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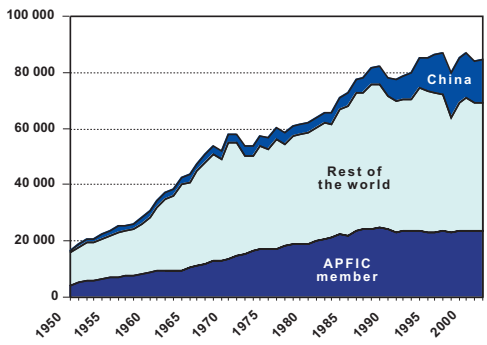
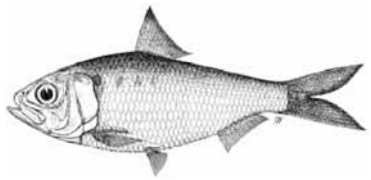
ASIA-PACIFIC FISHERY COMMISSION

Status and potential of fisheries and aquaculture in Asia and the Pacific 2010





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Status and potential of fisheries and aquaculture in Asia and the Pacific 2010

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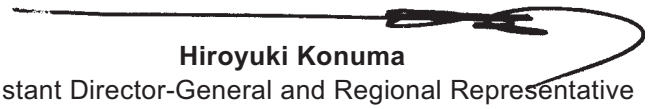
Foreword

The Asia-Pacific Fishery Commission (APFIC) is committed to acting as a regional consultative forum, providing member countries, regional organizations and fisheries professionals in the region with the opportunity to review and discuss the challenges facing the region's fisheries sector and helping them decide on the most appropriate actions to take. As part of this function, APFIC prepares a biennial status report to inform member countries and other stakeholders of trends in fisheries and aquaculture, of emerging issues and other information tracking related to fisheries governance. The report is prepared for and provided to member countries and other stakeholders to assist in their deliberations during the biennial APFIC regional consultative forum meeting and the regular session of the commission.

The present report *Status and potential of fisheries and aquaculture in Asia and the Pacific 2010* provides short reviews of some current issues facing fisheries and aquaculture in the region that are likely to challenge the sector as it adapts to the continuously changing production and market environments. The structure of the report has been organized to reflect the two large ecosystems of interest to the region, namely the South China Sea and the Bay of Bengal. The information contained here will support regional dialogue on the status of these two fishery subregions as well as provide valuable baseline or background information on the fisheries. It is also hoped that this type of report will assist the development of more effective ecosystem indicators or monitoring points.



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Preparation of this document

This document was prepared for the Thirty-first Session of the Asia-Pacific Fishery Commission (APFIC), which was held in Jeju, Republic of Korea from 6 to 8 September 2010. APFIC has continued to implement its new role as a regional consultative forum and is endeavouring to respond effectively to the changing requirements in the fisheries and aquaculture sector in the region. APFIC is committed to improving the quality of information on the status and trends of fisheries and aquaculture in the region and to reviewing and analyzing this information regularly. The purpose of this document is to inform APFIC Member States of the current status and potential of fisheries and aquaculture in Asia and the Pacific region and of the emerging issues facing the sector.

This review would not have been possible without access to the national statistical information of APFIC member countries, FAO colleagues, the work of regional organizations such as SEAFDEC, BOBP-IGO and the many others that collate and analyze information relevant to the fishery and aquaculture subsectors of the region. In particulalr, we would like to acknowledge the dedicated contributions by country correspondents:

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Bibliographic reference

Lymer, D., Funge-Smith, S. & Miao, W. 2010. *Status and potential of fisheries and aquaculture in Asia and the Pacific 2010*. FAO Regional Office for Asia and the Pacific. RAP Publication 2010/17. 85 pp.

Geographical scope of this review

States, entities and areas

This review covers the states, entities and areas of Asia and the Pacific region that report fisheries and aquaculture statistics to FAO, and which are within the area of competence of the Asia-Pacific Fishery Commission. They are subdivided into the subregions identified below, but other subdivisions, e.g. "South China Sea and Gulf of Thailand" and "Bay of Bengal and Andaman Sea" may appear as necessary later in the report.

South Asia: Bangladesh (the People's Republic of), Bhutan (the Kingdom of), India (the Republic of), Maldives (the Republic of), Nepal (Federal Democratic Republic of), Pakistan (Islamic Republic of) and Sri Lanka (the Democratic Socialist Republic of).

Southeast Asia: Brunei Darussalam, Cambodia (the Kingdom of), Indonesia (the Republic of), Lao PDR (People's Democratic Republic), Malaysia, Myanmar (the Union of), Philippines (the Republic of the), Singapore (the Republic of), Thailand (the Kingdom of), Timor-Leste (the Democratic Republic of) and Viet Nam (the Socialist Republic of).

China: China PR (People's Republic of), Hong Kong SAR (Special Administrative Region of China) and Taiwan POC (Province of China).

Other Asia: Iran (Islamic Republic of), Japan, Kazakhstan (the Republic of), Korea DPR (Democratic People's Republic of), Mongolia, Korea, RO (Republic of), Tajikistan (the Republic of) and Uzbekistan (the Republic of).

Oceania: American Samoa, Australia, the Cook Islands, Fiji Islands (the Republic of the), French Polynesia, Guam, Kiribati (the Republic of), the Marshall Islands, the Federated States of Micronesia (FSM), Nauru (the Republic of), New Caledonia, New Zealand, Niue (the Republic of), Norfolk Island, Northern Mariana Islands (the Commonwealth of the), Palau (the Republic of), Papua New Guinea (PNG), Pitcairn Island, Samoa (the Independent State of), Solomon Islands, Tokelau, Tonga (the Kingdom of), Tuvalu, Vanuatu (the Republic of), and Wallis and Futuna Islands.

Production areas

All catches made outside the subregional areas mentioned above are excluded from this review. The subregional areas included in this review are part of the FAO major fishing areas (MFAs) listed below. If specifically mentioned, the data presented in the report could also correspond to other production areas, e.g. "world production" might refer to all FAO major fishing areas.

Inland waters:	Asia — Inland waters Oceania — Inland waters	(MFA 04) (MFA 06)
Marine waters:	Western/Eastern Indian Ocean Northwest, Western/Eastern Central and Southwest Pacific Ocean	(MFA 51 and 57) (MFA 61, 71, 77 and 81)

Note: For the review of the two large marine areas, the Bay of Bengal and the South China Sea, the relevant sub-areas have been used and are described in detail.

Species

Data on aquatic mammals, aquatic plants, corals, pearls, sponges and crocodiles from capture fisheries are excluded.

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Introduction

Fish and fishery products make an enormous contribution to the nutrition and wellbeing of the peoples of Asia and the Pacific region, possibly exceeding their contribution in any other region of the world. The quantities produced and the sheer diversity of species and products from inland and marine waters that exist in the region is clear testimony to a deep-rooted tradition of fish consumption.

The Asia-Pacific Fishery Commission (APFIC) biennial review *Status and potential of fisheries in Asia and the Pacific* is intended to provide updated information on emerging issues relevant to fisheries and aquaculture, and to summarize regional information to describe some of the key trends that affect these resources and production systems. The sources of data for this review are extensive, but several primary sources must be acknowledged:

- National correspondents – country information was requested from country correspondents who are fisheries professionals working in the area of fisheries resources and have access to a wide range of national data.
- FAO/APFIC/SEAFDEC workshops – Report of the FAO/SEAFDEC/APFIC 2nd Workshop on the Assessment of Fishery Stock Status in South and Southeast Asia 5–9 October 2009 Bangkok, Thailand (proceedings published as FAO Technical Report No. 940).

For its biennial review for 2010, APFIC went beyond an analysis of aggregated official statistics and worked closely with fishery professionals in the region to provide more disaggregated information on local trends that underlie some of the "big picture" statistics. This is part of a major shift towards ecosystem level reporting requested by the APFIC members at its thirtieth session. In this regard, APFIC has modified the analysis of marine capture fisheries to focus on two marine areas: the Bay of Bengal and the South China Sea.

Compiling data from a variety of sources at the ecosystem level goes beyond national capture production statistics and enables a clearer overall picture of the fisheries. By using a range of indicators related to fishing and fishery resources, the social, economic and environmental characteristics of these fisheries can be viewed as interrelated components rather than isolated data or stand – alone trends.

This approach is in line with the recommendation of the thirtieth APFIC session to promote ecosystem approaches to management. Presentation of information in this format enables policy issues to be viewed in a broad context and our understanding of how these issues relate to other aspects of fisheries and aquaculture management to be increased. It is expected that this review will also encourage APFIC member countries to look deeper into the information and statistics that they collect, regularly or occasionally, with a view to present them in a more integrated, holistic manner, thereby broadening the analysis and improving understanding of trends in the region's fisheries and aquaculture.

As with all reviews of this nature, the information provided will raise more questions than it answers. It is intended that this biennial review will be updated regularly, allowing some of these indicators to be tracked over time. In some cases only individual "snapshots" are available and it is hoped that these will encourage further tracking and analysis where there are gaps or patchy information preventing better understanding. This review also serves the purpose of highlighting those areas where more information is needed and where trends need to be tracked.

Part 1
Capture fisheries

Capture fisheries — trends in Asia and the Pacific region

Capture fisheries production in Asia and the Pacific region increased to 48.3 million tonnes in 2008 from 47 million tonnes in 2006 – an increase of only 2.9 percent. The percentage increase between 2004 and 2006 was 19 percent. The region has been the world's largest producer of fish for decades and in 2008 increased its contribution to 51 percent of global capture production (from 49 percent in 2006 and 46 percent in 2004). Of the world's top ten producers of capture fish, six states are in Asia and the Pacific region: China, Indonesia, Japan, India, Philippines and Myanmar. Total capture fisheries production in the region has steadily increased since 1950, mainly from the marine capture fisheries sector (Figure 1).

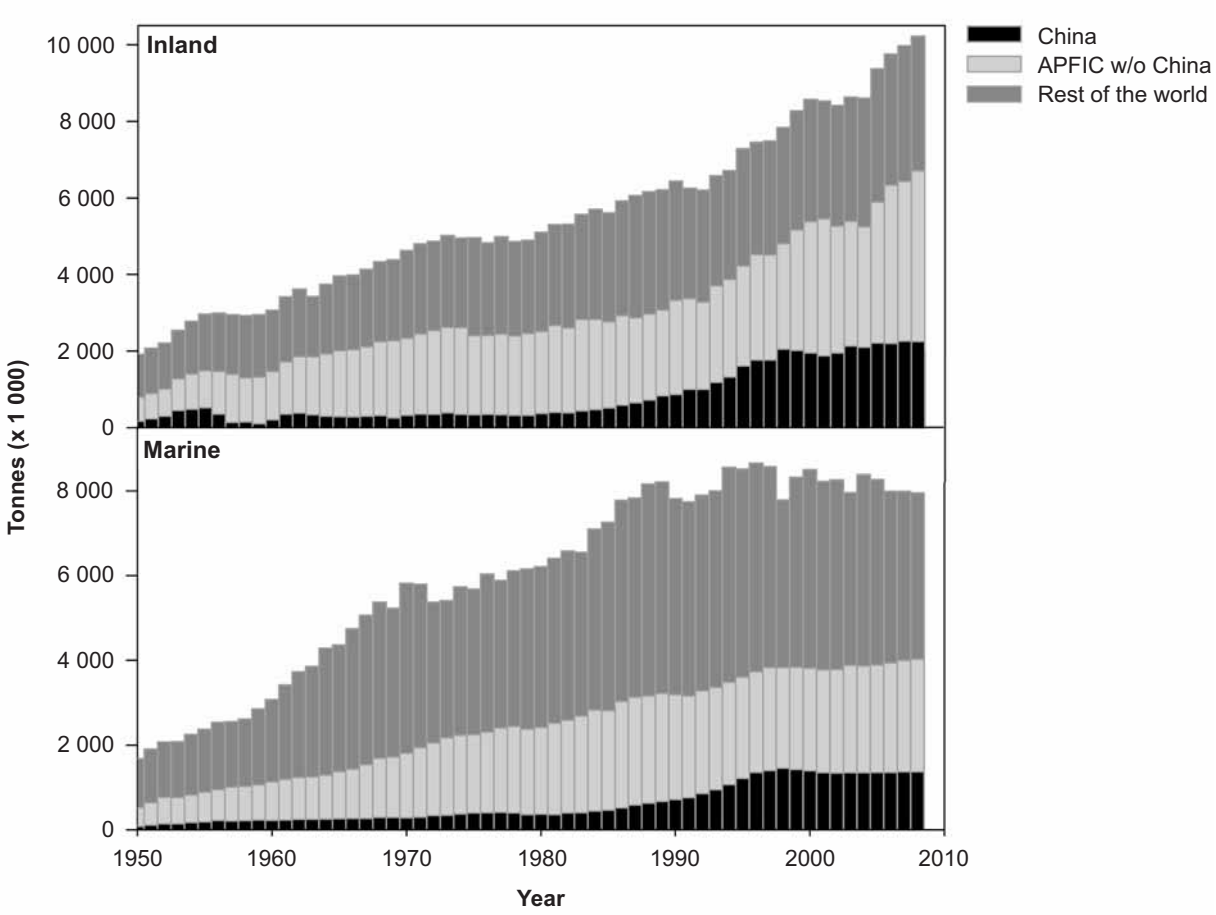


Figure 1 Trends in global capture production by region for inland and marine fisheries (1 000 tonnes)

Marine capture fisheries

Globally, marine capture production has been stagnating for the past decade, however production in Asia and the Pacific region is still increasing.

- China is still by far the largest producer in the region representing 34 percent of total regional production. Although its regional share is decreasing (40 percent in 2006) this is still more than three times greater than the share of the second largest producer in the region, Indonesia, and three and a half times greater than that of the third largest producer, Japan. Because of this enormous scale of production, China (which includes China, Hong Kong SAR, Macau SAR and Taiwan POC) is treated as a distinct subregion in this review unless otherwise indicated.
- Capture fishery production from the marine waters of the remaining countries of the APFIC region was the highest ever recorded in 2008 with 26.5 million tonnes.

- Southeast Asia has continued to increase its production and has maintained the largest share (excluding China) of the APFIC region since 1994 (Figure 2).
- There has been a relatively moderate increase in South Asia.
- The subregion Other Asia used to be the top contributor to capture fishery production in the region, but has continuously declined since 1988, a trend that now shows signs of levelling off. This can partly be explained by the facts that the Japanese and DPR Korea fisheries are not decreasing at the same rate as in previous years and the production of the Republic of Korea has been increasing.
- In terms of production increases, the largest share of the region's 2.9 percent increase over 2006 is from the subregions other than China, which increased 3.9 percent compared to 1.0 percent for the China subregion.

Inland waters

Inland capture fisheries production in the region grew by 6.0 percent between 2006 and 2008 compared to a growth rate of only 1.3 percent between 2004 and 2006.

- This region contributes 65.6 percent of global inland fisheries production (64.8 percent in 2006).
- In inland waters, excluding China, total production of the region reported in 2008 was 4.5 million tonnes (4.1 million tonnes in 2006).
- For the Chinese subregion, inland production was 2.2 million tonnes in 2008, representing 33.5 percent of the total regional catch (6.7 million tonnes in 2008).

This overall increase in inland fisheries is probably a result of more enhancement and growing effort as this increases the yield. However, part of the increase is probably because of a significant re-evaluation of the contribution of inland fisheries – this greatly revised the previous underestimates upwards (and is covered in depth in the section "*Historical and systematic underestimation of inland capture fishery production*" page 39). This is also a cause for concern when analyzing the inland fisheries status and trends: if the reported increasing production mainly relies on improved reporting, then the real production may *de facto* be decreasing. This would be in line with feedback from fishers reporting general decreasing catches. However, it should also be noted that there is an increasing number of fishers in the sector as predicted in the 2008 biennial report. Additionally, inland capture fisheries production in Thailand has been estimated at 1.0 million tonnes, compared to the reported 0.2 million tonnes (Lymer *et al.*, 2008).

Subregional trends from the FAO statistics

China

Total capture fishery production in the China subregion was 15.1 million tonnes in 2008. The production figure has been relatively stable since 2000 although there have been fluctuations in recent years (+0.5 percent since 2006).

- Production of pelagic marine fish and marine fish "not elsewhere included" (nei) increased by 2.6 and 3.9 percent respectively in 2007 and 2008 and now makes up 38 percent of the total catch.
- Demersal fish production is at an almost identical level as in 2006, comprising 24 percent of total catch (Figure 2).
- Freshwater fish show a continued increasing production trend (+4.1 percent since 2006)
- Mollusc and crustacean production show decreases (-14.1 and -6.5 percent respectively).
- Cephalopod production continues to increase (+18.5 percent) and total production was almost 0.7 million tonnes in 2008.

Southeast Asia

Increase in capture fishery production in Southeast Asia has also been very strong in the past four decades with marine capture production increasing almost linearly throughout this period. The total capture production in 2008 was 16.1 million tonnes (Figure 2). The main species groups are pelagic marine fish and marine fish nei.

- The production of marine fish nei keeps growing strongly (an average of 4.3 percent since 2006). Southeast Asia is a major driving force of the overall production growth for this group of non-identified species.
- Pelagic marine fish production has increased (an average of 5.5 percent since 2006).
- Demersal marine fish production has increased (an average of 5.5 percent since 2006).
- Production of crustaceans and molluscs has also increased since 2006.
- Production of freshwater and diadromous fishes has increased (an average of 10 percent since 2006).
- Production of "aquatic animals" has decreased on average by more than 80 percent since 2006.

South Asia

Capture fishery production in the South Asian subregion has grown continuously since 1980, with a small dip in production in 2004. The region has more than doubled its capture production from 3.1 million tonnes in 1980 to 6.6 million tonnes in 2008 and increased capture production by 5.5 percent since 2006 and 18 percent since 2004 (Figure 2).

- Among marine species, both pelagic fishes and demersal fishes showed almost parallel increasing trends with similar levels of production in 2008 (1.4 million tonnes and 1.3 million tonnes, respectively).
- Production of marine demersal fish has increased by 15 percent since 2006.
- Production of pelagic fish has increased by 5.5 percent.
- Freshwater fish and diadromous fish have been the number one production group for the last four decades (except in 1992) and achieved very rapid growth in the 1990s and in the previous biennium (37 percent between 2004 and 2006) but only increased by 2 percent since 2006.
- Crustacean production has been relatively stable.
- Production of cephalopods in this region is declining (Figure 2).
- Mollusc production has risen by 140 percent since 2006, however the volume is still relatively small (12 000 tonnes in 2008).

Other Asia

In the Other Asia subregion, total production increased to a peak production of 13.6 million tonnes in 1988, and thereafter decreased steadily until 2000. This now (in 2008) totals 6.5 million tonnes and the decline has levelled off, with production relatively stable over the last five years, with a slight increase of 2 percent since 2006 (Figure 2).

- The largest production figure is for pelagic marine fish with 50 percent of the catch composition. The production of pelagic marine fish has been relatively stable in the first half of this decade and increased by 0.5 percent between 2006 and 2008.
- Notably, the production of marine fish nei has increased by 11.5 percent in this region since 2006; however, compared to other regions, it still makes up a relatively small percent of the total catch (7 percent in 2008).
- The production of freshwater and diadromous fish and crustaceans decreased between 2006 and 2008 by 9.8 and 12.3 percent respectively.

Oceania

Oceania's capture production also consists mainly of fish taken from marine waters, but unlike Other Asia there was an increasing trend until 2006 (Figure 2). In 2006 there was a rapid drop of almost 7 percent compared to the year before and this trend has continued with a 12 percent drop between 2006 and 2008. The decrease can also be seen in the absolute values of pelagic marine fish, demersal marine fish, crustaceans, cephalopods and marine fish nei. Declining catches in the fisheries within Australia's EEZ can partly be explained by a reduction in effort and in lower catches following a structural adjustment and a ministerial direction in 2005 aimed at ending overfishing and allowing overfished stocks to rebuild. The economics of fishing are expected to improve in the medium and long term, but higher profits can also be expected for individual fishers in the short term because fewer vessels are operating.

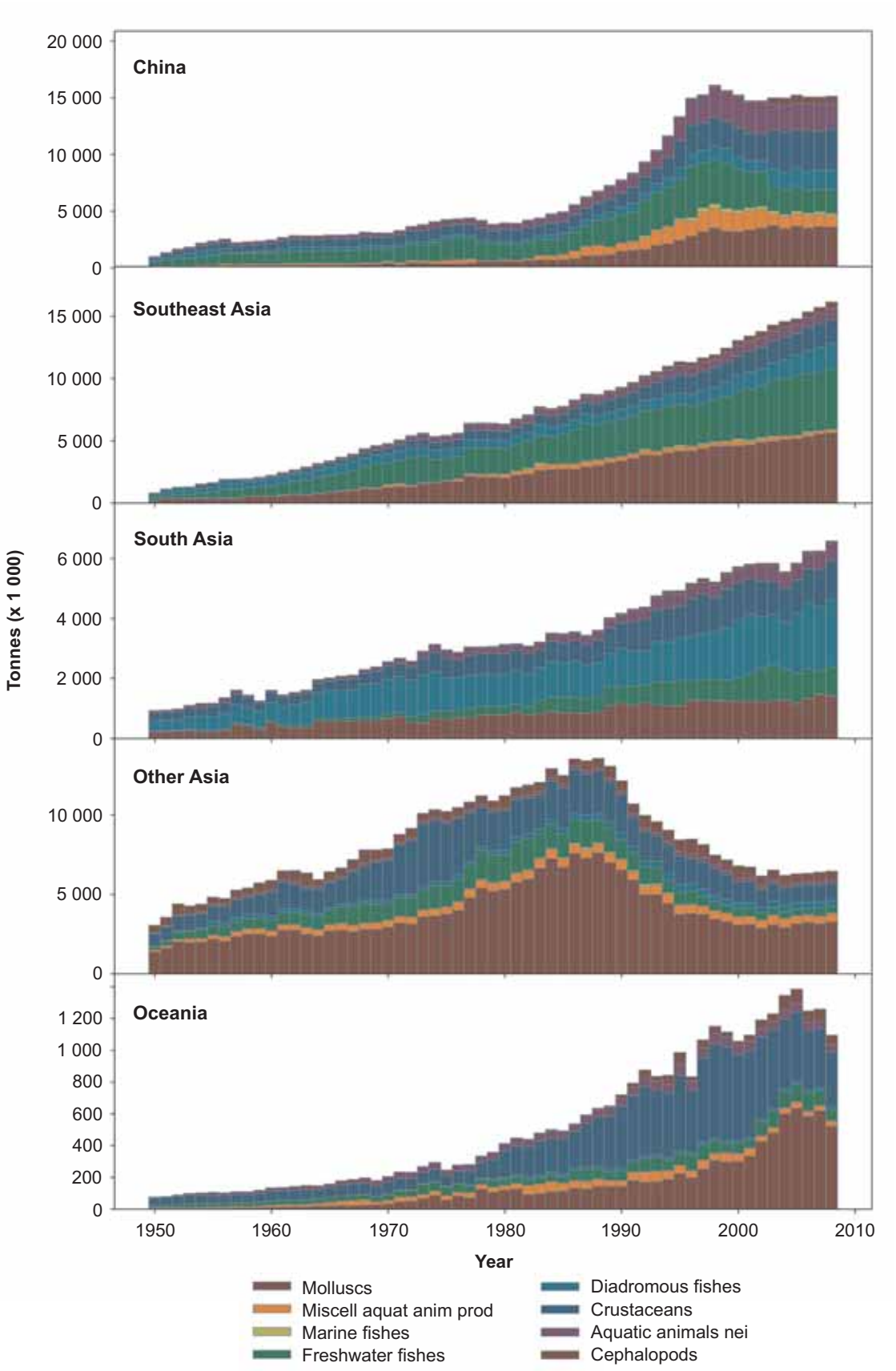


Figure 2 Subregional trends in capture production by species group

Issues of reporting species composition (not elsewhere included – 'nei')

There remains a considerable proportion of the region's capture production that is not identified at the species level but instead is recorded as marine/freshwater fish nei, marine/freshwater molluscs nei and marine/freshwater crustaceans nei (Figure 3). In 2008, 14.3 million tonnes or 30 percent of capture production in Asia and the Pacific region was not identified at species, genus, or family level. In 2006, the region produced 14 million tonnes that was reported as nei, representing 31 percent of the catch.

- The quantity reported under these categories has been increasing significantly in recent years for some subregions, which indicates a worrying trend in the quality of the available statistical information.
- The biggest producers of nei fish (Southeast Asia, China and South Asia) also report the least disaggregated data (Table 1).
- It is notable that China has improved its reporting on individual species. The reporting on nei species has been reduced from 52 percent of reported capture production in 2002 to 31 percent in 2008 (Table 1).
- The incease in reporting of nei fish may also reflect a strong trend towards the capture of smaller lower-value species. The percentages of these are high in the assessed catch composition (see Table 5). These small, low value or trash fish species may not be considered worth reporting in detail as part of catch landings. This hides the effects of overfishing on the capture of juveniles of higher value species.
- An alternative explanation is that the quality of catch landing statistics is deteriorating.

