.

In 2001, marine fisheries in the South China Sea area contributed 516,671 tonnes, or about 13%, to the total landings of marine fish in Indonesia. Total landings in Riau Province were 306,092 tonnes (59.24% of the total landings in the South China Sea), followed by West Kalimantan with 65,049 tonnes (12.59%), Bangka-Belitung with 54,223 tonnes (10.49%), South Sumatra with 46,192 tonnes (8.94%), and Jambi with 45,115 tonnes (8.73%) (Table 2).

Table 2 Marine fish landings (tonnes) in Indonesian provinces adjacent to the South China Sea in 2001.

Province	Category					Total
	Demersal	Pelagics	Crustaceans	Molluscs	Others	
Riau	116,644	116,544	51,175	20,492	1,237	**306,092**
Jambi	16,677	6,878	19,009	2,551	0	**45,115**
South Sumatera	24,718	14,799	6,154	521	0	**46,192**
Bangka-Belitung	26,961	17,974	3,525	5,763	0	**54,223**
West Kalimantan	23,080	22,723	16,920	2,326	0	**65,049**

Source: DGF (2003).

1.1.2 Fishing effort by gear

The distribution of fish resources in Indonesian waters of the South China Sea is concentrated in inshore waters. The bulk of marine fish landings are derived from small-scale fisheries conducted in coastal waters. Fishing activities are significantly influenced by the occurrence of the two monsoon periods that alternate on a biannual basis.

The fisheries statistics published annually by the Directorate General of Fisheries (DGF) highlight the wide range of gear types and fishing boats employed in Indonesian fisheries. Specifically, 29 fishing gear types are used, ranging from simple traditional gears, including hand lines, to more complex "modern" gears, including purse seines and longlines.

For planning purposes, Indonesia's marine fisheries sector is divided into small, medium, and large-scale fisheries. Both medium and large-scale fisheries are distinguished from small-scale fisheries by the use of inboard engine powered boats. Similarly, large-scale fisheries are differentiated from medium-scale fisheries based on investment levels and the areas in which they are permitted to operate. In this report, fishing activities are divided into 2 categories.

According to DGF, all boats powered by inboard engines (typically diesel) can be classified as either medium or large-scale. Small-scale fisheries, which are the most important in terms of employment, number of fishing units, and quantity of landings, are distinguished from the other categories by type of boat employed.

Indonesian marine fisheries in the South China Sea are mostly small-scale. Small-scale fisheries are defined as those in which fishing is conducting using boats powered by sail or outboard engines.

Fishers operating fishing gear without boats are also classified as small-scale. So far, Indonesia's small-scale fishing fleet has been divided into the following 3 categories:

(i) Dug out boat, i.e., boat made of hollowed-out logs. In 2001, only 0.02% of this boat type in Indonesia was observed in the South China Sea.

(ii) Non-powered plank built boats are divided into small (<7 m in length); medium (7 to 10m), and large (>10 m) categories. In 2001, the combined total number of these boats was 40,470, or 15.49% of the total fishing boats in Indonesia.

(iii) Out-board motor powered boats have engines attached to the rear of the boat. Some of these boats use modified gasoline or diesel generators with a long trailing propeller shaft and engine from 2 to 15 HP. In 2001, there were 230 boats of this type, or 0.22% of the total fishing boats in Indonesia.

The numbers of units of each fishing boat type are presented in Table 3.

At present, marine capture fisheries in the Indonesian part of the South China Sea are characterised by the use of various types of fishing gear to catch a diverse range of Indonesian fish species. These fishing gears are categorised into commercial fishing gears, including Danish seines, purse seines, drift/gillnets, and traditional fishing gears, including hook and line, trammel nets, liftnets, and traps. However, the fishing gears contributing to the bulk of the landings include Danish seines, purse seines, drift/gill nets, hook and line, and tidal-trap nets. Table 4 provides the number of fishing gear units used in the Indonesian part of the South China Sea.

Table 3 Number of fishing boats by sub-sector and size used in Indonesian waters of the South China Sea in 2001.

Boat type	Boat number	Percentage
1. Small-scale fishery		
dug-out boat	19	0.03
plank-built boat		
- small	5,592	9.61
- medium	5,831	10.02
- large	1,055	1.81
out-board motor	4,979	8.56
Sub total	**17,476**	**30.03**
2. Medium-scale fishery		
In-board powered boats:		
- less than 5 GT	29,208	50.20
- 5 to 10 GT	9,243	15.87
- 10 to 20 GT	1,522	2.62
- 20 to 30 GT	501	0.86
Sub total	**40,474**	**69.55**
3. Large-scale fishery		
- 30 to 50 GT	110	0.19
- 50 to 100 GT	75	0.13
- 100 to 200 GT	44	0.08
- 200 to 300 GT	1	0.001
Sub total	**230**	**0.42**
Total	**58,180**	**100**

Source: DGF (2003).

1.1.2.1 Trawl

As trawl fishing has been banned in Indonesian waters since 1980, except in the Arafura Sea, there is no trawling conducted legally in the Indonesian part of the South China Sea. The Indonesian Government is now combating illegal fishing in its territorial waters and exclusive economic zone (EEZ). It is also working with neighbouring countries to curb regional problems with illegal fishing.

Table 4 The number of fishing gear units used in Indonesian waters of the South China Sea from 1991 to 2001.

Fishing gear	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Payang (included Lampara)	1,094	817	1,233	1,208	1,146	1,239	2,005	3,282	35,375	3,764	543
Danish seine	240	296	297	281	240	201	221	241	241	241	375
Beach seine	1,140	1,122	1,154	1,114	2,117	2,168	1,741	1,782	16,975	1,952	1,726
Purse seine	71	62	62	77	129	155	734	840	1,011	1,210	1,187
Drift gill nets	7,397	7,493	7,724	8,202	7,808	8,233	9,531	10,202	10,372	10,281	7,486
Encricling gill nets	432	465	478	491	583	549	343	608	428	248	277
Shrimp gill nets	2,423	2,852	3,120	2,491	1,935	2,099	1,449	2,444	20,995	1,858	597
Set gill nets	3,359	3,358	3,453	3,529	5,148	5,175	4,481	4,966	4,973	5,098	5,135
Trammel nets	2,267	1,969	1,823	1,713	1,772	1,820	4,667	2,629	2,591	2,103	2,878
Boat/Raft nets	828	1,213	900	0	932	1,015	1,069	1,030	0	0	0
Bagan (included Kelong)	2,366	2,459	3,056	4,138	3,621	3,783	4,501	5,107	4,437	4,689	3,115
Scoop nets	1,316	1,085	805	558	1,103	796	796	1,293	690	279	512
Other lift nets	3,915	1,330	1,290	1,200	1,184	1,157	1,149	1,050	893	1,114	1,515
Tuna long line	0	0	0	0	0	0	0	0	0	0	0
Drift long line	639	709	596	394	306	325	358	179	592	464	526
Set long line	2,249	1,945	2,258	2,468	3,263	6,093	6,475	6,736	7,585	4,772	4,748
Skipjack pole and line	0	0	0	0	0	0	0	0	0	0	0
Other pole and line	9,468	9,393	10,106	10,428	8,241	11,595	12,238	13,752	10,760	9,916	8,107
Troll line	830	889	1,210	1,202	760	877	1,295	1,362	1,217	1,269	1,236
Guiding barriers	1,100	1,603	1,569	1,855	2,795	2,680	3,281	3,650	3,125	2,675	1,996
Stow nets	2,996	3,380	2,342	2,642	2,793	2,738	3,816	3,006	3,710	5,852	5,534
Portable traps	792	364	882	714	1,367	2,827	1,687	1,851	1,570	1,368	1,390
Other traps	1,435	1,649	1,505	1,880	2,429	2,466	2,436	2,184	21,355	2,204	1,735
Shell fish collection	2,744	2,327	4,356	2,636	1,462	1,515	1,342	1,389	1,280	1,678	1,998
Sea weed collection	77	0	0	36	0	0	0	0	0	99	0
Muroami	33	0	0	0	0	0	0	0	0	21	100
Cast nets, Harpon, etc.	956	806	1,138	573	53	134	412	409	322	477	534

Source: DGF (1993;2003).

1.1.2.2 Purse seine/ring net

Since the banning of trawl fishing in the 1980's, landings from the purse seine fleet have played a significant and dominating role in Indonesia's fish production. Purse seines are commonly used in all Indonesian waters to catch small tunas and other pelagic fishes. However, purse seine use is particularly prevalent in the Sunda Shelf area of Indonesia. The number of purse seine boats operating in the Indonesian part of the South China Sea increased from 71 units in 1991 to 1,187 units in 2001. Purse catches have increased accordingly from 2,141 tonnes in 1991 to 35,935 tonnes in 2001 (DGF 1993; 2003). Despite this growth trend, the catch per unit effort (CPUE) of purse seine operations has steadily declined over the last five years.

According to Potier and Sadhotomo (1994), 3 kinds of purse seine boats are used in the Java Sea, the South China Sea, and the Makassar Strait. Mini-purse seine fisheries use wooden boats with semi dugout and planked boats. The fishing areas are located along the coast, approximately 30 miles offshore. They stay at sea for 1 to 3 days. The medium sized purse seine fisheries use wooden boats fitted with inboard engines of 35 to 100 HP. Boat lengths range from 15 to 20m, with a capacity to hold between 20 and 25 tonnes of fish. They stay at sea for 8 to 15 days. The large purse seine fisheries use flat bottom boats fitted with inboard engines of at least 160 HP. These boats typically have a fish holding capacity of 50 to 80 tonnes, and are operated by a crew of 30 to 40 fishers.

The large purse seine boats usually operate in the Indonesian part of the South China Sea. Most of the purse seine boats in the South China Sea area are wooden, with a size range from 80 to 100 GT. Most boats are equipped with electronic and mechanical devices, including a generator (6000 watt), sonar, depth sounder, radar, direction finder, and power block. In general, 1 to 3 deployments are conducted per boat per night. The purse seine itself is usually 400 to 750m long, 50 to 100m deep, with a mesh size of 0.75 inches in the bunt area. Purse seine catches are dominated by shortfin scad (*Decapterus macrosoma*), followed by Indian mackerel (*Rastrelliger kanagurta*).

1.1.2.3 Gill net

Gill nets are single-walled nets found in various mesh sizes. Fish of different body shapes and sizes are gilled, wedged, or entangled in gillnets as they attempt to swim through them. Trammel nets are included in this group. These are passive gear, but fishers may drive or herd fish into gill nets. The use of drifting gill nets is widespread and most common in the Indonesian part of the South China Sea. The netting material is monofilament for small-scale gill nets, and multifilament for large-scale gill nets. Drifting gill nets hang on floats just below the surface and are used to capture various pelagic species. Gill nets used to catch demersal species are set on the seafloor with the use of anchors and ballast. However, trammel nets are increasingly replacing set gill nets. Trammel nets consist of 3 panels of netting of different mesh size. The primary target species of trammel nets are shrimp.

Drifting gillnets are commonly used to catch pelagic fish in coastal waters adjacent to Riau and West Kalimantan Provinces. The number of units of this gear type used in the Indonesian part of the South China Sea increased from 7,397 units in 1991 to 10,281 units in 2000. However, the number of trammel nets used remained relatively stable during the same period.

1.1.2.4 Traps

This gear category includes large stationary gears (guiding barriers and stow nets) and various small traps. Guiding barriers (*sero*) consist of a long stationary barrier set perpendicular to the current. Generally, guiding barriers are used along the coast of eastern Sumatra and the Malacca Straits. Typically, these gears consist of a series of four enclosed chambers, flanked by two wings and a prolonged leader. This arrangement is made of bamboo poles and slabs of split bamboo. It is regarded as a traditional fishing gear, and is used to catch demersal finfish and shrimps in shallow protected waters. Stow nets (*jermal*), or filter bag nets, are set or towed against a current. They usually have wings made of netting, bamboo matting, or leaves and branches. In the waters of East Sumatra and West Kalimantan, the wings of *jermal* are made from bamboo poles. In these areas, this gear is set semi-permanently in relatively deep waters, with the bamboo pole wings leading into the trap mouth.

A survey was conducted during a series of high tides in the coastal waters of Riau from October to November 1998. Badrudin *et al.* (2001) reported that the catches of guiding barrier and stow nets ranged from 100 to 200 kg per haul. The net was usually hauled twice a day.

1.1.3 Economic value of catch

The total value of Indonesian marine fish landings from the South China Sea was 3,345,864 million Rupiah. From the view point of value, Riau Province generated revenues as high as 1,201,802 million Rupiah in 2001, followed by Bangka-Belitung Province with 728,041 million Rupiah, West Kalimantan Province with 946,282 million Rupiah, South Sumatra Province with 270,311 million Rupiah, and Jambi Province with 199,426 million Rupiah (Table 5).

Table 5 Volume and value of Indonesian marine fish landings from the South China Sea in 2000 and 2001.

Province	2000		2001	
	Volume (ton)	Value (Rp. 1,000.-)	Volume (ton)	Value (Rp. 1,000.-)
Riau	286,290	1,163,592,330	261,519	120,1802356
South Sumatera	157,530	394,821,930	46,192	270,311,450
Jambi	41,106	308,375,005	44,935	199,426,680
West Kalimantan	61,503	766,724,585	64,616	946,282,452
Kepulauan Bangka Belitung*)			107,409	728,041,855
Total	**546,429**	**2,633,513,850**	**524,671**	**3,345,864,793**

**) New province since 2001.*
Source: DGF (2003) (1 US$ = 8,500 to 9,500 Rupiah).

During 1999, the main fish groups exported from Indonesia's catches in South China Sea areas were penaeid shrimp and tuna, including skipjack tuna and eastern little tuna. Riau Province made the largest contribution to fish exports (87,935 tonnes), followed by the provinces of South Sumatra (9,690 tonnes), West Kalimantan (2,829 tonnes), and Jambi 2,068 (tonnes). Of the total 102,522 tonnes of fish product exports, penaeid shrimps and tuna contributed 11,024 tonnes and 2,656 tonnes, respectively. The remaining 88,842 tonnes was comprised of 'other' non-specified species (Table 6).

Table 6 Fishery exports from Indonesian provinces bordering the South China Sea in 1999 (tonnes).

Fish resources	Riau	Jambi	South Sumatra	West Kalimantan	Total
Penaeid shrimps	4,667	1,866	1,812	2,679	11,024
Tunas	2,636	0	20	0	2,656
Others	80,632	202	7,858	150	88,842
Total	**87,935**	**2,068**	**9,690**	**2,829**	**102,522**

Source: DGF (2001).

1.1.4 Importance of the Fisheries Sector in Terms of Employment & Dependence

The province of Riau has Indonesia's largest South China Sea fishing area. As a result, Riau is the largest fish producing and exporting province adjacent to the South China Sea. Additionally, Riau Province has the largest number of fisheries labourers. In 2001, this province provided employment for 94,502 full-time and 33,109 part-time fishers. At that time, the number of full-time and part-time fishers employed in other provinces was: South Sumatra Province, 9,121 and 10,462; West Kalimantan Province, 17,409 and 24,887; Jambi Province, 2,382 and 1,283; and Bangka-Belitung Province, 32,228 and 8,229 (Table 7).

Table 7 Number of full-time and part-time fishers in Indonesian provinces adjacent to the South China Sea in 2001.

Province	Full-time	Part-time	Total
Riau	94,502	33,109	127,611
Jambi	2,382	1,283	3,665
South Sumatra	9,121	10,462	19,583
West Kalimantan	17,409	24,887	42,296
Bangka-Belitung	32,288	8,229	44,517
Total	**146,634**	**69,768**	**216,402**

Source: DGF (2003).

There are many small fishing boats working in Indonesian areas of the South China Sea, namely: (i) non-powered boats; (ii) boats with outboard engines; and (iii) boats with inboard engines. In 2001, there were 29,208 fishing boats with inboard engines and a size of 5 GT or less, 12,497 non-powered boats, and 9,243 boats with inboard engines and a size from 5 to 10 GT (Table 8).

Riau and West Kalimantan Provinces own more boats than the other provinces. A number of large inboard engine fishing boats (100 to 200 GT) are based in West Kalimantan Province.

Table 8 Number of different sized fishing boats operating in Indonesian waters of the South China Sea in 2001.

Province	Non-powered	Outboard engine	<5 GT	5 – 10 GT	10-20 GT	20-30 GT	30-50 GT	50-100 GT	100-200 GT
Riau	8,193	1,808	17,385	6,366	787	101	74	31	29
Jambi	107	0	3,570	408	167	147	1	0	0
South Sumatra	910	100	2439	410	46	132	12	17	0
West Kalimantan	1,685	1,66	1,652	1,367	317	121	23	27	16
Bangka-Belitung Isl.	1,602	1,807	4,162	683	205	0	0	0	0
Total	**12,497**	**4,979**	**29,208**	**9,243**	**1,522**	**501**	**110**	**75**	**45**

Source: DGF (2003).

2. SPECIES OF REGIONAL, GLOBAL AND/OR TRANSBOUNDARY SIGNIFICANCE

2.1 Ranking of importance in terms of

2.1.1 Landings (by site or province)

The 208,080 tonnes of demersal fish landed in 2001 was 29% higher than the total volume of pelagic fish landings. Approximately 70% of demersal fish landings were derived from commercial fishing. Traditional fishing gears, especially tidal trap-nets, are the main fishing gear types used to catch demersal fish species in eastern Sumatran waters. Within the last decade, i.e., from 1991 to 2001, demersal fish catches were dominated by red snappers (7.48%), followed by sea catfish (6.55%), croakers (4.90%), Bombay-duck (4.50%), threadfin bream (4.37%), sharks (3.64%), and rays (3.31%) (Table 9). The remaining groups of demersal fish belonged to the 'others' category that composed about 43.46% of total catch (DGF 1993; 2003).

So far, the category of 'other' has been used for demersal fish of poor commercial value, including species of the families of Apogonidae, Plotosidae, Pomacanthidae, Platycephalidae, Tetraodontidae, and Ophiidae, as well as juveniles of commercially important species such as the white pomfret (*Pampus argenteus*). This category dominated catches in the tidal trap-net fishery conducted along the east coast of Sumatra and the west coast of Kalimantan. According to Badrudin *et al.* (2001), the catches of tidal trap-nets in coastal waters of Riau Province were dominated by juveniles of Bombay-duck (*Harpodon nehereus*), hair-fin anchovy (*Setipinna* spp.), small individuals of black pomfret (*Formio niger*), marine catfish (especially *Arius caelatus*), and shrimps.

Based on the results of a trawl survey conducted in Indonesia's South China Sea areas, there are a number of demersal species, including red eyes fish (*Priacanthus tayenus*), red seabreams (*Scolopsis taeniopterus, Nemipterus tambuloides*, and *Nemipterus peronii*), lizardfish (*Saurida undosquamis*), and goatfish (*Upeneus bensasi*), that are almost always present in landings.

Table 9 Catch composition by group of species of demersal fish (tonnes) in Indonesian waters of the South China Sea from 1991 to 2001.

Common names	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Ave. (%)
Indian halibuts	559	556	941	369	627	958	1,279	1,772	1,446	1,373	1,541	0.50
Flat fishes	154	172	427	24	102	437	1,046	783	767	273	287	0.19
Bombay duck	13,784	11,188	11,018	10,765	9,538	8,622	9,346	9,613	6,763	6,785	6,093	4.50
Pony fishes	1,726	1,840	1,959	2,837	3,517	2,882	5,123	4,617	5,913	6,229	1,555	1.66
Sea catfishes	10,418	10,250	11,668	12,696	15,464	16,379	16,803	16,785	15,061	14,073	110,130	6.55
Lizard fishes	0	0	0	0	0	0	0	0	0	0	0	0.00
Goat fishes	201	200	154	137	353	1,183	748	850	857	1,149	1,288	0.31
Grunters	2,152	2,144	2,809	2,783	2,953	3,370	3,901	3,886	3,230	3,581	3,400	1.49
Red snappers	12,948	14,586	13,574	14,002	14,693	17,840	18,556	18,912	18,642	14,848	13,585	7.48
Groupers	1,572	3,286	5,837	16,509	4,837	5,274	5,525	5,852	5,941	7,129	6,933	2.99
Emperors	850	429	866	826	1,640	2,276	2,568	2,995	2,994	3,172	2,413	0.91
Barramundi	2,747	2,114	2,364	2,064	6,305	4,906	5,066	7,924	8,156	5,944	6,115	2.33
Treadfin breams	8,292	8,672	8,181	8,996	9,400	13,003	8,956	10,315	9,903	8,531	6,229	4.37
Big eyes	341	273	12	8	119	6	357	7	0	463	0	0.07
Yellow tails/Fusiliers	3,894	3,064	2,055	4,138	3,296	7,814	10,747	10,240	10,211	9,097	8,956	3.19
Croakers/Drums	6,795	8,502	10,012	6,312	7,524	12,802	11,906	11,739	14,226	11,482	11,436	4.90
Sharks	6,372	7,396	9,084	6,964	8,082	7,627	7,489	7,690	7,841	8,265	6,859	3.64
Rays	5,372	5,904	6,128	5,350	6,382	7,606	8,114	8,780	9,333	8,506	4,730	3.31
Black pomfret	3,918	3,714	4,035	5,844	4,063	4,934	5,360	4,751	4,904	4,935	5,314	2.25
Silver pomfret	2,046	2,191	2,234	2,450	2,895	4,041	3,972	4,560	5,593	6,311	5,509	1.82
Threadfins	3,425	2,536	2,418	2,662	8,016	4,828	6,156	6,309	7,243	7,150	7,320	2.52
Hair tail	1,720	2,362	1,838	1,129	1,931	15,482	1,942	2,609	2,501	1,977	2,520	1.57
Others	87,045	90,327	90,788	88,766	83,718	89,519	88,746	88,440	101,744	122,848	68,023	43.46
Total	**176,331**	**181,706**	**188,402**	**195,631**	**195,455**	**231,789**	**223,706**	**229,429**	**243,269**	**254,121**	**280,236**	**100**

Source: DGF (1993; 2003).

The landing of pelagic fishes from the South China Sea was 160,944 tonnes in 2001. Most of the landings, about 72%, came from Riau Province, 14% from West Kalimantan Province, 11% from Bangka-Belitung Province, 9% from South Sumatra Province, and 6% from Jambi Province. Landings of pelagic fish from the South China Sea from 1991 to 2001 are presented in Table 10.

Eastern little tuna (10.43%), fringescale sardinella (8.99%), Indian mackerel (7.65%), narrow-barred king mackerel (6.49%), wolf herring (6.41%), and anchovies and trevallies (5.98%) dominated catches of pelagic fish. The remainder of the catch was recorded under the category of 'others', representing as much as 30.83% of total pelagic landings (Table 10).

Table 10 Catch composition of pelagic fish (tonnes) in Indonesian waters of the South China Sea from 1991 to 2001.

Common names	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Ave. (%)
Barracudas	898	1,051	970	183	1,181	749	716	957	995	804	796	0.03
Scads	285	0	199	202	1,669	2,180	2,907	3,624	4,048	6,592	6,685	1.37
Trevallies	9,345	9,497	8,020	8,985	11,709	12,969	13,342	13,910	14,019	14,557	7,289	5.98
Jacks trevallies	1,462	1,845	1,914	2,931	2,229	2,882	2,373	3,954	4,068	3,427	2,441	1.43
Hjardtail scads	792	892	1,078	1,004	830	1,222	1,323	2,148	2,353	2,436	552	0.71
Queen fishes	2,008	2,127	2,300	1,819	3,262	2,927	3,067	3,737	4,843	4,138	2,901	1.60
Rainbow runner	120	122	147	268	287	190	0	0	0	0	0	0.05
Flying fish	0	0	0	0	176	283	396	470	510	0	0	0.09
Mullets	2,879	4,018	4,191	4,280	4,314	5,236	5,080	4,892	5,281	5,143	4,077	2.39
Needle fishes	70	89	407	583	992	1,386	1,049	1,434	1,475	1,550	4,573	0.66
Anchovies	8,043	8,581	8,378	8,787	11,030	10,756	18,298	15,966	13,777	16,131	3,845	5.98
Rainbow sardine	2,288	2,336	4,358	4,290	5,108	5,391	3,303	5,932	5,742	5,882	9,484	2.62
Fringescale sardinella	16,236	16,688	15,186	14,579	14,962	16,368	15,621	20,487	23,339	23,196	9,161	8.99
Indian sardinella	8,126	8,250	7,352	8,444	9,522	9,544	8,591	9,709	11,446	11,545	278	4.49
Wolf herrings	8,979	7,933	8,447	9,212	12,978	13,589	15,393	13,566	14,424	14,762	13,289	6.41
Chinese herrings	0	0	0	0	0	0	68	100	96	40	920	0.06
Indian mackerels	9,959	10,082	11,027	16,807	19,689	20,558	18,423	13,119	15,740	16,192	6,539	7.65
Indo-pacific king mackerel	568	581	629	630	1,098	954	808	1,011	612	1,137	1,241	0.45
Narrow barred king mackerel	10,843	10,160	9,824	10,334	14,281	14,389	16,913	13,246	13,575	12,036	8,631	6.49
Tunas	91	93	0	0	0	0	0	64	0	0	433	0.03
Skipjack tuna	6	473	0	0	763	717	3,198	3,536	3,649	4,446	4,685	1.04
Eastern little tuna	13,642	14,715	14,830	16,475	19,764	19,252	20,881	21,301	18,790	28,354	27,595	10.43
Others	52,226	55,805	53,973	54,147	51,629	57,105	56,817	61,107	66,290	78,503	45,529	30.63
Total	148,866	155,338	153,230	163,960	187,473	198,647	208,567	214,270	225,072	250,871	160,944	100

Source: DGF (1993;2003).