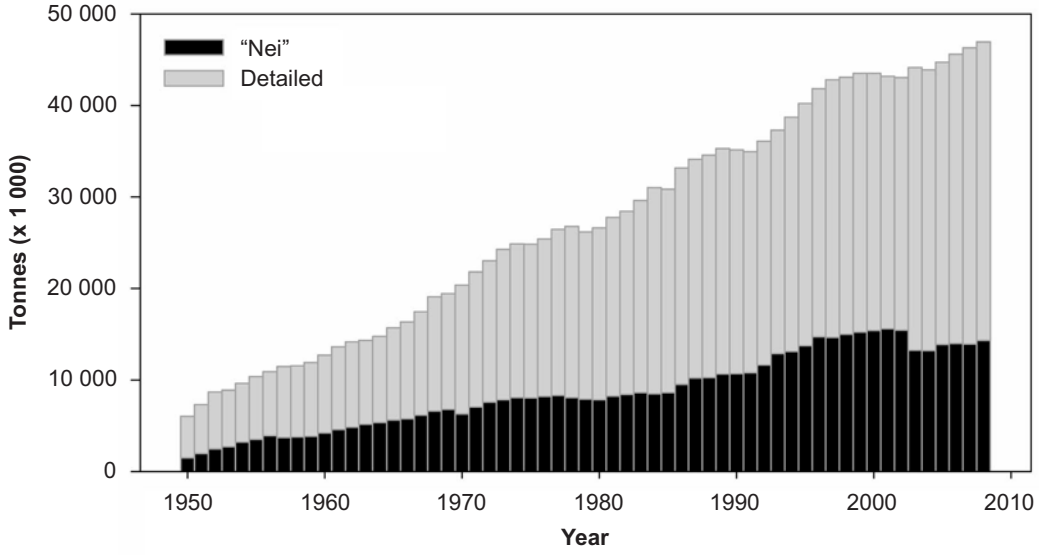


Figure 3 Capture productions in Asia and the Pacific region by detail of reporting

Table 1 Capture production in Asia and the Pacific region (by subregion) for major nei groups and the contribution of nei groups to total catch (x 1 000 tonnes)

	China	Southeast Asia	South Asia	Other Asia	Oceania
Marine fishes nei	2 103	4 868	991	495	60
Marine molluscs nei	646	80	12	2	4
Marine crustaceans nei	0	9	81	17	2
Freshwater fishes nei	1 615	1 588	1 361	13	8
Freshwater molluscs nei	268	63	0	2	2
Freshwater crustaceans nei	0	4	80	0	0
Total of included nei groups	4 633	6 613	2 524	529	77
Total capture production	**15 141**	**16 133**	**6 591**	**6 467**	**1 096**
Total % contribution of nei groups	**31%**	**41%**	**38%**	**8%**	**7%**

Marine capture fisheries subregional fisheries assessment

There is a general perception globally that fishery resources are declining and that the marine environment is deteriorating as a result of fishing and other human activities. Although there is evidence that this is occurring throughout the world, there are signs that fisheries are responding positively to effective management. The global evidence however is not particularly comprehensive and most of the information on effective management comes from developed country fisheries, typically in the more temperate regions of the world.

In South and Southeast Asia, catch trends are generally showing consistent increases that may be masking underlying fishing effects such as serial depletion of higher trophic level species (e.g. large demersal and pelagic species, sharks and rays) and a tendency towards faster recruiting species from a lower trophic level (small pelagic species, small demersal species, squids, low value/trash fish species). The expansion of new areas and transhipment of species between fishing areas complicates trend reporting by area and the determination of the status of stocks in specific localities. The combination of a lack of detailed information on and limited critical analysis of fish stocks trends mean that a clear message regarding the need for action to implement management measures cannot be clearly communicated. It also leads to the false assumption that there remains significant potential for further expansion of fishing.

Appropriate knowledge, analysis and communication of stock status are needed to enable decision-makers to develop appropriate harvest strategies to ensure sustainability of fishing activities and fishery resources.

In the 2006 report on the status and potential of fisheries and aquaculture several recommendations were made to member countries to improve the disaggregation of marine capture species composition data, including a recommendation to conduct targeted surveys to assess composition of nei reports to get better estimates. Following on from this, APFIC together with FAO and SEAFDEC and member countries conducted a series of workshops (FAO, 2009a and FAO, 2009b) to explore the idea of using existing information, including fishery-dependent data, scientific surveys and expert opinion to understand trends in stock development of marine resources.

Fisheries assessments were conducted by national consultants for selected areas/fisheries in Asia and the Pacific region. For each of these areas time series data were collected/compiled for the following variables: catch trends of larger groupings of fish (large, high value demersal species, large pelagic species, sharks/rays, small pelagic species, trash fish/low value fish (plus nei), squids/cuttlefish/octopus and crustaceans); production of fishmeal, surimi and trash fish; CPUE/catch-rates; fishery/stock assessment; fishing vessel capacity and employment; fishery zoning; management measures; protected/reserved areas; and the incidence and impacts of tropical storms and other natural disasters. However, it should be noted that there is incomplete coverage for all variables in these areas. The data for selected fisheries were sorted by area and were summarized and collated into two larger subregions (Figure 4): South China Sea and Gulf of Thailand subregion, including FAO fishing areas 61 and 71 (SCS region, shaded in green) and Bay of Bengal and Andaman Sea subregion, including FAO fishing area 57 (BoB subregion, shaded in grey).

For the South China Sea subregion (SCS) data for assessed fisheries and supporting fisheries management information were used from the following areas:

- China (northern South China Sea part, covering three provinces in the Beibu Gulf and the northern shelf);
- Viet Nam (whole country);
- Philippines (whole country);
- Thailand (east coast, Gulf of Thailand);
- Malaysia (Peninsular east coast, Sarawak and Sabah); and
- relevant fishing areas from Indonesia (FMA 711).

For the Bay of Bengal (BoB) subregion the data (for assessed fisheries) were used from:

- Sri Lanka (whole country);
- India (east coast);
- Bangladesh (whole country);
- Thailand (Andaman Sea/west coast);
- Malaysia (Malacca straits/Peninsular west coast); and
- relevant fishing areas from Indonesia (FMA 571, FMA 572).

The details of the fishing areas and their geographical descriptions are presented in Table 2.

Note that the data for the compilation into these two subregions is not based on complete geographical coverage (i.e. there are only partial data for Myanmar and no data for Cambodia); also note that additional data are included (e.g. from bordering areas such as the Philippines).

Despite the fact that these assessments and the data are not comprehensive, these subregional assessments do provide a picture of the status of stocks and resources in the region. Since this sort of synthesized assessment is not yet available at an ecosystem or ecoregion level, it is intended that this information will be used to complement other assessments and catch databases for the region (e.g. FAO FishStat, SEAFDEC, Bay of Bengal LME, ASEAN/BIMSTEC Working Groups on Fisheries), to identify gaps in data needs as well as to initiate more holistic assessments of resources at subregional levels.

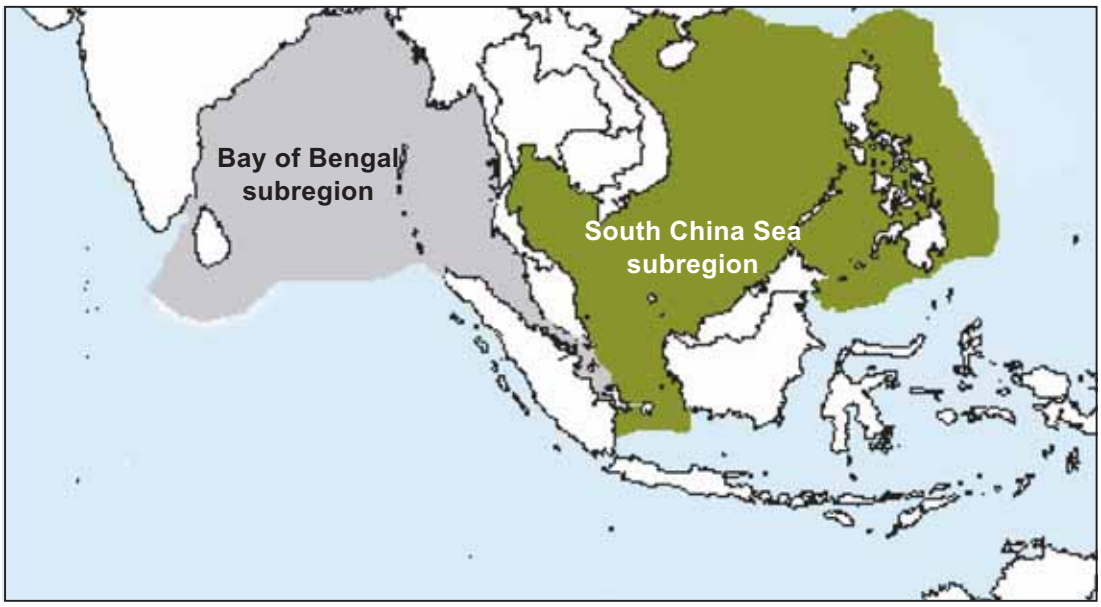


Figure 4 Outline of the two subregions and the areas included in this review

The following two sections (SCS and BoB subregions) describe and discuss these fishery related areas from a regional perspective based on country/area reports:

- Catch composition trends and production;
- CPUE/catch rates;
- fishery/stock assessment;
- fishing vessel capacity and employment;
- fishery zoning and management measures (including protected areas); and
- impacts of tropical storms and other natural disasters.

For each of the two subregions a review of the status of the resources and fisheries is given at the end of each of the two sections.

Table 2 Fishing areas or management areas by country

Countries	Fishing Areas
Bangladesh	**South patches** (6 200 km^2) 60–80 m depth (91°10'E – 91°50'E; 21°10'N – 21°40'N squares 302–305, 402–405, 502–505 and adjacent waters **Middle ground** (4 600 km^2) 80–100 m depth ▪ Southwest of south patches (90°30'E – 91°40'E; 20°45'N – 21°10'N, squares 603–609, 703–709 and adjacent waters) ▪ East of swatch of no-ground (90°00'E – 90°40'E; 21°00'N – 21°25'N Squares 509–512, 609–612) **Swatch of no-ground** (3 800 km^2) submarine canyon type, depth of 800–1000 m
Cambodia	
China (North SCS)	**Northern shelf**, South China Sea **Beibu Gulf** (Gulf of Tonkin)
India	**Northeast coast:** Orissa, West Bengal **Southeast coast:** Tamil Nadu & Puducherry, Andhra Pradesh **Southwest:** Goa, Karnataka, Kerala **Northwest:** Gujarat, Maharashtra **Andaman & Nicobar Islands; Lakshadweep Islands**
Indonesia	**Indonesian fishery management areas (FMAs)** (AFMR, 2005. Assessment of Fisheries Management Area) ▪ 571 Malacca Strait (135 522 km^2) ▪ 572 Indian Ocean (Western Sumatra) (938 944 km^2) ▪ 573 Indian Ocean (South of Java) (779 110 km^2) ▪ 711 Natuna Sea (577 451 km^2) ▪ 712 Java Sea (423 290 km^2) ▪ 713 Makassar Strait – Flores Sea (1 567 135 km^2) ▪ 714 Banda Sea (673 602 km^2) ▪ 715 Tomini Bay, Seram and Molucca Seas and Bintuni Bay (543 609 km^2) ▪ 716 Sulawesi, Halmahera Seas ▪ 717 West Pacific Ocean (including Sulawesi and Halmahera Seas 1 037 376 km^2) ▪ 718 Arafura and Timor Sea (481 511 km^2)
Malaysia	**South China Sea** ▪ Peninsular east coast ▪ Sabah ▪ Sarawak **Peninsular West Coast** ▪ Malacca Straits ▪ Peninsular west coast
Myanmar	Coastline 2 832 km, EEZ area 486 000 km^2
Philippines	Luzon, Visayas, Mindanao
Sri Lanka	**15 districts for enumeration and landings:** Puttalam, Chilaw, Colombo, Negombo, Kalutara, Galle, Matara, Tangalle, Kalmunai, Batticaloa,Trincomalee, Mullaithivu, Kilinochchi, Jaffna, Mannar
Thailand	**East coast/Gulf of Thailand fishery management area** **Fishery statistical areas:** ▪ Fishing ground 1*:* Eastern Gulf of Thailand consisting of the seas off the provinces of Trad, Chanthaburi and Rayong. ▪ Fishing ground 2: the Inner Gulf consisting of the seas off the provinces of Chon Buri, Chachoengsao, Samut Prakan, Bangkok Metropolitan, Samut Sakon, Samut Songkhram, and Phetchaburi. ▪ Fishing ground 3: Upper western Gulf of Thailand consisting of the seas off the provinces of Prachuab Khiri Khan, Chumphon, and Surat Thani. ▪ Fishing ground 4*:* Lower western Gulf of Thailand consisting of the seas off the provinces of Nakhon Si Thammarat, Songkhla, Pattani and Narathiwat. ▪ Fishing ground 5*:* Mid-Gulf of Thailand consisting of the seas in the mid-Gulf that extend southward to the international boundary line between Thailand and Kingdom of Cambodia and Thailand and Malaysia. **Andaman sea fishery management area** **Fishery statistical areas:** ▪ Fishing ground 6*:* Upper Andaman Sea consisting of the seas off the provinces of Ranong, Pang-nga, and Phuket. ▪ Fishing ground 7*:* Lower Andaman Sea consisting of the seas off the provinces of Krabi, Trang, and Satun.
Viet Nam	**Northern area:** comprising nine provinces from Quang Ninh to Quang Binh **Central area:** comprising nine provinces from Quang Tri to Ninh Thuan **Southeast area:** comprising eight provinces from Binh Thuan to Bac Lieu **Southwest area:** comprising Ca Mau and Kien Giang only.

Sources: Country correspondent reports and national reports

Total catch and estimated MSY by country

Maximum sustainable yield (MSY) is a measure used to express the average maximum level of production that a fish stock or fishery can sustain without suffering a decline in stock abundance. This is also sometimes expressed in aggregate terms for an entire fishery as the total potential yield, thus including all the species caught in the fishery. The use of total potential yield for an entire fishery may be misleading since the complex composition of tropical fisheries means that individual species can suffer severe depletion, but compensation by fast-growing small species continues to provide the same or even a higher total weight of catch from the fishery. In this way, extended periods of excess fishing pressure can greatly modify the species composition within a fishery, tending towards the reduction of abundance of more valuable (and often more vulnerable) larger species and the proliferation of lower-value small species. Under heavy fishing pressure, even these small, usually highly productive species start to decline and the fishery actually exhibits declining production. In the tropical fisheries of the South China Sea and the Bay of Bengal, these effects are already being seen either at species or fishery level. Therefore, combining all species caught in a fishery in a single assessment may cover up serious overfishing effects for some of the species and lead to depletions and changes in species composition, even though total catches may be maintained.

Table 3 Total catch and estimated MSY for country areas

Country		Catch	Estimated MSY	Area
China	1980s	530 000–710 000	1 000 000–1 200 000	Northern Shelf & Beibu Gulf (Gulf of Tonkin)
Viet Nam	2004	1 724 200	1 500 000–1 600 000	National figure. Total biomass estimated at 5 075 143 tonnes. Demersal biomass 1 174 261; large pelagic 1 156 032; small pelagic 2 744 850 tonnes
		~double MSY (Pomeroy et al., 2008)	582 212	Nearshore zone (50 m depth)
Thailand	2007	1 447 898	2 159 049	East Coast/Gulf of Thailand
	2007	631 453	912 943	Andaman sea
Indonesia	2008	4 702 933	5 120 000	National figure
	2008[1]		66 100	FMA 711 – Large pelagic group
			621 500	FMA 711 – Small pelagic group
			334 800	FMA 711 – Demersal group
			11 900	FMA 711 – Penaeid shrimps group
			27 700	FMA 571 – Large Pelagic group
			147 300	FMA 571 – Small Pelagic group
			82 400	FMA 571 – Demersal group
			11 400	FMA 571 – Penaeid shrimps group
			164 800	FMA 572 – Large Pelagic group
			315 900	FMA 572 – Small Pelagic group
			68 900	FMA 572 – Demersal group
			4 800	FMA 572 – Penaeid shrimps group
Malaysia	2008	1 409 929	1 616 988	National potential yield
			62 000	West coast peninsular demersal potential yield
			155 500	West coast peninsular small pelagic potential yield
			55 500	East coast peninsular demersal potential yield
			366 500	Eest coast peninsular small pelagic potential yield
			86 661	Sarawak demersal potential yield
			38 327	West coast Sabah demersal potential yield
			852 500	Sarawak and west coast Sabah small pelagic potential yield
				No declared MSY. Potential yield estimated as a management tool for vessel and gear numbers
Philippines	2008	2 559 191	2 500 000	National figure
Bangladesh	2008	514 644	MSY not established (MFO, 2009)	Estimated pelagic biomass 319 000 tonnes [1973]; estimated demersal biomass 1 560 000 tonnes [1986]. A 50% estimate for MBSY is ~939 500 tonnes
Sri Lanka	2009	293 170	MSY not established	Estimated potential yield 250 000 tonnes/year (170 000 pelagic, 80 000 demersal)
India	2009	3 160 000	3 930 000	National figure
Myanmar	2007	1 679 000	1 050 000	National figure based on marine fishery stock assessment survey conducted by FAO from 1980 to 1983

[1] Purwanto, S. Nurhakim and Wudianto (2010)

MSY can still be a criterion used to judge if a fishery is overfished or production of a fishery exceeds the level that may cause serious long-term impacts. The methods for the calculation of MSY vary from relatively complex methods to simpler surplus-production models that only require time series of catch and effort data. Even simpler methods can be used (e.g. Gulland's formula) that calculate MSY as a fraction of standing biomass. Estimating MSY is a challenge for tropical multispecies multigear fisheries because classical methods require good time series data of individual species. In situations where measurement of MSY may not be an appropriate tool, methodologies like the Productivity Susceptibility Analysis (PSA) can provide useful additional information for fisheries management, as they provide risk assessment of the species in a community that are being impacted by a given fishery/gear.

From Table 3 it can be seen that many countries appear not to have exceeded their declared or estimated MSY for the fisheries listed. This does not necessarily suggest that fishing the Bay of Bengal and South China Sea subregions is commensurate with the production potential of the fisheries. As indicated above, these aggregated estimates may be misleading as important changes in species composition may be occurring even though total catches can be maintained at a high level, at least for some time. The MSY estimates from total yields do not take into account the species specific effects. It is important that MSY information is supplemented with other assessment information that will also provide evidence on individual stock status. This sort of evidence for overfishing effects can be found in subsequent tables:

- The species composition of the catches indicates a shift towards short-lived, low trophic level species. (Tables 4 and 5).
- Species or resource group assessments record overfishing or depletion of larger, longer-lived and more valuable species. (Table 6).
- CPUE (catch per unit effort) appears to be declining for many of the assessed stocks, fishing gears or fisheries (Tables 7 and 8).
- Trash fish quantities are increasing and form significant percentages of catches. (Table 9).

There have been clear ecosystem level effects, however data for the past ten years (based on reports provided for this review) may indicate that the South China Sea area has reached a low level plateau and the shifts in composition from previous decades have now settled down to favour an ecosystem dominated by small species. These shifts may not be observed in aggregated catch statistics provided to FAO, but are evident from national records and this emphasizes the need to look more deeply into the national catch statistics. These lower value species are being utilized for various ways (surimi, canned fish, fishmeal, aquaculture feeds), but the loss has been in the higher value larger species and thus fishers are having to work harder to catch a lower value product. In economic terms, this is rather inefficient, however it may also reflect the tendency towards maximizing employment in the fishery at the expense of economic efficiency and product quality in many of the developing countries that comprise this region.

The picture for the Bay of Bengal is less clear. This area does not have the same area of productive shelf fisheries as the South China Sea and is more dominated by pelagic resources. They are still subject to overfishing and depletion in some areas. Recent fisheries expansion is also driving these fisheries towards reduction of higher value, larger species resources.

South China Sea and Gulf of Thailand subregion

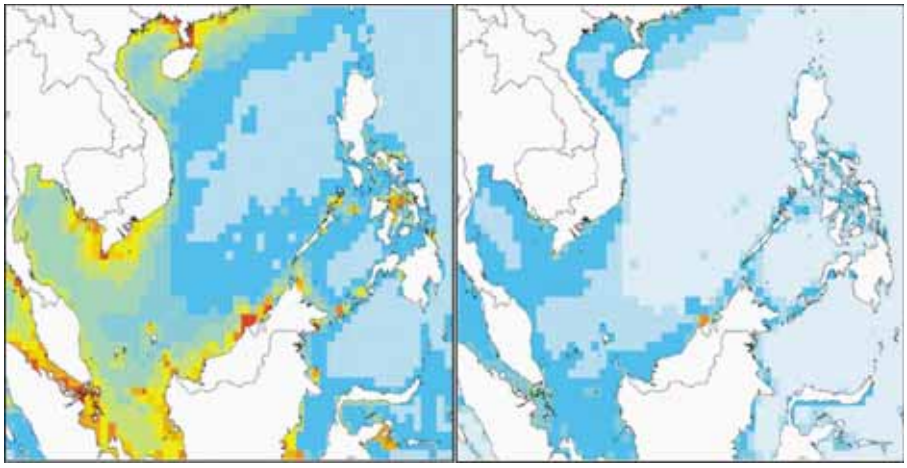
Historically, there have been large and widespread changes in the fish fauna of the South China Sea (Figure 5). These changes include changes in species composition whereby the abundance of the more valuable fishes (groupers, snappers, sharks and rays) has decreased sharply whereas the abundance of smaller, less valuable species has increased (e.g. cardinal and trigger fishes). The production trends of the past ten years do not reveal the changes very clearly as the majority of the impact is presumed to have taken place during the massive expansion of fisheries effort between 1975 and 1985. The picture that emerges is one of a subregional fishery that has been under heavy fishing pressure for more than 30 years and which has been fished down considerably. The changes were less obvious previously, but there remains a clear trend of a declining catch of large demersal and pelagic species and a rising catch of smaller fast recruiting species.

Catch composition trends and production

The catch from the assessed fisheries in the South China Sea subregion shows similar trends with an increasing fraction of the catch being made up of smaller sized species (Table 4). The comparison of the two maps for the South China Sea clearly show the decline in biomass across the subregion's coastal fisheries between 1960 and 1980. Multivariate analyses by the TrawlBase project showed differences in species composition between the two survey periods, i.e. in the 1970s and the 1990s. The percentage composition data from the west coast of Peninsular Malaysia generally showed that large and more valuable species declined in relative abundance whereas species of small body sizes increased, thus indicating a trend of "fishing down the food web".

Table 4 presents the changes in the relative composition of major species groups. The time frame for the data is the past decade, but trends from 1950 to the present are available for China. The relative trends were based on a 5 percent change over the period.

- **Large demersal species:** For the northern part of the South China Sea there is a trend of decreasing catches of large demersal species (37 percent of catch in the 1950s down to 17 percent in the 1970s and it has since been stable). There is also a decline in relative catch of large demersals in Malaysia and the Gulf of Thailand, but it is stable in the Philippines and even increasing in Indonesia.
- **Large pelagic species:** In the northern part of the South China Sea, large pelagics and sharks and rays have disappeared from the catch since the 1970s. Conversely, there has been an increased catch of larger pelagic species in the eastern parts of the South China Sea (the Philippines, including areas outside the South China Sea) and in the Gulf of Thailand and in the southern part of the South China Sea (Indonesia) in the last ten years.
- **Sharks and rays:** These have declined throughout the subregion except in the Gulf of Thailand.
- **Small demersal species:** Small demersal landings have increased in the Gulf of Thailand and in the southern part of the South China Sea (FMA 711, Natuna Sea, Indonesia), whereas catches have remained stable in Malaysia and declined in the Philippines.
- **Small pelagic species, (including sardines and anchovies):** In the northern part of the South China Sea, small pelagic species, including sardines and anchovies, have increased from 30 to 60 percent of the catch between 1970s and 2000 onwards. In other parts of the South China Sea, the relative catches of small pelagics have increased in all but one area, the Philippines, where they remain stable.
- **Trash and low value fish:** The relative catches of anchovies/sardines and trash fish have declined in the South China Sea over the course of the assessments. However, they still make up a large contribution of the total catch in the region (Table 5). This may be partly explained by greater classification into catch destined for human consumption and the massive boom in surimi in the region, or because of the rising costs of trawling reducing effort over the past decade. This group is reported in detail in Table 9.
- **Surimi species:** These are small demersal species, but specifically utilized for surimi production. The relative catch of surimi species has increased in all assessed areas (Table 4). The conversion of raw material to surimi is approximately 3.5 upwards, thus based on estimates of surimi production a total demand for raw material can be determined. The total production for the South China Sea area could be as high as 1 347 000 tonnes (see Table 11 later in the report).
- **Crustaceans:** In a majority of the areas the relative catch of crustaceans has declined and the catch of sharks and rays has declined in a majority of the fisheries.