Atmadja (1999) described the scad population that is fished in the southern part of the Sunda Shelf, i.e., the Java Sea. In general, the distribution of *Decapterus russelli* was concentrated in the southern part of the South China Sea. It was found that the scads (*Decapterus* spp.) provided the major component of the small pelagic fish resources in those areas. Additionally, Wagiyo and Nurdin (2002) describe the small pelagic fish resources of northern Indonesia waters, adjacent to Anambas and Natuna Islands. According to this study, a number of species of Clupeidae and Carangidae dominate the small pelagic fish fauna in this part of the South China Sea. Trolling has recently been conducted to catch large pelagic species such as tuna, whilst fish nets are used in waters less than 40 m deep to catch demersal fish.

The other important fisheries resource landed in Indonesian waters of the South China Sea is shrimp. Shrimp fisheries in this area are still limited to waters less than 20m deep. The gears used to catch shrimp by small-scale and medium-scale fishers include Danish seines, trammel nets, lift nets, and tidal-trap nets. In 2001, 43,974 tonnes of shrimp were caught in the South China Sea area. These catches were comprised of white shrimps (17.36%), endeavor shrimps (17.29%), tiger shrimps (8.98%), and smaller sized shrimps (other shrimps) (56.37%). The smaller sized shrimp catch was composed of the genera of *Metapenaeus, Parapenaeopsis*, and *Metapenaeopsis*. These species dominate shrimp catch in almost all Indonesian provinces bordering the South China Sea. The total landings by shrimp categories are presented in Table 11.

Table 11 Catch of shrimp in Indonesian waters of the South China Sea from 1991 to 2001 (tonnes).

Category	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Ave. (%)
Tiger	1,950	1,634	1,753	1,640	1,736	1,287	1,581	3,522	3,412	4,116	3,950	6.40
White	5,209	6,086	6,179	5,978	6,548	6,418	7,124	9,919	11,632	13,380	7,635	20.75
Endeavor	2,937	2,927	2,819	3,289	3,696	3,946	10,099	19,006	8,530	12,000	7,605	18.52
Other	17,811	18,610	18,487	20,059	18,661	20,836	23,061	19,257	22,226	21,728	24,784	54.33
Total	**27,907**	**29,257**	**29,238**	**30,966**	**30,641**	**32,487**	**41,865**	**51,704**	**45,800**	**51,224**	**43,974**	**100**

Source: DGF (1993; 2003).

2.1.2 Local market value

The development of fish price in the South China Sea and its adjacent waters is as follows:

In the province of North Sumatra from January to July 2002, the price of tuna-like fishes and lobsters decreased from 10,250 Rupiah/kg and 80,000 Rupiah/kg to 6,250 Rupiah/kg and 70,000 Rupiah/kg, respectively. On the other hand, the price of shrimp increased from 22,000 Rupiah/kg in January to 25,000 Rupiah/kg in July.

During the same period, price for tuna-like species also decreased in the Provinces of South Sumatra, Jakarta, West Java, Central of Java, and East Java. Whilst in the provinces of West and South Kalimantan, tuna prices increased to 14,000 Rupiah/kg. In Jakarta, the price of yellowfin tuna from March to June 2002 was 3,500 Rupiah/kg, whilst that for albacore and skipjack declined from 8,000 Rupiah/kg and 4,000 Rupiah/kg to 6,000 Rupiah/kg and 3,000 Rupiah/kg, respectively. The price of tuna-like fishes declined drastically from January to July. i.e., from 9,500 Rupiah/kg to 2,200 Rupiah/kg. The price of shrimp in West Java Province was stable at 50,000 Rupiah/kg, although in Central Java it increased from 47,850 Rupiah/kg to 52.000 Rupiah/kg [1].

Related to the above condition, and the positive demand for fish, the future for Indonesia's fish markets is positive. Even during the national economic crisis, when the price of chicken meat and eggs increased drastically, Indonesians, especially low-income earners, preferred to purchase relatively low cost fish products.

With increased fish production, and the export and import of fish and fishery products, the per capita consumption of fish reached 19.04kg/person/year in 1997, representing an annual average increase of 0.89% from 1994 to 1997. The per capita supply of fish has recently increased at an annual average of 4.63%, or from 19.98 kg/person/year in 1998 to 21.87 kg/person/year in 2000.

Increases in fish consumption, mostly driven by improved income levels in Indonesia, will have the additional benefits of improving the diet and overall well being of Indonesians. Indonesians are now aware of the importance of a healthy diet in maintaining or improving quality of life, and fish and related products are increasingly being recognised as healthy food options.

Importantly, Indonesians view fish as a source of high quality protein, essential amino acids, and minerals such as iodine. The omega-3 amino acid in fish, is thought to have a range of health benefits, including: (a) the prevention of arteriosclerosis, hypertension, and heart attack; and (b) enhancement of intelligence, and neural, and eye function.

2.1.3 Status (endangered, threatened, rare etc.)

Six sea turtle species occur in Indonesia, including the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricate*), olive ridley (*Lepidochelys olivaceae*), leatherback (*Demochelys coriceae*), loggerhead (*Caretta caretta*), and flatback (*Natator depressus*) turtles, all of which may nest on Indonesian beaches. Table 12 shows the protection status of sea turtles in Indonesian waters.

The green turtle is the most abundant species. The meat and eggs of this species are highly valued in Muslim communities, where the consumption of some other meat products is forbidden. There are several major nesting localities throughout Indonesia, and it appears that more than 25,000 females breed annually in western Indonesia.

The hawksbill turtle is also abundant, and is taken mostly for its shell. There are some valuable nesting sites for the rare leatherback turtle, and this species is hunted in several parts of the country, including the important Kai and Aru Island region. The major nesting site of this species at northern beach bird's head of Papua is the fourth largest in the world after Trengganu beach in Malaysia.

There is a paucity of information regarding the olive ridley, loggerhead, and flat back turtles. There is evidence of significant decline in green turtle populations connected with sites of heavy meat in Bali, Manado, and Ambon. Exploitation of the hawksbill turtle is increasingly high. This is especially the case in Makassa, where this species is harvested for its shell. More than 15,000 green turtles are brought annually into Bali alone, and there is a store of approximately 15 tonnes of hawksbill turtle shells in Makassar at any one time.

[1] *Rate of exchange for 1 US Dollar ranged from 9.000 to 10,000 Rupiah (Rp is Indonesian currency).*

Table 12 The protection status of sea turtles that occur in Indonesian waters.

No	Family	Species	Common name	Local name	Status		
					Cites	INA	IUCN
1	Chelonidae	*Caretta caretta*	Loggerhead turtle	Penyu tempayan	App 1	V	P
2		*Chelonia mydas*	Green turtle	Penyu hijau	App 1	E	-
		C. mydas					
		C. mydas japonica					
3		*Eretmochelys imbricata*	Hawksbill turtle	Penyu Sisik	App 1	E	P
4		*Lepidoche lysolivacea*	Olive Ridley turtle	Penyu Lekang	App1	E	P
5		*Natator depressa*	Flatback turtle	Penyu pipih	App 1	E	P
6	Dermochelydae	*Dermochelys lyscoriacea*	Leatherback turtle	Penyu blimbing	App 1	E	P
		D. coriacea					
		D. schlegelli					

Notes: INA = Indonesian Government Regulation; App 1 = Endangered species, not for commercial use; E = Endangered species; V = Vulnerable species; P = Protected.

The uncontrolled hunting and collection of protected species, including cetaceans, turtles, and seabirds, is a problem. Indonesia has trouble controlling the exploitation of marine resources and protecting endangered species in marine areas, as some species are highly migratory and may straddle national boundaries. For instance, populations of turtles, dolphins, and whales may be exploited across the entire area of their distribution, which may include the waters of multiple nations.

2.1.4 Food security (locally)

The per capita fish consumption in 1998 was 19.25kg/person/year. This represents 72.5% of the 26.55kg/capita/year, which the National Food and Nutrition Meeting in 1993 defined as the average dietary requirement. The per capita fish consumption in 1998 was below normal (i.e., per capita fish consumption in Japan is approximately 100 kg/person/year).

2.2 Biology & ecology of the species (from available information)

2.2.1 Large pelagic fishes

A number of species comprise the oceanic tuna and billfish resource of Indonesia's South China Sea area. They include swordfish (*Xiphias*) of the family Xiphiidae, sailfish and marlins (*Makaira, Istiophorus,* and *Tetrapturus*) of Istiophoridae, and tunas (*Euthynnus*, *Katsuwonus*, and *Thunnus*) of Scombridae. Several species of smaller tuna-like fishes are more important in continental shelf areas than the open ocean, including frigate and bullet tunas (*Auxis* spp.) and bonito (*Sarda* spp.).

The actual tuna species occurring in the South China Sea area include skipjack tuna (*Katsuwonus pelamis*), kawa-kawa (*Euthynnus affinis*), longtail tuna (*Thunnus tonggol*), and frigate tuna (*Auxis thazard*).

2.2.2 Small pelagic species

Taxonomically, the small pelagic fish occurring in Indonesia's South China Sea area can be classified into two orders. The first are the herring-like Clupeiformes, including wolf-herring of the family Chirocentridae, sardines, shads and gizzard shads of the Clupeidae family, and anchovies of Engraulidae. The second are the perch-like Perciformes, including the carangid scads, jacks, and trevallies of the Carangidae family, and the mackerels of the Scombridae family (Widodo 1997).

Clupeoids

Clupeoids are shoaling fishes that inhabit waters of the inshore continental shelf. Although they are typically pelagic, they may also be benthopelagic during certain seasons or times of the day. Therefore, it is rather difficult to categorise this group as either pelagic or benthopelagic. Clupeoids and Engraulids occur frequently in demersal trawl catches in areas of the South China Sea.

Among the clupeoids, the anadromus *Tenualosa macrura* and *Anadontostoma chacunda* belong to the river ascending shads. Most of the 20 species of anchovies (*Stolephorus* spp. and *Encrasicholina* spp.) are coastal shoaling species. Some of them (e.g., *Stolephorus commersonii* and *S. indicus*) enter brackish waters occasionally. The strictly coastal and neritic species include *S. heterolobus* and *S. bataviensis. Stolephorus tri* is most abundant near river mouths and frequently enters brackish water areas.

In addition to the sardinellas, a number of commercially important clupeoids, belonging to 6 families, exist in Indonesian waters. From these 6 families, 3 occur in the Indonesian part of the South China Sea. These include herring (Chirocentridae), sardines, shads and gizzard sardines (Clupeidae), and anchovies (Engraulidae).

Chirocentridae
Chirocentrus dorab (dorab wolf-herring): inhabit coastal waters. Common size: 30-50cm.

Clupeidae

- *Anadontostoma chacunda* (chacunda gizzard shad): inhabit coastal waters. Common size: 15 to 30cm.
- *Dussumieria accuta* (rainbow sardine): inhabit coastal waters and form shoals. Common size: 10 to 15cm.
- *Tenualosa macrura* (longtail shad): inhabits coastal waters, estuaries, and rivers. Common size: 15 to 25cm.
- *Sardinella fimbriata* (fringescale sardinella): inhabits coastal waters. Common size: 10 to 15cm.
- *S. brachysoma* (deepbody sardinella): inhabits coastal waters. Common size: 12 to 16cm.
- *S. gibbosa* (goldstripe sardinella): inhabits coastal waters. Common size: 12 to 18cm.
- *S. albella* (white sardinella): inhabits coastal waters. Common size: 5 to 10cm.
- *Amblygaster sirm* (spotted sardinella, sardine): inhabits coastal waters. Common size: 15 to 20cm.

Engraulidae
This family consists of a number of anchovy species, including *Stolephorus* spp. and *Encrasicholina* spp. Anchovies inhabit coastal water, river mouth, neritic, and continental shelf areas.

Carangoids
Most of the carangid and scombroid mackerels inhabit coastal waters, and are very important to pelagic fisheries in the South China Sea. The smaller scombroids are less diverse than the carangids, but of greater fisheries importance. *Rastrelliger* spp. are very important to small pelagic fisheries in the region.

Many species of carangoids occur in continental shelf and coastal waters. Among them, scads, jacks, and trevallies are prominent.

Carangidae

- *Scomberoides commersounnianus* (talang queenfish): inhabits coastal and neritic waters to the edge of the continental shelf.
- *Selaroides leptolepis* (yellowstripe scad): inhabits shallow coastal areas, benthopelagic.
- *Selar crumenophthalmus* (bigeye scad): inhabits coastal water areas up to 80m deep, benthopelagic. L_{max} 26.7cm (Pauly *et al.* 1996).
- *Megalaspis cordyla* (torpedo scad): inhabits coastal waters up to 60m deep, pelagic.
- *Decapterus russelli* (Indian scad): inhabits coastal and offshore continental shelf waters, pelagic. L_{max} 35.0cm (Pauly *et al.* 1996).
- *D. macrosoma* (shortfin scad): inhabits continental shelf waters, pelagic. L_{max} 29.0cm (Pauly *et al.*, 1996).
- *Caranx* spp. (trevallies): inhabit shallow waters of coral rocky reefs, benthopelagic.

Scombroids
Scombroid mackerels and neritic tunas occur throughout South China Sea waters. They are represented by the following species:

Rastrelliger kanagurta (Indian mackerels) and *R. faughni* (Island mackerel): form large shoals in coastal waters, pelagic.

Rastrelliger brachysoma (short mackerel): form large shoals in coastal waters, pelagic.

Scomberomorus commerson (narrow-barred Spanish mackerel): inhabits coastal and offshore continental shelf waters, pelagic.

S. guttatus (Indo-Pacific king mackerel): inhabits coastal and offshore continental shelf waters, pelagic.

According to Yanagawa (1997), Indonesia's South China Sea fisheries for Indian mackerels, eastern little tuna, and narrow barred Spanish mackerel, were stable from 1976 to 1993. Comparatively, the fishery for round scad experienced significant fluctuations in catches during the same period. In general, during the 18-year period discussed here, catches of the 12 main small pelagic species tended to increase, especially after 1987. At present, catches of all species, except for hardtail, are higher than the average observed during the 18-year period discussed.

2.2.3 Demersal fish species

Among of the order of Clupeiformes there is a great diversity and range of genera, in both pelagic and benthic-demersal areas. According to Longhurst and Pauly (1987), it is not satisfactory to categorise fish of this order into pelagic or benthopelagic groups, as clupeids and engraulids very often occur in catches from both pelagic and demersal parts of tropical seas.

The Perciformes are a significant group of fish in the region. Of the 150 families making up the order, a dozen families dominate the continental shelf fisheries of the tropics (Longhurst and Pauly 1987). Based on habitat associations, the tropical Perciformes represent 3 main groups, including: (i) species associated with inshore muddy substrate; (ii) those associated with sandy bottom substrate; and (iii) those associated with rocky substrate.

The Sciaenidae family (28 genera, 160 species) tends to dominate the fish fauna associated with areas characterised by substrates that are muddy, and waters that are brackish and turbid. Some of the drums and croakers, including *Sciaena, Pseudotolithus, Johnius,* and *Umbrina* may attain large sizes. Occurring with these croakers are golden-brown threadfins (Polynemidae, 35 species of 7 genera) and laterally flattened spadefishes (Ephippidae, 15 species of 7 genera) (Longhurst and Pauly 1987).

In sandy bottom areas, a wider range of Perciformes families are present. Breams (Sparidae, 100 species of 30 genera), threadfin breams (Nemipteridae, 175 species of 21 genera), and grunts (Pomadasyidae, 175 species of 21 genera) dominate. A range of genera of groups of mostly smaller sized fish, including Priacanthidae, Mullidae, Gerreidae, and the ponyfish (Leiognathidae, 20 to 30 species of 3 genera) also occur (Longhurst and Pauly, 1987).

Finally, 3 families of large bass-like fishes, including groupers (Serranidae) and snappers (Lutjanidae) dominate the fisheries resources associated with rocky grounds. Species of these groups may attain very large sizes, and represent many genera, including *Epinephelus, Plectropomus, Serranus, Caesio, Lutjanus*, and *Ocyurus* (Longhurst and Pauly 1987).

Pleuronectiform flatfish also occur in Indonesia's South China Sea area. These include the left-eyed flounders (Psettodidae), the right-eyed flounders (Pleuronectidae), soles (Soleidae). and tongue soles (Cynoglossidae). Finally, a number of highly evolved groups of fishes, including Balistidae (triggerfishes), Tetraodontidae (puffers), Ostraciontidae (boxfish), and Zeidae (John Dories) are part of the fisheries resources of the continental shelf (Longhurst and Pauly 1987).

Elasmobranchs are ubiquitous in South China Sea waters. The larger species are usually pelagic, whilst smaller species of Squalidae occur in all tropical oceans. Several families of bottom-dwelling rays (Rajidae), guitarfish (Rhinobathidae), and stingrays (Dasyatidae) make up part of Indonesia's South China Sea resource base.

Regarding demersal fish communities, Longhurst and Pauly (1987) identified 4 basic kinds of assemblages: (i) those of inshore/estuarine muddy habitats and turbid waters, dominated by sciaenids; (ii) those of sandy habitats and clearer waters, dominated by sparids; (iii) those of rocky reefs, dominated by lutjanids; and (iv) those of coral reefs with no single dominating family.

2.2.4 Commercially exploited invertebrates

2.2.4.1 Penaeid shrimps

Penaeid shrimps play an important role in the economies of some tropical nations, including those countries bordering the South China Sea. Consequently, shrimps of the family Penaeidae have been studied intensely, and many aspects of their biology and population dynamics are clear (Gulland 1971; Holthuis 1980; Garcia & LeReste 1981; International Development & Research Council, 1982).

Many countries adjacent to the South China Sea aim to increase shrimp exports via the intensification of fishing effort and aquaculture. However, other than possibly saturating shrimp markets, the feasibility of these plans depends on 2 key factors. The first is the resilience of wild shrimp stocks to fishing effort increases. The second is the capacity of the natural environment to sustain further modifications to coastal wetland habitat for the expansion of aquaculture activities. A key risk associated with the second factor is that the environmental effects of shrimp aquaculture may be sufficient to dimish the productive capacity of wild shrimp populations.

Penaeid shrimps are short-lived, with recruitment to the fishery occurring as soon as 4 months after spawning. Stock recruitment relationships play a critical role in maintaining the quality of shrimp stocks in the region, and there is a need to better understand spatial and temporal variations in parental stock and recruitment.

2.2.4.2 Squids

Squids (Cephalopoda and Teuthoidea) are important components of tropical marine ecosystems, both neritic and oceanic. The true magnitude of their biomass and level of exploitation has become apparent with the extension of Japanese squid fisheries beyond the northwestern Pacific Ocean in the 1980s. A phenomenon that has recently attracted much scientific attention is the explosive growth of cephalopod populations following the reduction in abundance of other species. This is believed to have occurred in the Gulf of Thailand (Pauly 1979; Caddy 1983).

As there are now several known instances of tropical squid outbursts following the reduction of fish biomass by commercial fishing, it is important to understand the trophic relationships that exist between squid and other commercially important species. Cephalopods are capable of capturing unusually large prey, frequently including smaller individuals of the same species. Specifically, squid feed on crustaceans, fishes, and squids, and are an important dietary item for many other fish species. They are usually exploited with demersal fishes and penaeid shrimps. The increase in regional squid populations is most probably a consequence of a reduction in predation on their young.

2.2.4.3 Sea urchins

The harvesting of sea urchins for their gonads is an economically important activity. Sea urchins also play an important role in the grazing of algae. These algae may be those that are harvested commercially, or those that act to shape the structure of shallow water tropical ecosystems (Gomez *et al.* 1983). Therefore, the biology and dynamics of sea urchin populations have received considerable attention in recent years, especially the factors controlling their recruitment and fluctuations in abundance.

3. CURRENT STATUS & THREATS

3.1 Status of the Fishery in terms of CPUE

Available data do not enable an accurate assessment of the status of important fish stocks in terms of CPUE. The number of fishing boats in Indonesia's South China Sea area was 58,180 in 2001, slightly higher than in 2000. The number of boats by size and by province from 1991 to 2001 presented in Table 13 provides some insight into the rate at which fisheries have developed over the past 10 years.

Table 13 The number of marine fishing boats by size of boat in Indonesia's South China Sea from 1991 to 2001.

Size of fishing boats	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Non powered boat	18,066	18,243	18,475	19,704	20,250	27,872	23,992	23,655	20,708	13,028	12,497
Outboard motor	4,026	4,335	5,249	6,030	7,018	6,425	8,418	8,773	6,864	7,550	4,979
<5 GT	13,416	14,124	15,937	16,523	17,211	17,736	20,097	21,287	18,111	25,959	29,208
5-10 GT	1,435	1,578	2,567	1,576	1,718	1,671	3,730	4,037	6,348	7,663	9,243
10-20 GT	171	230	226	237	500	616	641	772	1,184	1,069	1,522
20-30 GT	116	121	163	166	59	62	313	241	349	184	501
30-50 GT	20	27	17	25	12	0	0	19	18	28	110
50-100 GT	1	0	0	3	7	0	0	0	0	0	75
100-200 GT	0	0	0	0	0	0	0	0	0	0	44
200-300 GT	0	0	0	0	0	0	0	0	0	0	1
Total	**37,251**	**38,658**	**42,634**	**44,264**	**46,775**	**54,382**	**57,191**	**58,784**	**53,582**	**55,481**	**58,180**

Source: DGF (1993; 2003).

3.2 Status of Fish Stocks Based on Historical Review of Landings and CPUE

(i) Pelagic fishes

A fishery acoustic survey carried out in September 2001 indicated that the density of fish stocks ranged between sampling location from 101 to 920 individual fish per $1000m^3$, with an average of 162. By converting the acoustic target strength to the biomass, it was found that the density of small and large pelagic fishes in the South China Sea was 2.26 and 1.10 tonnes per km^2, respectively.

Trevallies (14.9%), anchovies (15.6%), sardinella (8.4%), wolf herring (21.0%), and mackerels (10.7%) dominated catches of small pelagic fishes. The main fishing season for small pelagics in Indonesia's South China Sea area is from October to December.

(ii) Demersal fish

Bottom trawl sampling indicates that the density of demersal finfish and penaeid shrimps is approximately 1.2 tonnes/km^3. The area of distribution of demersal finfish and shrimps in Indonesia's part of the South China Sea is $558{,}000km^2$ and $337{,}000km^2$, respectively (Widodo 1998). Accordingly, potential yields are estimated at 334,800 tonnes/annum for demersal finfish and 6,720 tonnes/annum for penaeid shrimps that constituted by 10% of tiger shrimp, 28% of banana shrimps and others.

The estimated density of lobsters was 1.34 tonnes per km^2, with a potential yield of 400 tonnes per year. The total catch of lobsters in 1997 was 272 tonnes.

Fish stock assessments were conducted in 1997 and 2000. The results indicate that a number of fish resources have been exploited at levels close to or beyond their productive capacity. The resources that appear to have no further room for development include demersal finfish, coral reef fishes, penaeid shrimps, and squids. There is potential to develop the remaining fish resources in a precautionary manner

3.3 Threats

3.3.1 Current

Destructive fishing practices have been adopted in Indonesia for many years; however, demand for reef fish in Asian markets may have contributed to a proliferation of such practices. Cyanide and explosives are mainly used for capturing coral reef fishes, including groupers, snappers, Napoleon wrasse, and ornamental fishes.

Almost all of Indonesia's coastal fish resources in the South China Sea area have been overexploited. Smaller sized fish from lower trophic levels, and typically of lower commercial value, are beginning to dominate catches previously composed of large fish from high trophic levels. This is especially the case for the longtail shad (*Hilsa toli*) in waters of Riau province. This species, exploited for its roe for many decades, is now almost commercially extinct.

In some important areas, overfishing is causing catches to decline in volume and value, and smaller sized fish are increasingly dominating landings. This is especially common along the coasts of Java, eastern Sumatra, and the Celebes region. Furthermore, the overexploitation of molluscs and ornamental coral fish for the souvenir and aquarium industries may have serious consequences for the ecological balance of reefs.

3.3.2 Potential

Demand for live reef fish and penaeid shrimp in Asian markets has increased rapidly, perhaps beyond the productive capacity of wild stocks. Accordingly, fishers are expending excessively large amounts of effort towards the capture of these species, which has often led to the neglect of resources and the environments upon which they depend.

The main depleted groups of fish species include the groupers, snappers, Napoleon wrasse, pomfrets, and rabbit fish. The tiger and banana shrimp (*Penaeus monodon* and *P. merguiensis*) are the Penaeid shrimp species most extensively exploited. Populations of mangrove crab have also suffered the negative consequences of overexploitation, especially in areas adjacent to high population centres.

4. HABITATS & AREAS OF IMPORTANCE IN THE MAINTENANCE OF EXPLOITED FISH STOCKS

The Sunda Shelf of the South China Sea extends through the Java and Timor Seas, and after an interruption by the deep basin of the Banda Sea, extends to the Sahul Shelf of Northern Australia (Longhurst and Pauly, 1987). This shelf is usually shallow: the central part is less than 100m deep, whilst between Sumatra and Kalimantan it is only 10 to 40 m deep.

As part of the Southeast Asian region, double monsoons, as well as the effects of climate change on sea level in the Pacific Ocean, and Pacific to Indian Ocean through flows, significantly influence the South China Sea (Sharp 1966). The north monsoon starts in October and peaks in January, pushing surface currents in a southerly direction until they reach the equator, where they are deflected southeastward.

Rates of through flow depend on both sea level and surface wind speed and direction. The south monsoon peaks in July and August, when southward transport dominates the water column. This is because surface winds affect the surface currents, and there is always a substantial sea level difference driving the movement of water from the Pacific Ocean to the Indian Ocean. Year to year climate-driven ocean variability, at both local and regional scales, plays an important role in fisheries of the South China Sea region.

The fishery situation in the South China Sea region is further complicated by the dominance of shoal topography, dominated by either coral reef or mangrove ecosystems. Both are affected by the strong vertical stratification set up by monsoonal rainfall and the large seasonal inflow of fresh water from rivers of the Sumatra and Kalimantan Islands. Accordingly, ecological dynamics of the South China Sea area reflect regional climate dynamics.

4.1 Physical, chemical, and biological characteristics

Some topographical features of Southeast Asia favour the development of strong surface circulation. The main feature is associated with the area formed by the South China Sea, the straits between Sumatra and Kalimantan, the Java Sea, the Flores Sea, and the Banda Sea, which has its main axis aligned with wind flux during both monsoons. This, along with the relative constancy of the winds, favours the development of surface circulation patterns strongly connected to the wind regime (Roy 1996).

High sea surface temperature (SST) (>25°C) and low seasonal amplitude (<3°C) are the dominant characteristics of Southeast Asian waters. Moreover, the spatial distribution of water temperature is relatively uniform, with a small gradient over the entire region. SSTs are high all year round with maximum values of 27.5°C observed during January and February in the southern part of the South China Sea. Maximum values are observed to be between 29.2°C (Sunda Strait) and 29.8°C (Malacca Strait).

High annual rainfall, largely exceeding evaporation, causes an average salinity of less than 34ppt. This rainfall, the river runoff it causes, and the archipelagic nature of the South China Sea region are responsible for an extremely variable spatial distribution of surface salinity. River runoff into the South China Sea drives low salinity levels in many coastal waters, even in some offshore areas. Low salinity levels are most common in April and May when water masses are transported from the Java Sea into the southern South China Sea. In June, water of higher salinity (>32ppt) enters the Java Sea from the east, and then moves further north into the southern part of the South China Sea. During the northeast monsoon, relatively high salinity levels are observed in the South China Sea.

Sediments are extremely sandy (mostly made up biogenic materials from coral reefs) in the straits between some of the major islands, such as the Malacca Strait. In the deeper areas to the north, as the Sunda Shelf slopes into the South China Sea basin, sediments are mostly soft mud (Longhurst and Pauly 1987).

The fish communities, on which tropical fisheries are based, typically follow the distribution and abundance patterns of their main dietary items, including benthic and pelagic invertebrates (Longhurst and Pauly, 1987). The demersal fish fauna of Indonesia's South China Sea area is determined by environmental factors, including the amount of organic mud in the substrate, the occurrence of isolated patches of rocky or biogenic reefs, the occurrence of brackish, estuarine conditions associated with river mouths, and the nature of the oceanic water mass lying over the waters.

There is a great wealth and diversity of pelagic fish in the South China Sea, and important fisheries are based upon them. Pelagic fisheries in the South China Sea are based on a variety of different taxonomic groups, some of which belong to stocks shared by a number of regional nations.

The marine habitats of the South China Sea and its adjacent waters are unique. Here, the interaction of land and sea creates complex systems where local processes may prevail over global dynamics. In addition, the monsoon regimes create such a strong seasonality of the characteristic of the environment. The alternation of the north and south winds completely reorganise surface circulation, which can be expected to significantly influence environmental conditions.

4.1.1 Spawning and nursery grounds

Fishes are well known for their high fecundity, with most species releasing thousands to millions of eggs annually (Bond 1979). Since each fish species occurs under a unique set of ecological conditions, it has a unique reproductive strategy, with special anatomical, behavioral, pysiological, and energetic adaptation. The success of any fish species is ultimately determined by the ability of its members to reproduce successfully in a fluctuating environment, thereby maintaining viable populations. Based on their reproductive strategy, fishes can be categorised into egg-layers (oviparous condition) and live-bearers (ovoviviparous, viviparous).

Some fishes engage in mass spawning. Spawning often occurs after migration to a suitable site, and into a current that will carry eggs and larvae to a nursery area. Pelagic spawners spawn in open waters, often near the surface. Many such spawners are schooling fishes, such as tuna (Scombridae) and sardines (*Sardinella*). Although pelagic spawning is most often associated with pelagic fishes, many benthic fishes temporarily rise off the bottom to spawn. Benthic spawners are of three basic types, those that spawn on gravel or rocks, those that spawn on aquatic plants, and those that spawn on sand.

Spawning grounds of demersal species are close to coastal waters of the South China Sea, where eggs can settle on the substrate or adhere to vegetation. Demersal fish spawning grounds are concentrated along the east cost of Sumatra, coastal waters adjacent to the many islands of Riau Province, Bangka and Belitung Islands province, and along the west coast of Kalimantan. Whilst pelagic fish spawning and nursery grounds are scattered in the 'open waters' of the South China Sea, specifically from the north of the southern Bangka and Belitung Islands to Natuna Islands in the north (Figures 3 and 4).

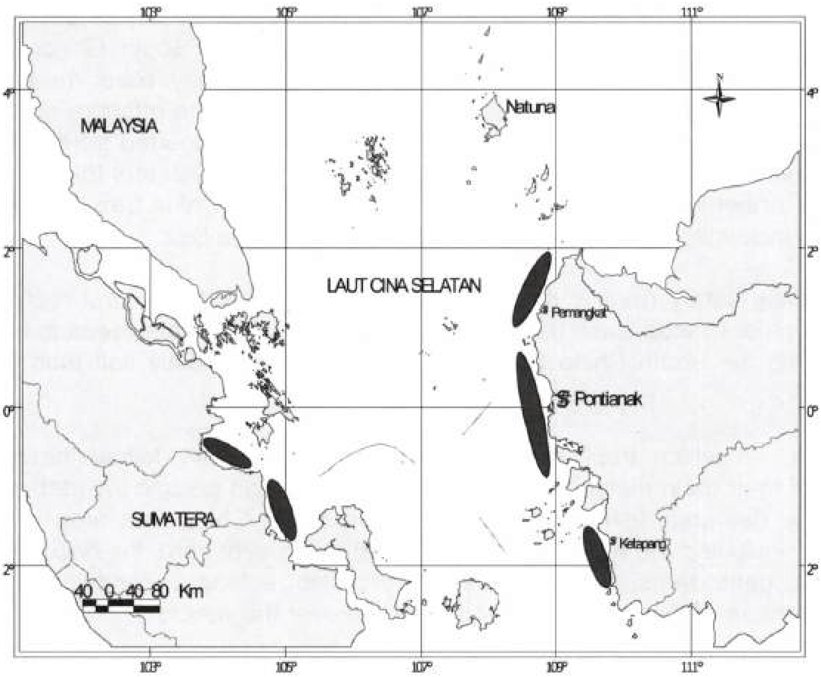

Figure 3 Spawning areas of demersal finfish and small pelagic fish species in Indonesia's South China Sea area (Sumiono and Widodo 2003).

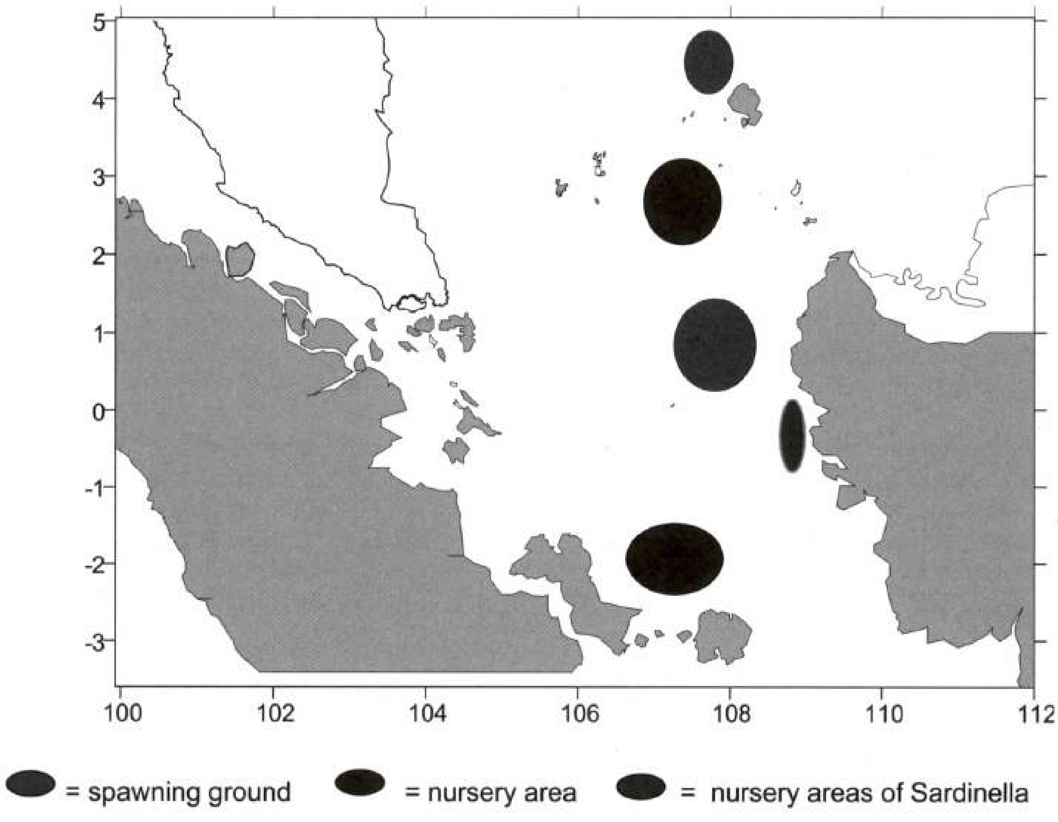

Figure 4 Spawning and nursery grounds of small pelagic fishes in Indonesia's South China Sea area (Haryati *et al.*, 2003).

4.1.2 Fishing grounds

Most fisheries in Indonesia and, in particular, the pelagic fisheries in the South China Sea are seasonal (Bailey *et al.* 1987). The fish resources of the South China Sea can be classified as small pelagic fishes, large pelagic fishes, and demersal finfish and invertebrates. Most of the central part of the Indonesian South China Sea is a trawlable area suitable for demersal fishing. Additionally, demersal fishing grounds are also located in the coastal waters along the east coast of Sumatra and west coast of Kalimantan Islands.

Small pelagic fishes can be harvested almost anywhere in the South China Sea, including coastal and offshore waters. Fishing grounds for large pelagic species are concentrated in northern waters, especially oceanic waters of high salinity (Figure 4).

4.2 Stocks with undefined spawning grounds

The spawning grounds of some species of small pelagic fishes, including *Decapterus* spp. and *Rastrelliger kanagurta*, and some large pelagic species, including skipjack and other tuna, have not yet been determined.

4.3 Threats (current and potential)

Coastal sand mining is being conducted on several islands of Riau Province. These activities can potentially threaten the spawning, feeding, and fishing grounds of fish caught by artisanal fishers. Additionally, deforestation of mangroves is occurring, especially on the eastern coast of Sumatra Island. Finally, destructive fishing practices are used throughout Indonesia, especially in coral reef areas.

4.4 Ranking of habitats

4.4.1 Association with species of importance to food security

Habitats along the eastern coast of Sumatra Island and the western coast of Kalimantan Island play a significant role in sustaining populations of fish important for food security. In these coastal areas, there are a large number of artisanal fishers. Artisanal fisheries are an important source of food, income, and employment in these regions.

4.4.2 Association with high values species

Habitats along the eastern coast of Sumatra Island and western coast of Kalimantan Island play an important role in preserving high value fish species, including large demersal reef fish and a number of penaeid shrimps species. Wild shrimp production still exceeds that from aquaculture.

4.4.3 Association with endangered, rare, threatened species

Habitats along the eastern coast of Sumatra Island, western coast of Kalimantan Island, and north of the Bangka and Belitung Islands, are important habitats for endangered, rare, and threatened species, especially reef fishes.

5. CURRENT MANAGEMENT REGIMES

5.1 Legal instruments

A large number of laws and regulations comprise Indonesia's legal framework for fisheries. Many of these regulations are valid for some parts of the South China Sea under Indonesia's jurisdiction.

Indonesia is an archipelagic State made up more than 17,500 islands. With a vast mass of water surrounding small pockets of land, Indonesia's marine and coastal areas contain a diverse and rich range of living aquatic resources. Approximately 8,500 fish species, 2,000 crustacean species, 20,000 mollusc species, 30 marine mammals species, and 6 species of sea turtles inhabit Indonesian waters. All of these species are fisheries resources according to Act No.9 of 1985 concerning fisheries. According to this law, the fishery sector is responsible for the management of these species. This basic Act should be read together with law no.5 of 1983, which, among other things, designates the officers qualified to enforce fisheries laws within Indonesia's EEZ, and defines law enforcement procedures.

The Fisheries Act no.9 of 1985 established a licensing regulation, whereby any individual or legal entity wishing to engage in fishing activities in Indonesian waters is required to be properly licensed. Subsistence fishers are not subject to this requirement. As a rule, fishing in Indonesian waters is restricted to Indonesian nationals or Indonesian legal entities, unless the national fleet does not have the capacity to harvest the total allowable catch as set by the minister with responsibility for fisheries management.

Furthermore, the Government Regulation no. 15 of 1990, juncto Government Regulation no. 141 of 2000 concerning Fisheries Business, and some other Ministerial Decrees, such as the Ministerial Decree no.15 of 1990 juncto the Ministerial Decree no 428 of 1999, were issued to detail the rules and procedures governing the licensing system.

The issuance of Act no.22 of 1999 concerning Regional Administration caused some modification to Act no.9 of 1985, including regulations for "Fishing Zones" and "Fish Aggregating Devices".

Following recent discussions with all Provincial Fisheries Services of Indonesia, and officials within the Ministry of Marine Affairs and Fisheries, the Act no.9 of 1985 is currently being revised.

The management and protection of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed species is the responsibility of the Directorate General of Forest Protection and Nature Conservation (PHPA), Ministry of Forestry.

5.2 Institutional arrangements (research, monitoring, control, and enforcement)

The rapid economic development and population growth of Indonesia over the past several decades has accelerated the loss of natural habitat and biodiversity. This is particularly evident in the coastal zone, where human populations are growing at more than twice the national average. Historically, coastal economies have prospered from trade and fisheries.

Coastal economies are now more diverse, including extraction of oil and minerals, aquaculture, forestry, recreation and tourism. However, the diverse needs of a large and growing coastal population, especially in the coastal areas of western Indonesia, are limited by a fixed supply of coastal resources (carrying capacity).

Based on information from the Central Research Institute of Marine Fisheries of Indonesia (CRIFI), the study of small pelagic fishes and fish stock abundance began in 1972. The occurrence of pelagic fishes around Karimata Island was detected during collaborative trawl surveys conducted by Indonesian and German Governments in 1975 and 1978.

Acoustic surveys of pelagic fish stocks were conducted during late 1985 in the waters adjacent to Natuna and Anambas Islands. The estimated pelagic fish stock in both areas was 150,000 tonnes and 183,000 tonnes, respectively.

Indonesia's South China Sea area is 550,000km^2, with a potential annual yield of small pelagic fishes of 506,000 tonnes. Based on research conducted by CRIFI, it is believed that 30% of this potential yield is caught annually.

The result of acoustic surveys conducted in September and October 2001 showed a density of small pelagic fishes in Indonesia's South China Sea waters of approximately 162 fishes per 1000m^3. The high density of the fish occurred in surrounding islands was low density occurred in certain areas. The average density of large pelagic fishes was 0.32 tonnes per km^2 or 1.1 tonnes per km^3, whereas the small pelagic density was 2.26 tonnes per km^2.

The results of these surveys also indicated that small pelagic fishes had been overexploited in several areas, especially in traditional fishing areas including eastern Sumatra in the South China Sea area. The Javanese purse-seine fleet has intensely exploited the pelagic resources of Indonesia's territorial waters and EEZ since 1983. This has been accompanied by investment in new large vessels (80 to 100 GT) and improvement in fishing methods, including the use of artificial light and fish aggregating devices (FADs). During 2000, the number of fishing boats in West Kalimantan was 216 units (10 to 20 GT), 54 units (20 to 30 GT), and 28 units (30 to 50 GT). Of these fishing boats, 110 used purse seines.

Monitoring, Control, and Surveillance (MCS) is a very important part of Indonesian fisheries management. Despite there being very few rules or regulations pertaining to fisheries in Indonesia, compliance levels are low and enforcement is weak.

Monitoring: implementation based on the Ministerial Decree no.03 of 2002, which requires the use of a fisheries logbook by certain sizes of fishing boats.

Control: implementation based on various legal instruments, including 4 Acts, 7 Government Regulations, 5 Presidential Decrees/Instructions, and more than 20 Ministerial Decrees.

Surveillance: Surveillance is conducted by WASKI. WASKI in cooperation with the Navy and Police Enforcement, Law Enforcement is being implemented through PPNS in cooperation with the Attorney General.

Recently, the abundance of some of these species has declined at an alarming rate, whilst some others have suffered depletion. Despite the importance of marine resources to Indonesia's economy and environment, the sustainable management of these resources has not occurred. The pressure on marine resources is growing rapidly, and many fishers have adopted the use of destructive, non-sustainable fishing methods in the race for fish. The result thus far, has involved the degradation of aquatic habitats and the overexploitation of fisheries resources.

Realising that demand for fish resources is probably greater than the productive capacity of Indonesia's waters, the Government of Indonesia has instituted a range of initiatives aimed at sustaining biodiversity. These include the:

a. Establishment of artificial rearing and restocking programs for endangered species;
b. Establishment and management of conservation areas;
c. Use of restocking in fisheries management;
d. Preparation of a gene bank as a buffer for species of high economic value;
e. Establishment of quotas and methods for controlling fishing effort appropriate to these; and
f. Development of a network of researchers (Indonesian Network on Fish Genetic Research and Development).

5.3 The Government of Indonesia's Policy to Overcome Iuu Fishing Practices

A key problem encountered in the development of marine affairs and the fisheries sector in Indonesia is that of illegal fishing, particularly in the Indonesian EEZ. The utilisation of fish resources within Indonesia's EEZ is high, although the benefits accrued by Indonesia are insufficient. At present, approximately 70% of the 7000 fishing boats licensed to operate in Indonesia's EEZ are foreign owned. In this setting, Indonesia may incur losses as a result of the following:

- Foreign fishing boats (licensed to fish in Indonesian vessels) buying diesel fuel at domestic prices (Indonesian Rupiah) that are relatively low.
- The loss of export earnings since large volumes of catch are landed in foreign jurisdictions.
- Foreign fishing boats using foreign crews, causing the skill development fund obtained by the Government to be lower than it should be.
- Foreign fishing boats not paying fees as appropriate.
- Foreign fishing boats violating fisheries rules and regulations by catching fish in territorial waters.

Losses are estimated to be US$1.36billion per year. Specific losses include:

- Loss of fuel price differences: US$ 0.24 billion
- Loss of country earnings: US$ 1.00 billion
- Loss of skill developing fund: US$ 0.02 billion
- Loss of unpaid fees: US$ 0.10 billion

In reference to an FAO report, up to 1.5 million tonnes (or US$1 to 4 billion) of fish are caught illegally each year. Other losses include those relating to national sovereignty and pride.

5.4 Overview of patterns of resource ownership and traditional utilisation

As mentioned previously, Indonesian fishers operating in the South China Sea are mainly based in the Provinces of Riau, Jambi, South Sumatra, and West Kalimantan.

In the Indonesian sense, traditional or small-scale fisheries involve fishers using only 1 fishing boat, either non-powered, or powered by an out-board or an in-board motor less than 5 GT, and fishing only for subsistence purposes.

In some parts of Indonesia, there is traditional community based fisheries management, such as in Maluku and Aceh provinces. However, in case of the South China Sea, there is an Indonesia-Malaysia Agreement on Malaysian Traditional Fishing Rights in the Indonesian Archipelagic Waters and EEZ 1982.

The Agreement defined "traditional fishing" as "fishing by Malaysian traditional fishermen using traditional methods in the traditional areas" within the archipelagic waters. Point 7 of the Record of Discussion, dated 25 February 1982, between the 2 countries, also states that the fishing area "shall not include maritime belts of 12 nautical miles, measured from the law water mark, around Indonesian Islands". Point 9 of the Record states that Malaysian traditional fishing rights shall also be exercised "in the designated area in the EEZ" of Indonesia in the South China Sea (see map 2 as attached).

In terms of ownership and exploitation rights, it should be emphasised that, based on the concept of *Mare Liberum,* the sea including the fish within it, is by nature Common and not susceptible to possession. Neither individuals nor governments can claim fish, and their possession is limited only through their being caught. It is a concept that continues to prevail today in Indonesia, despite the number of property rights (e.g., Individual Transferable Quotas) and regulatory regimes that have been adopted in response to the growing awareness of the tendency to overexploit in the open access setting. Therefore, transfer of authority over the exploration, exploitation, and management of fishery resources from the central government to regional and local government does not amount to a transfer of ownership of the fishery resources. Field interviews have revealed that the fundamental distinction between ownership and rights in relation to fishery resource use is not clear. It is therefore important that the central government launch an awareness campaign aimed at explaining the nature of the authority to be transferred to regional and local levels of government.

6. RECOMMENDED ACTIONS

A number of recommendation regarding management action required at the national and regional level have been prepared. These relate to fish resources, habitat degradation, and human resources.

6.1 Fish Resources

Recommendation:

National fisheries statistics are collected and analysed mainly based upon the reports delivered by provincial fisheries offices. The main sources of the fisheries data are those of fisheries reports from a large number of fish landing sites. The reporting system from landing sites to local fisheries offices should be improved in order to obtain continuous data that meets quantitative and qualitative standards.

National Plan of Action:

(i) Detailed regional level fisheries statistical data, especially relating to catch and effort, should be collected from Indonesia's South China Sea area at least once every 5 years, in order to enable the assessment of changes in the total catch (species and size compositions), catch per unit effort, and species diversity, abundance and distribution.

(ii) Special surveys on the spawning, feeding, and nursery areas of economically, ecologically, and regionally important species need to be carried out in South China Sea areas subjected to high levels of fishing effort and habitat alteration or degradation

Regional Plan of Action:

(i) It is necessary to carry out a regional survey concerning transboundary, migratory, straddling, shared, and endangered species. The results of this survey may assist the formulation of management strategies for fisheries involving these species.

(ii) A regional institutional arrangement should be established to implement management measures for transboundary fish stocks (including combating IUU fishing in the region) that have been agreed to by countries bordering the South China Sea.

6.2 Habitat Degradation

Recommendation:

Rehabilitation of habitats used for spawning, feeding, nursery areas, and fishing for transboundary species of the South China Sea needs to be carried out as soon as possible. Involvement of local communities should be encouraged through targeted educational programs.

National Plan of Action

In reversing the degradation of habitats used for spawning, feeding, nursery, and fishing for transboundary species, it is urgent that institutions are empowered to enforce laws relating to the deforestation of mangroves, destructive fishing practices, and sand mining. Involvement of local communities should be encouraged through targeted educational programs.