Source: TrawlBase, WorldFish Center, Penang, Christensen *et al.* (2003)

Figure 5 South China Sea fish biomass abundances from 1960 (left panel) to 1980 (right panel).

Table 4 Trends in catch composition for the assessed fisheries areas in the South China Sea

	China Northern SCS	**Viet Nam**	**Philippines** all	**Thailand** East coast	**Malaysia** all	**Indonesia** FMA 711
Time period	**1950–2000**	**nd**	**1998–2008**	**1997–2007**	**2000–2008**	**1997–2008**
Large demersal	-		0	-	-	+
Small demersal	nd		-	+	0	+
Large pelagic	-		+	+	0	+
Small pelagic	+		0	+	+	+
Anchovy/Sardine	nd		-	-	+	-
Trash fish/low value fish	-		nd	-	-	-
Surimi species	nd		nd	+	+	+
Shark/rays	-		-	+	nd	-
Squids/cuttlefish	+		-	0	-	-
Crustaceans	+		-	-	-	-
Shellfish	nd		0	-	0	+

* abs (change (percent)/initial value (percent)) <0.05

The different groupings were assessed against their relative occurrence (percent): Increased (+); - Decreased (-) or were stable* (0) over a specific time period, "nd" denotes no data available.

Source: Country correspondents

Table 5 Composition of catch landings by major resource groupings in the South China Sea (%)

	China (SCS)	**Indonesia** (FMA 711)	**Thailand** (East coast)	**Malaysia** Peninsular East coast, Sarawak, Sabah	**Philippines** all
	>2000	**2008**	**2007**	**2008**	**2008**
Large demersal	17	8	4	4	3
Small demersal		11	12	5	9
Large pelagic	0	16	9	8	32
Small pelagic	60	41	15	29	32
Anchovy/Sardine		7	14	6	22
Trash fish/low value fish	16	4	25	13	0
Surimi species		3	7	15	0
Shark/rays	0	2	0	2	0
Squids/cuttlefish	5	2	7	9	3
Crustaceans	2	5	5	9	0

- **Northern South China Sea:** From 1950 onwards the demersal catches rose until 1960 when they began a long-term decline, although the total catch showed a rising trend because of increasing catches of abundant low-trophic level species. There have been no fishery assessments since the late 1980s but some catch landing data is available. Total catch underwent a decline after 1990, indicating that even the dominating low-trophic species were also overfished.
- **The Gulf of Thailand** fishery contributes about 44 percent of the national total catch (40 percent of which is caught outside of Thai national waters). The estimated trawlable biomass (estimated from research trawl results) declined from 680 000 tonnes in 1961 to 560 000 tonnes in 1995. Landing data is composed of catch from 9 gears (Otter board trawl; pair trawl; beam trawl; purse seine; push net; anchovy purse seine; mackerel encircling gill net; king mackerel drift gill net; bamboo stake trap). Total landings have decreased from 1 919 564 tonnes in 1999 to 1 447 898 tonnes in 2007, attributed principally to overcapacity in the fishery.
- **The Philippines** has accepted 2.5 million tonnes as its maximum sustainable yield for the marine fishery sector. In 2008, 2 559 191 tonnes of marine fish were recorded for the marine fishery sector. Recent years have seen increasing catches of small species (up to 10 percent of landings). However, there have also been increases of larger species and for some areas the CPUE/catch per day is increasing.
- **Viet Nam's** annual landing of marine capture fisheries has increased rapidly over recent years from around 0.73 million tonnes in 1990 to 2.07 million tonnes in 2007.
- **Indonesia's FMA 711:** This FMA's fishing activities take place mainly in the coastal water in the surrounding area with a depth of less than 70 m and mostly dominated by trawlable ground for demersal fish. The area is a rich source of *Nemipterus* (for surimi production), coral reefs and coastal neritic small pelagic fish species in the southern area at a depth of less than 40 m. Small pelagic fisheries are mostly operated in the northern part. There is no significant legal transhipment in the overall FMA (approximately <10 percent), but there are indications that foreign vessels are operating in the area because of access to the open part of the South China Sea.
- **Malaysia (Peninsular east coast, Sabah and Sarawak):** Total marine fish production in Malaysia was 1.38 million tonnes in 2007 with 24 percent from the South China Sea off the east coast of Peninsular Malaysia and the remaining 26 percent was from the South China Sea, Sulu Sea and Celebes Sea off the coasts of Sabah and Sarawak. Inshore waters (an area of less than 30 nautical miles from the coastline) contributed 81 percent of the catch and fishing vessels were usually below 70 gross tonnes. This is consistent with the large number of inshore fishing vessels, which comprise 97 percent of the country's fishing vessels. Trawls and purse seines are the two major gear types and contribute up to 78 percent of the landings.

Fishery/stock assessments

Stock assessments based on estimations, calculation or expert opinion, were obtained for this regional overview. Some of this data was also presented in APFIC-related regional workshops (FAO, 2009a and FAO, 2009b). The assessment of fisheries/stocks has received little attention in recent years, despite its importance for decision-making in fisheries. The continued lack of this information is a major constraint on effective communication of the changing status of various species groupings and of the extent to which overfishing (driven by overcapacity) is occurring in this region. Basedon the stock assessments performed for the different groups of species show that a majority of the stocks or species groupings in the South China Sea subregion are overfished or fully-fished (Table 6). In some cases the species groups are even scored as depleted. Figure 6 presents this visually using an *indicative* "traffic light" system (note that this is an illustration rather than a definitive statement regarding the status of individual species or stocks)

- The heaviest fishing (indicated by depleted or fully-fished groupings) is on the western side of the South China Sea (in the shallower shelf fisheries) with stocks in better condition around Sabah, Sarawak and parts of the Philippines.

- The stocks of large demersals and small demersals are overfished in a majority of the areas.
- Large and small pelagics are overfished or fully fished in a majority of the cases.
- The stocks of anchovies and sardines are overfished in a majority of the assessed fisheries.
- Low value/trash fish species are fully fished where assessed.
- All the assessed stocks of surimi species are overfished.
- Squids/cuttlefish and crustaceans are scored as fully-fished or overfished in all the assessed fisheries.

Table 6 Status of fisheries/species groups for fisheries in the South China Sea areas

	China Northern shelf, Beibu Gulf, Deep sea	**Viet Nam**	**Philippines** Luzon, Visayas, Mindanao Sabah	**Thailand** East coast	**Malaysia** Peninsular East coast, Sarawak,	**Indonesia** FMA 711
Large demersal	D, D, nd	nd		O	O, O/U, O	F/O
Small demersal	O, O, na	nd	F, M, U	O	O, O/U, O	F/O
Large pelagic	nd, nd, F	nd	M, U, F	O	U, U, U	U/M
Small pelagic	O, O, F	nd	F, U, F	O	U, U, U	M
Anchovy/Sardine	O, O, nd	nd	M, U, F	O	O, nd, nd	nd
Trash fish/low value fish	F, F, nd	nd				F/O
Surimi species	O, O, nd	nd			O, O, O	F/O
Shark/rays	D, D, O	nd				nd
Squids/cuttlefish	F, F, nd	nd	F, M, F	O	F, F, nd	nd
Crustaceans	O, O, U	nd		O	F, F, nd	F/O

Note: This table presents *indicative status* for species groupings. Terminologies for the level of exploitation vary between countries as do the methods of assessment and date of last assessment and the geographic scope of those assessments.

Depleted (D); overfished (O); fully fished (F); moderately fished (M); underfished (U) and "nd" denotes no data available or uncertain status. Several values indicate the range of reported values (e.g. several sub-areas).

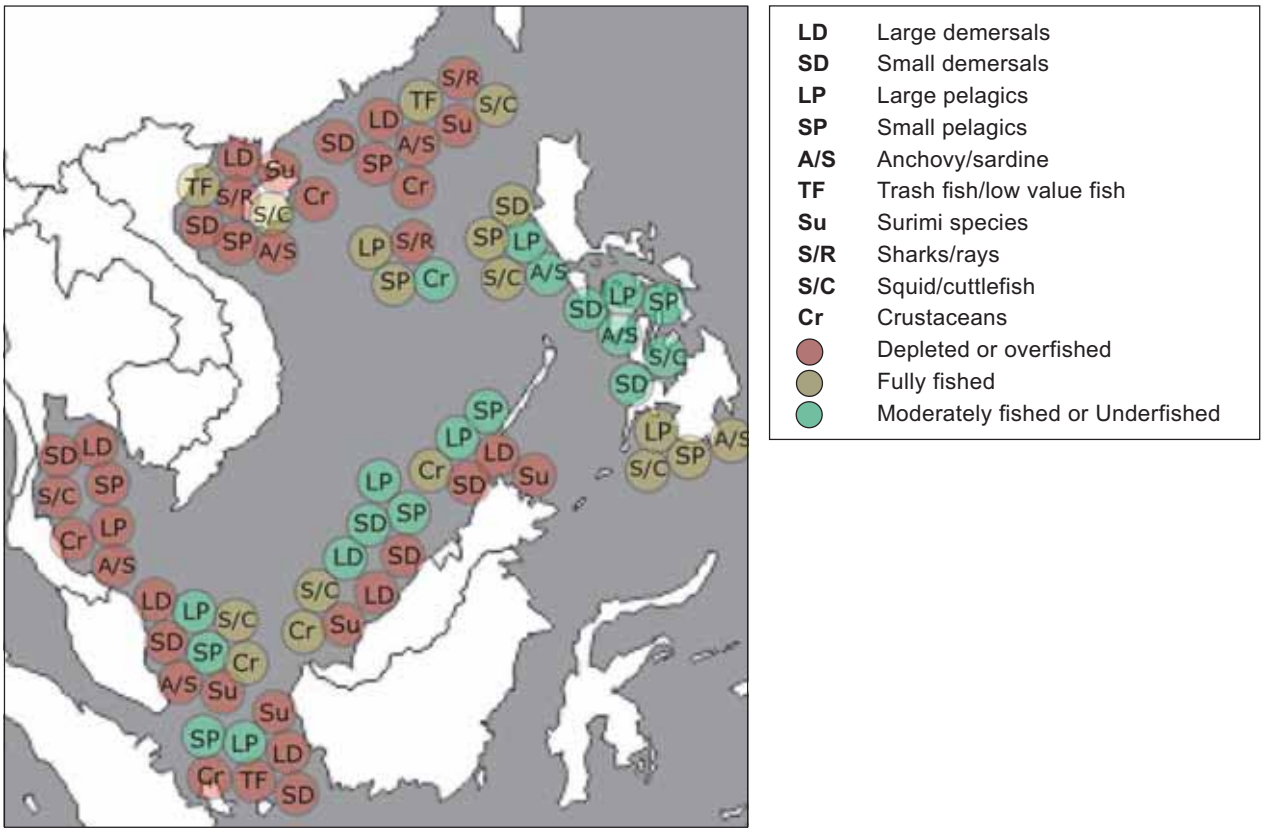


Figure 6 Fishery/stock assessments for the assessed fisheries areas of the South China Sea

CPUE/catch rates

For a majority of the assessed fisheries (by gear) in the region the catch per unit effort (CPUE) and catch rates are declining (Table 7; 12 out of 15 examples). *A majority of the assessed trawl fisheries show declining CPUE* or catch trends. Also a majority of the assessed purse seine fisheries show declining CPUE or catch rates. All net fisheries assessed show declining CPUE or catch rates. The CPUE for hand line fisheries declined in one of the two assessed fisheries. Table 8 contains more detailed CPUE data for specific gears or fisheries.

Table 7 Trends in CPUE/catch rates by gear for the assessed fisheries in the South China Sea areas

	China Northern SCS	**Viet Nam** Demersal CPUE	**Philippines** Moro Gulf	**Thailand** East coast	**Malaysia** Peninsular East coast	**Indonesia** FMA 711
Time period	**1970–2008**	**1985–2003**	**2003–2007**	**1997–2002**	**2000–2008**	**1990–2007**
Overall	↓ -43%	↓ -68%				
Otter/pair trawl	↓ -21 to -58%			↓ -8%	↑ +6%	↓ -43%
Purse seine			↑ +21%	↓ -35%	↓ -25%	↓ - 63%
Other seines					↓ -3%	
Drift/gill net			↓ -47%		↓ -17%	↓ -36%
Hand line			↑ +48%			
Longline						

Increased (↑); Decreased (↓) over the time period indicated. Where data were available, a two year average for the CPUE at the start and finish dates was used.

- **China:** CPUE showed a decreasing trend until the 1990s. This is perhaps a similar situation to the Gulf of Thailand where heavy fishing pressure has resulted in a "fishing down" effect and the fishery has stabilized, with a shift to faster recruiting smaller species.
- **Thailand:** CPUE appears relatively stable in the Gulf of Thailand fishery, although overall rates are extremely low compared with rates 20 years ago. This perhaps suggests a relative stability in the fishery at a highly "fished down" level.
- **Indonesia (FMA 711):** CPUE/catch per hour decreasing – mainly the demersal and some small pelagics. This is expressed in mT/boat/y between 1998 and 2008: large demersals decreasing from 600 to 20; small demersals decreasing from 300 to 20; small pelagics decreasing from 40 to 20; large pelagics stable at 5 to 6; small tuna stable at 10 to 15; crustaceans stable at 400.
- **Viet Nam:** Catch rate has declined over the last few decades, from about 1.1 tonnes/hp/year in 1985 to 0.35 tonnes/hp/year in 2003.
- **Philippines:** CPUE has been increasing in some areas, although no data are presented for nearshore coastal demersal or reef associated resources.
- **Malaysia:** CPUE is generally decreasing in all fishing zones.

Box 1 Note on interpretation of CPUE trends

Information on trends in CPUE can be informative but it does have to be interpreted.

1. Declining CPUE is normal when a fishery is developed. It is considered a bad situation when CPUE starts falling below ***about 50 percent of initial value*** and, as a rule of thumb, 20 percent of initial values should be considered as the limit.
2. Stabilizing CPUE means that some kind of equilibrium has been reached, but this does not necessarily mean that the fishery is being operated at the optimum level.
3. Increasing CPUE can be obtained through a reduction in effort. However, it can also be increased by increased efficiency in fishing operations or changes in the system productivity.

It is therefore important to analyze CPUE trends in association with other background information about the fishery if a reasonable interpretation is to be made about the condition of that fishery.

Table 8 Detailed trends in CPUE/catch rates by gear or resource for the assessed South China Sea fisheries areas

Country	Time period	CPUE/comment	Area
China	1990 to present	CPUE decreasing and seems to have levelled off since the late 1990s	Northern South China Sea
		Otter trawl 251 to 104 kg/hr (1983 to 1992)	Northern shelf
		Pair trawl 792 to 382 kg/kW/yr (1986 to 1998)	
		Pair trawl 638 to 275 kg/hr (1986 to 2008)	
		Otter trawl 159 to 116 kg/hr (1983 to 2007)	Beibu Gulf (Gulf of Tonkin)
		Otter trawl 1870 to 750 kg/kW/yr (1970 to 1992)	
Viet Nam	1985 to 2003	CPUE decreasing from 1.12 tonne/hp/year (1985) to 0.35 tonne/hp/year (2003)	National
	2000 to 2005	87 kg/hr	Demersal, north
		60 kg/hr to 40 kg/hr	Demersal, southwest
		40 kg/hr to 70 kg/hr	Demersal, southeast
		71 kg/hr to 88 kg/hr	Demersal, central
Philippines	2003 to 2007	Handline: (YFT) 45 to 114 kg/day	Moro Gulf
		Purse seine: (YFT) 858 to 1 704 kg/day	
		Purse seine: (skipjack) 3 450 to 5 820 kg/day	
		Ringnet: (YFT) 1 472 to 701 kg/day	
		Ringnet: (skipjack) 5 989 to 1 777 kg/day	
Thailand	1976 to 1998	77.5 kg/hr decline to 17.9 kg/hr	Gulf of Thailand
	2003 to 2005	22.4 to 24.2 kg/hr, overall	
		1.01 to 0.94 kg/hr, pelagic species	
		6.85 to 6.4 kg/hr, demersal species	
		4.05 to 5.8 kg/hr, cephalopods	
		0.11 to 0.06 kg/hr, shrimp	
		0.27 to 0.23 kg/hr, crab	
		9.59 to 10.38 kg/hr, true trash fish	
Malaysia	2000 to 2008		Peninsular east coast
		Drift gillnet: 0.054 to 0.060 mT/trip – slight increase	Zone A
		Purse seine: 2.2 to 1.5; 5.5 to 4.2; 21 to 15 mT/trip – decreasing	Zone B; Zone C; Zone C2
		Anchovy purse seine: 1.13 to 1.05 mT/trip – decreasing	Zone B, Zone C
		Trawl: 0.8 to 0.96; 9.8 to 9.5; 13 to 15 mT/trip – slight increase	Zone B; Zone C; Zone C2
Indonesia	1998 to 2008	Trawler stable 40 to 50 tonnes/boat/yr	FMA 711
		Seiners decreasing from ~50 to ~20 tonnes/boat/yr	
		Drift gillnets fluctuating between ~8 to ~5 tonnes/boat/yr	

Low value/trash fish production

Total production of trash/low value fish species in the South China Sea subregion is estimated at 4.85 million tonnes (Table 9). The percentages of total production vary according to area, but reaches 60 percent or more in some areas. Overall, in the reported fisheries low value trash fish is consistently more than 20 percent of the overall catch and will be a considerably higher percentage for the trawl fisheries (more typically 40 to 60 percent of catch) which are responsible for the majority of the catch.

Table 9 Production of trash fish/low value fish for the South China Sea fisheries areas

	Tonnes	% of total fisheries production	Comments/reference
China	**3 300 000**	~60%	Based on estimate of 5 500 000 tonnes of marine catch in 1999 for China mainland provinces (Watson & Pauly, 2001) and assuming 60% of trash fish from Chinese data.
Viet Nam	**933 183**	36% (of national catch, which was 2.6 million tonnes in 2002) 28 to 51% (Gulf of Tonkin) 47 to 68% (southeast area)	Tables in the report "Preliminary Analysis of the Enumerator Sampling Program", RIMF, Hai Phong, 2002 & survey data from Halong (408 vessels in 1996 to 1997) Otter trawl survey data 1996 to 1997, ALMRV.
Philippines	**78 000**		
Thailand (east coast)	**367 505**	43% of overall trawl catch 65% of otter trawl catch 21% of pair trawl catch	Research trawls 2007 figure, decreased from 561 514 tonnes (1997) Fisheries statistics 2007 (DOF, 2009)
Indonesia (FMA 711)	**65 300**	Estimated as 11-15% of total landing	2008 figure, increased from 21 900 in 1980 National total 427 900 tonnes in 2008.
Malaysia	**109 307**	34% (as percent of total low value/trash fish landings: 21% Peninsular east coast; 7.5% Sarawak; 5.7% Sabah)	Predominantly from trawl fisheries Fisheries annual statistics 2000 to 2008 Decreased from 43% of total capture landings in 2000.

Fishmeal production

The total fishmeal production (Table 10) for the South China Sea subregion is estimated at 576 000 tonnes and is derived largely from the low value/trash fish catch reported in Table 9, although there are some targeted small pelagic catches that are directed into fishmeal production. This estimate uses a figure of 5 000 tonnes for the Southern Chinese provinces bordering the South China Sea (the major fishmeal producing provinces in China are Shandong, using *Engraulis japonicus* and Zhejiang, using *Benthosema pterotum*). Production of fishmeal from processing wastes from capture fish and aquaculture is significant. These are trimmings and processing waste from fish processing converted to fishmeal (from canning, filleting, heading and from shrimp heads/wastes, pangassius processing wastes). IFFO estimates that ~56 percent of the fishmeal produced in the East Asian region is derived from this source. Globally this figure is only 25 percent. There is an increasing interest in finding small pelagic fisheries which can be certified for fishmeal production in order to enable the production of certified animal feeds (e.g. pet foods and aquaculture feeds). The data on fishmeal production are rather difficult to obtain and typically refer to production by industrial scale producers.

Table 10 National production, import and export of fishmeal in countries bordering the South China Sea (tonnes)

	China*	Viet Nam	Philippines	Thailand	Malaysia	Indonesia
IFFO (2008) National production	141 000	*46 000	nd	466 000	44 000	15 000
Fish meal imported**	1 141 128	113 980	24 235	15 123	18 886	55 963
Fish meal exported**	51 185	19 935	5 339	96 123	33 738	8 249

* This figure is variously estimated with reports of up to 185 000 mT of "fish powder" produced. Estimated by Dr Dao Manh Son, Dang Van Thi & Huynh Nguyen Duy Bao (2005) background paper to APFIC regional workshop on low value/trash fish.

** IFFO estimate is for all China mainland provinces, there is very limited fishmeal production in the China mainland provinces bordering the South China Sea (~5 000 tonnes).

*** 2007 data, FAO FishStat Commodities data set (2009).

Note: besides various forms of fishmeal, this also includes fish solubles, fish silage, fish waste, fish bone meals.

Capture production of surimi species

The production of surimi in the region has increased dramatically over the past decade and has reached more than 321 250 tonnes in the South China Sea subregion (Table 11). This has been driven by two main factors: The processing techniques for surimi have transferred well within the region and raw materials from trawl fisheries are increasing. This second factor is one reason why the low value trash fish levels of trawl fisheries are not increasing despite the increasing trawl effort; increasingly species previously regarded in the trash fish category and not previously targeted are now increasingly sought out for processing into surimi (Table 12).

Table 11 Production of surimi and catch of fish (raw material) from which it is derived (tonnes)

	Surimi production 2005*	Total raw material required	Thread fin bream	Lizard fish	Goat fish	Croaker	Snapper (big eye/ king)	Barracuda	others
Thailand** (National)	150 000	530 000	189 000	190 000	119 000	incl. with goat fish			32 000
Malaysia*** (National)	100 000	670 000	127 300	154 100	67 000	incl. with snapper	100 500	214 400	6 700
Viet Nam (National)	63 250	115 035		67 620		55 860	126 420		44 100
Indonesia**** (National)	8 000	32 000	21 760		4 160	3 200	2 560		320
Total	**321 250**	**1 347 035**							

* Unless specified, the 2005 figures are derived from reference http://map.seafdec.org/SurimiMile/index.php and Siriraksophon & Laong-manee (2005).

** Thailand's 2007 produciton of surimi was 309 479 tonnes form a catch of fish suitable for surimi of 1 169 215 tonnes.

*** Malaysia's figure for raw material may be overestimated (typically 3.5 to 5 kg of raw material are needed for 1 kg of surimi).

**** Indonesia's surimi production is approximately 19 percent of total landings of surimi species. It is assumed the rest is exported as raw material for surimi production elsewhere.

Table 12 Typical species used for surimi production

Common name	Genus/species	China	Thailand	Malaysia	Viet Nam	Indonesia
Threadfin bream	*Nemipterus* spp.		X	X		X
Lizard fish	*Saurida* spp.	X	X	X	X	
Goat fish	*Upeneus* spp.		X	X		X
Croakers	*Sciaenidae* spp.		X	X	X	X
Snapper (big eye/king)	*Priacanthus* spp.	X		X	X	X
Barracuda	*Sphyraena* spp.			X		
Conger pike	*Muraenesox cinereus*	X				
Spanish mackerel	*Scomberomorus* spp.	X				
Shark		X				
Cuttlefish		X				
Other species			X	X	X	X

Recommendation: The quantity of surimi produced and the sources and quantities of raw materials need to be tracked more accurately in future assessments.

Fisheries classifications

The number of vessels in the region is increasing and there has been a trend of increasing motorization and increase of total fleet capacity in the region. This has led some countries to put in place measures to decrease either the number of vessels or limit capacity (e.g. China). A large fraction of the fleet in the region is still classified as small-scale according to regional and national definitions (Table 13).

Recommendation: Harmonized methods for classification or comparison of fleets would assist regional capacity assessments. National vessel inventories remain incomplete and these should be updated.