Regional Plan of Action

A regional institutional arrangement may play an important role in reversing the habitat degradation that is having wide-ranging negative impacts on the spawning, feeding, nursery, and fishing grounds for transboundary species in the region.

6.3 Human Resources

Recommendation:

Institutional arrangements are needed to avoid the conflicts of interest among national and regional fishers exploiting similar and limited transboundary fish resources in South China Sea waters.

National Plan of Action

The fish resources of the South China Sea are not only being harvested by local fishers, but also by fishers from other part of Indonesia. Institutional arrangements are needed to avoid the conflicts of interest among fishers exploiting similar and limited fish resources in South China Sea waters.

Regional Plan of Action

(i) Regionally, fishers of different nations exploit the fish resources of the South China Sea. Institutional arrangements are needed to avoid the conflicts of interest among fishers exploiting similar and limited transboundary fish resources in South China Sea waters.

(ii) Regional training in fisheries statistics, especially regarding sampling techniques, and data management needs to be carried out in order to obtain fisheries data that is compatible across the whole South China Sea area.

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NATIONAL REPORT

on

The Fish Stocks and Habitats of Regional, Global and Transboundary Significance in the South China Sea

PHILIPPINES

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1. BACKGROUND INFORMATION

1.1 Geographic and oceanographic description

The Philippines (**Figure 1**) is an archipelago with an Exclusive Economic Zone (EEZ) of 2,200,000km^2, of which 266,000km^2 is coastal (12%) and 1,934,000km^2 is oceanic (88%). Its shelf area covers 184,600km^2, with the coral reefs spanning 30,000km^2. Four major water bodies surround the archipelago: the Pacific Ocean in the east; the Celebes Sea in the south; the South China Sea (SCS) in the west; and the Philippine Sea in the north. Its bathymetric features are complex, consisting of various trenches, submarine ridges, deep-sea basins, island arcs, and plateaus.

The North Pacific Equatorial Current mainly influences the properties and dynamics of eastern Philippine waters. This current flows from the Pacific Ocean toward the eastern coast of the archipelago and then splits into a northward branch generating the Kuroshio Current and a southward branch that deflects eastward across the Pacific Equatorial Counter Current, with a minor stream forming the Mindanao Current flowing toward the Celebes (or Sulawesi) Sea. On the other hand, seasonal monsoon winds have the dominant effects on the surface circulation of western Philippine waters. An eddy reportedly forms on the western side and encloses a warm water patch whose position shifts with the season; such an eddy is vertically smaller than the eddy that dominates the water circulation off eastern Luzon (Ronquillo 1975). Eddies in the SCS are predominantly cyclonic in winter and anticyclonic in summer, with sizes from small to medium scale. During the northeast monsoon (October to March), a southwesterly flow, originating from a cyclonic pattern of surface water movements in the SCS, develops along the coast of Luzon and Palawan. In the same season, Wyrtki (1961) found that surface water masses from the Pacific Ocean are transported into the SCS through the Luzon Strait, mainly along the western side of the SCS at depths from 400 to 900m. This condition reverses during the summer season; Western Pacific waters enter the northern SCS through the Luzon Strait and, after mixing, form distinct water masses. Continental freshwater runoff is also very significant. The dominant current during the southwest monsoon (April–August) flows in a northeasterly direction through the Luzon Strait and into the West Philippine Sea (Wyrtki 1961; Barut *et al.* 1997).

The marine environment of the Philippines is typically tropical, with relatively warm and less saline waters. Sea surface temperature varies between 24 and 30°C, depending on the season but with mean values varying slightly between 27 and 28°C. Mean annual range in the temperature of waters west of Luzon is around 5°C. Salinity variations are relatively narrow; in the west-northwest part of the Philippines, sea surface salinity ranges from 33.7 to 34.6 psu (Rojana-anawat *et al.* 2000). The South China Sea portion exhibits a marked reduction in surface salinity during the southwest monsoon as the western part of the archipelago experiences the rainy season. Temperature decreases with depth by 0.03°C/m from the surface to 200 m depth. The thermocline layer, ranging from 12 to 15°C, occurs at 150m depth on the western side (Rojana-anawat *et al.* 2000), which is thinner and shallower than the thermocline formation on the eastern side of the archipelago. Recent estimates of primary productivity in the northern SCS portion ranged from 0.10 to 1.53gC/m^2/d (Furio and Borja 2000).

Water quality of the western Philippines has shown signs of deterioration. Saramun and Wattayakorn (2000) found DDPH (dissolved dispersed petroleum hydrocarbons) in the area, at concentrations of 0.03 to 0.47 µg/l and 0.02 to 1.47 µg/l for the nearshore and offshore zones, respectively. The DDPH were attributed to maritime and shipping activities, as well as oil exploration and production in the west and northwest area of the Philippines. Several areas along the SCS side of the Philippines are identified as pollution hotspots (Talaue-McManus 2000). Pollutive effects have been attributed to high sediment loading and waste disposal, mostly of anthropogenic origin, that may severely affect marine habitats in the SCS. Various forms of waste come from domestic, industrial, and agricultural sources, causing the degradation of aquatic environments. The possible eutrophication effect of agricultural runoff, which may trigger harmful algal blooms, is a major concern. The pollution threat of Manila Bay, Subic Bay, and Batangas Bay to the waters of the SCS is clear, given the presence of industrial estates and oil refineries/depots around these bays. Other areas at high risk and exhibiting a strong sensitivity to pollution include Masinloc Bay (Zambales), Bacuit Bay (Palawan), and Apo Reef (Mindoro).

1.2 Biogeographic and demographic features

The South China Sea portion of the Philippines is geographically delimited by western Luzon, Palawan, and Mindoro Occidental, covering administrative regions I and III, and parts of Region IV and the National Capital Region (NCR). In dealing with aquatic resources in the area, especially fisheries, data constitute those obtained from the extensive coast and several embayments along western Luzon, including the Batanes Islands further north, as well as from western Palawan waters and the northern Mindoro coast (**Figures 1 and 14**). A review of demographic profile, resource accounting, and environmental assessment of the area is provided in Talaue-McManus (2000), with related data on other countries bordering the SCS. The SCS portion of the Philippines, excluding Batanes Islands, is around 50,000km^2, harbouring 16 cities and a total population of 26.3 million people (from 1996 data in Talaue-McManus 2003). Population density in the same year stands at 472 persons/km^2, with a finite growth rate of 2.1%. The area has a watershed spanning 27,500km^2, with five major rivers emptying into the SCS.

Mangroves, coral reefs, and seagrasses abound along the South China Sea side of the archipelago, but measures of total coverage of these resources for the SCS sub-region are lacking. These vital resources, which serve prominently as crucial habitats for diverse marine life, have been under severe stress and the threats of further destruction remain unabated. Nationwide, the total cover of mangroves in the Philippines has declined by 60%, with only 160,000ha remaining at present. Over a 70-year period, a mean loss rate of 460ha/y translates to around US$1.7 million that is lost to the local economy. Two-thirds of the mangrove forests around the entire SCS, including those found in other countries, have been decimated due to human utilisation and intervention. Coral reefs along the SCS coast of the Philippines exhibit a degradation rate ranging from 10 to 30%, and about 50% of the remaining stands are at high-risk. Similarly, around 30 to 50% of Philippine seagrass beds have been severely damaged, with the SCS-wide meadows experiencing the same rates of loss. The rampant destruction of these resources is mostly attributed to irresponsible resource-use practices, reflecting a widespread disregard of their crucial ecological roles.

The distribution and condition of mangroves, corals, and seagrasses, along with their associated fauna and flora, within the Philippine territory of the South China Sea are detailed below. The transboundary relevance of these resources mainly pertains to the cross-border effects of losses in biodiversity and fisheries productivity, along with issues associated with the trade of threatened species (*e.g.* seahorses and marine turtles) and the sharing of responsibilities for conservation and management in the region.

1.3 Overview of the fisheries sector

The fisheries sector of the Philippines is composed of culture and capture sub-sectors. Fishing is classified into municipal or commercial type, depending on the gross tonnage (GT) of the boats used. Municipal fishing includes activities not requiring the use of boats and those using boats not more than 3 GT. Commercial fishing involves the use of boats more than 3 GT. The Philippine Fisheries Code, enacted in 1998, prohibits commercial fishing within municipal waters whose designated offshore boundary is 15 km from the shoreline. This practically grants the right of access to nearshore fishing grounds exclusively to municipal fishers, whose population far exceeds that of commercial fishers. However, with this right comes greater accountability and regulatory control. Municipal fishers secure licences to fish from local government units (LGUs), whereas commercial fishers obtain licences from the Bureau of Fisheries and Aquatic Resources (BFAR), which also issues licences to fish in international waters.

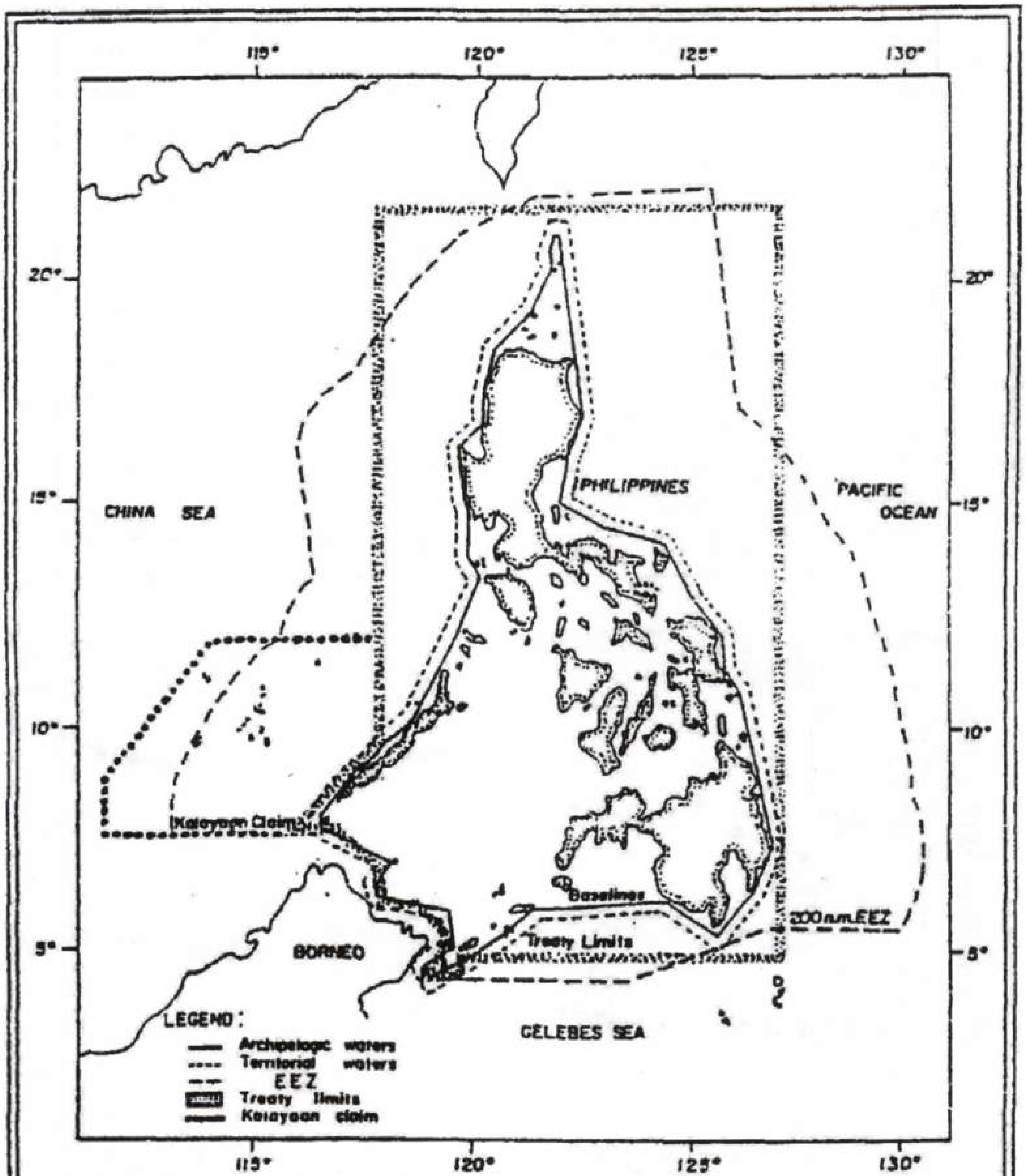

Figure 1 Philippine Marine Jurisdictional Boundaries.

Table 1 Total fish landings (MT) by region in 1997 to 2001. Regions that interact with the South China Sea, wholly or partly, are highlighted.

Region	1997	1998	1999	2000	2001
CAR	1,417	1,650	3,318	3,279	3,570
I	41,308	48,871	52,972	60,805	63,617
II	21,542	22,187	30,475	35,202	38,417
III	121,752	112,333	116,138	136,810	181,364
NCR	215,114	220,395	165,517	147,959	146,487
IV	607,184	588,866	613,107	643,315	619,858
V	119,352	113,282	111,947	115,065	150,514
VI	320,961	309,174	337,070	356,998	357,596
VII	153,970	152,332	159,243	164,545	191,531
VIII	73,707	72,312	76,200	78,728	91,318
IX	392,526	409,750	405,181	407,220	398,083
X	56,949	57,539	63,746	67,738	84,187
XI	41,996	41,141	44,481	45,170	49,180
XII	100,256	142,805	180,927	188,323	192,508
ARMM	455,893	468,790	482,907	453,912	505,096
CARAGA	69,629	68,093	80,543	88,263	93,204
Total	**2,793,556**	**2,829,520**	**2,923,772**	**2,993,332**	**3,166,530**

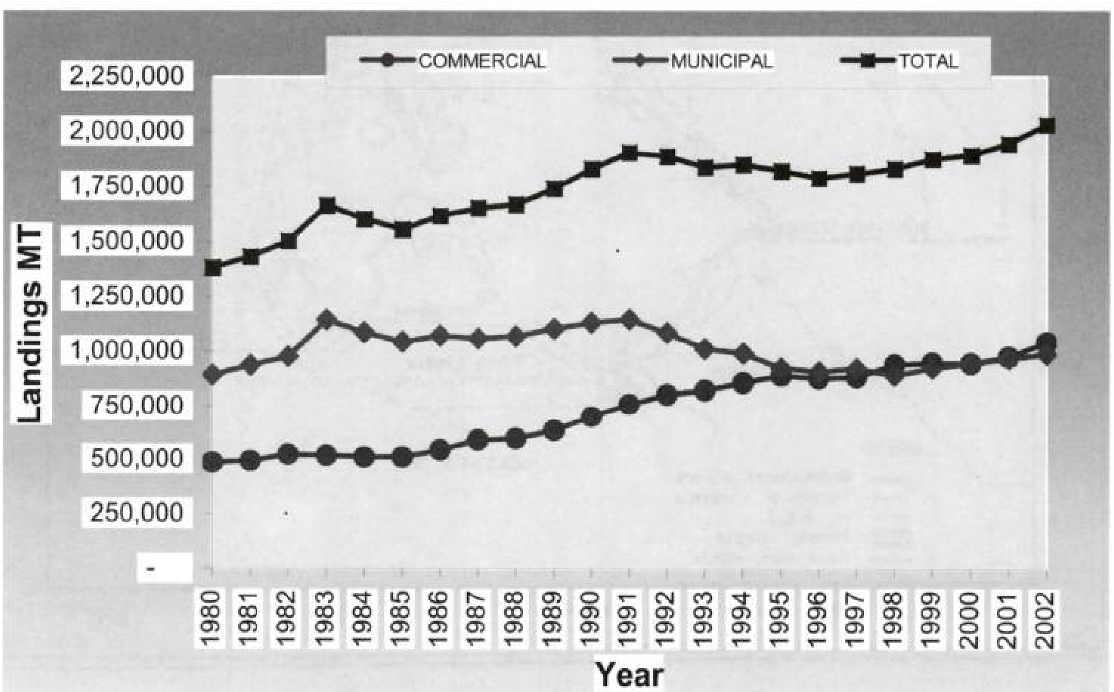

Figure 2 Total marine fish landings (MT) of the Philippines by sector in 1980 to 2002.

1.3.1 Total landings by fishing area

Fisheries constitute an important component of the agricultural sector in the Philippines. Total fish landings increased steadily from 1980 to 2002, with the commercial yield increasing from 488,478 MT in 1980 to 1,042,193 MT in 2002 (**Figure 2**). In contrast, total municipal landings declined from the early 1990s until 1998, but peaked slightly from 1999 to 2002 (**Figure 2**). The total marine fish landings by administrative region are presented in **Table 1**. Fish landings from Regions I and III, including parts of Region IV and the NCR, constitute the catches from the SCS area (**Figures 3 and 4**). **Figure 5** shows the different fishing grounds, which in Philippine waters are designated into statistical areas, including the SCS sub-region. The landing sites monitored by the National Stock Assessment Program are also indicated.

The SCS is one of the most important fishing grounds in the country. Although continuous fishing takes place during the first semester of each year, the volume of fish catch contributes significantly to total fish production. During the second semester, inclement weather associated with the southwest monsoon hinders commercial fishing, thus commercial operations occur during periods of calm weather conditions while municipal fishing takes place throughout the year. There are no direct records of landings from the SCS portion of the Philippines. To provide a rough picture of fisheries exploitation in the area, marine landings of Regions I and III, as well as those of Manila Bay and West Palawan, in 1992 to 1995 are shown in **Table 2**. Although records of landed catch for Regions I and III exist only until 2001, data for Manila Bay and West Palawan are available only until 1995.

Capture fisheries production in the SCS area during 1992 to 1995, ranged from 12 to 17% of total annual production in the Philippines, and was much higher than the 1996 value of 120,592 MT/y reported by Talaue-McManus (2000). As shown in **Table 2**, the commercial sub-sector made the greatest contribution to total marine landings from the SCS, mostly from activities in the West Palawan area. This reflects the relative superiority of commercial fishing technology (*e.g.* purse seines and ringnets). Municipal landings, however, surpassed the commercial landings in West Luzon, except in Manila Bay, possibly due to a large difference in the number of fishers.

Table 2 Philippine marine landings (MT) from the South China Sea area in 1992 to 1995. Values in parenthesis indicate the share (%) of commercial and municipal sub-sectors, respectively.

Year	Region I	Region III	Manila Bay*	West Palawan	Total (SCS area)	Nationwide
1995	23,172 (16/84)	28,607 (21/79)	22,836 (100/na)	162,420 (81/19)	229,786 (68/32)	1,889,226 (49/51)
1994	23,686 (10/90)	17,888 (31/69)	30,386 (100/na)	198,448 (82/18)	260,762 (73/27)	1,838,325 (46/54)
1993	25,364 (10/90)	23,853 (39/61)	38,417 (100/na)	191,110 (79/21)	266,549 (71/29)	1,851,906 (45/55)
1992	21,726 (6/94)	21,908 (37/63)	36,695 (68/32)	234,676 (80/20)	315,005 (71/29)	1,820,275 (43/57)

*- *Municipal landings in 1992 to 1994 not available* (na) *for Manila Bay.*

Commercial fish landings by the major fishing gears are presented in **Figure 6**. At the national level and in terms of total production, purse seine is the most important commercial fishing gear, contributing 47 to 58% of the total marine fish landings in 1992 to 1995, followed by ringnet that contributed 14 to 21% (**Figure 6**). In the case of municipal landings by gear type during the same period, gillnet accounted for 31 to 33% of the total, followed by line gears (hook and line, handline) with 18 to 24% (**Figure 7**). To extract the same data for the SCS-wide fisheries, a ratio and proportion scheme was employed with the assumption that the gear types used and the percent composition of each gear are the same for the nationwide and SCS-wide scales. The gears used specifically within the SCS sub-region must be verified in the future. Considering the limitations of the data used in **Figures 6** and **7**, there is an apparent increase in the landings from purse seines and ringnets for the commercial sub-sector, and gillnets and hook and line for the municipal sub-sector from the SCS area. The dominant municipal gears are relatively size and species selective, and conceivably more suited to the rough sea conditions and the hard ground relief on the SCS side of the archipelago.

1.3.2 Fishing effort by gear

So far, the available records on fishing effort in the SCS area only pertain to registered commercial fishing vessels from Regions I and III **(Table 3)**, without indicating the kind of fishing gears used. Concerning the latter, preliminary inventory indicates that the major gears used in the SCS area are ringnets, purse seines, modified Danish seines, gill nets, handlines, bagnets, and pushnets. Similar data on municipal vessels for the SCS area are unavailable since their registration/licensing are the responsibility of the respective local government units. **Table 3** therefore underestimates the nominal effort for the SCS sub-region; fishing boats from Region IV and the NCR must also be taken into account. Attempt to disaggregate the fishing effort cannot be made without any baseline data on total vessels and gears from the localities constituting the SCS sub-region. This highlights the need for an improved and expanded collection of catch and effort statistics specific to the area.

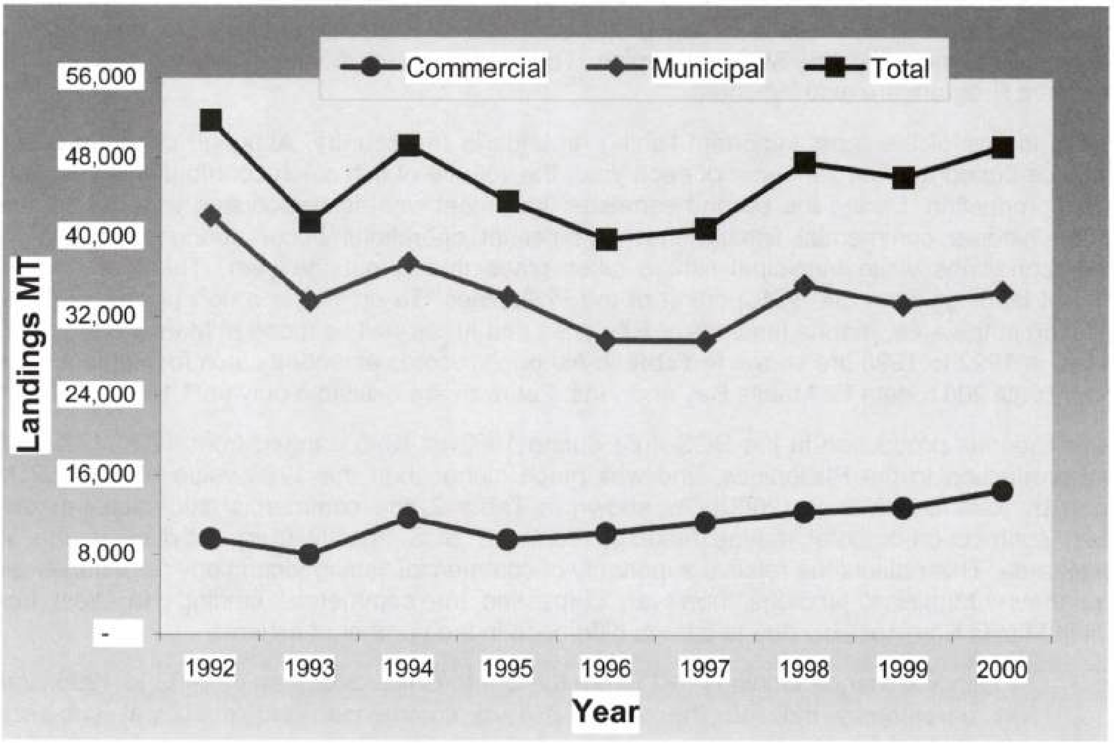

Figure 3 Marine fish landings from western Philippine waters (Regions I and III).

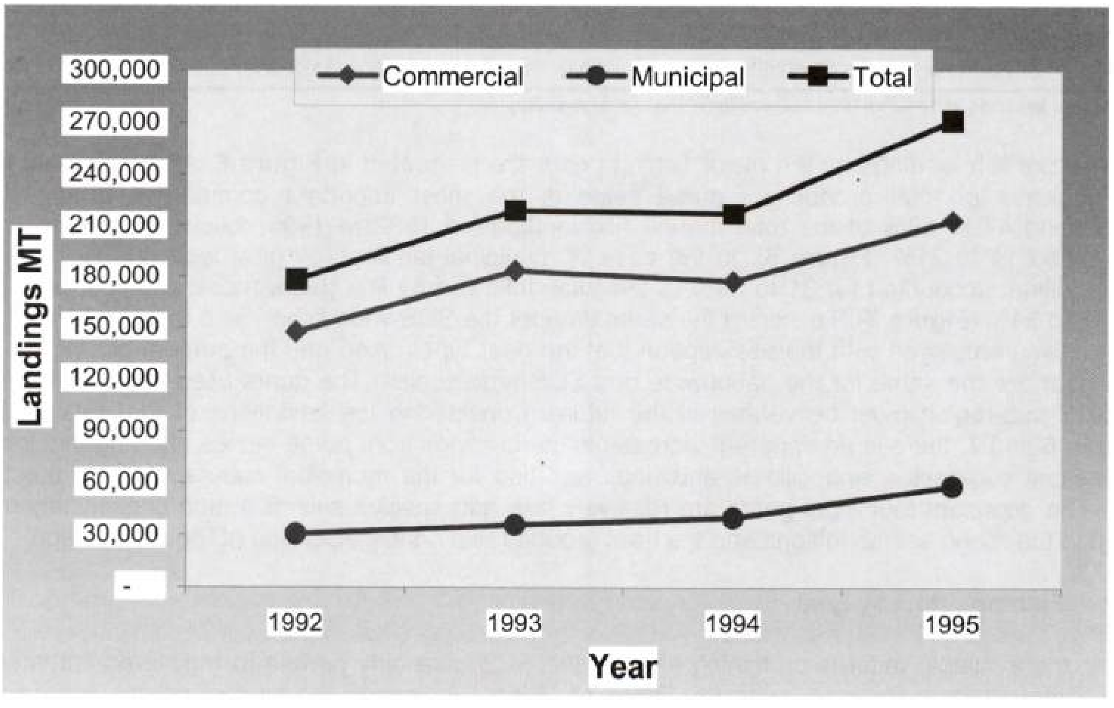

Figure 4 Marine fish landing from western Philippine waters (Manila Bay and West Palawan).

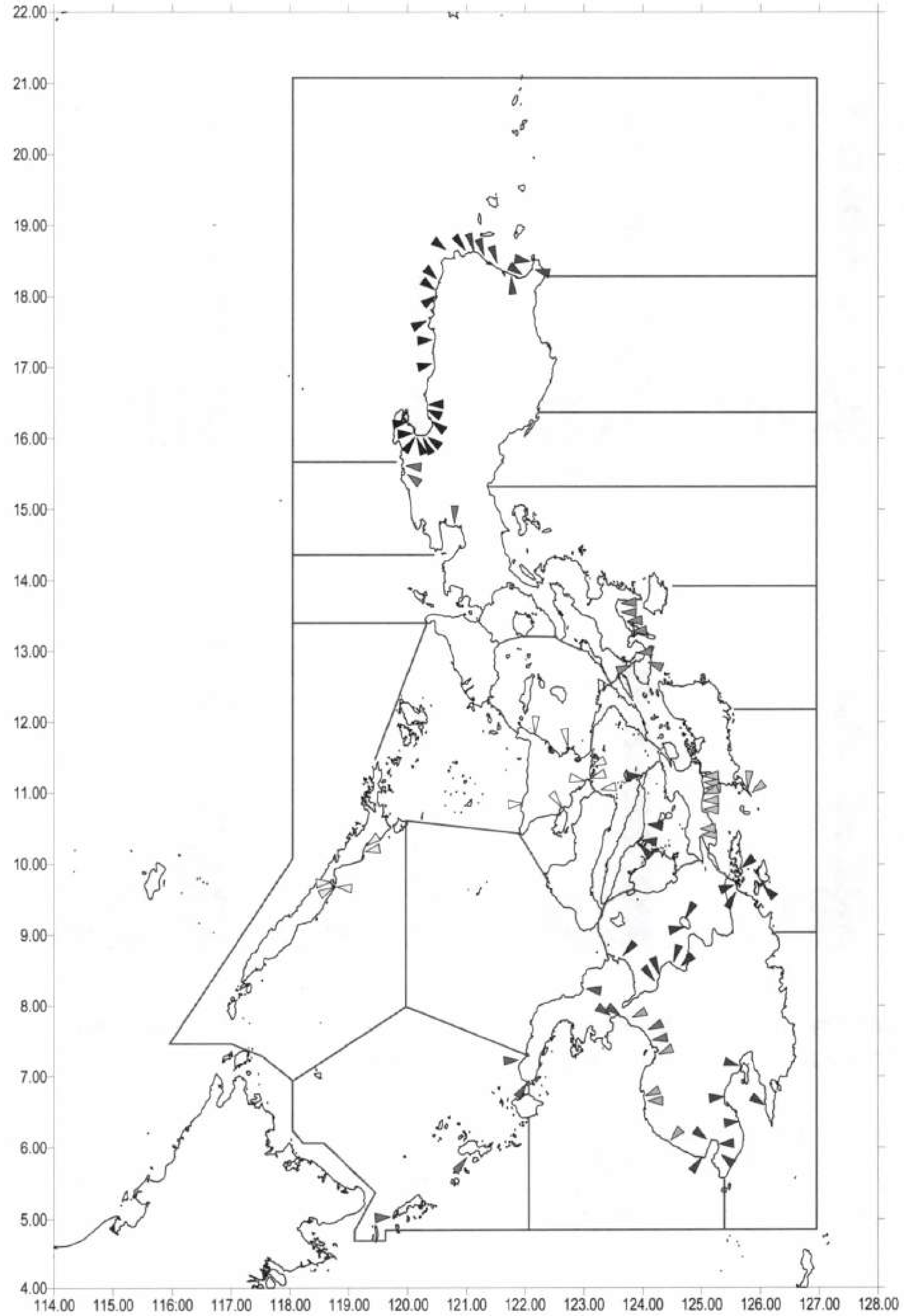

Figure 5 Map of the Philippines showing the different statistical fishing areas (enclosed by lines) and sampling sites per administrative region (arrowheads).

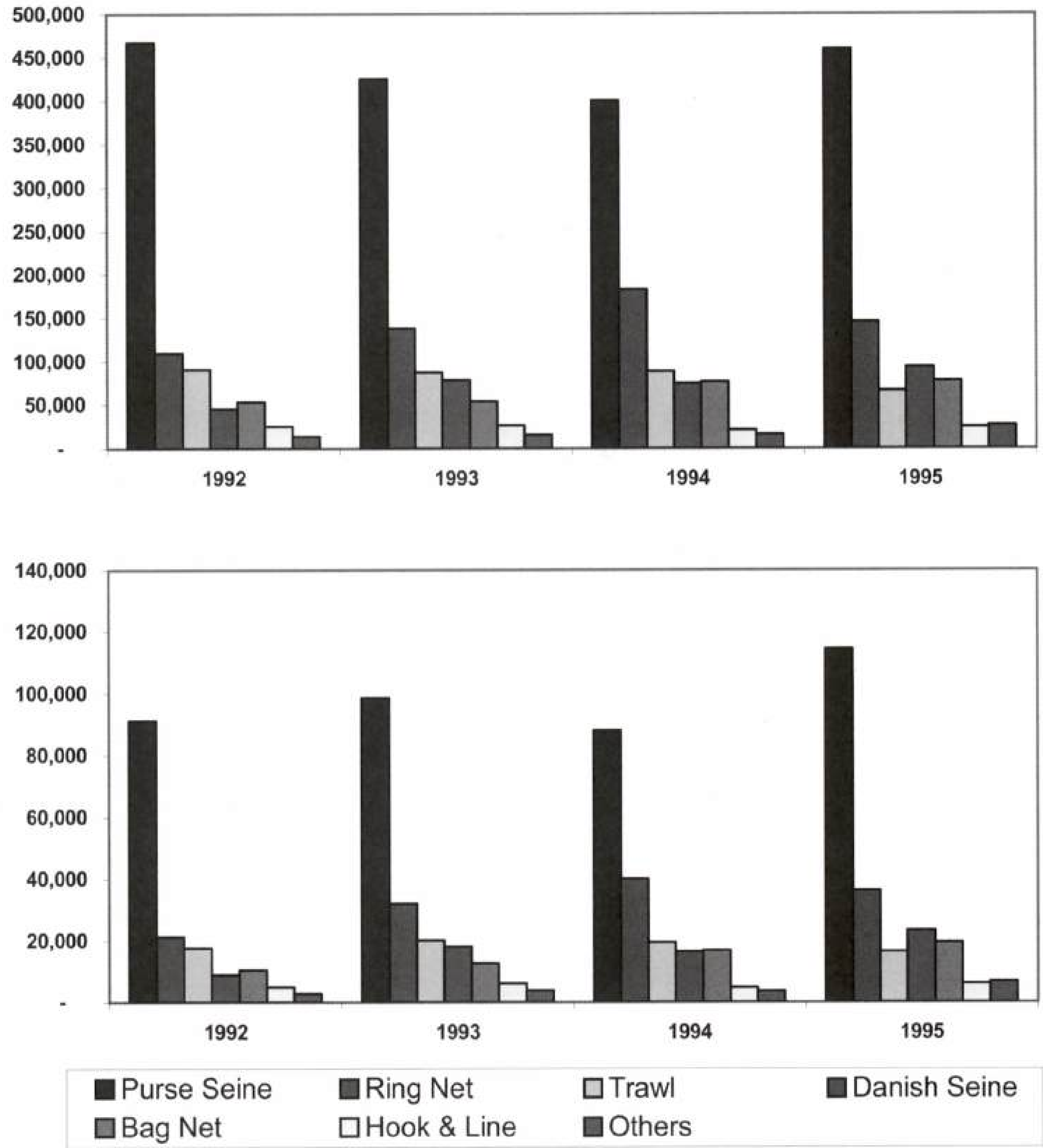

Figure 6 Commercial marine fish landings (MT) by major fishing gear for the entire Philippines (upper panel) and the SCS sub-region (lower panel) in 1992 to 1995. SCS sub-region constitutes landings from Regions I and III, Manila Bay, and West Palawan waters. Gear type and composition (%) per gear assumed the same for the nationwide and SCS-wide scales.

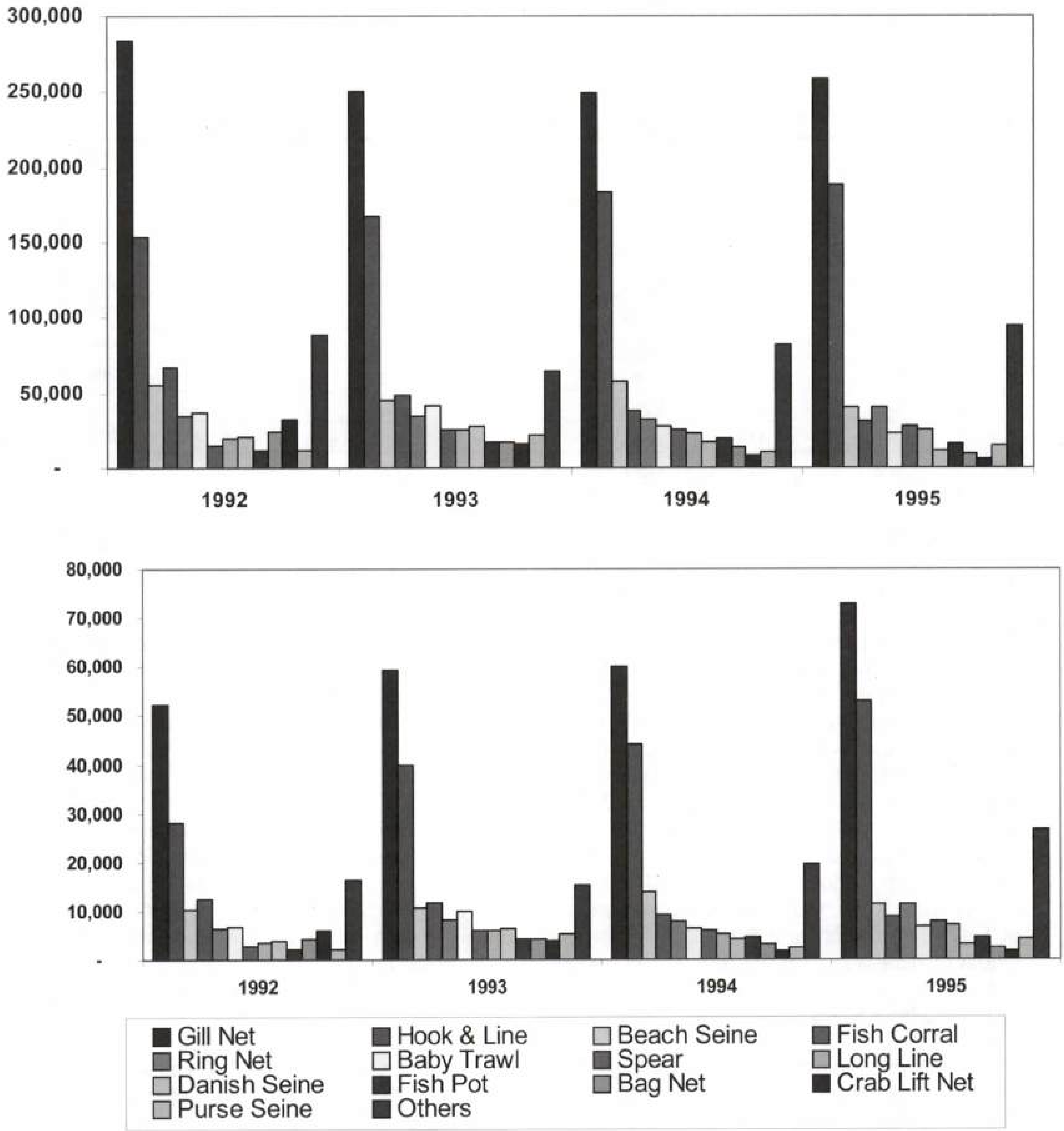

Figure 7 Municipal marine fish landings (MT) by major fishing gear for the entire Philippines (upper panel) and the SCS sub-region (lower panel) in 1992 to 1995. SCS sub-region constitutes landings from Regions I and III, Manila Bay, and West Palawan waters. Gear type and composition (%) per gear were assumed the same for the nationwide and SCS-wide scales.

Table 3 Total Number and Gross Tonnage (GT) of Commercial Fishing Vessels In Regions I and III from1990 to 2002. Na – Not available.

Year	Region I		Region III		Total	
	Number	Total GT	Number	Total GT	Number	Total GT
1990	3	41	27	628	30	668
1991	na	na	na	na	na	na
1992	67	1,366	50	808	117	2,174
1993	na	Na	na	na	na	na
1994	59	1,229	298	4,815	357	6,044
1995	59	1,229	298	4,815	357	6,044
1996	59	1,229	298	4,815	357	6,044
1997	73	1,286	35	981	108	2,268
1998	60	1,232	32	866	92	2,089
1999	113	1,833	40	1,081	153	2,914
2000	113	1,833	40	1,081	153	2,914
2001	113	1,833	40	1,081	153	2,914
2002	113	1,833	40	1,081	153	2,914

1.3.3 Economic value of fisheries production

Fisheries contribution to total Gross Domestic Product (GDP) in 2002 was 2.2% at current prices and 4.0% at constant prices. Philippine GDP in 2002 was US$356 billion. On the other hand, the contribution of the fisheries sector to the Gross Value Added (GVA) in agriculture, fishery, and forestry by industry group for 2002 is shown in **Table 4**. Fisheries GVA amounts to PhP90,180 million (15.2%) at current prices, whereas PhP41,772 million (20.3%) at constant prices. Nationwide, the total value of fisheries production, both sub-sectors and aquaculture included, increased steadily from PhP70,215 million in 1993 to PhP113,244 million in 2002 (**Table 5**). For the SCS sub-region, the economic value of landings was estimated using the average contribution of each sub-sector to total capture fisheries production, *i.e.* excluding aquaculture, in 1992 to1995. The four-year average contribution of the SCS municipal sub-sector and commercial sub-sector to nationwide total production was 7.8% and 22.5%, respectively. Thus, municipal and commercial landings from the SCS sub-region in 1993 were valued at PhP1,718 million and PhP4,055 million, respectively (**Table 5**). In 2002, the value of the SCS landings increased to PhP2,976 million and PhP8,928 million for the municipal and commercial sub-sectors, respectively. By aggregation, the total value of marine landings from the SCS sub-region increased from PhP5,773 million in 1993 to PhP11,904 million in 2002 (**Table 5**).

Regarding the balance of trade, national fishery exports in 2002 (182,032 MT valued at US$506 million) were higher than in 2001 (159,069 MT valued at US$459 million). The volume of fisheries imports for both years was higher than the volume of exports. Nevertheless, there was a positive balance of trade for both years in terms of value (**Table 6**).

Table 4 Agriculture, fisheries, and forestry contribution to the Gross Value Added (GVA) by industry group. Prices are in PhP million.

Industry Group	At Current Prices	% to Agricultural Sector	At Constant Prices	% to Agricultural Sector
Agricultural crops (*Palay*, corn, coconut, *etc.*)	343,295	58.0	105,163	51.0
Livestock	78,983	13.3	26,580	12.9
Poultry	50,960	8.6	23,611	11.5
Agricultural activities	27,920	4.7	8,737	4.2
Fishery	90,180	15.2	41,772	20.3
Forestry	803	0.1	335	0.2
TOTAL	**592,141**	**100**	**206,198**	**100**

Table 5 Value (PhP million) of nationwide and SCS-wide (landings from Regions I and III, Manila Bay, and West Palawan) fish production in 1993 to 2002. *P*–preliminary.

Year	NATION-WIDE				SCS-WIDE*		
	Culture (PhP)	Municipal (PhP)	Commercial (PhP)	Total (PhP)	Municipal (PhP)	Commercial (PhP)	Total (PhP)
2002	35,404	38,159	39,681	**113,244**	2,976	8,928	**11,904**
2001	36,634	34,222	36,089	**106,945**	2,669	8,120	**10,789**
2000	32,148	32,595	33,879	**98,622**	2,542	7,623	**10,165**
1999	29,046	31,034	32,242	**92,322**	2,420	7,254	**9,674**
1998	26,430	28,966	29,737	**85,133**	2,259	6,691	**8,950**
1997	27,289	27,393	25,935	**80,617**	2,137	5,835	**7,972**
1996	33,347	25,373	24,555	**83,275**	1,979	5,525	**7,504**
1995	33,658	26,464	23,065	**83,187**	2,064	5,190	**7,253**
1994	35,003	24,475	20,714	**80,192**	1,909	4,539	**6,448**
1993	30,163	22,031	18,021	**70,215**	1,718	4,055	**5,773**

** The estimator for the SCS-wide sub-sector value was the ratio of SCS-wide landings over the nationwide landings for each sub-sector from 1992 to1995; estimation was limited to that period due to data limitation in the SCS sub-region. Estimator values were 0.078 for the municipal sub-sector and 0.225 for the commercial sub-sector.*

Table 6 Balance of trade for the fisheries sector in 2001 and 2002.

Category	2002			2001		
	Quantity	FOB Value		Quantity	FOB Value	
	(MT)	(PhP M)	(US$ M)	(MT)	(PhP M)	(US$ M)
Fishery Export	182,032	26,178	506	159,069	22,723	459
Fishery Import	218,585	5,073	97	179,994	3,815	76
Trade Balance	36,553	21,105	409	20,925	18,908	383

1.3.4 Importance of the fisheries sector in terms of employment and dependence

The fisheries sector employs around a million people broken down into following: municipal 68%; aquaculture 26%; and commercial 6%. This constitutes 3 to 4% of the national labor force. Assuming that a typical family is comprised of 5 to 6 persons, then around 5 to 6 million people are directly dependent on fisheries. In addition, the fisheries sector indirectly provides employment to those engaged in fish distribution, marketing, processing, operation of ice plants and cold storage, and related industries such as net-making, boat-building, and boat-engine sales and repairs.

2. SPECIES OF REGIONAL, GLOBAL, AND TRANSBOUNDARY SIGNIFICANCE

2.1 Ranking of Importance

The Regional Working Group on Fisheries identified 13 pelagic and 9 demersal fish species, 10 cephalopods, and 11 crustaceans to be considered in the initial review as species with transboundary significance (see Tables 1a, 2a, 3a, and 4a of Annex 4 UNEP/GEF/SCS/RWG-F 2/3). The 13 pelagic species belong to four major groups under the ISSCAAP (International Standard Statistical Classification of Aquatic Animals and Plants) classification system: *Selar crumenophthalmus*, *Decapterus macrosoma*, and *D. maruadsi* under Group 34 (Jacks, Mullets, Sauries, *etc.*); *Sardinella* spp. and *Stolephorus* spp. under Group 35 (Herrings, Sardines, Anchovies, *etc.*); *Scomberomorus commerson*, *S. guttatus*, *Auxis thazard*, *A. rochei*, *Euthynnus affinis*, and *Thunnus tonggol* under Group 36 (Tunas); and *Rastrelliger kanagurta* and *R. brachysoma* under Group 37 (Mackerels). On the other hand, the 9 demersal species are lumped under Group 33 (Red fishes, Basses, Congers, *etc.*).

2.1.1 Ranking in terms of landings

In the Philippines, the Bureau of Agricultural Statistics (BAS) of the Department of Agriculture (DA) generates the statistics for aquaculture, commercial, and municipal fisheries. Species-specific information for marine fish is limited to the top 30 species. These 30 species belong to eight groups under the ISSCAAP system and account for almost 68% of nationwide fish production (**Table 7**). Hence, any significant fluctuation in total fish landings, especially of the pelagic species, would definitely affect the country's position as a global fish producer. Further, almost half of the top 30 species are in the priority list and they form the bulk of species traditionally harvested/landed in areas/regions facing the SCS. The proportion of the eight species groups in fish catches from the SCS area is much higher compared to the national average (**Table 8**), except for Group 42 (Crabs). This could be explained by the fact that West Palawan, which is part of Region IV, is a major contributor to commercial fish production (~19%) in the Philippines.

2.1.2 Local market value

Wholesale and retail prices of selected fish species groups are given in **Table 9**. Except for Groups 57 (Squids) and 45 (*Acetes*), price data are available for representative species of all groups. Although the traditional group with the highest local market value is crabs, only Groups 33 and 37 are the fish groups typically consumed locally and command a high price. This is possibly attributed to the high price of some demersal species, *e.g.* threadfin bream and fusilier in Group 33, compared to the small pelagics.

Table 7 Average landings (MT) and percentage share to total marine fish production of the priority species groups.

ISSCAAP Code		Share (%)	Production[a] (MT)	Value[b] (PhP million)
Group 33	(Slipmouth, Threadfin bream, Fusilier, Goatfish, Grouper, Snapper, Siganid, Parrotfish, Porgies)	8.8	195,864	5,254
Group 34	(Roundscad, Big-eyed scad, Crevalle, Flying fish, Cavalla, Mullet)	18.0	403,030	10,812
Group 35	(Indian sardine, Fimbriated sardine, Anchovy, Round herring)	17.3	386,314	10,364
Group 36	(Skipjack, Frigate tuna, Yellowfin tuna, Eastern little tuna, Spanish mackerel)	15.4	344,078	9,231
Group 37	(Indian mackerel, Indo-Pacific mackerel, Hairtail)	3.9	88,090	2,363
Group 42	(Blue crab)	1.4	32,326	867
Group 45	(*Acetes*)	0.7	15,890	426
Group 57	(Squid)	2.2	48,916	1,312
Total		**67.8%**	**1,514,508**	**40,630**

[a] *Refers to yearly production from 1997 to 2001 as reported by the Bureau of Agricultural Statistics (BAS).*
[b] *Refers to the Weighted average value.*

Table 8 Percentage share of priority species caught from selected areas/regions facing the South China Sea[a] in 1992 and 1995 in comparison with the national average.

ISSCAAP Code	Nat'l Average	1992 Catch	1995 Catch
Group 33 (Slipmouths, *etc.*)	8.77	12.36	12.61
Group 34 (Roundscads, *etc.*)	18.01	32.95	29.67
Group 35 (Indian sardines, *etc.*)	17.32	14.34	25.32
Group 36 (Tunas)	15.40	18.51	16.47
Group 37 (Mackerel, *etc.*)	3.94	9.44	7.40
Group 42 (Blue crab)	1.44	0.56	0.80
Group 45 (*Acetes*)	0.71	3.90	2.21
Group 57 (Squid)	2.20	3.54	3.19
Total	**67.79%**	**95.61**	**97.67**

[a]*Refers to landings from Lingayen Gulf, Manila Bay, Batangas Coast, and West Palawan.*

Table 9 Wholesale (W) and retail (R) prices for selected fish species in Philippine peso.

ISSCAAP Code	1997		1998		1999		2000		2001	
	W	R	W	R	W	R	W	R	W	R
Group 33 (Demersals[a])	45.4	70.3	46.8	72.1	50.9	76.1	54.1	80.7	57.4	85.3
Group 34 (Roundscad)	31.9	45.0	34.4	47.4	40.0	53.4	41.5	54.9	44.4	59.4
Group 35 (Anchovies)	28.1	44.1	31.2	44.9	32.6	46.7	35.8	48.0	36.0	50.2
Group 36 (Frigate tuna)	35.3	46.3	36.4	49.0	42.4	51.3	43.5	52.6	48.0	57.3
Group 37 (I. mackerel)	47.9	60.9	49.3	61.7	53.6	64.8	56.8	67.5	60.2	70.7
Group 42 (Blue Crab)	51.6	74.2	58.4	77.4	61.6	82.2	61.5	88.8	62.4	98.0

[a]*Average price for threadfin bream, slipmouth, and fusilier.*

2.1.3 Status

IUCN (International Union for the Conservation of Nature, presently World Conservation Union) classifies species into 9 categories: Extinct (EX); Extinct in the Wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threatened (NT); Least Concern (LC); Data Deficient (DD); and Not Evaluated (NE). So far, none of the 43 species identified by the Regional Working Group on Fisheries are listed on the IUCN Red List of Threatened Species.