Table 13 Classification of small-scale and commercial fisheries

Countries	Small-scale Fisheries	Commercial Fisheries
Brunei Darussalam	**Small-scale/artisanal fisheries:** Operating in all zones but concentrating in Zone 1 (0 to 3 nm)	**Trawler, purse seiner, or long liner:** ▪ <60 GT; <350 hp operating in Zone 2 ▪ 60.1 to 150 GT; 351 to 600 hp operating in Zone 3 ▪ 151 to 200 GT; 600 to 800 hp operating in Zone 4
Cambodia	**Coastal fisheries:** Small-scale fisheries with/without engine (from 5 to 50 hp) operating in Zone 1.	**Commercial fisheries:** More than 50 hp operating in Zone 2
Indonesia	Fisheries that operated without using boat, using non-power boat, using outboard motor size <5 GT, or inboard motor size <5 GT.	▪ Fisheries where outboard motor size 5 to 30 GT or inboard motor size 5 to 30 GT is used. ▪ Fisheries where outboard motor size >30 GT or inboard motor size >30 GT is used.
Malaysia	**Traditional fisheries:** Small-scale fisheries using traditional fishing gears (i.e. other than trawls and purse seiners) with vessels less than 40 GRT operating in all zones concentrating in Zone A.	**Commercial fisheries:** Medium and large-scale fisheries using commercial fishing gears such as trawls and purse seines. ▪ With vessels less than 40 GRT operating in Zone B. ▪ With vessels from 40 to 70 GRT operating in Zone C. ▪ With vessels above 70 GRT operating in Zone C2.
Myanmar	**Inshore-fisheries/coastal fisheries:** ▪ Vessels of less than 30 ft or using less than 12 hp engine ▪ Operating in Zone 1 ▪ 5 nm from shore (Rakhine coastal region) ▪ 10 nm from shore (Ayeyarwaddy and Taninthayi region)	**Industrial fisheries:** ▪ Vessels more than 30 ft or using more 12 hp engines, operating in Zone 2 (outer limit of inshore fishing zone to the EEZ)
Philippines	**Municipal fisheries:** Upto 15 km from shore, or equidistant between two adjacent municipalities. Small-scale fisheries with vessels of less than 3 GT operating in Zones 1 and 2.	**Commercial fisheries:** ▪ Small-scale commercial fisheries: from 3.1 to 20 GT vessels operating in Zone 2; can also operate within 10.1 to 15 km (within Zone 1) if authority is granted by the concerned local government unit. ▪ Medium-scale commercial fisheries: from 20.1 to 150 GT operating in Zone 2; can also operate within 10.1 to 15 km (within Zone 1) if authority is granted by the concerned local government unit. ▪ Large-scale commercial fisheries; more than 150 GT operating in Zone 2.
Singapore	**Small-scale fisheries** with vessels of less than 3 GT operating in Zone 1.	**Small-scale commercial fisheries:** Inboard engine less than 50 GT or 380 hp operating in Zone 2.
Thailand	**Small-scale fisheries:** Vessels of less than 5 GT operating in Zone 1.	**Large-scale fisheries:** Vessels of more than 5 GT operating in Zone 2.
Viet Nam	**Small-scale fisheries:** Vessels with no engine and with engine less than 40 hp. "Nearshore fishery": Fishing vessels with an engine capacity of less than 90 hp, that have not registered for operating offshore. Fishing vessels fishing in waters of less than 30-m depth from the shore in the Tonkin Gulf waters, East and Southwest waters, and Gulf of Thailand or in waters of under 50-m depth from the shore onwards in the Central coastal area.	**Large-scale fisheries:** Vessels with engine more than 40 hp. **"Offshore fishery":** Defined as fishing in the waters bordered by a 30-m deep line from the shore onwards for the Tonkin Gulf waters, East and SouthWest waters, and Gulf of Thailand and by a 50-m deep line from the shore onwards for the Central coast

Source: SEAFDEC (2008)

Vessel numbers and employment

There are approximately 1.72 million fishing vessels operating in the SCS subregion, the majority are small-scale vessels (Table 14). Only two areas reported vessels by type of gear and of these two areas gillnetters and trawlers dominate the fleet composition. Purse seiners are relatively common, however, smaller sized gears are used to a large extent (e.g. hook and line). The capacity of the Vietnamese and Chinese SCS fleet is between 3 and 4 million kW each, giving an average vessel capacity of about 35 kW or 45 hp.

Table 14 Number and type of fishing vessels in the assessed fisheries (by area)

	China (SCS)	**Viet Nam**	**Philippines**	**Thailand** (East coast)	**Malaysia** (Peninsular East coast, Sabah, Sarawak)	**Indonesia** (FMA 711)
	2000	**2003**	**2002**	**2000**	**2008**	**2008**
Trawlers	10 357	24 231				5 509
Purse seiners	3 729	5 545				4 256
Gillnet	51 754	31 200				50 472
Hook-and-line	5 022					58 761
Set net	4 117					–
Others	2 650	40 870				86 043
Longline		2 444				–
Non-powered				2 639	2 894	21 402
Outboard engine				42 217	10 200	14 888
Inboard engine				13 263	9 875	32 187
<5 GRT					15 508	24 567
>5 GRT					7 461	7 620
Small scale			1 371 676			
Commercial			16 497			
Total	**77 629**	**104 290**	**1 388 173**	**58 119**	**22 969**	**68 477**
Fleet capacity (kW)	3 176 168	3 910 976				

Notes:

Malaysia: the breakdown of vessel numbers does not sum to the total number of vessels because the breakdown is given for both motorization and GRT.

Thailand: data from the 2000 Intercensal Survey of Marine Fishery in: Department of Fisheries. 2009;

Indonesia: the gear breakdown is more than the total number of vessels since one vessel may use more than one type of gear. The breakdown by GRT applies only to inboard powered vessels. The total for all Indonesian FMA is 596 184 vessels,

The number of people employed in the sector in the South China Sea area, is more than 5.4 million people, of which more than two million are part time (Table 15). This figure is probably an underestimate due to the notorious difficulties of assessing everyone who is engaged in some form of fishing as a livelihood, especially the part-time segment. Foreign crews are found in some fisheries and they are largely migratory labour from neighbouring countries.

The definitions of employment in small-scale fisheries and larger scale more commercial type fisheries are poorly defined and thus it is not possible to indicate employment in the two parts of the sector. However, the fact that the majority of vessels are operating within the small-scale sector indicates that this is the most significant form of employment as well.

Fishery zoning and management measures (including protected areas)

All countries in the region have zoned their EEZ, although the zoning differs among the countries (Table 16). All countries have two or more zones and most countries have two zones but some have up to four different zones. The zones are either divided by distance (i.e. nautical miles) from shore or by depth of the water. The outer zone extends to the limit of the EEZ.

Table 15 Employment in the South China Sea fisheries (and associated areas)

	China (SCS)	Viet Nam	***Philippines	****Thailand (East coast)	Malaysia (Peninsular East coast, Sabah, Sarawak)	**Indonesia (FMA 711)
	2000	**2003**	**2002**	**2000**	**2008**	**2008**
Full-time	354 966	591 398*			56 113	162 648
Part-time	183 355	1 971 326*				125 788
Family member				80 857		
Employee/crew				87 823		
National					44 364	
Foreign crew					11 749	
Small-scale			1 781 000			
Commercial			7 800			
Total	**538 321**	**2 562 724***	**1 788 800**	**168 140**	**56 113**	**288 436**

* Estimate.

** No data available at FMA level , total national employment in fisheries in Indonesia is 2 231 000 (2007).

*** Special Release 159 National Statistics Office, April 18, 2005.

**** 2000 Intercensal Survey of Marine Fishery in Department of Fisheries. 2009.

Table 16 Fishing zones of the countries in Southeast Asia

Countries	Fishing Zone 1	Fishing Zone 2	Fishing Zone 3	Fishing Zone 4
Brunei Darussalam	From shoreline to 3 nm	From 3 nm to 20 nm	From 20 nm to 45 nm	From 45 nm to EEZ limit
Cambodia	From shoreline to 20 m depth	From 20 m depth to EEZ limit		
China	Inshore (<40 m)	Offshore (40 to 100 m)	Shelf edge (100 to 200 m)	Deep-sea (>200 m)
Indonesia	From shoreline out to 4 nm	From the outer limit of first fishing zone to 12 nm from shore	From the outer limit of second fishing zone to EEZ limit	
Malaysia	From shoreline to 5 nm	From 5 nm to 12 nm	From 12 nm to 30 nm	From 30 nm to EEZ limit
Myanmar	From shoreline to 5 nm in the northern area, 10 nm in the southern area	From outer limit to first fishing zone to EEZ limit		
Philippines	From shoreline to 15 km	From 15 km to EEZ limit		
Singapore	From shoreline to within port limits	From 12 nm to EEZ limit		
Thailand	From shoreline to 12 nm	From 12 nm to EEZ limit		
Viet Nam	From shoreline to 30 m depth in Northern and southern areas, to 50 m depth in the central area	From 30 to 50 m depth to the EEZ limit		

Adapted from: SEAFDEC (2008), with additional data for China.

The zoning is partly used to apply different management measures for different areas and different fleet segments. The management measures used differ among the countries in the region (Table 17). Closed areas and closed seasons are common in the nearshore zone (Zone 1) of many countries in the region. Gear restriction and licensing, when applied, are used in all zones. Size limits (e.g. fish length) and quotas are not used by any of the countries in the region as a management measure.

Table 17 Examples of management measures used in the different fisheries (by zone)

Area	Closed areas	Closed seasons	Size limits (Biological)	Gear restrictions	Licensing	Quotas
China (northern part of South China Sea)	Zone 1	Zone 1		Zones 1 & 2	Zones 1 & 2	
Viet Nam	Exist	No closed seasons				National TAC
Philippines		Zone 1		All zones	All zones	
Thailand (east coast)	Zone 1	Zone 1		All zones		
Malaysia (Peninsular east coast, Sarawak, Sabah)	Zone 1			All zones	All zones	
Indonesia (FMA 711)				All zones	All zones	

Closed areas come in many forms of which marine protected areas (MPAs) are the most common and well-known. The countries in the region have a total of at least 726 MPAs at national, district and local level (Table 18). There is a degree of mixing of marine protected areas (inferring water surface or benthic ecologies such as coral or seagrass) and more general mangrove or coastal areas (which are a combination of water and land). The contribution of these environments to fisheries varies, but they all have unique value and should not be aggregated. There are many examples of seasonally closed areas or zones in many of the countries. Artificial reefs have also been constructed in several countries and these could be included in future inventories. Additionally, there are examples of oil exploration areas that tend to be *de facto* no fishing zones (or exclusion areas).

Table 18 Marine protected areas and areas where fishing is restricted or excluded

	China (SCS)	**Viet Nam**	**Philippines**	**Thailand** (East coast)	**Malaysia** (Peninsular East coast, Sabah, Sarawak)	**Indonesia**** (FMA 711)
Marine protected areas (number) Area	(32) 4 635 km^2	(22) 2 577 km^2	(~600)*	(5) 1 271 km^2	(41 marine parks; 6 MPA)	3 411 km^2
No fishing zones	0				(47)	
Oil exploration areas	0			21 479 km^2		
Seasonal closed areas	(21) 60 000 km^2		(3)	(8)**		

* At local and district level

** Indonesia existing MPA nationally 66 000 km^2

Sources: Country reviews, http://www.wdpa-marine.org/, http://www.southchinasea.org/docs/marine%20protected%20areas_in_South%20East%20Asia.pdf (2002)

Recommendation: It remains a challenge to summarize the wide *variety of management approaches and measures* implemented within the region. An inventory of these would assist in monitoring fishery management at the ecosystem level.

Recommendation: A more comprehensive inventory of the different *types of area* which are protected or managed on a seasonal or permanent basis would be an important ecosystem level indicator. Ideally, there would also be some measurement or monitoring of their function or value for fisheries sustainability.

Bay of Bengal and Andaman Sea subregion

The Bay of Bengal and Andaman Sea subregion has seen total catches steadily increasing and there are no signs of the catch levelling off[2]. From the country correspondents' reports there are indications that the catch, although increasing, has changed composition. Until quite recently the catch was composed of large and valuable fish but here is now apparently a trend over the last five to ten years for the catch to be composed of lower value and smaller fish. This may not yet be reflected in the aggregated national catch statistics reported to FAO and will require further analysis at national level.

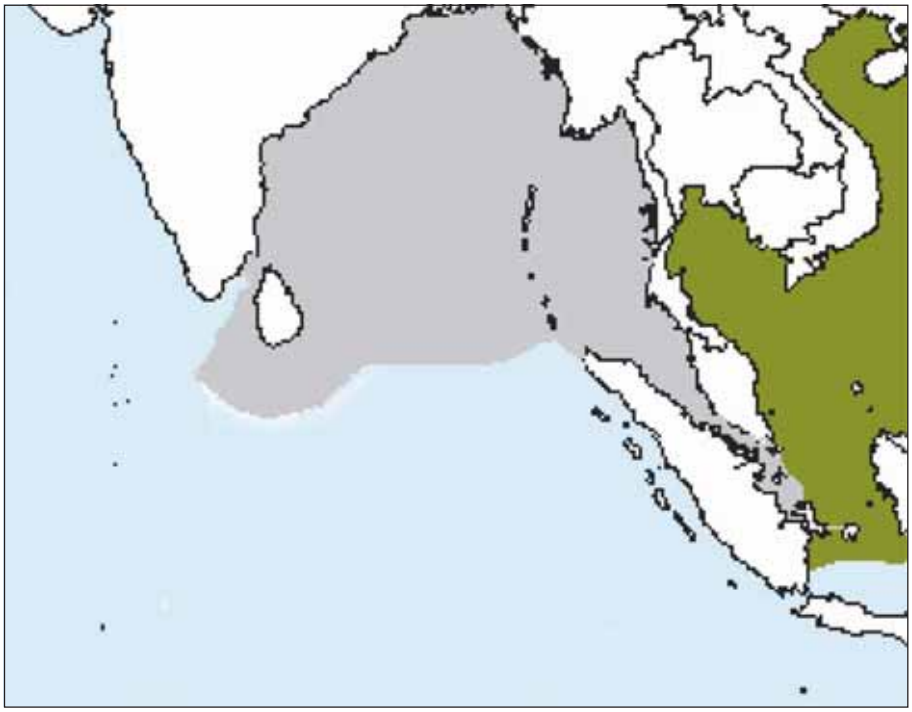


Figure 7 Outline of the area covered by the Bay of Bengal and Andaman Sea subregions

Catch composition trends and production

The catch composition from the assessed fisheries in the Bay of Bengal subregion shows different trends depending on areas (Table 19). The trends for catches of large demersals are divided into an east and west part, with catches in the east decreasing whereas the catches in the west are increasing.

- **Small demersal species:** there is an overall stable or increasing relative catch in the region.
- **Large and small pelagics:** relative catch trends are increasing or are stable.
- **Sharks and rays:** The catch of sharks and rays are decreasing in a majority of the assessed fisheries, however it is increasing in some fisheries.
- **Squids/cuttlefish, crustaceans and shellfish:** The same picture, with both increasing and decreasing relative catch trends in different fisheries.
- **Anchovy/sardine:** Catches have increased in half of the assessed fisheries.
- **Trash/low value fish:** The relative catches have declined in the subregion over the course of the assessments. The total production of trash/low value fish is about 800 000 tonnes and together with anchovies/sardines still makes up between 12 and 47 percent of the total catch in the subregion (Table 20).

[2] FAO FishStat 2010 (The total catch of fish in the Bay of Bengal and Andaman Sea subregion was estimated by looking at the catch from the surrounding countries and their specific catch from the FAO fishing area Indian Ocean, Eastern. The total catch today is about 5 000 million tonnes and has been steadily increasing since the start of measurements (1950). The rate of increase has been more rapid in the last 30 years of measurement than in the first 30 years with the most extensive increase in catch in the 1990s.

Table 19 Trends in catch composition for the assessed Bay of Bengal fisheries areas

	Sri Lanka	India East & West coast	Bangladesh	Thailand West coast	Myanmar	Malaysia all	Indonesia FMA 571 FMA 572
Time period	**2000—2009**	**1995—2009****	**1999—2009**	**1997—2007**	**1978—1994**	**2000—2008**	**1997—2008**
Large demersal	+	+	+	-	-	-	-
Small demersal		0	+	+	-	0	-
Large pelagic	+	+	0	-	+	0	+
Small pelagic		0	+	0	-	+	+
Anchovy/sardine	0	+	nd	-		+	+
Trash fish/low value fish		+	-	+	+	-	-
Surimi species	nd	+	0	+	+	+	+
Shark/rays	-	+	-	-	0	0	+
Squids/cuttlefish	nd	-	+	-	nd	-	+
Crustaceans	+	-	+	-	nd	-	0

Note: The different groupings were assessed in terms of their relative occurrence (percent): Increased (+); - Decreased (-) or were Stable* (0) over a specific time period, "nd" denotes no data available.

* abs (change (percent)/initial value (percent)) <0.05.

** Data for whole country.

Table 20 Composition of catches by major resource groupings (percent)

	Sri Lanka	India	Bangladesh	Myanmar	Thailand Andaman Sea	Malaysia Malacca Straits	Indonesia FMA 571
	2009	**2005/2009**	**2008/2009**	**1994**	**2007**	**2008**	**2008**
Large demersal	6	9	11	14	6	3	12
Small demersal		15	11	21	13	6	12
Large pelagic	53	12	41	4	5	5	10
Small pelagic	31	40	9	4	19	36	25
Anchovy/Sardine			0		7	2	5
Trash fish/low value fish		12	17	47	34	35	7
Surimi species		16	0	9	5	6	8
Shark/rays	4	4	1	1	1	1	3
Squids/cuttlefish		4	0		6	1	2
Crustaceans	6	15	10		4	3	16

Source: APFIC correspondents' reports.

- **For Sri Lanka,** in 2007 and 2009 the marine catch was recorded as 252 670 and 293 170 tonnes respectively. There is nearly an annual increase of 40 000 tonnes. This increase is mainly a result of the catch from the north and east and also because of the ending of fishing restrictions imposed during the civil war. It is expected to increase more as the fishery is developing in the north and east. There is increasing fishing capacity in offshore fisheries and gill net fishery is being gradually replaced by tuna longlining. This is largely driven by export demand for tuna from the European Union (EU).
- **Across India,** annual average landings increased from 0.56 million tonnes during 1950 to 1954 to 2.9 mt during 2005 to 2009. This is largely driven by technological advances (mechanization and motorization of craft; introduction of high-opening trawl net and ring seine). The contribution of small pelagics, as a group, has increased by 1.3 percent. Within the small pelagics, the contribution of oil sardine has increased from 8 percent during 1995 to 1999 to 13 percent during 2005 to 2009. Significant changes in the contribution of low-value, small demersals were not noticed. The contribution of high-value, large pelagics has increased by 1.3 percent, and

that of large demersals by 1.6 percent. This is because of selective fishing for sharks, tuna, ribbonfish and major perches. In the southeast trawl fishery there is a declining catch rate with economic collapse of whitefish and silverbellies and "fishing down" the food web is evident (Vivekanandan *et al.*, 2005). The area is home to relatively large numbers of fishermen and fishing craft but the productivity is less than other areas. In the northeast, marine fisheries are developing rapidly with catches increasing. This is because of the relatively recent upgrading of the fishing fleet.

- **In Bangladesh,** in 1991/1992, the marine catch recorded was 245 474 tonnes and the catch then increased to 333 799 tonnes in 1999/2000, 474 597 tonnes in 2004/2005 and 514 644 tonnes in 2008/2009 (FYSB, 1999–2009). In 2009, 0.611 million tonnes of marine fish were recorded as a production from the marine fishery sector (MFO, 2009). Hilsa shad (*Tenualosa ilisha*) is the most important species in marine capture fishery and accounts for nearly half of the national marine catch and 12 to 13 percent of the total fish production of the country.

- **Myanmar:** Marine fisheries have developed continuously since 1950 and gone through a phase of rapid growth since the late 1990s, increasing production from 0.6 million tonnes in 1998 to about 1.6 million tonnes. Formal stock assessment was last conducted in Myanmar 30 years ago and no current information on fish stock status is available. Some fishery indicators seem to indicate a declining trend in marine resource abundance. Size composition of the catch of some commercially important fishes such as pomfret and hilsa shad has become smaller, and the CPUE of bottom trawl fisheries is also declining annually. It may be assumed that some marine fishery resources in Myanmar are overexploited and this seems consistent with the fact that the current landings are 50 percent higher than the estimated MSY. The national MSY estimation might need to be revised if ecosystem shifts have occurred increasing the productivity of smaller species.

- **The Andaman Sea fishery in Thailand** has seen a reduction in total landings from 805 643 tonnes in 1999 to 631 453 tonnes in 2007 and this is principally attributed to overcapacity. This fishery contributes 16 percent of the national production, of which 60 percent is caught in Thai waters (~40 percent is caught outside of Thai waters).

- **Malaysia:** 50 percent of the total national catch (1.38 million tonnes) was from the Strait of Malacca. Inshore waters (an area of less than 30 nautical miles from the coastline) contributed 81 percent of the catch and fishing vessels were usually below 70 gross tonnes. This is consistent with the large number of inshore fishing vessels, which comprise 97 percent of fishing vessels in the country. Trawls and purse seines are the two major gear types and contribute up to 78 percent of the landings.

Fishery/stock assessments

The stock assessments performed for the different groups of species show that a majority of these species groups in the region are overfished or fully-fished (Table 21 and Figure 8). However, there is also a large fraction of the species groups that are scored as moderately fished. The stocks of large demersals and small demersals are overfished in a majority of the areas and large and small pelagics are overfished or fully fished in a majority of cases. However, for all these groups, some stocks are scored as moderately fished. The stocks of anchovies and sardines are fully fished in a majority of the assessed fisheries. The assessed stocks of surimi species are overfished and moderately fished but certain stocks are overfished or even underfished. The stocks of crustaceans are scored as fully fished in a majority of the assessed fisheries whereas squids/cuttlefish have some stocks fully fished and others are moderately fished. No assessments were made for shellfish in this region.

Recommendation: Routine assessments are required to enable adequate tracking of resources for management decision making. This is particularly important to assess ecosystem level changes in relative compositions, shifting trophic levels in response to fishing pressure and the determinations of appropriate fishing effort/capacity levels in both nearshore and offshore fisheries.

Table 21 Status of fisheries/species groups for fisheries in Bay of Bengal fisheries areas

	Sri Lanka	India SE, NE coast	Bangladesh <40 m, >40 m	Thailand West coast	Malaysia Peninsular west coast	Indonesia FMA 571 FMA 572
Large demersal	M, U	O/F, M	O, F	O	O	F/O, F/O
Small demersal	M	O, M	O, M	O	O	F/O, F/O
Large pelagic	F	F, M	F, U	O	F	M, M
Small pelagic	F, M	M, M	F, M	O	F	M, M
Anchovy/sardine	F		M, U		F	
Trash fish/low value fish	M	nd, M	O, U			F/O, F/O
Surimi species		F, M			O	F/O, F/O
Shark/rays		F, M	M, U			
Squids/cuttlefish	M	F, M	U, U		F	
Crustaceans	F	F, M	F, M		F	F/O, F/O

Note: This table presents *indicative status* for species groupings. Terminologies for level of exploitation vary between countries as do the methods of assessment and date of last assessment and the geographic scope of those assessments.

Depleted (D); overfished (O); fully fished (F), moderately fished (M); underfished (U) and empty cells or "nd" denotes no data available. Several values indicate a range of reported values (e.g. several sub-areas).

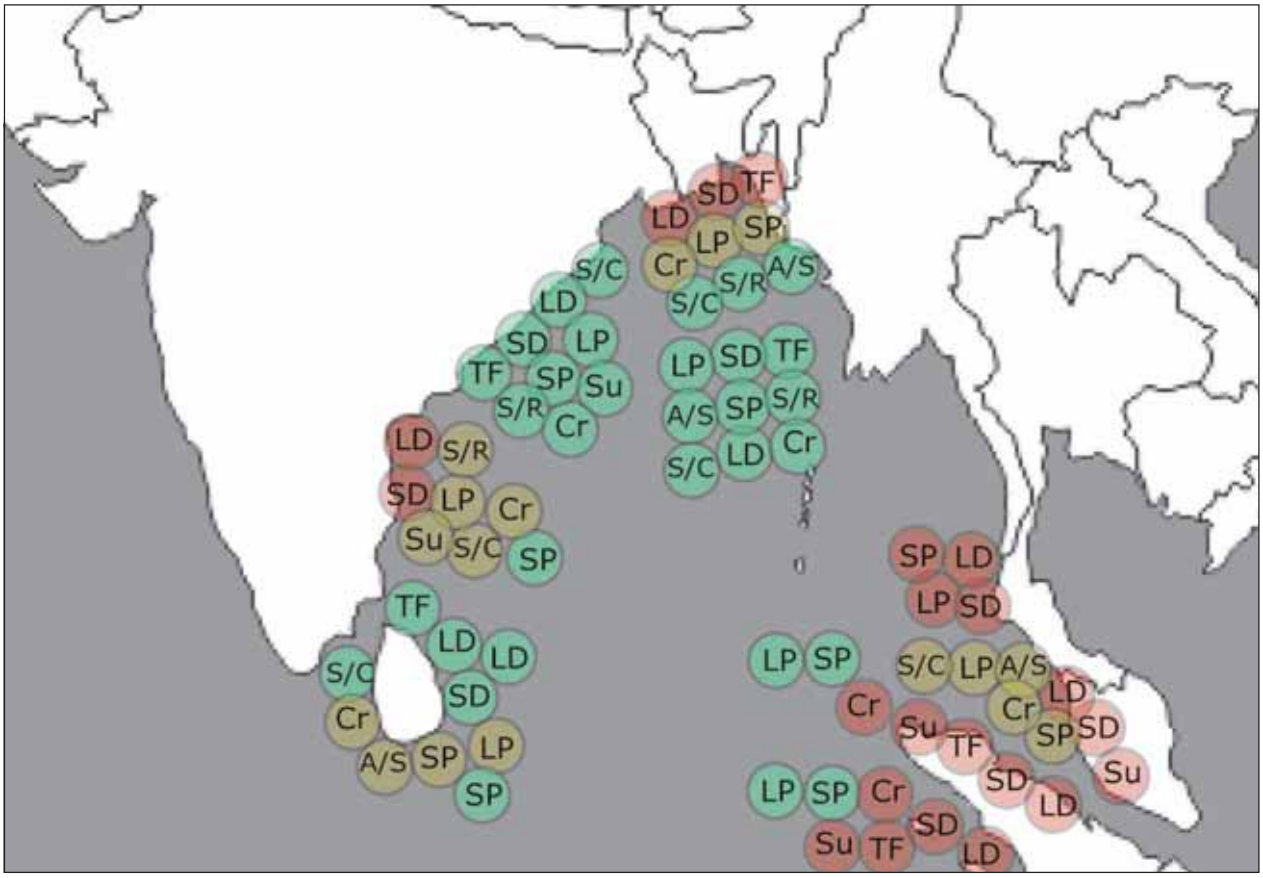


Figure 8 Indicative fishery/stock assessments for the assessed fisheries areas

CPUE/catch rates

For a majority of the assessed fisheries (by gear) in the region the catch per unit effort (CPUE) and catch rates are declining (Table 22). A majority of the assessed trawl fisheries show declining CPUE or catch trends. Moreover, a majority of the assessed purse seine fisheries show declining CPUE or catch rates and also other seine fisheries are declining. A majority of the net fisheries assessed show declining CPUE or catch rates. The CPUE rates for prawn and lobster fisheries have declined. Detailed CPUE rates are presented in Table 23.

- **Sri Lanka:** It is not certain whether CPUE/catch per hour is increasing or decreasing as there is no long term data set on CPUE.
- **India:** CPUE trends have declined in trawl fisheries nationally. In the southeast, CPUE is 25 percent of 1992 rates.
- **Bangladesh:** CPUE/catch per day per trawler is steady for shrimp trawlers but declining for fish trawlers (MFO, 2009).
- **Myanmar:** the CPUE of bottom trawl fisheries is declining annually.
- **Thailand (Andaman Sea):** CPUE trends are either stable or slightly increasing over a three year period.
- **Malaysia (Peninsular west coast):** Trends in CPUE here appear to be stable or increasing.
- **Indonesia (FMA 571 Malacca Strait):** CPUE/catch per hour show large decreases, mainly the demersal and some small pelagic (mT/boat/y between 1998 and 2008): Large demersal – decreasing from 400 to 40; small demersal – decreasing from 300 to 40; small pelagic – relatively stable at 30 to 35; large pelagic – fluctuating between 30 and 35; large tuna – increase from 0.1 to 0.6; small tuna – stable at 15 to 20; crustaceans – decreasing from 400 to 50.
- **Indonesia (FMA 572 Western Sumatra):** Large demersal – decreasing from 200 to 20; small demersal – decreasing from 300 to 30; small pelagic – stable at 60 to 80; large pelagic – increasing from 2 to 8; large tuna – decreasing from 7 to 3; small tuna – fluctuating between 50 to 70; crustaceans – decreasing from 100 to 20.

Table 22 Trends in CPUE/catch rates by gear for the assessed Bay of Bengal fisheries areas

	Sri Lanka	**India** Southeast coast	**Bangladesh**	**Thailand** West coast	**Malaysia** Peninsular west coast	**Indonesia** FMA 571 FMA 572
Gear	**1985–2005**	**1995–2009**	**1999–2009**	**1984–2005**	**2000–2008**	**1977–2008**
Overall						
Trawl		↓ -73%	↓ -38%	↓ -38%	↑	↓ -94% ↑ +116%
Purse seine				↓ -76%	↑	↓ -61% ↓-21%
Other seines	↓ -69%				↓	
Net (drift, gill ring)	↓ -51%				→	↑ +71% ↑ +250%
Hand line						
Longline						↓ -76% ↓ -83%
Prawn trawl fishery	↓ -6%		↓-1%			
Lobster fishery	↓ -60%					

Increased (↑); decreased (↓) over a specific time period – where data available, a two year average for the CPUE at the start and finish dates were used. *Refer to Box 1, page 19 for a note on interpreting CPUE trends.*

Table 23 Detailed CPUE/catch rates by gear or resource for the assessed Bay of Bengal fisheries areas

Country	Time period	CPUE/catch rate	Resource/Area/source of information
Sri Lanka	1986–1995	3.3 to 1.0 kg/boat/day	South coast lobster fishery
	1990–1995	9.1 to 8.6 kg/boat/day	Prawn trawl fishery (Negombo lagoon & adjacent waters)
	1953–1986	65 to 177 kg/haul	West coast beach seine fishery
	1953–1986	83 to 210 kg/haul	North West coast beach seine fishery
	1983–2005	336 to 28 kg/haul	South West coast beach seine fishery
	1985–2005	186 to kg/haul	South West coast ring net (scad) fishery
India	1995–2008	48.5 to 35.7 kg/hr	All India average for trawl
	1992–2008	82.5 to 21.8 kg/hr	SE coast (Chennai)
Bangladesh	2000–2009	3 000 to 1 859 kg/day	Fish trawl, <40 m depth within EEZ
	2000–2009	490 to 483 kg/day	shrimp trawl, <40 m depth within EEZ
	2004–2009	139 to 25 kg/day	Fishing >40 m depth Chittagong/Cox's Bazaar
Myanmar	1979–1980	670 to 946 kg/hr	Fritjof Nansen Survey
	1983–1989	184 to 253 kg/hr	FRV Chulaborn, FV251, Commercial data
	1996–1998	96 to137 kg/hr	Commercial fishing
	2006–2007	90 kg/hr	MV SEAFEC Survey
Thailand	2003–2005	76.5 to 82.8 kg/hr total 1.8 to 2.2 kg/hr pelagic 21.4 to 25.9 kg/hr demersal 6.6 to 5.0 kg/hr cephalopod 16.1 to 16.0 true trash fish	Andaman Sea
Malaysia	2000–2008		Peninsular west coast
		Drift/gillnet – stable	Zone A
		Purse seine – increasing	Zone B; Zone C; Zone C2
		Anchovy purse seine – decreasing	Zone B; Zone C; Zone C2
		Trawl – increasing	Zone B; Zone C; Zone C2
Indonesia	1998–2008	Trawler – 90% decrease 1 284 to 130 tonnes/boat/yr Seiners – decreasing from 56 to 41 tonnes/boat/yr Drift gill netter – fluctuating between 8 to 6 tonnes/boat/yr	FMA 571
	2001–2007	Trawlers – decreasing from 225 to 54 tonnes/boat/yr Seiners – initially 102 increasing to 146 tonnes/boat/yr Drift gill netters – ~5 increasing to ~20 tonnes/boat/yr	FMA 572

Low value/trash fish production

Total production of trash/low value fish species in the Bay of Bengal subregion (Table 24) is estimated at 0.9 million tonnes (including the whole of India). The percentages of total production vary according to area, but reaches 65 percent or more in some areas. Overall in the reported fisheries, trash/low value fish ranges between 4 and 65 percent, with a more typical range of 14 to 64 percent. The principal source of this information is reports from trawlers.

Table 24 Production of trash/low value fish for the assessed Bay of Bengal fisheries areas

	Tonnes	% of total catch	Comments/reference
Sri Lanka	**nd**		Shrimp trawl fisheries bycatch in Sri Lanka's Palk Bay and Gulf of Mannar fisheries have ratios of trash fish: shrimp of 14:1 and 12:1, respectively. The ratios for Negombo and Chilaw shrimp trawl fisheries are much lower at 1.3:1 and 1.8:1, respectively.
Bangladesh	**85 843**	17%	Includes nei species.
India	**347 862**	12% of total national production 25% (Veraval, NW coast) 14% (Chennai, SE coast) 32% (Visakhapatnam, SE) 24% (Mangalore, SW coast) 17% Calicut, SW coast)	Total country production. Recalculated from annual report of CMFRI, 2009. Detailed figures from trawler landings.
Thailand (West coast)	**215 571**	64% of otter trawl catch; 23% of pair trawl; 10% purse seine catch (Andaman Sea)	2007 figure, decreased from 260 596 tonnes (1997). Fisheries statistics 2007 (DOF, 2009).
Malaysia (Peninsular west coast)	**206 105**	65% national low value/trash fish catch	Predominantly from trawl fisheries. Fisheries annual statistics 2000–2008.
Indonesia (FMA 571) (FMA 572)	 **25 500** **18 000**	 6.2% 4.3% 9% (nationally)	 2008 figure, reduced from 77 400 (1980). 2008 figure, increased from 5 200 (1980). National total 477 900 tonnes in 2008.

Fishmeal production

The total fishmeal production for the Bay of Bengal subregion (Table 25) is estimated at 152 000 tonnes (Malaysia, Indonesia and Thailand production is reported under South China Sea subregion). This is presumed to be derived largely from the catch above. The region produces large quantities of dried fish, which are powdered/pounded to form basic animal feeds or fish feeds or directly as human food and which are not classified as fishmeals (alternative local terms are used such as "fish powders" etc.). Reducing demand in Bangladesh is attributed to the decline in shrimp production. There appears to be interest in some areas (e.g. India) to increase the utilization of discards (75 000 tonnes) for fishmeal by establishing a collection system at sea. This is in response to increasing demands associated with aquaculture intensification in the Bay of Bengal subregion and could start to drive direct targeting and mesh size reductions if a significant onshore market was established. This has been the experience from the South China Sea subregion. In other cases (e.g. Thailand and Malaysia) the trash fish production above will be directed into fishmeal as well as fed directly to marine fish cages.

Table 25 Production, import and export of fishmeal (tonnes)

	Sri Lanka	India	Bangladesh
Fishmeal produced	*0	**19 300	***2 000
Fishmeal imported	7 390	9 222	1 017
Fishmeal exported	63	10 170	421

* Sri Lanka does not produce fish meal commercially, there is some home based small-scale production.

** IFFO production figure 19 300 tonnes/year, fishmeal production capacity 300 000 tonnes/year.

*** Estimated, 105 tonnes reported to FAO.

Capture production of surimi species

The relative catch of surimi species has increased in all assessed areas (Table 20) and the total production for the region is roughly estimated as 75 000 tonnes, requiring approximately 262 500 tonnes of raw material. (Table 26). Many countries in the Bay of Bengal subregion do not produce surimi in

significant quantities. This largely assumes that facilities to produce surimi are not yet established (there is a technological lag). It may also be speculated that the fisheries of this region are also in a better condition, thus fish is utilized directly for consumption and there is less pressure to process fish into surimi to increase utilization for human consumption (especially products of trawl fisheries). Note that surimi production for Thailand, Malaysia and Indonesia is reported in the South China Sea section as the majority of production of these species is derived from this subregion.

Table 26 Production of surimi and catch of fish (raw material) from which it is derived (tonnes)

	Surimi production 2005	Total raw material required	Threadfin bream	Lizard fish	Goat fish	Croaker	Snapper (big eye/ king)	Barracuda	others
India*	~70 000	**245 000							
Myanmar	5 000	17 500	10 150	1 050	2 450	2 800	700	350	
Total	**75 000**	**262 500**							

* India figure for whole country.

** Estimate.

Note: Bangladesh and Sri Lanka do not produce surimi.

Vessel numbers and employment

The total number of vessels in the BOB subregion is less than 415 000 (this includes all of India and thus the west coast Indian fleet should be subtracted, Table 27). Small-scale, outboard, non-motorized or artisanal gears comprise 77 percent of the fishing vessels. The number of people employed in the sector is more than 1.6 million and a large fraction of these are part-time fishers. Employment figures in fisheries are notoriously difficult to obtain and even more so for the “hidden” workforce (Table 28). In many cases entire households are engaged in some form of work in the fishery either directly in fishing or indirectly in the post-harvest activities. In some cases there is considerable foreign employment of fishing crews from neighbouring countries.

Table 27 Number and type of fishing vessels and employment in the assessed Bay of Bengal fisheries (by area)

	Sri Lanka	India	Bangladesh	Myanmar	Thailand West coast	**Malaysia Peninsular west coast	Indonesia FMA 571 FMA 572
Year	**2007-2008**			**2008**	**2000**	**2008**	**2008**
Trawlers		29 241					2 217
Purse seiners		983					2 012
Gill net		14 183					27 957
Dol net							
Hook-and-line		8 862					32 133
Set net							
Others		5 284					46 949
Longline		1 190					7 691
Non-motorized	39 104	104 270		15 219	19 412	98	
Motorized/outboard		75 591				10 027	43 031
Inboard/mechanized	4 749	59 743		16 376	1 744	7 865	34 560
<5 grt						10 884	
>5 grt						7 106	
Small scale			43 026				
Large-Commercial			200				
Total	**41 733**	***239 604**	**43 236**	**31 595**	**21 156**	**17 990**	****118 959**

* Whole country. Note that gear categories ar ento strict, as more than one gear type may be utilized.

** Malaysia figures do not include 61 vessels operating on high sea.

*** Data based on Indonesia annual statistical report (2009). Note that this figure differs from Lymer D., Funge-Smith S., & Greboval D. (2009). The national total for Indonesia is 590 000 fishing vessels comprising 348 000 motorized fishing vessels and 242 000 non-motorized.

Table 28 Employment in the assessed Bay of Bengal fisheries (by area, excluding Myanmar)

	Sri Lanka	India East coast	Bangladesh	Thailand West coast	Malaysia Peninsular west coast	Indonesia FMA 571 FMA 572
Year	**2007- 2008**			**2000**	**2008**	**2008**
Full time	132 000	430 654	519 000		42 846	261 002
Part time	33 100	117 241	259 500*			75 279
Family members				29 820		
Employees/crew				17 717		
Nationals					32 349	
Foreign crew					10 497	
Total	**165 000**	**547 895**	**778 500***	**47 537**	**42 846**	**336 281*** **

* Estimate.
** Whole country.
*** Lymer D., Funge-Smith S., & Greboval, D. (2009) cite a figure of 46 714 for FMA 571.

Recommendation: Improved statistical information on the workforce and its structure would inform policy making as well as allow more effective valuation of the role of fisheries in the subregion.

Fishery zoning and management measures (including protected areas)

All the countries have established an economic exclusion zone (EEZ), although the zoning differs among the countries (Table 29). All countries have at least two zones but some have up to four different zones. The zones are either divided by distance (i.e. nm) from shore or by depth of the water. The outer zone extends to the limit of the EEZ in all cases except for India, which has not included it in its definition.

Table 29 Fishing zones of the countries in South and Southeast Asia with waters in the East Indian Ocean

Countries	Fishing Zone 1	Fishing Zone 2	Fishing Zone 3	Fishing Zone 4
Sri Lanka*	Lagoon fisheries, continental shelf and the slope	Offshore area is up to EEZ and high seas		
India (Southeast coast)	Artisanal craft within 5 km from shore;	Mechanized craft beyond 5 km from shore	Mechanized craft OAL <20 m beyond 10 km	Mechanized craft OAL >20 m beyond 23 km
(Northeast coast)	Artisanal craft within 5 km from shore;	Mechanized craft OAL <15 m beyond 5 km;	Mechanized craft OAL >15 m beyond 20 km	
Bangladesh	Coastal area and shallower part of the EEZ of Bangladesh which is shallower than 40 m	Whole EEZ of Bangladesh which is deeper than 40 m		
Myanmar	From shore line to 5 nm in the northern area (Rakhine), 10 nm in the southern area (Ayeyarwaddy and Taninthayi) Engine <12 HP; Boat OAL <30 ft	From outer limit of inshore fishing zone (1) to EEZ limit Engine >12 HP; Boat OAL >30 ft		
Thailand	From shoreline to 12 nm	From 12 nm to EEZ limit		

Table 29 *(continued)*

Countries	Fishing Zone 1	Fishing Zone 2	Fishing Zone 3	Fishing Zone 4
Malaysia (Peninsular west coast)	From shoreline to 5 nm	From 5 nm to 12 nm	From 12 nm to 30 nm	From 30 nm to EEZ limit
Indonesia	From shoreline out to 4 nm	From the outer limit of first fishing zone to 12 nm from shore	From the outer limit of second fishing zone to EEZ limit	

Adapted from: SEAFDEC (2008), with additional data for Sri Lanka, India and Bangladesh.

* No official zoning exists.

The zoning is partly used to apply different management measures for different areas and different fleet segments. The management measures used differ among the countries in the region (Table 30). Closed areas and closed seasons are common in the nearshore zone (Zone 1) of many countries in the region, but there are examples of these measures being applied in other zones. Gear restriction and licensing, when applied, are used in all different zones for most countries. Size limits (e.g. fish length) are used by some countries but quotas are not used by any of the countries in the subregion as a management measure.

Table 30 Examples of management measures used in the different Bay of Bengal fisheries (by fishing zone)

Area	Closed areas	Closed seasons	Size limits (Biological)	Gear restrictions	Licensing	Quotas
Sri Lanka		Zone 1	Zone 1	Zone 1	Zone 1	
India (East coast)	Zones 1–3	Zones 2–4	All zones	All zones		
Bangladesh	Zone 1	Zone 1		All zones	All zones	
Myanmar	All zones	All zones		All zones	All zones	
Thailand (West coast)	Zone 1	Zone 1		All zones		
Malaysia (Peninsular west coast)	Zone 1			All zones	All zones	
Indonesia (FMA 571)				All zones	All zones	

Closed areas come in many forms of which marine protected areas (MPAs) are the most common (and known). The countries in the subregion have a total of at least 636 MPAs at national, district and local level (Table 31). Additionally, there are examples of oil exploration areas that are often *de facto* no fishing zones, and there are seasonally closed areas in many of the countries. There are also areas designated as no fishing zones in a majority of the countries.

Table 31 Marine protected areas and areas where fishing is restricted or excluded

	Sri Lanka*	India** East coast	Bangladesh	Myanmar	Thailand West coast	Malaysia Peninsular west coast	Indonesia FMA 571 FMA 572
Marine protected areas/parks	(2)	(31) 6 271 km^2	4	(4) 387 km^2	(13) 4 359 km^2	(4) 188 km^2	(10) 2 488 km^2
No fishing zones	1		2			4	
Oil exploration areas	0	2	1			0	
Seasonal closed areas	0	2	4			0	

* Two marine parks, four marine sanctuary/reserves, nature reserves, mangrove reserves.

** Not entirely marine area as includes some land. There are 31 MPAs and two biosphere reserves (6.16 percent of coastal biogeographic zone; there is a proposal to increase this to 7.61 percent). Oil fields in Bombay High and Godavari Basin also function as MPAs. All MPAs include some fishing exclusion zones.

Interest in potential for offshore fisheries

All countries of South Asia and Southeast Asia have policies to promote and expand fishing further offshore from their coasts. In some cases the policy explicitly states that the move offshore is to transfer fishing from overexploited inshore areas to underexploited areas. The push offshore will need a concerted effort and development of appropriate technologies and human capacity that make harvesting, processing and marketing these resources effective, efficient and environmentally responsible. The main policy drivers are:

- Overfishing in inshore areas;
- attempting to realize the potential of offshore fishing;
- building up catch history records for subsequent negotiations in regional fisheries management organizations (RFMOs); and
- ensuring full utilization so that others cannot fish under the provisions of the UN Convention on the Law of the Sea (UNCLOS).

Although it is known that there are resources which could be exploited in the offshore waters of South Asia and Southeast Asia, including tunas, small pelagic resources, oceanic squid and some economically important demersal species such as snapper and grouper and deep-sea shrimp, the extent of the potential is not known as exploratory fishing and technology advances are still being made. However, the indications are that these resources are limited and, in the case of the oceanic tuna, already heavily fished in both the Pacific Ocean and the Indian Ocean. Although some surveys have been undertaken, the data have generally been analyzed or communicated poorly. They have not provided conclusive evidence of the potential yield of the resources, but indications are that they are approximately 10 percent of the densities that are typically found in nearshore areas and therefore a cost-benefit analysis may conclude that there is little benefit accessing these resources. In some cases, the results from surveys have been converted into potential yield estimates (Table 32).

Table 32 Potential yield estimates of various offshore resources in the South and Southeast Asia regions provided (tonnes)

	Southeast Asia			South Asia		
	Malaysia (inc. Sarawak & Sabah)	**Viet Nam**	**Brunei**	**India*** **	**Pakistan**	**Sri Lanka**
Pelagic	25 000			247 000	25 000	
Small pelagic	340 000	1 150 000*		159 000		
Small demersal	79 000	355 000		230 000	217 000	
Offshore potential yield/MSY	542 000		1 200**	635 000		150 000

* Small and large pelagic combined

** Mainly large pelagic

*** all India EEZ

Sources: APFIC (2009) and Staples (2009)

The typical yield estimates can be converted into sustainable catches per unit area (tonnes/km^2):

- For pelagic species these annual yields correspond to sustainable catches of between 100 and 155 kg/km^2 of offshore area in these countries.
- Fewer estimates of the offshore potential yield of small pelagic are available; these correspond to 79 kg and 2 125 kg/km^2 of EEZ, respectively. One combined figure for large and small pelagics was 1 150 kg/km^2. It should be noted that these sustainable yield figures are at least one tenth of those calculated for inshore resources.
- Demersal species density estimates vary between 100 and 900 kg/km^2 of offshore area. As with the pelagic resources, it should be noted that these sustainable yield figures are at least one tenth of those calculated for inshore resources.

Governments are providing a number of incentives to facilitate this move. Illegal, unreported and unregulated (IUU) fishing is already a major constraint on sustainable development in many of the coastal fisheries of the region. This is also linked to limitations with monitoring, control and surveillance (MCS) programmes and other management controls. There is a high risk that this limited control will become even more overstretched as fishing capacity moves offshore, leading to increased IUU fishing activity and subsequent undermining of sustainable management objectives. Some of the offshore resources of the region, especially the highly migratory species like tunas, are being exploited by countries both from within the subregion as well as from outside the subregion. Likewise, competition exists for the same resources between countries in the subregion as well as between small-scale and large-scale fishing boats within the countries.

Inland capture fishery production

In the 2006 *Status and potential* report several recommendations were made to member countries to improve the disaggregation of inland capture species composition data and capture trends. It was also recognized that the lack of updated data might hamper the proper recognition of this important subsector. The capture statistics from inland fisheries in the region have shown a steady increase during the last years. However there are concerns that this might only reflect improvements in monitoring systems rather than a real increase in catch.

Historical and systematic underestimation of inland capture fishery production[3]

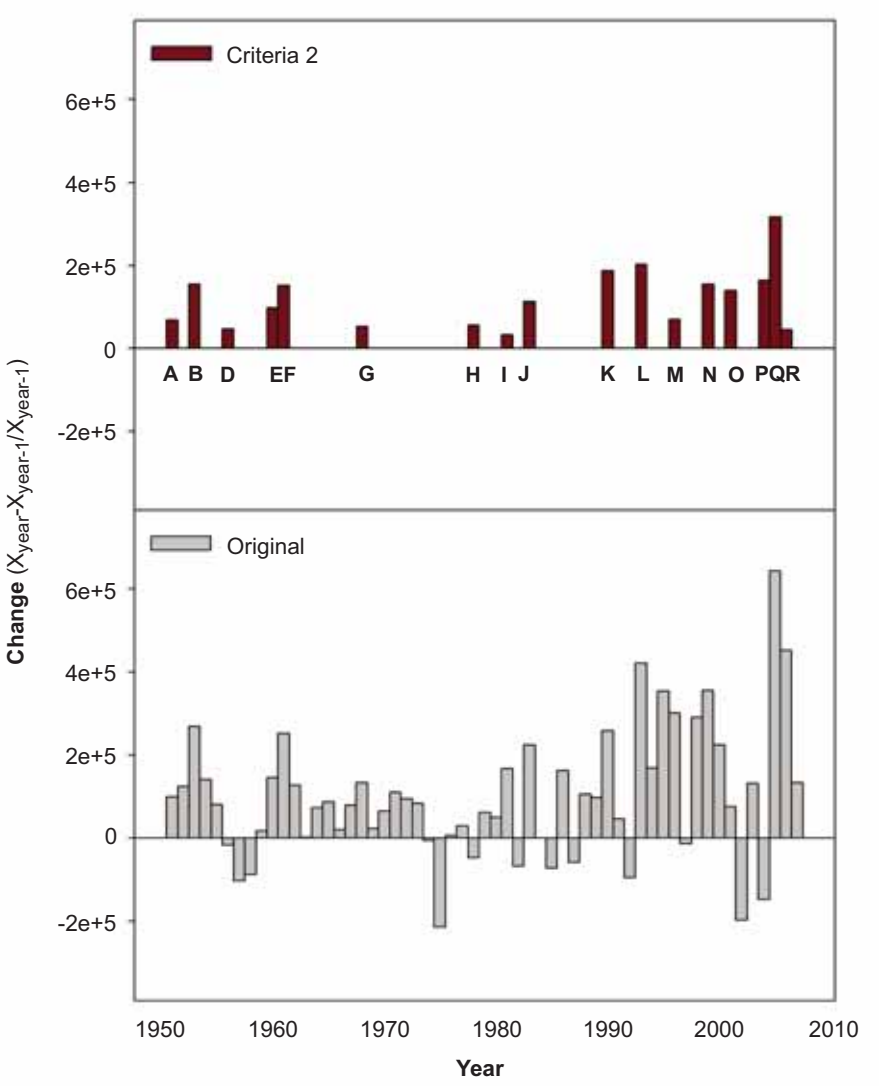
The apparent regional trend of inland fishery production in Asia and the Pacific region is one of sustained increase in production (Figure 1). It is not clear when viewing aggregated statistics whether this is because of a gradual increasing production from all countries' inland fisheries, or because of large increases from individual countries. The rising total could also be a result of better reporting of catches that were already being made by previously unrecorded sectors of the fishery, such as rice field fisheries or small-scale subsistence catches, or could represent real gains in production. If the latter, stock enhancement may have played a part.