2.1.4 Food Security

Local fish production exhibited a steady increase from 1997 to 2001, accounting for 96% of the national fish supply, while the contribution of food fish imports averaged about 4% (**Table 10**). Assuming such rates to remain constant while population increases by 2% and per capita consumption remains at 2000 level, domestic fish production will have to increase, with necessary reinforcement by imports.

Table 10 Annual fish supply and consumption (MT) from 1997 to 2001.

Item	1997	1998	1999	2000	2001
Production	2,136,264	2,144,184	2,227,660	2,286,293	2,380,735
Food Fish Import	118,069	51,893	120,586	120,180	68,388
Apparent Food Use	1,894,210	1,837,612	1,984,944	2,034,235	2,088,499
Per Capita Use (kg)	26.62	25.32	26.81	26.59	26.80
Population	71,145,556	72,581,223	74,045,637	76,498,735	77,925,894
Total Fish Supply	2,254,333	2,196,077	2,348,246	2,406,473	2,449,123

2.2 Biology and ecology of the priority species

About 2,400 fish species have been recorded in the Philippines, but the number occurring along the western (South China Sea) portion of the country is still unknown. It is therefore likely that the number occurring in the Philippines, and in other countries in the region, is much larger than that currently recorded.

The Regional Working Group (Fisheries) has issued a comprehensive list of demersal and pelagic fish, as well as invertebrates, with defined levels of transboundary significance. Information on the biology and ecology of the listed species occurring in the Philippines were derived largely from databases, particularly FISHBASE and CEPHBASE, and from available reports and publications.

Table 11 shows those species in the comprehensive list that have been recorded in the Philippines. Several species have no records of occurrence in areas along the South China Sea, although they have been observed at several localities in the country. In such cases, the locality/area where they have been observed is indicated. Most of the listed species, however, occur in areas bordering the South China Sea.

Depending on the availability of references, the information includes: a) geographical distribution of the stock; b) migration pattern; c) size-related aspects of the stock; d) growth parameters; e) reproductive biology; f) spawning time (season); g) spawning areas; h) nursery grounds (areas); and i) food and feeding habits.

Most data regarding commonly occurring species pertain to relative abundances in catches and estimates of population parameters; reproductive biology (particularly spawning areas) and feeding habits are relatively scarce, although useful insights may be provided by data on related species or the same species from other fishing grounds in the country or region. Any local (Philippine) information is therefore vital and incorporated into the sheets. The lack of information is usually remedied by citing relevant data from the next most similar area. Focus is placed on two major areas, Lingayen Gulf and Manila Bay, mainly because of available information. Relevant areas include the Batanes Islands, Ilocos Coast, Subic Bay and Zambales coast, Batangas-Mindoro waters, Malampaya area and northern Palawan, and the Kalayaan (Spratlys) Islands Group.

2.2.1 Large pelagic fishes

This group includes the various tuna species. In the Philippines, there are a total of 21 tuna and tuna-like species, but only six are caught in commercial quantities (PCAMRD 1993). The six species include the highly migratory *Thunnus albacares* (yellowfin) and *Katsuwonus pelamis* (skipjack), which are normally caught in offshore waters, and *Thunnus obesus* (big-eyed), *Euthynnus affinis* (eastern little), *Auxis thazard* (frigate), and *A. rochei* (bullet), which are more frequently caught in inshore waters.

Tuna spawning grounds are located throughout Philippine waters (**Figure 8**), including the waters off West Palawan, Mindoro Strait, and West Luzon. The major spawning ground, however, is the Celebes Sea in the south. Migration through the Sulu Sea (**Figure 9**) allows the mixing of stocks between the Pacific Ocean (via the Celebes Sea) and the SCS.

The prevalence of young tuna (TL<30 cm) in commercial and municipal catches has been a major concern since the 1980s because it may lead to growth overfishing (Aprieto 1982). Worse, the use of fish aggregating devices (FADs), locally called *"payaos"*, tends to enhance cannibalism thus exacerbating the above situation (PCAMRD 1993). Of the six tuna species mentioned above, only *T. obesus* is believed to be facing a high risk of extinction and is thus listed under the vulnerable category.

Large pelagics typically include other oceanic fish such as *Makaira* spp. (marlin), *Xiphias gladius* (swordfish), *Istiophorus platypterus* (sailfish), *Scomberomorus commerson* (Spanish mackerel), Elopidae (tenpounder), Sphyraenidae (barracuda), Coryphaenidae (dolphinfish), large *Caranx* spp. (cavalla), *Elagatis bipinnulatus* (rainbow runner), and *Chanos chanos* (milkfish). As a group, these fish contribute around 7% to total landings of pelagic fish (Pagdilao *et al.* 1991), but little is known about their biology or ecology in local waters. Milkfish are extensively cultured in the Philippines, but only those caught in the wild are included as large pelagics.

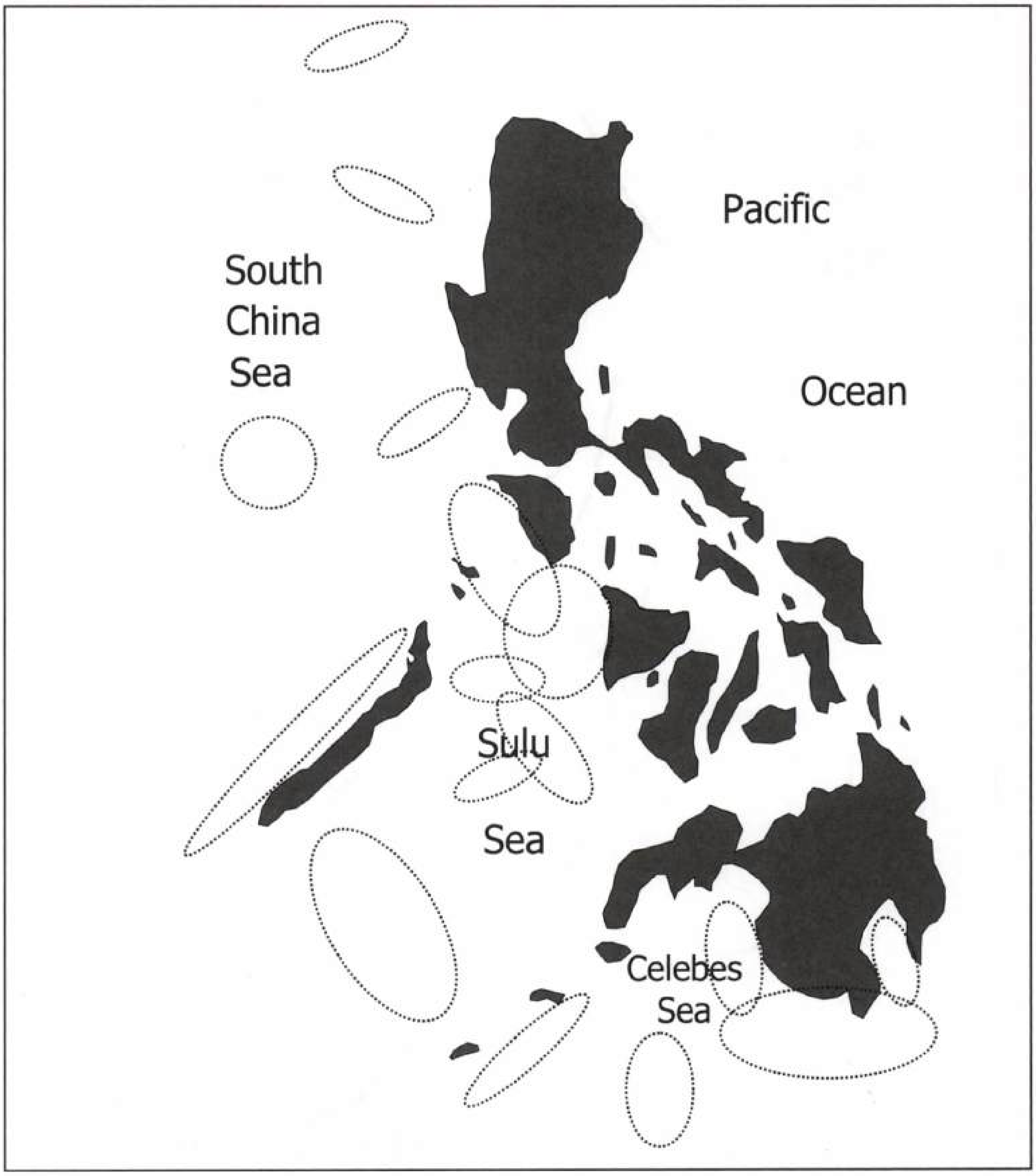

Figure 8 Tuna spawning grounds in the Philippines (Wade 1951).

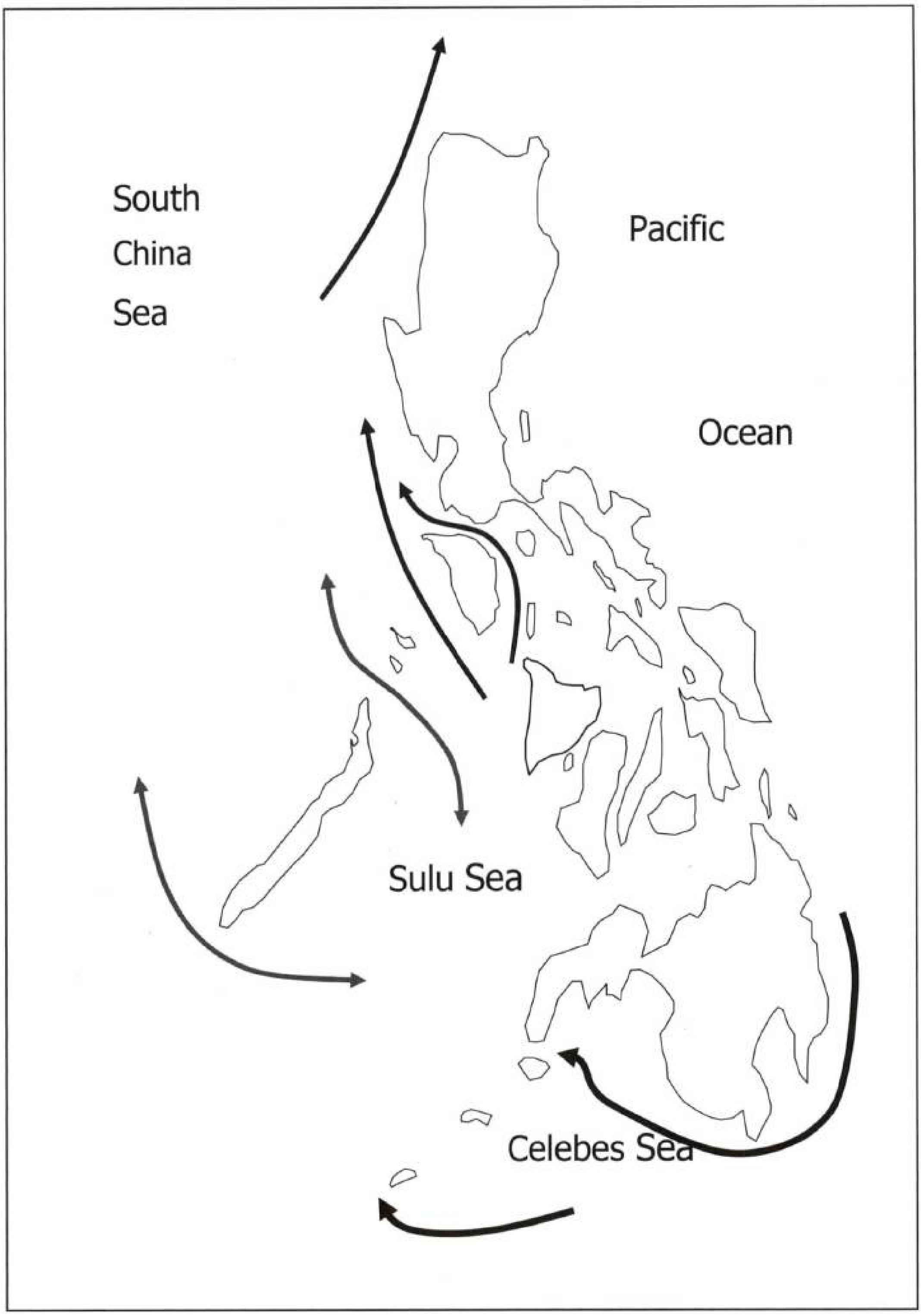

Figure 9 Tuna migration routes to the South China Sea.

Table 11 Species of transboundary significance and their recorded occurrences in waters of the South China Sea side of the Philippines.

SPECIES	Common name	Occurrence
Aetobatus narinari	Spotted eagle ray	Manila Bay
Dasyatis kuhlii	Blue-spotted stingray	Lingayen Gulf; Manila Bay; Cavite
Manta birostris	Giant manta ray	No information
Taeniura lymma	Blue-spotted ribbontail ray	Ulugan Bay, Palawan
Alopias pelagicus	Pelagic thresher shark	No information
Alopias vulpinus	Thintail thresher shark	No information
Carcharhinus dussumieri	Whitecheek shark	Dumaguete, Negros Oriental (*)
Carcharhinus limbatus	Blacktip shark	Pilas Is., Basilan, Sulu Sea (*)
Carcharhinus longimanus	Oceanic whitetip shark	No information
Carcharhinus melanopterus	Blacktip reef shark	Manila (market)
Carcharhinus sorrah	Spottail shark	Cavite
Chiloscyllium indicum	Bamboo shark	Manila Bay
Chiloscyllium griseum	Bamboo shark	Sim Sim Laut Is., Sulu Sea (*)
Chiloscyllium plagiosum	Bamboo shark	Manila Bay; Calapan, Mindoro
Chiloscyllium punctatum	Bamboo shark	Manila Bay
Rhicodon typus	Whale shark	Mariveles Bay, Bataan; Manila Bay; Batangas Bay and Bauan, Batangas
Sphyrna lewini	Scalloped hammerhead shark	No information
Sphyrna zygaena	Smooth hammerhead shark	Cavite; Taytay, Palawan
Istiophorus platypterus	Indo-pacific sailfish	
Makaira indica	Black marlin	
Makaira mazara	Indo-pacific blue marlin	
Makaira nigricans	Atlantic blue marlin	
Xiphias gladius	Swordfish	Manila Bay; Western Philippines
Auxis rochei	Bullet tuna	Western Philippines
Auxis thazard	Frigate tuna	Nasugbu and Balayan Bay, Batangas Province, Luzon,
Euthynnus affinis	Kawakawa	Western Philippines
Katsuwonus pelamis	Skipjack tuna	Taal and Balayan Bay, Batangas
Thunnus albacares	Yellowfin tuna	Western Philippines
Thunnus tonggol	Longtail tuna	Western Philippines
Rastrelliger brachysoma	Short mackerel	Bauang, La Union; Manila Bay; Calapan, Mindoro
Rastrelliger faughni	Island mackerel	Visayan Sea (*)
Rastrelliger kannagurta	Indian mackerel	Nasugbu, Batangas Province, Luzon;

Table 11 *cont.* Species of transboundary significance and their recorded occurrences in waters of the South China Sea side of the Philippines.

SPECIES	Common name	Occurrence
Scomberoides commersonnianus	Talang queenfish	No information
Scomberoides lysan	Double-spotted queenfish	Vigan, Ilocos Sur; Manila Bay; Bolbok, Batangas; Malampaya Sound, Palawan
Scomberoides tala	Barred queenfish	Manila Bay; Cavite
Scomberomorus commerson	Narrow-barred spanish mackerel	San Fabian, Pangasinan; Manila Bay
Scomberomorus guttatus	Indo-pacific king mackerel	Guinlo, Malampaya Sound, Palawan
Scomberomorus lineolatus	Streaked seerfish	No information
Coryphaena hippurus	Common dolphin fish	Fortune Is., Nasugbu, Batangas; Naujan, Mindoro; Malampaya Sound, Palawan
Cypselurus spp.	Flying fish	Batangas; Manila Bay
Alepes djedaba	Shrimp scad	Samar Sea; San Pedro Bay
Atule mate	Yellowtail scad	Bauang, La Union; Manila Bay
Decapterus macrosoma	Shortfin scad	Manila Bay
Decapterus maruadsi	Japanese scad	Amurang, North Celebes
Decapterus russelli	Indian scad	Iloilo (*)
Megalaspis cordyla	Torpedo scad	Bauang, La Union; Mariveles, Bataan; Balayan Bay, Batangas; Linapacan Island, Palawan
Selar crumenopthalmus	Bigeye scad	Bangui, Ilocos Norte; Orion, Bataan; Manila Bay; Calapan, Mindoro
Selaroides leptolepis	Yellow-stripe scad	Bauang, La Union; Manila Bay
Amblygaster sirm	Spotted sardinella	No information
Anadontostoma chacunda	Chacunda gizzard shad	Santa Maria, Ilocos; San Fernando, La Union; Lingayen Gulf; Orani and Orion, Bataan; Manila Bay; Cavite; Balayan Bay, Batangas
Chirocentrus dorab	Dorab wolf herring	Vigan, Ilocos Sur; Rosario, La Union; San Fabian, Pangasinan; Manila Bay; Cavite
Chirocentrus nudus	Whitefin wolf herring	No information
Sardinella albella	White sardinella	Basud River and Port Jamelo, Luzon; Sta. Cruz, Marinduque; Panabutan Bay, Zamboanga (*)
Sardinella brachysoma	Deepbody sardinella	Manila Bay, Luzon
Sardinella fimbriata	Fringescale sardinella	Bauang, La Union; Manila Bay; Nasugbu, Batangas
Sardinella gibbosa	Goldstripe sardinella	Vigan, Ilocos Sur; Orani and Orion, Bataan; Manila Bay
Encrasicholina devisi	Devi's anchovy	No information
Encrasicholina heteroloba	Shorthead anchovy	No information
Encrasicholina punctifer	Buccaneer anchovy	No information
Stolephorus commersoni	Commerson's anchovy	Manila Bay

Table 11 *cont.* Species of transboundary significance and their recorded occurrences in waters of the South China Sea side of the Philippines.

SPECIES	Common name	Occurrence
Stolephorus indicus	Indian anchovy	Balayan Bay, Batangas; Puerto Galera, Mondoro
Epinephelus akaara	Hongkong grouper	No information
Epinephelus bleekeri	Duskytail grouper	Dagupan, Pangasinan; Subic Bay, Zambales; Calapan, Mindoro; Linapacan Is. and Ulugan Bay, Palawan
Epinephelus fuscoguttatus	Brown-marbled grouper	Manila Bay; Puerto Galera, Mindoro; Ulugan Bay, Palawan
Epinephelus malabaricus	Malabar grouper	Cavite; Calapan, Mindoro; Cuyo Is., Palawan
Epinephelus sexfasciatus	Sixbar grouper	Bauang, La Union; Manila Bay; Nasugbu and Lemery, Batangas
Epinephelus tauvina	Greasy grouper	Cavite, Cavite Province
Plectropomus aereolatus	Squaretail coral grouper	No information
Plectropomus leopardus	Leopard coral grouper	Manila Bay; Port Hamilo, Batangas; Bolalo Bay and Endeavor Straits, Palawan
Plectropomus maculatus	Spotted coral grouper	Verde Is. Passage; Endeavor Strait, Palawan
Lutjanus argentimaculatus	Mangrove red snapper	Camiguin Is., Batanes; Mariveles, Bataan; Cavite; Pagapas, Batangas
Lutjanus lutjanus	Bigeye snapper	Mariveles, Bataan; Port Jamilo, Batangas; Calapan, Mindoro; Quiminatin and Cuyo Is., Palawan
Lutjanus malabaricus	Malabar blood snapper	Dagupan, Pangasinan; Manila Bay; Batangas
Lutjanus sanguineus	Humphead snapper	Manila bay; Balayan Bay, Batangas
Lutjanus sebae	Emperor head snapper	Linapacan and Cuyo Is., Palawan
Lutjanus vitta	Brownstripe red snapper	Manila Bay; Cavite
Pristipomoides filamentosus	Crimson jobfish	Cebu; Dumaguete, Negros Oriental; Balabac Strait (*)
Pristipomoides typus	Sharptooth jobfish	Manila (market); Nasugbu, Batangas
Caesio cuning	Redbelly yellowtail fusilier	Port Matalvi, Zambales; Limbones Cove, Cavite; Nasugbu, Pagapas Bay and Port Hamilo, Batangas; Taytay, Palawan
Saurida spp.	Lizardfish	Bauang, La Union; Cape Bolinao, Pangasinan; Manila Bay; Balayan Bay, Batangas; Cuyo Is., Palawan
Nemipterus spp.	Threadfin breams	Curimao, Ilocos Norte; San Fernando, La Union; San Fabian, Pangasinan; Orion, Bataan; Manila Bay
Priacanthus macracanthus	Red bigeye	Tayabas Bay, Quezon (*)
Priacanthus tayenus	Purple-spotted bigeye	San Fernando and Bauang, La Union; Mansalay, Mindoro
Trichiurus lepturus	Largehead hairtail	No information

(*) – Indicates areas not bordering the South China Sea.

2.2.2 Small pelagic fish species

Small pelagic is an arbitrary category of various fishes that are generally surface dwelling within continental shelf waters. Most of these small, fast-growing, and short-lived species belong to 13 families: Scombridae (mackerels), Carangidae (crevalles and other jacks), Clupeidae (herrings and sardines), Engraulidae (anchovies), Chirocentridae (wolf herring), Trichiuridae (hairtails), Atherinidae (silversides), Hemiramphidae (halfbeaks), Exocoetidae (flying fish), Mugilidae (mullets), Strongyluridae (garfish), Megalopidae (tarpon), and Caesionidae (fusiliers) (Dalzell and Ganaden 1987).

As a group, small pelagics comprise 40% of the total fish landings. The dominant groups are anchovies (*Stolephorus* spp.), sardines (*Sardinella* spp.), roundscads (*Decapterus* spp.), and mackerel (*Rastrelliger* spp.). Population parameter estimates for small pelagic stocks from different fishing grounds are available in Ingles and Pauly (1984), Corpuz *et al.* (1985), Lavapie *et al.* (1987), and several unpublished reports from 1990 to 2000.

A recent review of their general biology and ecology is given in Calvelo (1997). Small pelagic fish generally attain a maximum weight of not more than 500 g. They are generally short-lived, with lifespan of two to three years, although the round scads may live to about four years (Calvelo 1997). Many exhibit inshore-offshore migrations, but most are limited to the neritic zone. Because of the difficulty in identifying their larvae to the genus or species level, specific spawning locations are unknown. Previous studies, however, point to such areas as Mindoro Strait and the waters off Manila Bay as likely spawning grounds for some pelagic fish in the South China Sea (Ronquillo 1975). Most pelagic species are planktivorous, although some are carnivorous particularly on the young of other species. As planktivores, they are known to live near the water surface and are therefore strongly influenced by environmental conditions (PCAMRD 1993). The high seasonal variation in their abundance is attributed to environmental influences such as monsoons, rainfall, salinity regimes, and plankton biomass.

2.2.3 Demersal fish species

A total of 46 species groups comprise the demersal landings in the Philippines, with the Leiognathidae (slipmouths) comprising about 15% of the total (Pagdilao *et al.* 1991). Others groups include the Nemipteridae (threadfin breams), Mullidae (goatfish), and Synodontidae (lizardfish), which are common in soft-bottom areas, and Lutjanidae (snappers), Lethrinidae (emperor fish), Siganidae (rabbitfish), and Serranidae (groupers), which are generally associated with reefs. Also included in this category are the many species of sharks, skates, and rays (elasmobranchs). Together, these nine groups represent over 50% of demersal fish landings in the Philippines (Pagdilao *et al.* 1991). Because of their diversity in form, feeding, and behavior, demersal fish are exploited with various gears over different substrate types, including mangrove swamps, seagrass beds, and coral reefs. As bottom-dwellers, their food includes seaweeds and seagrasses, worms, small shrimps, small fish, and even shelled organisms and corals.