Most countries at some stage review their inland fisheries statistics basing this on newer information, or improved estimation of the proxy indicators. As a result of this type of updated information, countries may revise their inland fisheries production quite radically, resulting in a significant increase or decrease in the reported inland fishery production. Large changes in national estimates indicate that there may have been a significant revision in the statistical data collection system, or an adjustment in the national estimate based on new supporting evidence, for example:

- The availability of direct measurement data, rather than estimates or proxies;
- revision of the area of fisheries such as inclusion of other habitats (where estimates are based on habitats and productivity per unit area estimations (new information of fishery habitats, wetlands areas previously not included);
- inclusion of previously unrecorded fisheries (e.g. inclusion of artisanal or subsistence fisheries, where previously only large-scale fisheries were reported);
- revision of the number of fishers (typically as a result of census updates);
- recalculation of fixed transformation values (e.g. catch/ha or catch/fisher);
- availability of updated consumption data, economic survey data (e.g. per capita consumption of freshwater fish); and
- revision based on assumptions regarding effects of enhancements of wild stocks as a result of stocking or other interventions.

Large changes in national estimates indicate that there may have been a significant revision in the statistical data collection system, or an adjustment in the national estimate based on new supporting evidence. Analysis of the reported inland waters capture production data in Asia and the Pacific region has shown that individual countries have reported an overall annual increase of more than 40 percent, a total of 128 times in terms of national statistics between 1950 and 2007 (Figure 9). On average, this corresponds to more than two countries per year reporting a very large increase in national production. These identified events accounted for more than 43 percent of the total increase in inland water production between 1951 and 2007. Not all of these changes will significantly influence the trend of inland fisheries catch at a regional or global level (i.e. many of these countries have a relatively small contribution to total production). It is nevertheless noteworthy that such large increases are a common occurrence.

[3] A more comprehensive review can be found in Lymer D. & S. Funge-Smith (2009).



Note: Alphabetic code corresponds to the identified changes and countries as follows: **A** (1951, China); **B** (1953, China); **D** (1956, Myanmar); **E** (1960, China); **F** (1961, China); **G** (1968, Philippines); **H** (1978, Philippines); **I** (1981, Cambodia); **J** (1983, Philippines); **K** (1990, India); **L** (1993, India); **M** (1996, Viet Nam); **N** (1999, Cambodia); **O** (2001, Cambodia); **P** (2004, Myanmar); **Q** (2005, India); and **R** (2006, Pakistan).

Figure 9 Changes in reported production that contributed to more than 30 percent of the APFIC regional total change in the same year (top graph) and the total regional change for inland capture fishery catches 1950–2007 (bottom graph)

Out of the 128 events, 17 events were of a magnitude that they were greater than 30 percent of the average regional change (1950–2007) and hence significantly affect the regional trend. These 17 events were confined to seven countries and represent more than 36 percent of the total change between 1951 and 2007 or 2 050 966 tonnes. It can be concluded therefore that the regional trend in inland catch is significantly driven by these large changes in only eight countries. Since the APFIC region is the largest inland capture fisheries producer in the world, the effects of these events on the APFIC regional trend have a major influence on the global trend.

These revised estimates do not represent a sudden increase, but almost certainly a systematic and historical underestimation of the national production. The implications of this are that we must avoid falling into the trap of assuming that production is increasing, when we are really only seeing a re-adjustment of the baseline and that from some countries at least there may actually be a trend of decline in the fishery being masked by the aggregation of catches and production of multiple countries. If these sudden "jumps" in production are smoothed backwards (assuming that the trend is the same, but systematic errors have resulted in underestimation), a very different trend curve for production emerges (Figure 10).

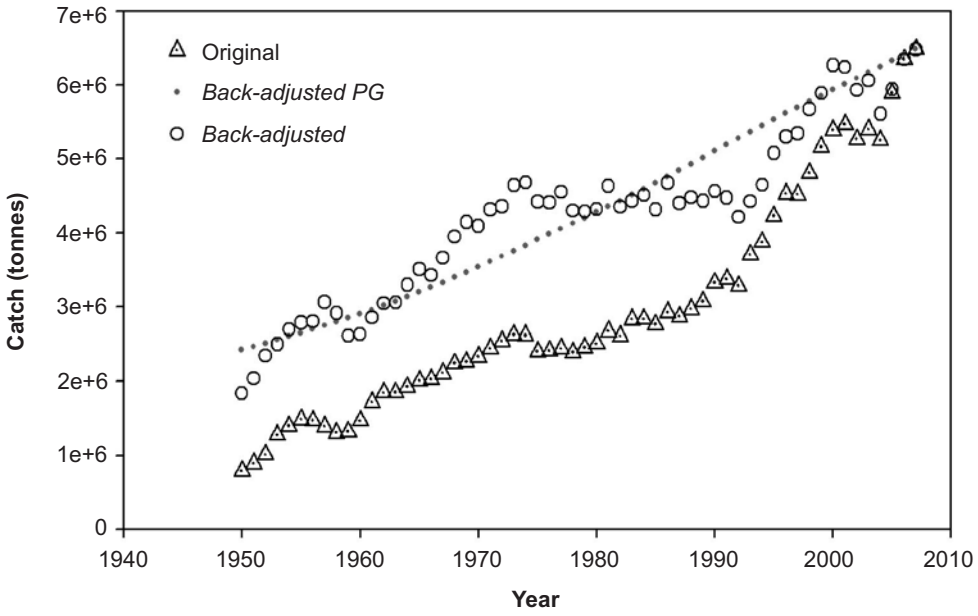


Figure 10 Historically modelled data of inland water capture fisheries catch in the APFIC region

Although inland fisheries are generally considered to be underreported for the reasons provided earlier in this review, there are a number of reasons why production increases may be reported. The stocking or enhancement of inland fisheries can significantly increase their productivity leading to reports of increasing production. Such increases may be genuine in which case there is real increase and contribution to production, however they may simply be artefacts created by the optimism generated from national programmes to increase production, leading to impacts being overestimated. In the case of commercialization of enhanced fisheries, the actual production increases may be real and this is an area which also requires further attention: the production increases from inland wild fisheries is driven by pressure and "fishing down the food chain" whereas productivity increases from enhanced fisheries are driven by the enhancement regime. The two do not exist in isolation and both of these factors may be occurring simultaneously in adjacent fisheries or even within some fisheries.

The multistakeholder issues surrounding freshwater use (for power, irrigation, leisure etc.) also mean that fisheries services may not be valued highly and as a consequence little effort and few resources have been allocated to information gathering with respect to inland fisheries and their management. There is a growing awareness that in certain parts of the world inland fisheries can be a major source of protein and livelihoods and this has sparked recent interest in these fisheries. Furthermore, the common lack of inclusion of recreational and subsistence catches and the fact that many countries still encounter great difficulties in managing and funding the collection of inland capture statistics are highlighted as major problems by FAO. In addition, the very poor species breakdown reported by many countries risks a biased trend analysis by species or species groups of the inland catch data. In 2006, global inland catches classified as "freshwater fishes not elsewhere included (nei)" again exceeded 50 percent (57.2 percent) of the global catch and about 74 percent in Asia and the Pacific region (Table 1). A most worrying trend is that these figures are actually increasing both globally and in the region.

Status of enhancement of inland fisheries resources in Asia[4]

Inland capture fisheries production of APFIC members reached 6.7 million tonnes in 2008 (FAO Fishstat, 2010). In contrast to marine capture fisheries, the production increased by 130 percent compared to 1988. Although the increase resulted from improved reporting of inland capture fisheries production by the members, inland fisheries resource enhancement and conservation have definitely made a significant contribution to the increase. Enhancement and conservation of inland fisheries resources have been practiced for a long time in many Asian countries for the purpose of promoting inland capture fisheries, conservation of biodiversity and environmental benefit. The latter two have become the objectives of enhancement and conservation activities recently. However, the objectives of such enhancement and conservation activities are often different in different countries, for different species and in different water bodies. Enhancement and conservation activities in river systems tend to focus more on protection of aquatic biodiversity (including genetic biodiversity) and reinstallation of depleted wild stock, whereas, enhancement and conservation activities in lakes, reservoirs and floodplains usually focus more on enhancing catch and sometimes on environmental benefit.

Current enhancement and conservation of inland fisheries resources cover all kinds of inland water bodies and involve many varieties of fish and other aquatic animals in the region. More than 100 species of fish and other aquatic animals are directly used in the enhancement or are directly/indirectly impacted by conservation activities. Thirty-three species (mostly fish, but some crustaceans) are currently used for enhancement in two or more countries in the region.

Objectives and practices

Although promotion of inland capture fisheries is still one of the primary objectives of inland fisheries resources enhancement and conservation, there are a variety of objectives including:

- Promotion of the inland capture fisheries for enhancement of the livelihoods of traditional inland fishery communities;
- restoration of depleted natural populations;
- preservation of endangered species and aquatic biodiversity;
- improvement of ecosystem function and environment condition;
- preservation of aquatic genetic resources; and
- promotion of ecotourism.

Practices relating to the enhancement and conservation of inland fisheries resources are extremely diversified in the region, varying with water environment, species of animal involved and the enhancement objectives. Among the enhancement and conservation approaches, the most common are release of seed, establishment of protected areas/sanctuaries, gear restrictions and closed seasons (Table 33).

Table 33 Approaches for enhancement and conservation of inland fisheries resources in Asia

	Artificial release	Artificial fish breeding substrates	Protected areas	San-ctuaries	Habitat improve-ment	Closed season for fishing	Restriction of harmful gears	Fishing quota
Rivers	✓		✓			✓	✓	
Lakes	✓	✓	✓		✓	✓	✓	✓
Reservoirs	✓	✓	✓			✓	✓	✓
Flood plains	✓			✓	✓			

[4] This section is a brief summary from the outputs of the APFIC/FAO regional review on enhancement and conservation of inland fisheries resources that covered ten Asian countries with significant practices relating to the enhancement and conservation of inland fisheries resources (Bangladesh, China, India, Indonesia, Republic of Korea, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam).

Investment and benefits

The regional review identified some economic aspects of inland fisheries resources enhancement and conservation such as investment and benefit distribution. Enhancement and conservation of inland fisheries resources used to be principally funded by governments. Government funding is still a major funding source for large-scale enhancement and conservation programmes in many countries. Many enhancement and conservation activities are not aimed at increasing catch and thus do not generate direct economic benefits to any specifically targeted group of people. Instead, they usually serve the purpose of protection of endangered species, preservation of aquatic genetic resources, restoration of depleted wild populations and environmental improvement.

More recently, sources of investment are becoming more diverse. In many cases, enhancement and conservation activities are often jointly funded by different levels of government, together with other sources of funding. Entrepreneurial investment is commonly used for covering the costs of an enhancement programme when fishing rights are leased to companies/collectives/cooperatives. Contributions from beneficiaries (fishers) have become an important source of investment for the enhancement and conservation programmes. The common practice is a resource enhancement fee collected from fishers when renewing fishing licenses. Public donation is becoming a significant source of investment for the enhancement programmes and often results from public campaigns or religious practices. In some countries, governments allocate significant financial resources for enhancement and conservation activities. Elsewhere, the activity remains dependent on external donors.

Properly implemented inland fisheries resource enhancement and conservation activities can directly generate economic and/or ecological benefits. Economic benefits are usually shared by a targeted population (e.g. licensed fishers in the vicinity of a lake, reservoir or river) or among a designated group of people (such as a cooperative or individual), which happens when the fishing rights to a water are leased to group of people (e.g. people displaced by the construction of a reservoir) or individual entrepreneurs (in the case of concession fisheries).

Issues and constraints

The review concludes that inland fisheries resource enhancement and conservation activities typically contribute positively to improved livelihoods of inland fisher communities and provide ecological and environmental benefits in the region. It does recognize though that there have been some problems and constraints on the enhancement and conservation efforts, and these have resulted in limited positive impacts.

Inequality in benefit distribution: As a common practice, fishing rights to a certain reservoir, floodplain and lake are often leased to a small group of people or even individual entrepreneurs. Such enhancement protocols might bring about an increase in food fish production, but could marginalize other users, particularly traditional fishers in the vicinity of the water body, by preventing access to a potential food source and a subsidiary income opportunity.

Lack of informed planning and poor execution of enhancement and conservation programmes: Fisheries enhancement and conservation programmes are often well-intended by government, development assistance agencies or through traditional or religious practice, but without proper knowledge-based planning and design. Enhancements are often implemented by different agencies and groups of people and lack of coordination among the different parties often prevents maximized benefit from these efforts. Lack of attention to basic technical aspects can seriously limit the effectiveness of the enhancement practice. The result of fisheries resource enhancement and conservation is significantly affected by the hydrological condition of the water bodies that is usually under the control of water authorities and poor coordination of water management can significantly affect the fishery potential of a water body under an enhancement programme.

Potential negative impacts on biodiversity through releasing programmes: Release of hatchery-produced seed is a commonly used approach for inland fisheries resource enhancement. Seed of alien species is also used in releasing programmes in some countries. Lack of control of genetic quality/attributes in indigenous species seed used for a releasing programme may result in potential negative impacts on

biodiversity and genetic diversity of natural populations. The use of alien species may result in competition with indigenous species and negative impacts on the diversity of indigenous species.

Standardized protocol for good practice of enhancement and conservation activities: There are a few examples of guidelines/codes of conduct for implementing enhancement and conservation programmes in the region, however, there is general lack of science-based standardized protocols covering planning and implementation of enhancement and conservation programmes. This has resulted in uncertain results and adverse impacts.

Applicable methodology for effective impact assessment: In general, there is no applicable methodology for effective impact assessment of different enhancement and conservation programmes. This hinders the needed improvement in planning and implementation of enhancement and conservation practices as well as demonstration of socio-economic, ecological and environmental benefits generated from the enhancement and conservation efforts.

Effective fisheries management: Results of fisheries enhancement and conservation efforts largely rely on effective management of fishing activities for target waterbodies and species. Although there are good examples (e.g. in Republic of Korea and China), there is lack of effective management in the fisheries activities in many countries in the region, which greatly undermines the effectiveness of enhancement and conservation efforts.

Human resources capacity building: Although enhancement and conservation of inland fisheries resources has been practiced for decades in the region, there is general lack of well-trained human resources in many countries in the region. Higher education programmes tend not to include subjects related to inland fisheries enhancement and conservation.

Recommendations

In order to promote good practice of inland fisheries enhancement and conservation to improve the livelihoods of inland fisher communities and ecological goods and avoid any potential negative impacts, it is recommended that national governments, international organizations and NGO to take the following actions in the region:

Strengthen capacity: The government should strengthen the human and institutional capacity related to inland fisheries resource enhancement and conservation.

The inclusion of inland fisheries resources enhancement and conservation is recommended as an important component of the curricula of tertiary educational programmes related to fisheries/aquaculture.

Promote regional cooperation: There is an urgent need for governments to cooperate on inland fisheries resource use and enhancement in the region. The cooperation could be started by establishing a mechanism for networking/continuing interaction for sharing of experience on enhancement and conservation of inland fisheries resources through Web-based networking. It would be supported by regional lesson-learning and sharing activities such as workshops and collaborative projects through the joint efforts of regional/intergovernmental organizations.

Develop normative tools and guidelines: There is urgent need to develop normative tools and guidelines on impact assessment and monitoring of inland fisheries enhancement and conservation activities in the region Guidelines/code of conduct for informed planning and execution of enhancement and conservation are also required for the APFIC region. It is expected that international and regional organizations would take the initiative.

Promote advocacy of inland fisheries: Inland fisheries are often neglected in high-level decision-making processes. Contribution of proper use and management of inland fisheries resources is not only limited to the supply of fisheries products, but includes rural livelihoods, aquatic biodiversity, ecological function and environmental benefit of inland waterbodies. Therefore, there is great need to increase the visibility of inland fisheries issues with proactive advocacy at government and international forums such as FAO Committee on Fisheries (COFI), which might consider the possibility of issuing specific technical guidelines.

Part 2
Aquaculture trends in Asia and the Pacific region

Trends in Asia and the Pacific region

In 2008, Asia and the Pacific region produced 46.6 million tonnes of aquaculture products (total aquaculture production excluding aquatic plants), representing 89 percent of global aquaculture production[5]. In terms of value, the region's share is 79 percent of the total value of global aquaculture.

Box 2 Top aquaculture producing countries in 2008

By weight: Top ten aquaculture producer states by quantity (excluding aquatic plants) in 2008 were China, India, Viet Nam, Indonesia, Thailand, Bangladesh, Norway, Chile, Philippines and Japan. Asian states hold the top six positions.

By value: China, India, Viet Nam, Japan, Indonesia, Thailand, Bangladesh and Philippines are among the top ten producer states (see Table 34).

When aquatic plant production is included (the vast majority of global production also originates in Asia and the Pacific region), the region becomes even more dominant, representing 91 percent of global aquaculture production by quantity and 80 percent by value. Compared with 2006, the share of production remains almost unchanged (91 percent in 2006). However, the share of value increased significantly (77 percent in 2006 up to 79 percent in 2008).

The growth rate of aquaculture production in the region has continued to be very strong, reflecting the trend for the last 15 years with a growth rate of 11.4 percent between 2006 and 2008. The growth of aquaculture production in the APFIC region used to result mainly from the continuously increasing production from China[6]. However, the growth rate of APFIC excluding China overtook that of China during 2006–2008 (16.1 percent compared to 9.4 percent. The quantity produced by APFIC amounted to 2.9 million tonnes.

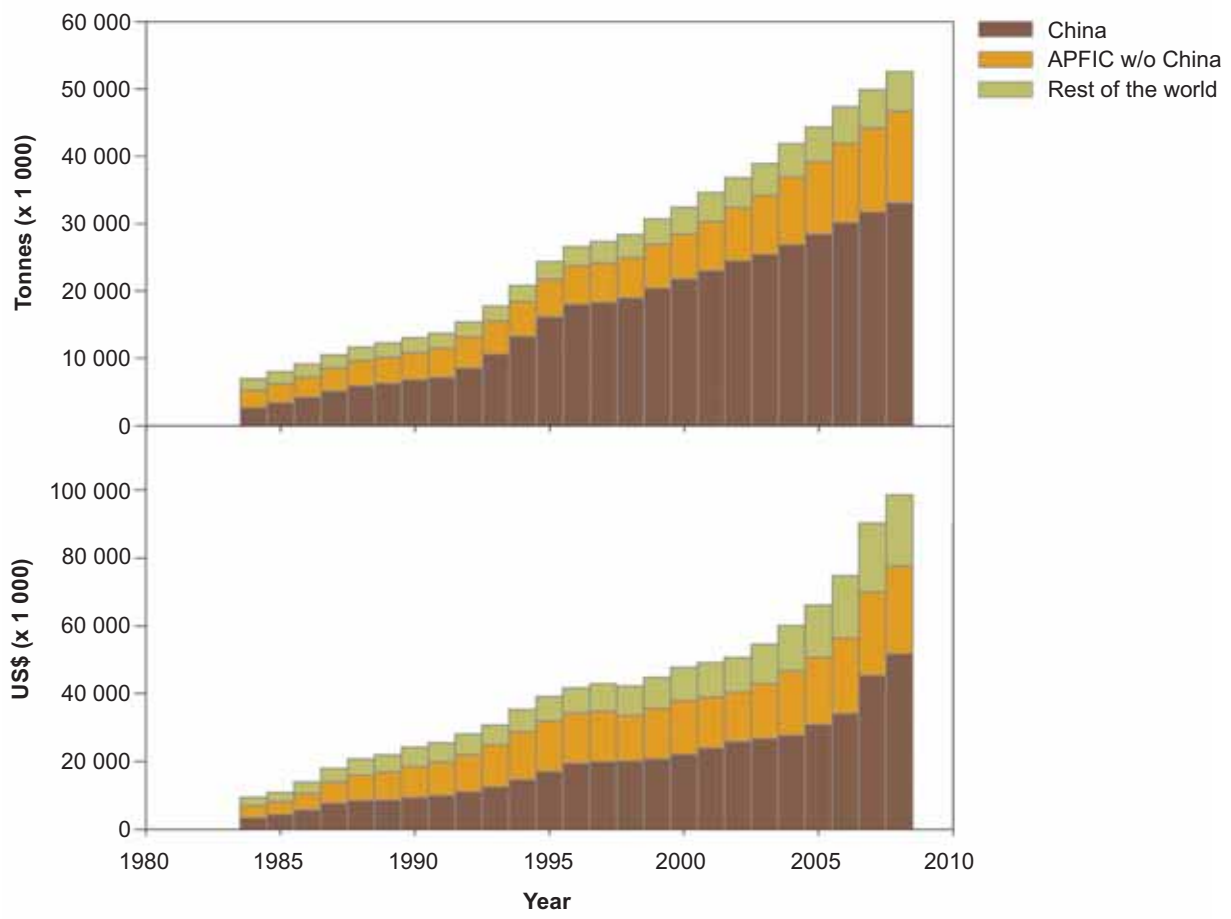
Table 34 Top ten global aquaculture producer states in 2008, by quantity and value (excluding aquatic plant production)

By Quantity		By Value	
	(1 000 tonnes)		**US$ (Million)**
China	32 736	China	50 639
India	3 477	India	5 044
Viet Nam	2 462	Viet Nam	4 510
Indonesia	1 710	Chile	4 503
Thailand	1 374	Norway	3 119
Bangladesh	1 006	Japan	3 104
Norway	844	Indonesia	2 824
Chile	843	Thailand	2 202
Philippines	741	Bangladesh	1 766
Japan	732	Philippines	1 576
Other	6 642	Other	19 187
Total	**52 568**	**Total**	**98 564**

[5] Note recent revisions for Chinese aquaculture data; see Box 1 in *Status and potential of fisheries and aquaculture in Asia and Pacific 2008*.

[6] Growth rate (average) for the last 15 year was 8 percent, excluding aquatic plants production.

In terms of tonnage, other countries that have shown large increases included Viet Nam (49 percent), Indonesia (31 percent), India (9 percent), Philippines (19 percent), Bangladesh (13 percent) Myanmar (17 percent) and Malaysia (44 percent). Both inland culture and mariculture have shown steady growth, but the growth rate of the inland culture sector was more rapid in Asia and the Pacific region if China is excluded (Figure 11).



Note: The data for China refer to the subregion (see page iii this report).

Figure 11 Trends in global aquaculture production (quantity and value) 1984–2008 (excluding aquatic plants)

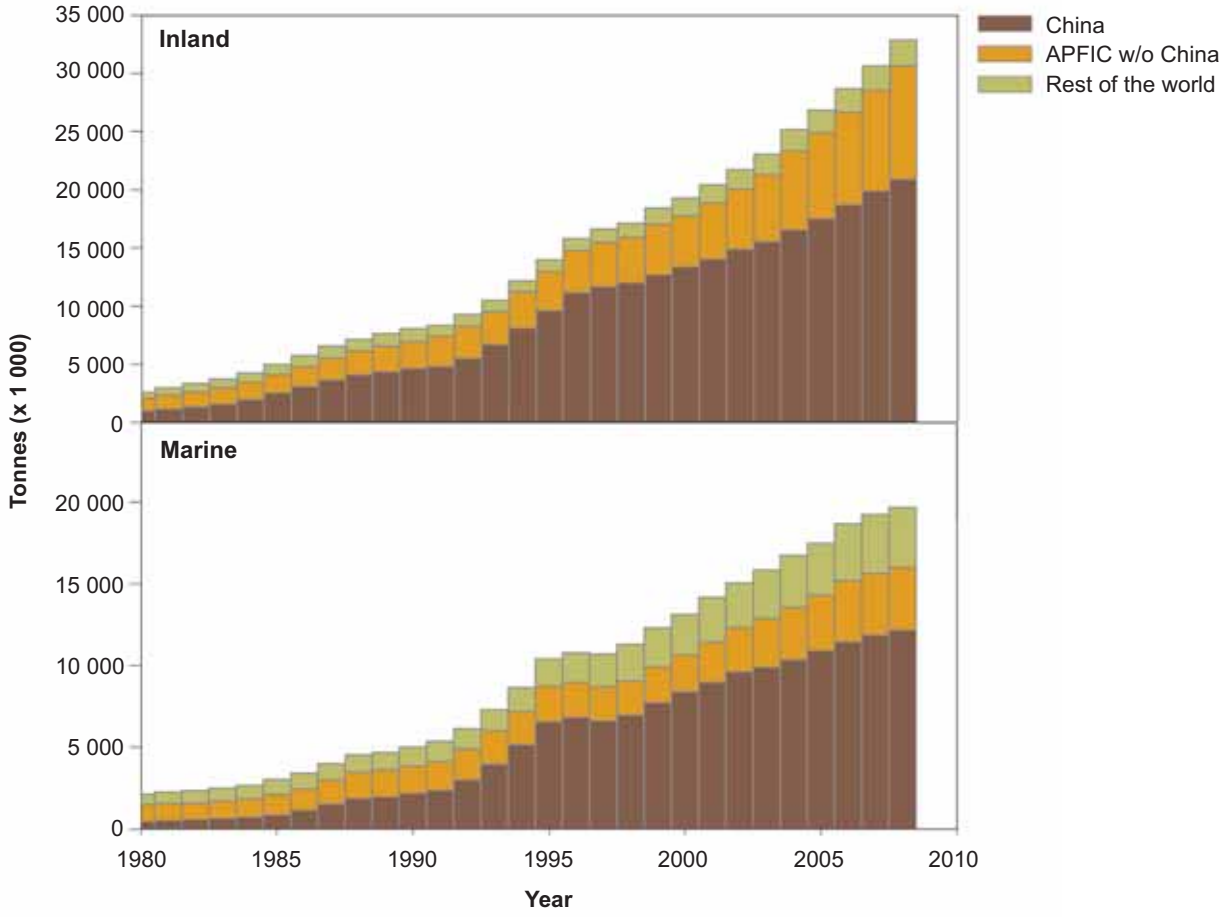
Aquaculture production is not increasing throughout the region, with some countries in the region experiencing negative or zero growth in production during 2006–2008. These countries include Republic of Korea (-7.74 percent), Thailand (-2.34 percent) and Japan (-0.21 percent). The negative growth from both Republic of Korea and Thailand is mainly a result of the reduced production of mollusc (some 45 000 tonnes for Republic of Korea and 30 000 tonnes for Thailand). In some cases this reflects reduction in the intensity of production or the restriction of culture areas.