The classification of elasmobranchs as by-catch is typical in most fisheries of the Philippines. As a result, their catches are likely underreported. Little is known about their biology and ecology in local waters because fishers usually discard their carcasses at sea after removing and retaining their fins. Six rays and 43 sharks that reportedly occur in the Philippines, although not necessarily in the SCS area, are included in the Red List. Of the rays, *Urogymnus asperrimus* (porcupine ray) and *Aetomylaeus nichofii* (banded eagle ray) are vulnerable (at high risk of becoming extinct in the wild), another two species are near threatened (likely to be vulnerable in the future), whereas data are deficient for both *Aetobatus narinari* (spotted eagle ray) and *Manta birostris* (manta ray). Of the 43 sharks in the Red List, only *Carcharhinus hemiodon* (pondcherry shark) is listed as critically endangered (extremely at high risk of extinction in the wild), 4 other species are endangered (facing a very high risk of extinction), 10 are vulnerable, including *Rhincodon typus* (whale shark), 7 are near threatened, 15 are almost nearly threatened, while 6 have insufficient data for categorizing.

Reef-associated fish are also included in this category. While the higher valued species, such as groupers and snappers, are exploited for human consumption, a number of species not consumed by humans have also been exploited for the live aquarium fish trade (Nañola and Aliño 1999). The more commonly targeted aquarium fish include chaetodontids (butterflyfish) and pomacanthids (angelfish). Seahorses and pipefishes (syngnathids) are also exploited and marketed as "aphrodisiacs" in other countries (Nañola and Aliño 1999). Among the syngnathids, nine species (including two pipefish) are redlisted, five as vulnerable, and four with insufficient data. Those categorised with insufficient data are species whose biology and ecology are prone to disruption from observed levels of exploitation. Syngnathids brood their eggs in male abdominal pouches, and as such, the number of eggs produced per female is very limited.

Aside from seahorses, eight other bottom dwelling fish are included in the Red List, inlcuding three groupers (*Cephalopolis boenak, Cromileptes altivelis,* and *Epinephelus lanceolatus*), the humphead wrasse (*Cheilinus undulatus*), two dragonfishes (Pegasidae), and two gobiiform fish.

2.2.4 Commercially exploited invertebrates

The commercially exploited invertebrates in the country include species of molluscs, crustaceans, and echinoderms. Each of these groups is very diverse. A listing of species would be too extensive to include in this review. For several invertebrates, rearing and culture techniques have been investigated and developed for the purpose of propagation. As such, susceptibility to local extinction would be negligible. These include sea urchins (*Tripneustes gratila)* (Juinio-Meñez *et al.* 1998), sea cucumbers, shrimps, crabs, and several molluscs, including giant clams. The latter group is of special conservation concern as most are slow-growing and have reduced abundances in the wild. Six species of locally occurring giant clams are included in the Red List, categorised as either vulnerable (*Tridacna derasa* and *T. gigas*) or least risk (*Hippopus hippopus, H. porcellanus, Tridacna maxima, and T. squamosa*), although the vulnerability of the least risk group to current exploitation levels cannot be ignored. Some biological information on the 15 cephalopod species occurring in the SCS area is provided in **Table 12**.

Table 12 Summary of biological and ecological information for cephalopod species with transboundary significance in the South China Sea.

Species	Max. Size	Prey Items	Other Information	References
Octopus (Octopus) macropus	120-150cm TL	hermit crab, blue crab, shrimp		Boletzky and Hanlon (1983); Roper *et al.* (1984)
O. (O.) membranaceus				
O. (O.) aegina	30cm ML			Roper *et al.* (1984)
Sepia (Acanthosepion) brevimana	10cm ML			Roper *et al.* (1984)
S. (A.) lycidas	38cm ML	shrimp		Boletzky and Hanlon (1983)
S. (A.) aculeata	23cm ML	prawn, mysid		Boletzky and Hanlon (1983); Roper *et al.* (1984)
S. (Sepia) pharaonis	43cm ML ♂ 33cm ML ♀		Hatching size:0.1g Size/age at maturity: 84.1g, 110d; 3300deg-d	Roper *et al.* (1984); Wood and O'Dor (2000)
Sepiella inermis		prawn, crab, fish,	Hatching size: 0.01g Size/age at maturity: 36.6g, 90d; 2700deg-d	Boletzky and Hanlon (1983); Wood and O'Dor (2000)
Sepioteuthis lessoniana	36cm ML	fish, mysid, shrimp,	Hatching size: 0.044g Size/age at maturity: 122.7g, 90d; 2700deg-d	Boletzky and Hanlon (1983); Wood and O'Dor (2000)
Uroteuthis (Photololigo) chinensis	30cm ML			Roper *et al.* (1984)
U. (P.) duvauceli:	29cm ML			Roper *et al.* (1984)
U. (P.) edulis	40cm ML			Roper *et al.* (1984)
Nototodarus hawaiiensis	15.2cm		Caught in depths up to 710m	Nateewathana *et al.* (2000)
Sthenoteuthis oualaniensis	18cm ML ♂ 26cm ML ♀		Abound in W. Phil. at 50–100m; lifespan ~1yr; >75% diet comprised of fish and cephalopods; size at 1st mat. ♀: 11cm ML	Siriraksophon *et al.* (2000); Nateewathana *et al.* (2000); Basir (2000); Zakaria (2000)
Thysanoteuthis rhombus	100cm ML		Generally caught in upper 50m of water column	Nateewathana *et al.* (2000)

3. STATUS AND THREATS

3.1 Current Status

In this section, the Philippines part of the South China Sea is categorised into two sectors: western Luzon, including the Batanes Islands and the major fishing grounds of Lingayen Gulf and Manila Bay, and western Palawan, including the western coast of Mindoro, Calamianes Islands, and the embayments of Malampaya Sound, Bacuit Bay, and Ulugan Bay.

3.1.1 Fisheries Status in terms of CPUE

Fishing effort data are not regularly and adequately included in the published statistics for Philippine fisheries, thus assessment of catch per unit effort (CPUE) is difficult. This section presents information for the years where the computation of CPUE is possible, as well as that stemming from site-specific studies.

At present, CPUE in the SCS area depends on the location and habitat where fishing takes places. In the waters adjacent to Batanes Islands, pelagic fisheries exhibited high levels of CPUE levels in 1997 to 2002 (**Table 13**). The trend observed is that catch rates have either increased (*e.g.,* simple handline, drift gillnet) or remained constant (*e.g.,* multiple handline, drift lines for flying fish), thus suggesting that the area is still in good condition for pelagic fisheries. This may be attributed to the distance of the fishing grounds from the major fishing ports and the limited fishing period (March-June) imposed by perennially rough sea conditions, which both serve as a natural stopgap mechanism to fishing activities in the area. This is in contrast to its reef fisheries, where exploitation occurs year round. Although catch rates there are mostly higher than elsewhere in the country, latest figures (1998-2002) indicate decreasing CPUE for spear fishing and octopus fishing (**Table 13**). The high CPUE observed for many gear types in the area may have driven increases in total fishing effort levels. The total number of fishers operating in the area increased 8% from 1997 (1330) to 2002 (1431). Similarly, the number of fishing gear units increased 741% from 423 in 1997 to 3557 units in 2002. A possible cause of the large discrepancy in the effort (boats and gears) data is the change in the survey method.

Most fisheries, especially demersal fisheries, in enclosed bays and gulfs along the SCS indicate an overfished status. In Manila Bay, only 10% of the 1947 level of demersal fish population remained in 1993 (Armada 1993). From a high catch rate of 44kg/h for trawls in 1947, it decreased to only 10kg/h in 1993. **Fugure 10** shows the CPUE trend of trawls in Manila Bay. In Lingayen Gulf, catch rates of trawls are even lower at 4.4kg/h in 2002, a huge reduction from the 67.7kg/h observed in 1947.

Table 13 Catch rates (kg/h) of fishing gears used in Batanes waters (from Villarao *et al.* 2003).

	Demersal			Reef			Pelagic							
Year	BS Gnet	Multi HL	Hookah	Spear	Octo Jig	Simp HL	Troll Line	Anch Dlnet	Surf Gnet	Drift Gnet	Mod Egnet	Jigger	Gar TL	FF Dline
1997	3.0	1.8		3.9		1.1	3.4			1.7	5.9	4.3		
1998	4.4	2.7		6.6		1.1	2.0			5.0	10.4	1.2		
1999	5.1	2.7		5.7		1.2	4.3		0.6	8.9	17.7	2.4		0.6
2000	2.3	3.1	22.2	4.7	1.2	1.8	3.7		4.6	2.2			1.5	0.4
2001	2.6	3.3	14.8	1.9	0.2	1.9	4.1	6.0	7.7	14.9			1.9	0.4
2002	4.6	2.9	19.7	3.7	0.7	2.7	3.9	6.5	5.6	15.6			2.7	0.7

Legend: BS Gnet, bottom-set gillnet; Mutli HL, multiple handline; Octo jig, octopus jig; Simp HL, simple handline; Anch Dlnet, anchovy drive-in net; Surf Gnet, surface gillnet; Drift Gnet, drift gillnet; Mod Egnet, modified encircling gillnet; Gar TL, garfish troll line; FF Dline, flying fish drift line.

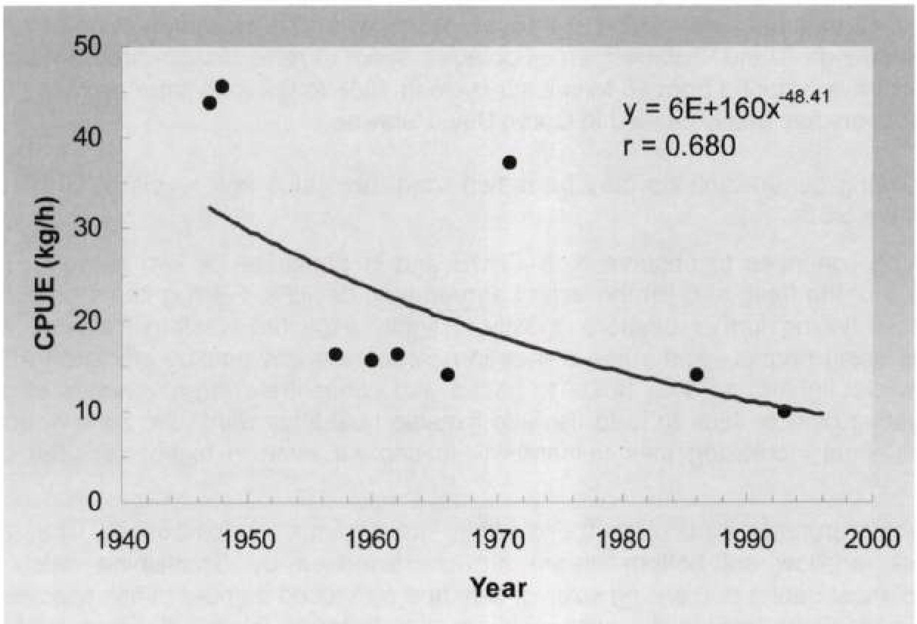

Figure 10 Catch per unit effort (CPUE) of trawls in Manila Bay (from Armada 1993).

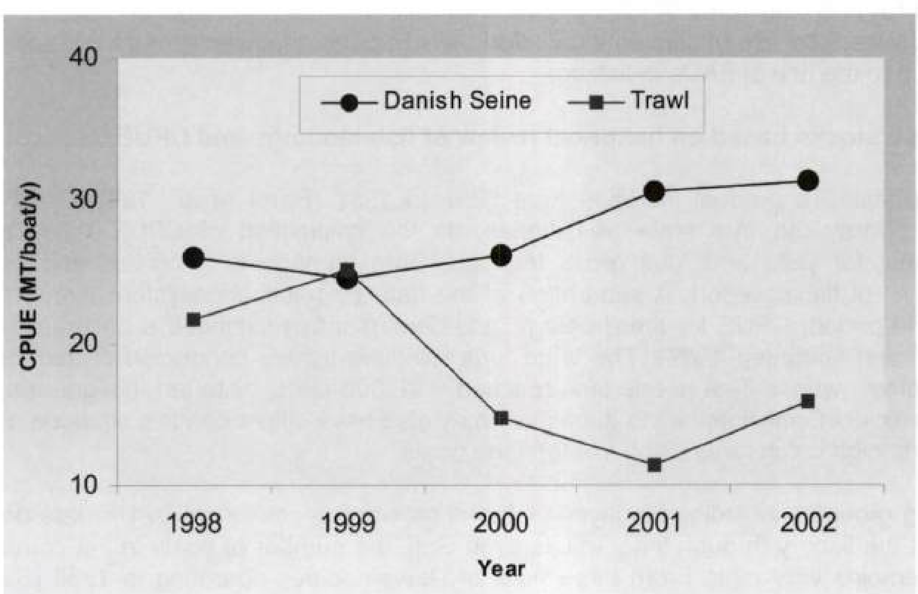

Figure 11 Catch per unit effort (CPUE) of Danish seines and trawls in Lingayen Gulf (from Gaerlan *et al.,* 2003).

There appears to be a succession of fish populations in overfished areas, in which pelagic species replace lost demersal biomass. This has been observed in Manila Bay and Lingayen Gulf, where an increase in pelagic catch replaced the loss in demersal stocks. For instance, data from Lingayen Gulf indicate that from 1998 to 2002, CPUE (tons/boat/y) of Danish seines, which exploit both pelagic and demersal fish, increased by 20.8% while trawl CPUE declined by 26.8% over the same period (**Figure 11**) (Gaerlan *et al.*, 2003). In Manila Bay, the high variability of trawl CPUE is attributed to seasonal catches of small pelagics within trawl nets constructed with large mouth openings.

In western Palawan waters, pelagic resources remain in good condition, with ringnets and purse seines yielding an average of 42 tons per lunar cycle (~14-16 d/mo) (Ingles 2000). However, in nearby coastal waters adjacent to Busuanga Island, Palawan, small pelagics seem to have disappeared. In this case, catch rates of bagnets have dropped from 15 tons/lunar cycle in 1988 to 0.2 tons/lunar cycle in 1998. At present, the use of bagnets has totally ceased in Coron Bay, Palawan.

In summary, the following generalisations may be drawn from the status and levels of CPUE in the Philippines portion of the SCS:

1. Commercial fishing continues to observe high CPUE and is profitable for two reasons: (a) the offshore relocation of the fleet; and (b) the use of aggregating devices. Fishing fleets based in the SCS area are now fishing further offshore, mostly in lightly exploited western Palawan waters. Whereas vessels using ringnets and purse seines in nearshore areas employ efficient FADs and high-intensity artificial lighting on their boats to attract and concentrate large volumes of pelagic fish. The aggregating devices tend to herd fish into fishable quantities within the zone of action of the netting gears, thus increasing their vulnerability to capture even in highly depleted coastal areas.
2. All nearshore fishing grounds, particularly those within embayments, are overfished. These areas (*e.g.,* coral reefs, shallow soft-bottom areas) are characterised by diminishing catch rates, increased units of most gears, decreasing sizes of fish, and a reduced number of fish species in the fishery. Notable exceptions include the waters adjacent to Batanes Islands, Lubang Island, and some protected areas in west Palawan.
3. In highly exploited and overfished areas such as Manila Bay and Lingayen Gulf, the decline in demersal resources has led to an abundance of pelagic species triggering a massive shift in fishing gears and fish catching techniques.
4. There is a need for new measures of fishing effort that reflect actual and effective fishing capacity and exploitation rates. The use of conventional effort units (*e.g.* horsepower, gross tonnage) seems inappropriate due to the use of FADs in fishing.

3.1.2 Status of fish stocks based on historical review of fish landings and CPUE

Generally, CPUE exhibited a gradual increase from 1967 to 1987 (Barut *et al.*, 1997). This trend, however, may not portray the true state of fisheries, as the calculation of CPUE relied on the relationship between total yield and total gross tonnage. Boat tonnage is a coarse and perhaps inappropriate indicator of fishing effort. A separation of the data by habitat/ecosystem type indicates that, during the same period, CPUE for small pelagic and demersal fish exhibited a decreasing trend (**Figure 12**) (Dalzell and Ganaden 1987). The large tuna handline fishery conducted in the southern waters of the Philippines, whose fleet at one time reached ~ 20,000 units, distorted this general trend. The entry of highly efficient Danish seines to the fishery may also have influenced this situation. Both of these gears have very high catch rates using low tonnage boats.

For traditional fishing grounds, including Lingayen Gulf and Manila Bay, historical CPUE data describe the various states of the fishery through time. In Lingayen Gulf, the number of boats in the commercial fishing sub-sector remains very high. From three units of Danish seines operating in 1988 (Silvestre *et al.*, 1991), the number increased to 42 units in 2002. Similarly, the 23 units of trawlers in 1985 (Mines 1986) increased to 48 units in 2002. It is important to note that observers in 1985 considered Lingayen Gulf to be overfished. While the combined numbers of commercial boats increased from 1998 to 2002, total gross tonnage actually decreased (**Figure 13**). This is possibly a result of an increase in the number of Danish seiners and a decrease in the number of larger trawlers.

Manila Bay is one of the oldest fishing grounds in the country and its history of fishing could be used to infer the status of Philippine fisheries in general and the fisheries along the South China Sea in particular. The historical trend of trawl catch rates in Manila Bay (**Figure 10**) indicates that the demersal stock observed in 1993 represents just 10% of the total biomass level of demersal species observed in 1947. However, the CPUE of catches of pelagic fish have recently increased, thus indicating that pelagic fish now dominate the area's fish fauna. In addition, a unit of drift gillnet in 1993 landed an average of 19.1 kg/d whilst a unit of a high bottom-set gillnet averaged 10.4 kg/d, with the catch in the latter gear type mostly being composed of small pelagic species.

Palawan, which is noted for its pristine waters, is experiencing the same plight. Data in Ingles (2000) indicates a rapid decrease in CPUE for both small- and large-scale fishing gears in West Palawan. Reduced catch rates are common in many small-scale, reef-based fishing gear operations. For instance, catch rates in fisheries supporting the trade of live reef fish, typically groupers and wrasses, have declined in areas depending on reefs that are highly accessible; sighting surveys in 1998 support this observation (Ingles 2000). Fisheries have greatly reduced the population densities of groupers, lobsters, and octopuses on the reefs of Calamianes Islands, Palawan.

3.2 Current and potential threats

3.2.1 Current threats

Legal fishing

The absence of a national policy to regulate effort is one of the main causes of resource depletion. In practice, fisheries policies and laws are formulated as a reaction to the current fisheries situation instead of taking into account future needs and trends. Fisheries management as practiced in many areas of the country is "self regulating", *i.e.*, if the resource collapses, the fishery simply stops.

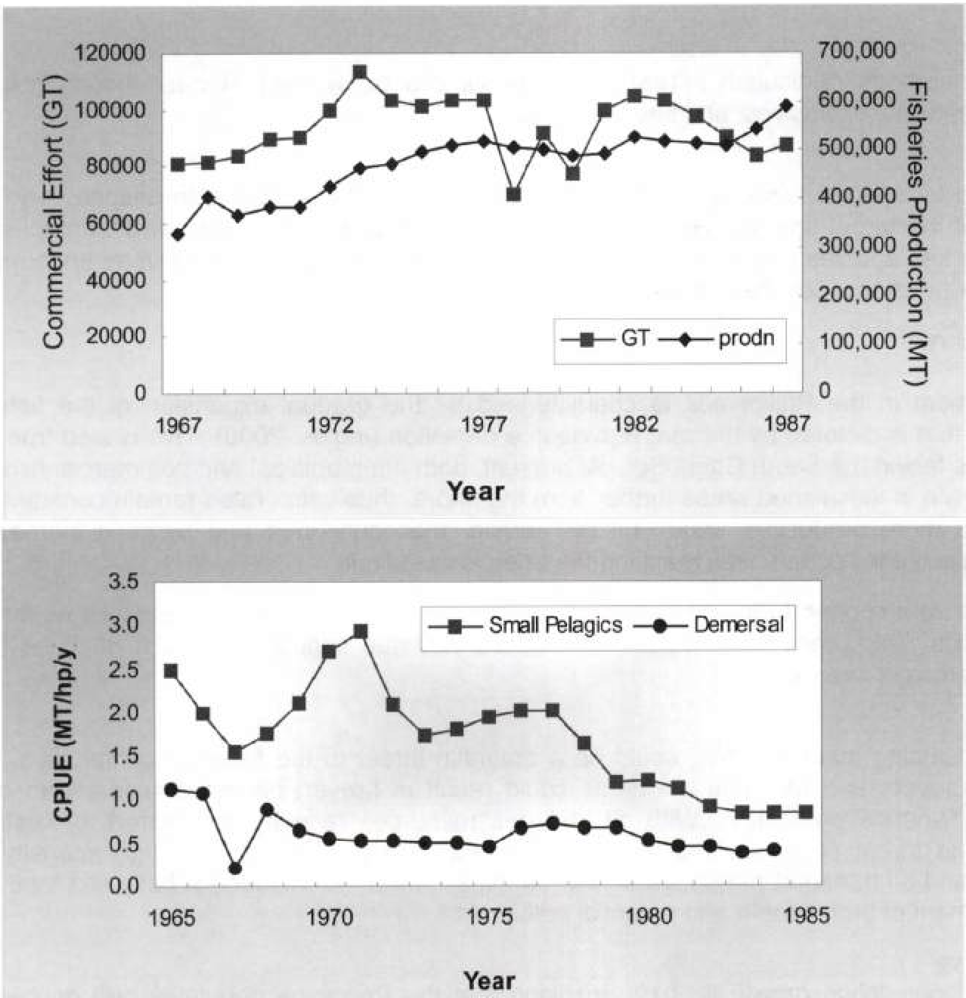

Figure 12 Total fisheries production (metric tons, MT) and fishing effort (gross tonnage, GT) (upper panel; from Barut *et al.*, 1997) and catch per unit effort (CPUE) of small pelagic and demersal fish (lower panel; from Dalzell and Ganaden 1987) in the Philippines.

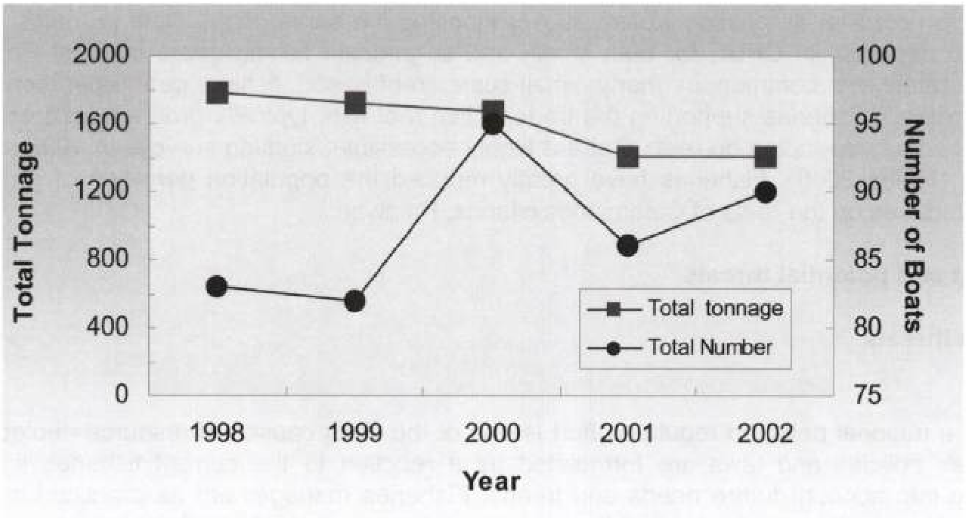

Figure 13 Total number and gross tonnage of fishing boats in Lingayen Gulf.

Illegal fishing
Destructive fishing methods, particularly in reef areas, are still commonly used. These methods include the use of toxic chemicals, explosives, and fine mesh nets.

Market forces
The global demand for specific fishery products could drive a fishery to be profitable despite very low population levels of the target species. High prices for invertebrates (*e.g.*, shrimps, crabs, octopuses, lobsters) and other key species (live groupers, Napoleon wrasses) in export markets may encourage fishers to fish out populations, despite low catch rates.

3.2.2 Potential threats

Fisheries development in the Philippines is characterised by the gradual expansion of the fishing grounds at a pace that is dictated by the rate of resource depletion (Ingles, 2000). This is also true for the Philippine areas facing the South China Sea. At present, both the municipal and commercial fishers are tending to operate in less fished areas further from the shore, thus catch rates remain constant as the fleet moves to more productive areas. In this setting, the continuous and perhaps increased exploitation of fish resources occurs until reaching the open access limit.

Handline fishers, *muro-ami* operators, and even spear fishers now regularly visit reef patches as far as the Kalayaan Islands. This practice, if not stopped, would continue until the very last of those few remaining pristine areas is overexploited.

Pollution
Marine pollution, including marine debris, could be a potential threat to the fisheries of the area. Oil spills from oil rigs/depots and maritime accidents could result in irreversible ecodisasters with dire consequences for fisheries production. With oil and gas resources recently discovered in western Palawan waters, the threat of oil spills may escalate in the future. Similarly, the high intensity of shipping activities and oil transport may pose similar dangers. The area is indeed a busy sea-lane for the constant movement of both people and potential pollutants.