China[7] reported a production of 43 million tonnes in 2008 (including aquatic plants), representing 63 percent of the world aquaculture production. This continues China's consistent domination of global aquaculture production but there is a slight decrease over previous years[8] (67 percent in 2004, 65 percent in 2006). Although Chinese aquaculture production is still increasing, its world market share is slightly decreasing. Since China is such a predominant producer, the scale of reported production can mask other regional trends and China is therefore hereafter treated separately in this report.

[7] This figure is for all China (see page iii), the massive scale of China's aquaculture production challenges statistical collection and there are uncertainties regarding the quantities reported.

[8] China has recently reviewed and revised aquaculture production statistics and these have been reduced from previously reported levels. This means that a comparison with production figures in earlier FAO and APFIC reports will not be possible, although the FAO FishStat data have been adjusted backwards to compensate for this and thus the latest time series in datasets of FAO are comparable.

If China's aquaculture production is excluded, Asia and the Pacific region still remains an important production area for aquaculture, exhibiting steady growth regardless of the culture environment. In particular, inland aquaculture production has tripled from 3.1 (or 2.8) million tonnes in 1994 to 9.7 (or 9.0) million tonnes in 2008 and marine production has also almost doubled (+90 percent) in the same period. Such advances far exceed the growth of aquaculture in the rest of the world (Figure 12). Excluding aquatic plants, fresh water aquaculture production achieved much faster growth (23 percent) than marine/brackish aquaculture production (4 percent) during 2006–2008.



Note: China refers to the subregion, see page v.

Figure 12 Trends in aquaculture production in Asia and the Pacific region by environment 1980–2008

There has been considerable change in the top twenty cultured species[9] in the region between 1990 and 2008 (excluding aquatic plants and molluscs).

There are six new members (whiteleg shrimp, pangas catfishes nei, Chinese mitten crab, cyprinids nei, red swamp crawfish and black carp) in the top 20 species compared with 1990, although inland waters species (mainly Chinese and Indian carps) still hold the top seven positions. Besides, there is also significant change in the order of the top 20. Whiteleg shrimp and pangas catfishes nei are among the top ten species now.

Box 3 Top cultured species in Asia and the Pacific region 2008

The top four cultured species in 2008 were all freshwater carps (grass carp, silver carp, common carp and bighead carp) and their aggregated production was 12.6 million tonnes accounting for 27 percent of total aquaculture production of the region (excluding aquatic plants).

[9] There is still significant volume of aquaculture production reported by large group of species, e.g. not identified at family, order or species level. Consequently, the species items totals could have underestimated the real production of the individual species.

It is worth noting that the number of high-value species that are carnivorous or dependent on high (animal) protein feed has increased during the past 15 years. Those species with current production exceeding 50 000 tonnes include whiteleg shrimp, channel catfish, mandarin fish, large mouth black bass, oriental river prawn, yellow catfish, Japanese seabass, swimming crab, left eye flounder, red drum and large yellow croaker.

In marine waters, the production is generally dominated by high-value carnivorous/high protein feed dependent species such as penaeid shrimp, jacks and sea breams. Production of crabs as well as the whiteleg shrimp have made significant advances in recent years, with whiteleg shrimp now the top production species in the region at 1.3 million tonnes (Table 35).

Table 35 Top fifteen cultured species in Asia and the Pacific region by quantity, excluding aquatic plants and molluscs (1 000 tonnes)

Inland Waters				Marine Waters			
1990		**2008**		**1990**		**2008**	
Silver carp	1 432	Grass carp	3 761	Milkfish	434	Whiteleg shrimp	1 277
Grass carp	1 042	Silver carp	3 726	Giant tiger prawn	290	Giant tiger prawn	708
Common carp	678	Common carp	2 767	Fleshy prawn	185	Milkfish	676
Bighead carp	672	Bighead carp	2 318	Jap. amberjack	162	Jap. amberjack	159
Roho labeo	245	Catla	2 282	Silver seabream	52	Penaeus shrimp nei	125
Catla	235	Crucian carp	1 956	Banana prawn	33	Indo-Pacific swamp crab	119
Crucian carp	216	Nile tilapia	1 829	Metapenaeus shrimps	29	Aquatic invertebrates nei	104
Nile tilapia	199	Pangas catfishes nei	1 381	Sea squirts nei	28	Japanese seabass	98
Japanese eel	164	Roho labeo	1 159	Coho salmon	24	Japanese sea cucumber	93
Wuchang bream	162	Wuchang bream	600	Penaeus shrimp	20	Swimming crabs, etc. nei	84
Mrigal carp	160	Whiteleg shrimp	547	Aq. invertebrates	12	Banana prawn	80
Mud carp	80	Chinese mitten crab	518	Kuruma prawn	9	Silver seabream	79
Tilapias nei	80	Cyprinids nei	505	Bastard halibut	7	Lefteye flounders nei	78
Silver barb	47	Mrigal carp	464	Indian white prawn	7	Groupers nei	70
Mozambique tilapia	42	Red swamp crawfish	365	Jap. jack mackerel	6	Large yellow croaker	66
Freshwater fish nei	**800**	**Freshwater fish nei**	**1 218**	**Marine fishes nei**	**39**	**Marine fishes nei**	**390**

It is notable that following an APFIC recommendation in 2006 to provide disaggregated reports of aquaculture production, **the quantity of freshwater fishes *nei* has decreased by almost 27 percent**, whereas total production has increased indicating improved disaggregation of statistics supplied by member countries.

Species composition

Aquaculture is an expanding sector in Asia and the Pacific region and very important for many of its economies. The current trend and current expectations are that aquaculture will play an even more important role in the future, both in terms of an important rural livelihood and an invaluable source of protein for both the poor and the rich in Asia and the Pacific region, although attention from outside tends to focus more on international traded commodities.

To highlight the changes taking place within the sector, a review of the major groups of species that are currently cultured in the region is presented below. Species are grouped according to the trophic needs of the species and in some cases the degree of reliance on external inputs (such as feeds and infrastructure for culture). Often the lower trophic levels of aquaculture do not generate the same amount of attention as the higher level trophic species. The lower trophic levels of aquaculture that require fewer inputs are often the cornerstone of the diet for both the rural poor and the urban poor. Production is presented per species (family, order) from all environments (i.e. freshwater, brackish and mariculture) except for salmonids, in which case production is presented per environment.

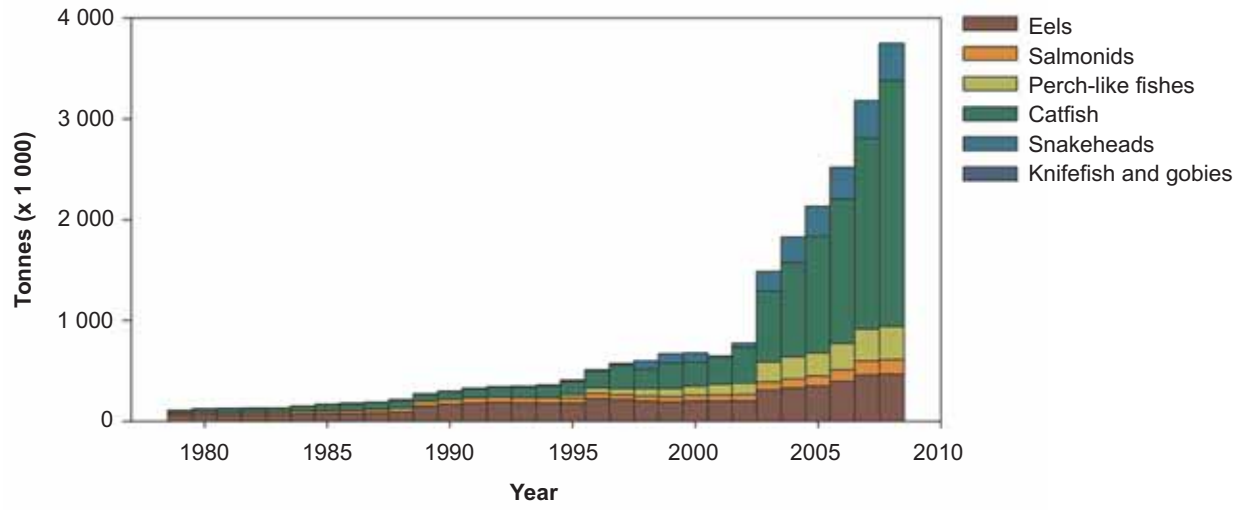


Figure 13 Changes in freshwater carnivorous species production, 1979–2008 in Asia and the Pacific region

Freshwater carnivorous species or species requiring higher production inputs

Catfish (order *Siluriformes*)

This is by far the most widely cultured freshwater species group that is carnivorous or dependent on relatively high protein feed. This group includes the pangas catfish (*Pangassius* spp.), *Clarias spp.*, *Mystus spp*., and some introduced species (e.g. channel catfish from USA, African catfish). The total volume exceeds the global production of salmonids. The top five producing states are China, Viet Nam, Thailand, Indonesia and India. Total production in Asia and the Pacific region in 2008 was 2.4 million tonnes which is an increase of 70 percent over 2006 (1.4 million tonnes in 2006) and similar to the increase between 2004 and 2006 (53 percent).

Viet Nam has seen a dramatic increase in the production of tra (*Pangasianodon hypothalamus*) and basa (*Pangasius bocourti*), the two main catfish species cultured in that country with a 140 percent increase in production of pangas catfishes over the past two years. The production is mainly located in a few provinces in the south of Viet Nam in the Mekong River delta. The production in 2008 reached a record 1.25 million tonnes. The United States used to be the largest market for Vietnamese produced catfish, but after a trade dispute in 2003 the Vietnamese exporters have gradually diversified away from the US market. The export to the European Union increased and today accounts for more than 50 percent

of the export. The Vietnam Association of Seafood Exporters (VASEP) estimates that Viet Nam accounts for about 40 percent of the total European (27 countries) frozen freshwater fillets market.

China started to report on this group in 2003 and produces 28 percent of the total production in the region (down from 36 percent in 2006). The *Clarias* and *Mystus* spp. of catfish are generally consumed domestically and are not exported (except the Chinese export of channel catfish to USA).

Snakeheads (family *Channidae*)

The total production of this group for Asia and the Pacific region in 2008 was 373 080 tonnes. The top four producing states are China, India, Indonesia and Thailand. China has recently started to report snakehead production separately (as with the catfish) and in 2008 China produced 87 percent of the total Asian production for snakeheads.

The trend for this group is hard to describe because of the recent of inclusion of the Chinese production in 2003. Indonesia and Thailand show a stable trend at a low level (approximately 10 000 tonnes). India has fluctuated in the past ten years with a high in 2000 of 80 000 tonnes and a low in 2001 of 1 300 tonnes, and is again showing a decrease to 18 000 tonnes (35 000 in 2006). The production in China has increased by 24 percent to 324 000 tonnes since 2006.

The snakehead species, although generally popular in some countries do not enjoy a large export market, even within the region. There is certainly no intraregional trade, the fish has no real fillet value and is generally sold live or whole. However, some of it is exported from China to Hong Kong SAR. The rapid rise of *Pangassius spp*. and tilapia has undermined the significance of the species group in some countries where it once had greater prominence as a cultured species. Its carnivorous nature also means that profit margins are generally lower than those which can be achieved from the more omnivorous catfish species.

Eels (order Anguilliformes and Synbranchiformes*)*

The global production of eels in 2008 was 477 704 tonnes, more than double the production in 2002. The vast majority (98 percent) of this production was produced in Asian farms, and increased by 18 percent compared with 2006 (Figure 13). Production in China has risen steadily, reaching a new high in 2008 of 205 000 tonnes. The production of Taiwan POC has declined greatly to 21 000 tonnes in 2008, compared to the top production year of 1990 (55 000 tonnes). Eel production in Japan (*Anguilla japonica*) has remained stable for the past five years at about 20 000 tonnes. Taiwan POC, Malaysia and Republic of Korea also produced some quantities of Japanese eel through aquaculture. All of this production is reported as Japanese eel.

China has regularly imported European glass eels (*Anguilla Anguilla*) and therefore its reported Japanese eel production is likely to include the European eel too. Europe has increasingly supplied Asian eel farms with glass eels and the region has gradually become more dependent on the wild-caught eels of Europe. In 1997, for example, France exported more than 266 tonnes of European eels to destinations outside the European Union (EU), amounting to 55 percent of all EU eel exports outside Europe that year. Correspondingly, the Chinese import of eel in 2007 was 203 tonnes (Ringuet *et al.,* 2002). The listing of European eel under CITES Appendix II came into effect on March 2009 and this now means that export outside of Europe is restricted. The sourcing of elvers within Asia and the Pacific region has now become a priority, with reports of several countries looking to their own resources for possible export to China and other eel culturing countries.

The Asian swamp eel (Synbranchidae) production is also high at 212 000 tonnes for 2008 in China with minor production reported from Thailand and Cambodia[10].

It should be noted that the accurate reporting of eel production with respect to the actual species produced is now of considerable importance with regard to the CITES listing. The APFIC region should see a significant decline in *Anguilla Anguilla* production (in principle to zero) from Asian countries that lie outside of its natural range and therefore cannot import elvers from Europe.

[10] Previously reported as Chinese swamp eel and “lai”. The word “lai” is Thai and is generally used for eel (i.e. pla lai; probably swamp eel *Monopterus albus*). This reporting from China could be because of the import of elvers from Thailand.

Perch-like fishes (family Percichthyidae*)*

China reported a production of 229 000 tonnes for mandarin fish (*Siniperca chuatsi*) in 2008. The production has been steadily increasing since 1995 when it was first reported in China. Other reported species in this family are Murray cod (Australia) and golden perch. The culture of mandarin fish in China is worth mentioning since being highly carnivorous it is considered only possible to raise it on live food. There has now developed a complete service sector of farmers who produce small bream as live feed for this fish. This is a good example of a low trophic level fish being cultured as feed for a carnivore, with little or no reliance on marine sources of feed in the system. A lesson here is that small-scale farmers can use low risk systems to service more intensive or higher-value aquaculture operations. China also reported the production of 166 601 tonnes for largemouth black bass (*Micropterus salmoides*), which was introduced to China from North America and was first reported in 2003.

Salmonids – freshwater (family Salmonidae*)*

Freshwater production of salmonid species in the region has developed rapidly in the last four years and reached 93 628 tonnes in 2008, an increase by 27 percent compared with 2006. This is in part because of the development of the rainbow trout industry in the Islamic Republic of Iran, which has more than doubled the production in four years (to 62 630 tonnes) and in part because of the salmonid (trout) production in China that now amounts to almost 17 000 tonnes (increased from 10 247 tonnes in 2004)[11]. Trout is now also produced in smaller quantities in several other Asian countries (e.g. Republic of Korea, Viet Nam, Thailand, India, Nepal and Afghanistan), but in some cases may not appear in the disaggregated statistics.

Knifefish and gobies (order Osteoglosiformes and Gobiformes)

These species are not widely cultured but have a good market price in certain countries. The sand goby production in Asia continues to be almost totally based on on-growing of wild caught fingerlings. The total production of knifefish and gobies was 698 tonnes in 2008 (840 tonnes in 2006) which however is an increase by more than 500 tonnes over 2004. Almost all this increase can be attributed to the Indonesian production of marble goby.

Marble goby is hence also the most cultured species in the order. Thailand has shown a declining trend and in Malaysia the production has declined by half to about 100 tonnes in 2008, except for a peak in 2003 of almost 700 tonnes. The slow growth rate and carnivorous habit as well as the requirement for moving or well-aerated water make culture of this species comparatively costly. The low densities of culture also mean that returns per unit area are low and the rerun period is long. Farmers may now be tending to move away form this species towards more rapid turnover and intensive systems of tilapia, where margins and lower, but cash flow is more regular.

Marine and brackish water carnivorous species or species requiring higher production inputs

Amberjacks (family Carangidae)

Japanese culture of amberjack (Seriola) is the leader within this family with production stable at 158 300 tonnes in 2008 (Figure 14). The Japanese fishery for fingerlings of this species (Mojako) is an interesting example of what might be considered a sustainable fish seed fishery for aquaculture. The juveniles are caught in a fishery using seaweed as attractants and the juveniles are transported live to the farms for on-growing. The system is demonstrably sustainable because of the length of time it has been pursued and the fishery catch records show no discernable impact on the adult fishery.

Barramundi and Japanese seabass (family Centropomidae and Percichthyidae)

China reported large production of Japanese seabass (*Lateolabrax japonicus)* starting in 2003 and is now up to 96 000 tonnes. This may have been an effect of China's improved reporting on individual species (these species may have previously been reported under marine finfish nei). Republic of Korea

[11] Not reported at species level, although probably included in nei group.

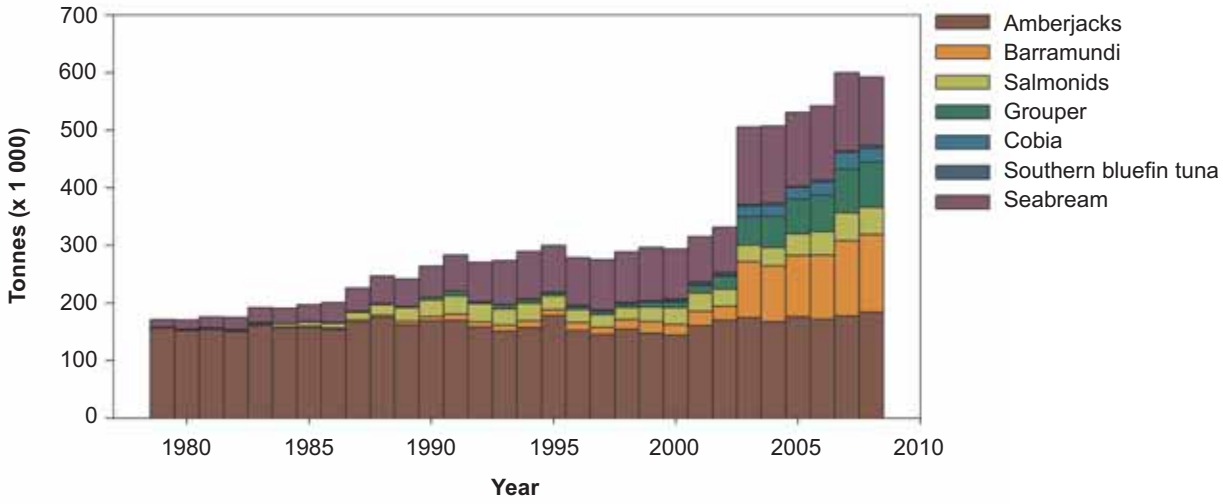


Figure 14 Marine and brackish water carnivorous species production, 1979–2008

is also producing Japanese seabass (2 000 tonnes in 2008). Barramundi (*Lates calcarifer*) production is increasing, with the regional total reaching 44 841 tonnes in 2008 with an increase of 42 percent over 2006. Thailand has become the top producer in the region with a stable production trend since 1998. Additionally, there are recent increases from Malaysia (11 705 tonnes in 2008, more than double the production in 2006). This species has become popular in supermarkets as a whole tablefish.

Salmonids – Brackishwater/Mariculture

Culture of salmonids (chinook, coho, and Atlantic salmon) in brackish water and mariculture is reported from Australia, New Zealand and Japan and currently the production amount is 47 000 tonnes. Japanese coho salmon culture peaked in 1991 and has declined sharply since. However in 2008 the production again increased to almost 13 000 tonnes. New Zealand's chinook salmon production has increased in the last two years and is now above 9 000 tonnes. Over the past ten years the Australian Atlantic salmon industry has developed considerably with 25 000 tonnes in 2008 (21 000 tonnes in 2006).

Grouper (Serranidae)

Production of grouper has increased rapidly from 22 000 tonnes in 2002 to 78 000 tonnes in 2008. This increase is because China started to report on this species in 2003. The major producers include China, Taiwan POC, Malaysia, Indonesia, Philippines and Thailand. In 2008, production of four different grouper species was reported, however the bulk production (93 percent) was reported as groupers nei. Additionally, Viet Nam is producing grouper, but has yet to report on this species separately.

There are at least 16 species of groupers that are cultured in many Southeast Asian and East Asian countries, including Indonesia, Malaysia, Philippines, Taiwan POC, Thailand, Hong Kong SAR, the southeast of China, and Viet Nam — as well as other parts of the tropics in the south eastern USA and the Caribbean (Sadovy, 2000). Grouper culture is also undertaken in India, Sri Lanka, Republic of Korea and Australia.

Despite the huge popularity of live fish in China and Southeast Asia, ***only 15 to 20 percent of the amount consumed each year comes from aquaculture***, as culture is principally constrained by limited and unreliable supplies of wild seed and the difficulties of spawning in captivity (Tupper and Sheriff, 2007). The grouper trade has come under the spotlight (see APFIC's *Status and potential of fisheries and aquaculture 2004*) with respect to the live reef fish trade. This is not strictly classified as aquaculture as it involves the taking of fish and "holding them" (rather than significantly increasing size or weight through feeding/growth). However, the distinctions become difficult when juvenile fish are taken from the wild and on-grown. The culture of fingerlings in hatcheries has been achieved for some species and there is a contribution to supply fingerlings/juveniles from hatcheries, however reporting on this contribution remains weak.

Since grouper are particularly difficult to culture in closed systems, full-cycle culture of most grouper species is not yet possible (although several important advances have been made in recent years). For this reason, about two-thirds of all grouper culture involves the capture and grow-out of wild seed (Sadovy, 2000). There needs to be greater disaggregation from grouper produced from hatchery reared fingerlings versus that dependent on wild caught fingerlings and juveniles.

This is an area that would benefit from improved labelling and traceability possibly under a certification scheme. The starting point for this would be to target those countries that are producing significant numbers of grouper fingerlings from hatcheries to determine the relative percentage contribution of fingerlings from each source (and the species that this comprises).

Cobia (*Rachycentridae*)

Cobia (*Rachycentron canadum*) culture has increased rapidly from 13 tonnes in 1996 to 2 400 tonnes in 2002 and was almost 25 000 tonnes in 2008. One main reason for the rapid increase is that China is reporting this species separately. Chinese production in 2008 was 23 500 tonnes whereas Taiwan POC reported a production of 1 000 tonnes (a decrease of almost 2 000 tonnes compared to 2006). Culture of this species is believed to take place in other states such as Viet Nam and Thailand, largely as a result of the increasing availability of fingerlings from Taiwan POC. This production is, however, not reported widely, therefore the total production can be considered conservative.

The very rapid growth rate of this species and relative hardiness in ponds make it an attractive species for aquaculture. It has been dubbed the “tropical salmon” because of these characteristics, however feed conversion ratios (FCRs) are high currently which increases production costs and reduces the profit margin (in some cases there is a net loss). The fish does not enjoy wide acceptance in Asia partly because of it being an unusual catch item (it has a solitary habit) and hence an unfamiliar species to many. Its firm flesh makes good sashimi and it bakes well, but in other places it is more commonly known as a dried or salted fish.