Population increase
The current rate of population growth is 2.1%, implying that the Philippine population will double in 23 years. Hence, the number of fishers would proportionately increase. With the current state of fisheries resources and without any actions aimed at rebuilding depleted stocks, population increases will exacerbate the current pressure on fisheries resources.

Climate change
Global warming and the impacts of sea-level rise may also affect fisheries. There are studies that demonstrate how ENSO events influence fisheries. Coral bleaching during the 1998 El Niño episode has devastated wide coral reef areas on the western side of the country. In El Nido, Palawan, many of these reefs failed to recover. The effects of coral bleaching on fisheries need to be further studied and better understood.

Market forces

The globalisation of trade in fisheries products may be advantageous to some fishing sectors but disadvantageous to others. The reduction of trade barriers is expected to have short-term impacts on Philippine capture fisheries. Subsidies to fisheries by many developed countries will have a pronounced impact on the competitiveness of Philippine fisheries products. There is likewise a tendency to the imposition of non-tariff barriers (*e.g.*, ecolabeling, sanitary and phytosanitary restrictions) upon fisheries products from developing countries.

4. HABITATS AND AREAS OF IMPORTANCE IN THE MAINTENANCE OF EXPLOITED FISH STOCKS

In discussing habitats and areas important in the maintenance of fish stocks, particularly those with transboundary relevance, it is necessary to examine things on a large, at least basin-wide, scale since the focus is on species occurring over a wide geographical range and thus subject to large-scale dispersal mechanisms and other processes. Furthermore, plankton investigations showing spatial egg and larval distributions typically cover large areas rather than specific localities or habitats. Hence, the following discussion deals primarily with fishing grounds or basins rather than specific localities and their habitat characteristics.

In this respect, certain portions of the western Philippine coastline stand out due to coastal topography and available fisheries information. These include Lingayen Gulf and Manila Bay, and a group of islands with high topographic complexity, namely Northern Palawan and the Calamianes Islands (**Figure 14**).

4.1 Biophysical profile

Mangroves, seagrass beds, and coral reefs comprise the most productive shallow water habitats in the marine environment. Besides having their respective resident fauna and flora, they may also serve as habitats for different life stages (*e.g.,* spawning grounds for adults, nursery grounds for juveniles) of various fish and invertebrates. As such, the ecological interconnections between these habitats serve a major role in the productivity of coastal and offshore waters.

The overall distribution of coral reefs in the country is shown in **Figure 15,** covering about 30,000km^2 (McManus 2002) or about 5% of the world's coral reefs. This includes the double barrier reef system north of Bohol (Danajon Reef) and the barrier reef system several kilometers off the west coast of Palawan in the South China Sea. Other extensive reef areas (not adequately shown in the figure) include the northern Palawan Shelf, the Surigao Shelf, and the Bicol Shelf. Overall, about 400 coral species (Licuanan, 2000) and over 1000 reef-associated fish species (Hilomen *et al.,* 2000) have been recorded in the country. Along the western Philippines, coral reefs are most extensive in Palawan, where reef cover is estimated at about 9,800km^2, or about 1/3 of the country's total reef area (PCSD, 2000). The northernmost portion of Palawan (Calamianes Islands) ranks as one of the highest in terms of hard coral diversity (305 species) in the country (Werner and Allen, 2000; Capili *et al.*, 2002. Other reef areas of high biodiversity significance include the Balabac Strait in Southern Palawan, Southern Mindoro, portions of Batangas and Zambales coasts, western Lingayen Gulf, northern Batanes, Scarborough Reef, and the Kalayaan Island Group (CI, 2002).

Maps of the overall distribution of mangrove forests and seagrass beds in the country are unavailable, although maps showing high priority areas in terms of biodiversity conservation are given in **Figures 16a and b**. At least 50 mangrove and mangrove-associated species have been reported in the country, although the total cover of mangrove forests has been drastically reduced from about 500,000ha in 1920 to around 100,000ha in 1997 (Calumpong and Meñez 1997). Much of this is attributed to forest conversion to fishponds and other shoreline development activities. Along the western Philippines, priority areas of high biodiversity conservation for mangroves include the entire province of Palawan and a few remaining stands along the coast of Batangas, southeastern Lingayen Gulf, and on the northern coast of Cagayan province (**Figure 16a**).

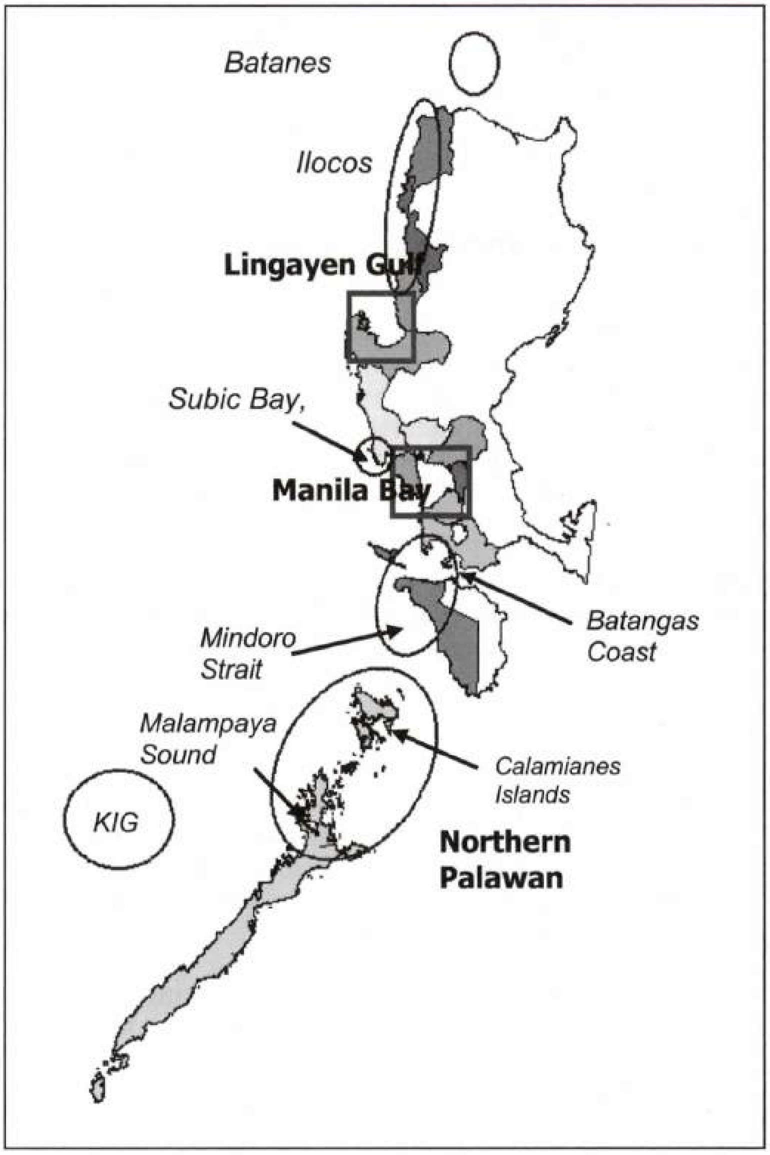

Figure 14 Map of western Philippines showing locations of main embayments (red squares) and other coastal areas of transboundary significance in the South China Sea. KIG-Kalayaan (Spratlys) Islands Group.

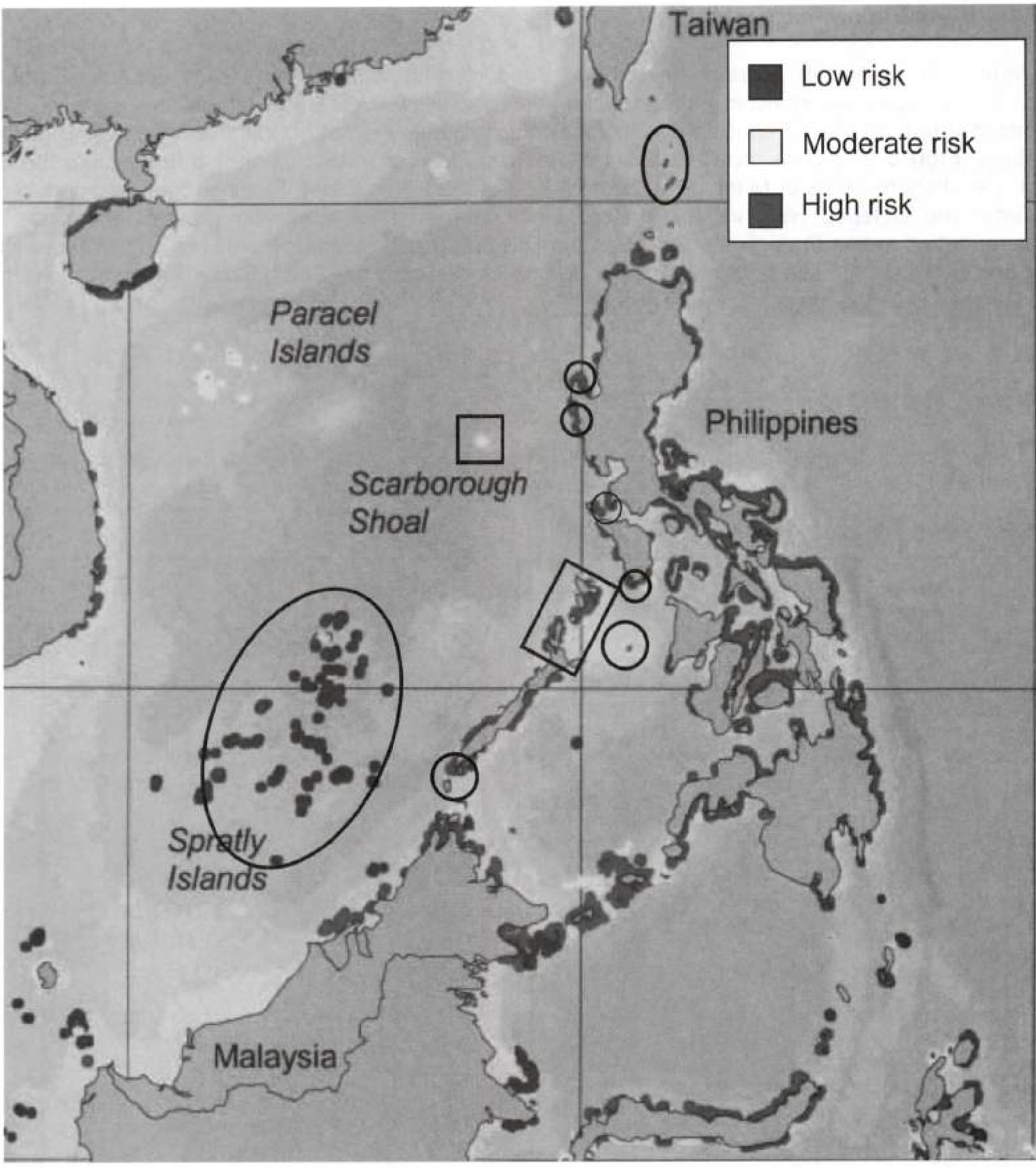

Figure 15 Overall distribution of coral reefs of various risk levels in the Philippines. Areas along the western coast with highest priority in terms of reef biodiversity and conservation are indicated by ellipses or squares.

At least 13 species of seagrasses have been recorded in the country (Calumpong and Meñez, 1997). Similar to mangroves, the habitat offered by seagrass beds is more important than the species richness of the grasses themselves. In both ecosystems, it is the primary producers themselves (*i.e.*, mangroves and seagrasses) that form and provide the bulk of physical habitat for the diverse faunal and floral (*i.e.*, seaweeds) assemblages commonly found in them. Primary production in both ecosystems is consumed primarily through the detritus pathway, which involves several levels of benthic consumers that in turn serve as (protein-rich) prey for the more mobile and visible invertebrates (*e.g.*, crabs, lobsters, molluscs, and echinoderms) and fish (Odum, 1971; Mann, 1982). The natural abundance of small benthic detritivores, the physical protection provided by the grasses and the mangrove roots/trees, and the physiological requirements of these shallow water coastal ecosystems make them ideal nursery grounds for a diversity of marine animals.

4.1.1 Known spawning grounds

Several ichthyoplankton surveys have been conducted in various parts of the country wherein information regarding spawning grounds is available. However, since larvae are generally only identifiable to family level, species-specific spawning grounds cannot be identified. Spawning grounds for tuna (**Figure 8)** include the west coast of Palawan, Mindoro Strait extending further into the Sulu Sea, the offshore areas of Manila Bay-Zambales, and the Ilocos coast. Findings that are more recent consider the Celebes Sea, including Moro Gulf, as the major spawning grounds for tuna, with subsequent migration through the Sulu Sea via Balabac Strait, Northern Palawan, and Mindoro Strait (**Figure 9**). This migration facilitates mixing of tuna stocks from the South China Sea with those from the Celebes Sea, the major spawning ground.

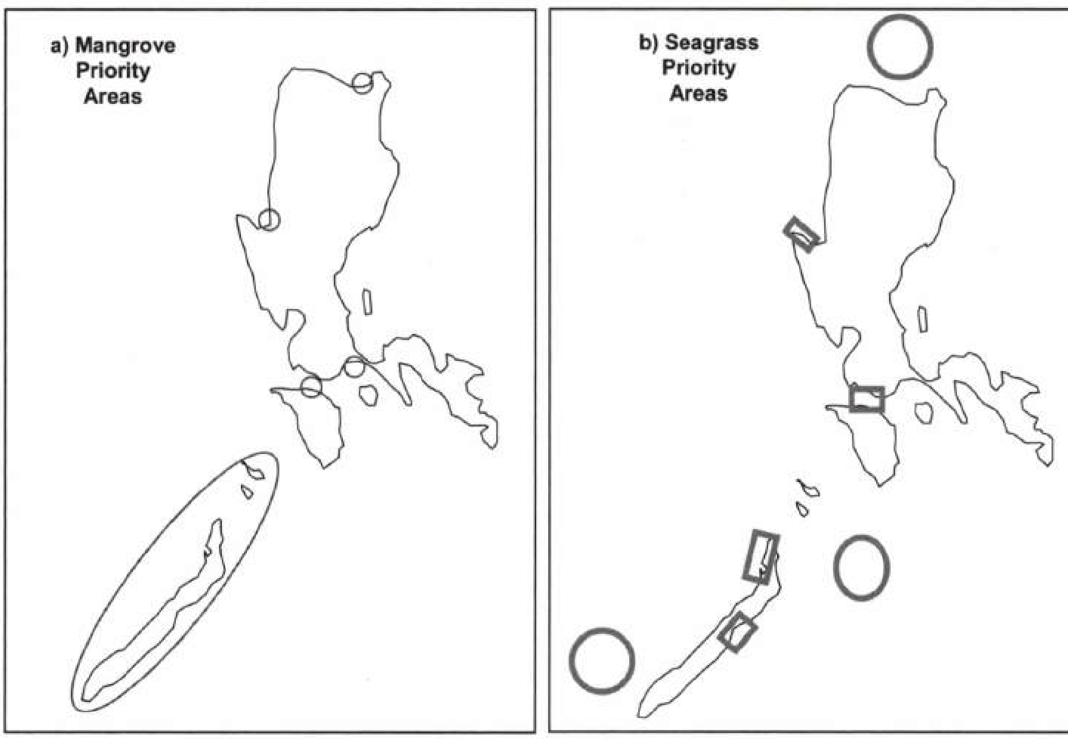

Figure 16 Areas of highest priority for a) mangrove and b) seagrass biodiversity and conservation along the coast of the western Philippines.

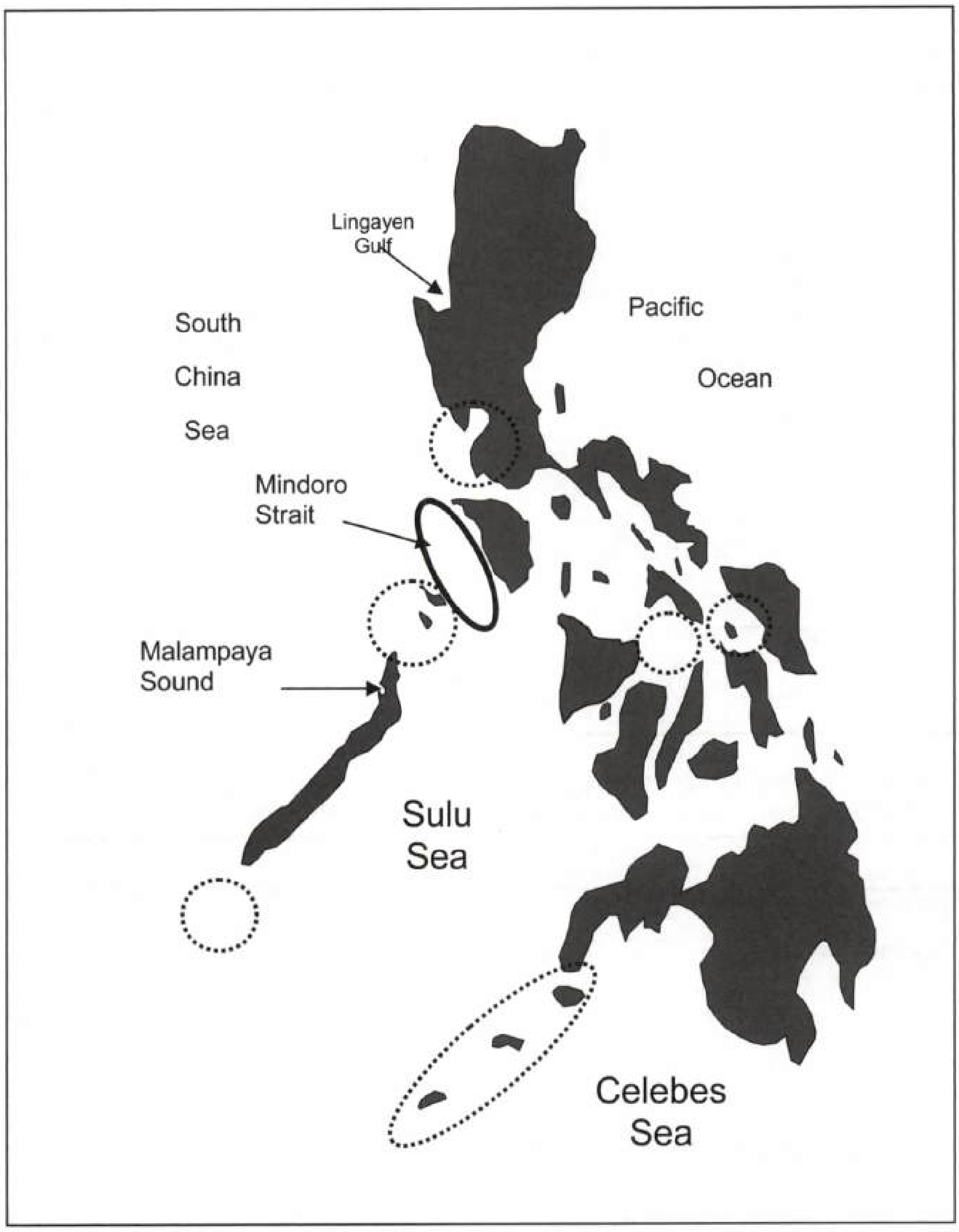

Figure 17 Major areas of intense fish spawning based on Magnusson (1970) and Tan (1970).

Table 14 provides a summary of zooplankton biomass and ichthyoplankton density in various areas along the western Philippines and adjacent internal waters. Both fish egg and larval density estimates are highest in Malampaya Sound (Estudillo *et al.*, 1980), a rather deep embayment on the west coast of northern Palawan (**Figure 14**). Zooplankton biomass for the same year was likewise high in this area. Recent estimates of zooplankton density in the Sound (Ingles 2002) also show high values (**Table 15**). If a zooplankton biomass of $0.01 ml/m^3$ is considered typical of oceanic waters (Hermes and Villoso 1985), then based solely on plankton densities, Malampaya Sound is likely a spawning ground for various fish species. Unfortunately, species composition of ichthyoplankton is not reported.

Ordoñez *et al.* (1975) reported concentration of fish larvae in Mindoro Strait (**Figure 17**) during their survey, although reported values were much lower than that recorded in Malampaya Sound (**Table 15**). Because larval densities have large differences with those observed in internal waters (Batangas Coast/Manila Bay), the area was thus considered a spawning ground, especially for Thunnidae, Carangidae, Serranidae, and Mullidae, which comprised over 75% of the ichthyoplankton in the area.

Specific areas of high larval densities may not necessarily be the area where the spawning actually took place, but more likely at the downstream portion of the latter due to the displacement by water currents. Local hydrography (current speed and direction) would then determine the magnitude of the displaced distance. What is perhaps more relevant is that locations for both spawning (*i.e.*, high egg concentrations) and settlement (high larval concentrations) are equally important for the survival and continued reproduction of fish stocks. In the marine environment, both locations are more likely found within at least a portion of a fishing ground rather than in a single specific habitat within the fishing ground (*e.g.*, specific reef or seagrass bed).

Table 14 Comparison of zooplankton biomass (ml/m^3) and fish egg and larval densities (ind/100 m^3) at locations along the South China Sea side of the Philippines.

Location	Biomass	Egg Density	Larvae Density	Peak Density	References
South China Sea (W. Phil.)	-	18.4	11.9	-	Chamchang and Chayakul (2000)
Lingayen Gulf	0.6	115.4	53.6	Dec-Apr	Estudillo (1985)
Malampaya Sound (Inner)	5.1	1126.7	575.0	May-Sep	Estudillo *et al.* (1980)
Malampaya Sound (Outer)	3.6	1081.7	465.2	May-Sep	Estudillo *et al.* (1980)
Mindoro Strait	1.9-26	1.08	28-35	-	Ordoñez *et al.* (1975)
Northern Palawan	-	-	10-50	-	Armada (1997)
Northern Palawan	0.2	41.2	12.3	-	Campos (2000)
Batangas Coast/Manila Bay	-	-	1.2	-	Ordoñez *et al.* (1975)
Sulu Sea	0.03-0.25	-	-	-	Hermes and Villoso (1985)
Visayan Sea	0.86	339.6	67.9	-	Campos *et al.* (2002)

Table 15 Comparison of net primary production (gC/m^2/d) and zooplankton density (ind/m^3) in the South China Sea and some coastal areas of the Philippines.

Area	Net 1° Production	Zooplankton Density	Reference
South China Sea *(Western Philippines)*	0.1–1.53	446–4,683	Furio and Borja (2000) Relox *et al.* (2000)
South China Sea *(NW Palawan)*	0.4–0.5	–	San Diego-McGlone *et al.* (1999)
South China Sea *(North of KIG*)*		4114±256	Palermo *et al.* (2003)
Lingayen Gulf	0.5–2.8	1,000–9,000	MERF (2002)
Manila Bay	0.7–3.8	220–6240	MADECOR (1995)
Malampaya Sound (Northern Palawan)	–	1,900–10,700	Ingles (2002)
Visayan Sea	–	11,700	Campos *et al.* (2002)

**Kalayaan (Spratlys) Islands Group.*

Comparable larval densities have also been recorded in Lingayen Gulf (Estudillo 1985), the SCS (Chamchang and Chayakul 2000), and Northern Palawan (Armada 1997; Campos 2000) (**Table 14**). In Lingayen Gulf, eggs and larvae were concentrated along the coast from the southern central to the eastern portions of the Gulf. Low ichthyoplankton densities were recorded at the mid-Gulf stations (Estudillo 1985). Unfortunately, the survey did not include the western Gulf area, which includes much of the reefs in there. A more recent plankton survey (MERF 2002) reported a hundredfold difference in zooplankton biomass between the high concentrations in the Western Gulf region extending from Bolinao to the Hundred Islands Reef system, and the rest of the Gulf. Water circulation in Lingayen Gulf (**Figure 18**) is forced by the northward shelf current passing Cape Bolinao, resulting in a wake feature that forms an eddy across the mouth of the Gulf (Altemerano and Villanoy, 2002). Dispersal modeling showed that most particles (*i.e.*, larvae) released near the Bolinao Reef Flat are entrained in the headland eddy, favoring settlement and recruitment along the western Gulf region. Therefore, it is more likely that the latter region is a major spawning ground for reef and other fish within Lingayen Gulf.

In the SCS, highest egg concentrations were recorded at about 100nm off the coasts of Ilocos southward to Zambales, whereas the highest larval densities occurred further south and in internal waters of Mindoro and Northern Palawan (Chamchang and Chayakul 2000). The latter is consistent with the results of Ordonez *et al.* (1975). The dominant fish groups in more recent surveys include the gobiids, carangids, and apogonids, which were found closer inshore, whereas the scombrids and thunnids were found further offshore (Chamchang and Chayakul, 2000).