Southern bluefin tuna (Scombridae)

Aquaculture fattening of southern bluefin tuna in Australia has emerged as a significant industry for the country over the past ten years reaching 4 000 tonnes in 2002 and 4 500 tonnes in 2008. Although the quantity is relatively low compared with other species, the very high value of this product makes its production a significant economic activity wherever it is practiced. The total effective catch limit of the Australian southern bluefin tuna wild harvest component of the fishery was set at 4 015 tonnes[12]. Since 1 January 2009, the Commission for the Conservation of Southern Bluefin Tuna (CSSBT) has established a list of authorised farms, which are approved to operate for farming southern bluefin tuna. SBT Farms not on the list are deemed not to be authorised to operate for farming of southern bluefin tuna. Currently, data regarding the weight added through fattening is not available.

Seabream (Sparidae)

Seabream production is confined to Japan, China, Taiwan POC, Republic of Korea and Hong Kong SAR. The Japanese production of seabream was 71 000 tonnes in 2008. China reported almost 40 000 tonnes from 2003 (the first year figures for seabream production were reported). In 2008 the production was 36 000 tonnes (down from 46 000 tonnes in 2006). The production of this species was probably reported earlier as “other marine finfish nei”.

Other important carnivorous species

There are some important marine carnivorous species that were not specially mentioned in earlier editions of the APFIC biennial status and potential review. These species may have significant impact on marine finfish culture in the region in the coming years although their culture is currently limited to a few countries. These species include silver seabream (78 515 tonnes in 2008), lefteye flounder (78 141 tonnes in 2008), large yellow croaker (65 977 tonnes in 2008), red drum (50 947 tonnes in 2008), bastard halibut (50 632 tonnes in 2008), porgies and seabream nei (38 753 tonnes) and puffer fish (21 733 tonnes).

[12] http://www.ccsbt.org/docs/management.html

- Silver sea bream is mainly cultured in two countries: Japan with more or less stable production in recent years and Republic of Korea with increased production of about 20 percent between 2006 and 2008. Production of lefteye flounder nei is primarily from China where production has been increasing steadily since it was first reported in 2003 (an increase of 40 percent between 2006 and 2008).
- This group of fish also includes the European turbot which represents more than 50 percent of the lefteye flounder nei produced in China. DPR Korea has recently started the experimental culture of European turbot through an FAO TCP project.
- Both large yellow croaker and red drum are currently cultured only in China with steady increase in the production since it was first reported in 2003. The production of the species both increased by nearly 30 percent during 2003–2008. Bastard halibut production is reported from Japan and Republic of Korea only. Production from Japan has declined slightly and production from Republic of Korea has increased steadily in recent years.
- Production of porgies and seabream nei were reported from China (including Taiwan POC) and Republic of Korea. The production has fluctuated in China and declined in Republic of Korea in recent years.

Other marine finfish not elsewhere identified (*nei*)

Most of the fish in this group are assumed to be carnivorous species and are fed by trash/low value fish from capture fisheries. This group of fish is of interest because of the large reported production from China. Even though China has decreased its reporting on nei species by 64 percent from 2002 to 2004, it has since increased again in 2006 and again in 2008 (Table 36). Since the individual species are not reported, trends cannot be determined.

Total production of culture marine/brackish carnivorous fish species in the APFIC region has increased considerably in the last four years and reached some 650 000 tonnes in 2008, an increase of 23 percent over 2004. The culture of marine carnivorous fish typically depends on direct use of low-value fish, which has brought about increasing concern over the pressure on capture fisheries recently. To address the issue, an FAO regional TCP project on substituting low value fish with pellet feed has been implemented successfully and indicates that the substitution with formulated feeds can be profitable and improve management.

Table 36 Aquaculture production reported under marine fishes nei, 2006 and 2008 (tonnes)

Country/Entity	2006	2008
China	243 950	308 451
India	75 000	37 064
Indonesia	826	22 449
Japan	5 930	7 900
Viet Nam	0	5 000
Malaysia	3 276	2 460
Philippines	416	2 391
Taiwan POC	3 056	2 259
Australia	27	1 924
China, HK SAR	728	342
Korea, Republic of	262	231

Finfish requiring lower inputs

Freshwater omnivorous and herbivorous fish have been important food fish for developing states in Asia and the Pacific region. Traditional production methods have become diversified and intensified, starting with fertilized polyculture systems and moving towards systems using more supplementary feeds and even complete feeds. Driven by the pursuit of a high economic return per unit water body and offsetting the slacked market price, further pressure on intensification and the use of feeding can be expected in many states.

Traditional pond culture still remains as the dominant production system for finfish species requiring lower inputs in the region. For instance, production from pond systems accounts for 80 percent of the total production. On the other hand, non-dominant farming systems, such as backyard ponds, paddyfields and floodplains are expanding in some countries in the region. Production from these non-dominant farming systems is often poorly captured in national statistical data collection, mainly because of the small unit size and scattered distribution. The production from individual operation of such systems may be insignificant. However, the large number of these ponds and the aggregated production and value to

the households engaging in the activity is probably very significant. The lack of reliable information about this part of the sector currently limits evaluation of the grassroots impact of rural aquaculture in the region. Member countries should improve the data collection for aquaculture statistics to fully capture the contribution of all kinds of aquaculture operations.

Although it has been suggested that the wide range of aquatic species currently cultured would reduce as greater rationalization and aggregation of production operations focus on a small number of species based on the lesson of livestock sector "industrialization", this has not appeared to be the case in the region so far. Instead, significant diversification of species used in aquaculture has been observed in many countries in the region as the response to diversifying market demand domestically and internationally.

Freshwater fish nei

The reported statistics from China saw a reduction of "freshwater fish nei" from almost 1.8 million tonnes in 2002 to less than 500 000 tonnes in 2003, but this has now increased again to 675 000 tonnes in 2008. Many of these "freshwater fish nei" are now reported by species and interestingly are mostly carnivorous species with the exception of pirapatinga. The species which are now reported in detail by China are Amur catfish (307 000 tonnes), snakehead (303 000 tonnes), swamp eel (lai) (192 000 tonnes), channel catfish (170 000 tonnes), pond loach (127 000 tonnes), yellow catfish (100 000 tonnes), pirapatinga (90 000 tonnes), Chinese longsnout catfish (24 000 tonnes), sturgeons nei (17 000 tonnes), trout (15 000 tonnes), pond smelt (10 000 tonnes), and salmonids nei (1 500 tonnes). Of these, the channel catfish and Chinese longsnout catfish have seen the biggest increases (in terms of percentage) since 2004.

Tilapia (Cichlidae)

Tilapia production has increased steadily over the past two decades and is the 2nd most important cultured finfish species group after carps. Tilapia production reached 2.13 million tonnes in 2008 with an increase of 23 percent over 2006. This development has been mainly driven by the demand in the international market. In order to meet the export standard on size of fish, the culture is getting more intensive and dependent on pellet feed. Such an "industrialization" trend is seen in some states with species such as tilapia. There is a trend towards standardization of size, feeds and production systems, some quality control, avoidance of off-flavours, and marketing to supermarket chains. In 2008 the top eight producers in the region together produced 2.1 million tonnes of tilapia, a large increase from the 1.7 million tonnes produced in 2006 (Table 37).

Table 37 Top eight producer States of tilapia, 2008

Country	Tonnes
China	1 110 298
Indonesia	328 831
Philippines	257 133
Thailand	209 945
Taiwan POC	81 009
Viet Nam	50 000
Malaysia	34 823
Myanmar	32 794

Table 38 Countries exporting tilapia, 2008

Country	Tonnes
China	164 008
Taiwan POC	37 071
Thailand	18 735
Bangladesh	112

Reported volume of exports of tilapia is equivalent to 14 percent of the regional production volume. However, tilapia is usually exported in processed form (often fillet). Considering the normal dressing out percentage of 60 percent for whole fish and 35 percent for fillet, raw tilapia used for export may account for nearly 30 percent of the total production. The production of tilapia is still largely consumed locally. The continuing domestic demand and the high quality required for export targeted fish mean that domestic marketing is still attractive in many states. The biggest exporter of frozen whole tilapia and frozen fillets to the USA was China (mainland and Taiwan Province, Table 38), accounting for 90 percent of total supply in 2006.

Carps and barbs (Cyprinidae)

Finfish aquaculture production from the APFIC region has long been dominated by carps and barbs, a situation which is very unlikely to change in the foreseeable future. This is because of the massive volume of production, which is almost entirely consumed domestically. Total production of carps and barbs from APFIC states in 2008 exceeded 20 million tonnes for the first time in history (Table 39). Compared with 2006, the share of carps and barbs in total aquaculture production (43 percent, excluding aquatic plants) remained the same in 2008. Within the region, production of carps and barbs declined in China from 46 percent in 2006 to 44 percent in 2008, whereas regionally the production of carps and barbs in APFIC countries excluding China increased from 38 percent in 2006 to 41 percent in 2008.

Table 39 Top ten producer States of carps and barbs, 2008

Country	Tonnes
China	14 609 519
India	3 200 621
Bangladesh	696 053
Myanmar	553 101
Viet Nam	415 000
Indonesia	287 877
Pakistan	135 000
Iran (Islamic Rep. of)	87 679
Thailand	63 016
Lao People's Dem. Rep.	58 410

The top four cultured fish species are carps from freshwater production (Table 35). Their production is particularly important in terms of the vital supply of protein in the major populous states in the region such as China, India and Bangladesh. Silver carp has had the highest production for decades, however in 2008 grass carp, which was previously in a distant second position, has now moved to first place. Common carp, bighead carp and crucian carp follow on this list. Common carp is the most widely cultured species in the region with 20 states and areas having reported culturing this species.

Although production of most of the species in this group generally exhibits an increasing trend, the rate of growth since 2001 for silver carp has started to show signs of slowing down. There are reports that the profitability of production of these species in India and China is declining and farmers are starting to explore the production of alternative higher value species. Since the markets of these species are largely domestic, there is little opportunity for export, although India, for example, does export to neighbouring Nepal and Bangladesh. Moreover, Myanmar has recently strongly developed its exports of carp to neighbouring Bangladesh and also to the Near East.

Pacus and pirapatinga (*Collossoma* spp. and *Piaractus* spp.*)*

These Latin American species are not reported in detail for most countries, instead they are grouped under "freshwater species nei". China began reporting production of pirapatinga (*Piaractus brachypomus*) separately in 2003 and there was a reported 78 000 tonnes produced in 2006 and 77 000 tonnes produced in 2008. Additionally, Viet Nam and Myanmar started to report production in 2008, about 6 000 tonnes each.

Milkfish

Milkfish culture is a strong tradition in the Philippines and this reflects the country's preference for the species (Table 40). There are also traditions of milkfish culture in some of the Pacific Islands (e.g. Guam, Kiribati, Cook Islands and Palau). Milkfish have typically been produced in brackishwater ponds but there is an increasing trend in mariculture production reported, indicating the more intensive use of cage systems. These systems are fed with either pellets or trash/low value fish and are part of the general trend of intensification of mariculture in the Philippines. Indonesia and the Philippines are traditionally the largest producers. Taiwan POC is reducing its production, possibly because of increasing attention to higher-value species. Singapore has developed its mariculture of milkfish steadily.

Table 40 Top four producer States of milkfish, 2008

Country	Culture Environment	Tonnes
Philippines	Brackish	226 032
	Marine	80 365
	Freshwater	44 439
Indonesia	Brackish	277 002
	Marine	469
Taiwan POC	Brackish	27 944
	Freshwater	18 930
Singapore	Marine	917

Mullet (order *Mugiliformes*)

Pond-based brackishwater culture of mullet is typical, but Republic of Korea has been reporting increasing mariculture production since 2000 (over 6 000 tonnes in 2008), and the freshwater culture is almost zero. Indonesia produces the bulk of these species (over 8 000 tonnes) and although the country experienced a sharp decline in 1998, it has since shown a stable positive trend (although there was a sharp drop again by nearly 50 percentage in 2007). Taiwan POC has seen a 50 percent drop in production between 2006 and 2008 and Thailand has greatly reduced production in recent years. Although not reported as a separate species, China is a noteworthy producer of mullet (reported as marine finfish nei).

Crustaceans

Crustaceans are the aquaculture species group of highest value in the region. Production of crustaceans has been increasing since the mid-1990s despite problems with a number of diseases. Cultured crustacean production reached 4.45 million tonnes in 2008, an increase of 19 percent over 2006. Although a large number of crustacean species are cultured currently in the region, the predominant commercial species are two penaeid shrimp, two freshwater prawn and three crab species.

Penaeid shrimp culture

Marine shrimp continued to dominate crustacean aquaculture, with two major species (the whiteleg shrimp *Penaeus vannamei* and giant tiger shrimp *Penaeus monodon*) accounting for 57 percent of the total crustacean production in 2008 (62 percent in 2006). Whiteleg shrimp production in Asia and the Pacific region increased from 2 000 tonnes in 2000 to over a million tonnes in 2004. Production of whiteleg shrimp in the region reached 1.82 million tonnes in 2008 with an 8 percent increase over 2006. China, Thailand, Indonesia and Viet Nam were the major producers of cultured whiteleg shrimp in the region during 2008 (Table 41). The production from China reached more than 1 million tonnes in 2007 with a significant increase of 20 percent over 2006, production has since stabilized. Production from Thailand has remained stable during 2006–2008 (0.5 million tonnes). Production from Indonesia has increased steadily since 2004, reaching 209 000 tonnes in 2008. Viet Nam has seen a huge drop in production (-74 percent) in 2008 following rapid increases between 2004 and 2006).

Table 41 Top ten producers of Penaeid shrimp, 2008

Country	Tonnes
China	1 268 074
Thailand	507 500
Indonesia	408 246
Viet Nam	381 300
India	86 600
Bangladesh	67 197
Malaysia	51 047
Myanmar	48 303
Philippines	48 199
Taiwan POC	11 761

Giant tiger prawn is the most important species of crustacean traditionally cultured in the region. After continuous decline of production during 2004–2007, production of giant tiger prawn increased by 22 percent at 714 527 tonnes in 2008. However, such increase was mainly because of the drastic growth of production from Viet Nam (174 000 tonnes) and a limited increase from the Philippines (7 000 tonnes). A declining trend of production was observed for most other producers in the region. This may be caused by the shift of some farmers to extensive farming practices.

Many other countries are now producing this species, but not yet at a level that it is entering the statistics. Whiteleg shrimp ranked tenth by weight in terms of regional aquaculture production in 2006 (excluding plants). However, it ranked first by value at US$6 485 million, which is almost a doubling since 2004. Production trends in the region have increased over the past twenty years for the major producers (Table 35). China suffered a major setback in shrimp farming in the mid-1990s because of the occurrence of viral diseases in shrimp culture, but since that time production has recovered (initially slowly) and has been increasing rapidly in recent years.

Other major producers, Thailand and Viet Nam, have also encountered fluctuations in production primarily associated with the impact of viral diseases. Production in the Philippines, India, Sri Lanka and Indonesia has also been affected by the impact of viral diseases, typically white spot syndrome virus (WSSV). There are good indications that the development of more biosecure shrimp farming systems and better

farm management practices have made it possible for shrimp farmers to limit the negative impact of viral diseases. The introduction of specific pathogen free (SPF) broodstock and post-larvae has also been important in this development. Generally, the high demand from the international market has maintained interest in the culture of shrimp for export. The main reason for importing *P. vannamei* to Asia has been the poor performance, slow growth rate and disease susceptibility of the major indigenous cultured shrimp species, *P. chinensis* in China and *P. monodon* virtually everywhere else.

The trend in shifting production away from *P. monodon* to *P. vannamei* is quite clear now and has been reported in previous APFIC publications. The massive increase in the volume of production of whiteleg shrimp coupled to the similar size ranges produced by all countries has led to severely depressed prices for whiteleg shrimp. With so many states now producing essentially the same product, global prices dropped dramatically during 2002 and 2003. There has been a trend of decreasing shrimp prices for a number of years now, especially for the smaller sized whiteleg shrimp. This has follow-up effects regarding the actual value of the product sold and disagreements regarding possible dumping of shrimp onto markets.

Producers are attempting to overcome the problem of low prices and narrow profit margins through greater intensification. This echoes the trend in the early 1990s and although systems have improved with the use of limited water exchange and SPF stock, there are still aggregated environmental impacts at the system level because of the total loadings. *P. monodon* prices remain very high because of a lack of supply, however, until SPF broodstock can be produced, the disease risks for intensive systems remain too high for farmers. It can be anticipated that there will be a significant shift back to *P. monodon* production once reliable and commercially available supplies of SPF stocks can be accessed in the region.

Freshwater prawns

Giant river prawn and oriental river prawn are major freshwater prawn species cultured in the region. Production of these two species has increased by 13 percent during 2006–2008. Oriental river prawn is currently cultured in China only. Giant river prawn is cultured in some 13 countries in the region. However, the major production is from China, Thailand, Bangladesh, India and Taiwan POC (Table 42). Total production of the species reached 207 093 tonnes in 2008 with an increase of 13 percent over 2006. Production from China, Thailand and Bangladesh increased significantly during 2006–2008. However, production from India declined more than half from 30 115 tonnes in 2006 to 12 800 tonnes in 2008.

Table 42 Top eight producers of freshwater prawn, 2008

Country	Tonnes
China	345 894
Thailand	28 500
Bangladesh	23 377
India	12 800
Taiwan POC	10 058
Myanmar	2 881
Indonesia	942
Malaysia	355

It is not easy to intensify production of freshwater prawns because of their territorial habits and divergent growth effects. This means that the development of this sector is reasonably slow and in some states the sector has even shrunk, as attention and resources have been diverted to brackishwater shrimp production. Export markets for freshwater prawns are much smaller and less developed, mainly because consumers in general are not as familiar with these species as they are with brackishwater shrimp. Freshwater prawns, however, enjoy good domestic markets especially in South Asian and Southeast Asian states.

Crabs

During 2006–2008, culture crab production continued its increasing trend of the past two decades. The production reached 759 114 tonnes in 2008 with an increase of 25 percent over 2006. Chinese mitten crab contributed 68 percent of the total culture crab production in the region in 2008. This species is currently mainly cultured in China with a very small amount produced in Republic of Korea, although a few countries have shown some interest.

Indo-Pacific swamp crab (*Scylla serrata*) is the most cultured species in the region (12 countries reported production in 2008) with 138 000 tonnes produced in 2008 (an increase of 29 percent over 2006). Indo-Pacific swamp crab has shown a stable increasing production trend for the past decade.

Production of swimming crab from China has increased steadily since it was first reported in 2003. Production reached 83 803 tonnes in 2008, which is an increase of 8 percent over 2006.

Freshwater crayfish

Freshwater crayfish production has increased dramatically in recent years, because of the rapid increase of production of red swamp crayfish from China. The production reached 364 619 tonnes in 2008, an increase of 224 percent over 2006. The other three crayfish species (yabby crayfish, red claw crayfish and marron crayfish) totalled little more than 200 tonnes, a significant reduction from the 2006 figure of 260 tonnes.

Lobster

Lobster is a commodity with very little production volume but very high value. Its production reached 372 tonnes in 2008, more than ten times the production in 2006. The dominant species cultured is tropical spiny lobster. Indonesia is the largest producer followed by the Philippines. The rapid increase in the culture of lobster may adversely impact the natural resources as it is entirely dependent on natural seed. Lobster culture is also practiced in other countries in the region such a Viet Nam, but this is not disaggregated in the reporting to FAO.

Molluscs

Mollusc culture is split into low-value species produced in extensive cultured systems (e.g. seeded blood cockle mudflats, mussel and oyster stake culture) and high-value species produced in intensive systems (fed systems, and possibly recirculation).

Recent improved breakdown by species of aquaculture production of Chinese molluscs has given a better indication of the proportion of low- and high-value mollusc production. China's reported production of "molluscs nei" has dropped from 1.3 million in 2000 to below 1 million tonnes in 2006 and down to 780 000 tonnes in 2008, back to the 2004 level (the major drop between 2002 and 2004).

Although it is possible to separate species such as abalone or giant clam as high-value species, there are difficulties with some species such as mussels that may be cultured in low-input systems in one country (e.g. Thailand) but relatively high-input systems in another (e.g. New Zealand). Many states report their mollusc production in large groupings such as "marine molluscs nei". The IFPRI/WFC outlook on fish supply (Delgado *et al.*, 2003) projected increasing mollusc production, although this may have been based on current production trends rather than the resource potential.

Unlike fish culture, the intensification of mollusc culture is quite difficult and probably not economically viable. The issue of site availability is likely to constrain future development of mollusc culture in several states as can be seen in the levelling off, or decline in production from both Japan and the Republic of Korea. In these two states, the production of molluscs decreased significantly in 2008 (Tables 43 and 44).

Table 43 Top ten producers of lower value molluscs, 2008

Country	Species	2006	2008	% Change
China	Japanese carpet shell	2 639 841	3 058 073	16
China	Constricted tagelus	593 771	742 084	25
China	Blood cockle	276 288	290 177	5
Thailand	Green mussel	272 901	243 821	-11
New Zealand	New Zealand mussel	97 000	100 100	3
Korea, Republic of	Korean mussel	81 617	67 442	-17
Thailand	Blood cockle	66 062	66 140	0
Malaysia	Blood cockle	45 674	61 138	34
Philippines	Green mussel	19 690	23 017	17
India	Green mussel	10 060	16 789	67

Table 44 Top ten producers of higher value molluscs, 2008

Country	Species	2006	2008	% Change
China	Cupped oysters nei	3 403 446	3 354 382	-1
Korea, Republic of	Pacific cupped oyster	283 296	249 976	-12
Japan	Yesso scallop	212 094	225 600	6
Japan	Pacific cupped oyster	208 182	190 400	-9
Taiwan POC	Pacific cupped oyster	28 547	34 514	21
Thailand	Cupped oysters nei	21 612	21 800	1
Philippines	Slipper cupped oyster	16 838	20 175	20
Australia	Cupped oysters nei	5 397	5 448	1
Australia	Sydney cupped oyster	4 071	4 000	-2
New Zealand	Pacific cupped oyster	2 800	3 170	13

The trend in mollusc culture is more likely to be a shift from lower-value species to higher-value species in those areas where sites are suitable. A further dimension is the development of intensive onshore culture operations such as those for abalone and a number of gastropod species. Abalone production in the region increased 70 percent between 2006 and 2008 reaching 39 046 tonnes.

Aquatic plants

Aquatic plant production can be divided into two distinct groups. The first group consists of seaweeds of temperate waters that are traditionally used for food purposes and are mainly produced in East Asia. The second group consists of tropical species mainly processed as a source of commercially valuable biopolymers (carrageenan, agar) that are used for various food and non-food purposes and are produced in Southeast Asia (Table 45).

Seaweeds for food purpose

This group includes Japanese kelp, laver (nori), green laver and wakame. The production of these species is confined to East Asian states and has a relatively stable production. The only exception to this is Japanese kelp culture, which has the largest share of aquatic plant production. The production of Japanese kelp has doubled from two million tonnes in three years to 1993 and another one million tonnes was added in the next six years. This rapid increase was probably a result of continued expansion of cultured areas in China. The production of Japanese kelp peaked in 1999 and since then has stabilized, which might indicate that the rapid expansion of production area reached a limit and further sites are not available, in 2008 the total production was almost 5 million tonnes (Table 46). Recent detailed reporting from China has given a clearer picture of aquatic plant production (Table 46).

Table 45 Top ten producers of aquatic plants, 2008

Countries	Tonnes
China	9 933 785
Indonesia	2 145 061
Philippines	1 666 556
Korea, Republic of	921 024
Japan	455 400
DPR Korea	444 300
Malaysia	111 298
Viet Nam	35 700
Cambodia	16 000
Taiwan POC	6 879

Table 46 Top ten cultured species of aquatic plants, 2008

Species	Tonnes
Japanese kelp	4 320 776
Aquatic plants nei	2 470 617
Eucheuma seaweeds nei	2 007 041
Wakame	1 755 886
Zanzibar weed	1 422 691
Warty gracilaria	1 151 321
Nori nei	814 660
Laver (Nori)	562 160
Gracilaria seaweeds	245 649
Elkhorn sea moss	239 768

Seaweeds for biopolymers

This group[13] consists of *Eucheuma cottonii*, *Kappaphycus alvarezzi*, *Gracilaria* spp., red seaweeds and others. The Philippines has the highest production of these aquatic plants and *Euchema cottonii* (also known as Zanzibar weed), and far exceeds the production of other seaweeds (1.4 million tonnes in 2008). Also, Indonesia reports a large production of Eucheuma seaweeds, almost 2 million tonnes in 2008. New areas are being investigated for the expansion of seaweed production since global demand for carrageenan and other alginates is expected to continue to rise.

Reptiles and amphibians

Reported species are soft shell turtle and frogs. China has greatly increased its reported production of soft shell turtle in the past five years to a total production of 204 000 tonnes in 2008. Other states that reported production of turtles are Thailand, Taiwan POC, Republic of Korea and Malaysia. There are limited data on frog production, although frogs are being increasingly cultured in many states. China has reported a production of 82 000 tonnes of frogs in 2008. The small size of a typical frog farm (using small cement tanks or even pens) means that quantification of this type of operation is problematic.

Crocodile production is growing quickly in the region with Cambodia exporting juvenile crocodiles to both Viet Nam and China. Thailand and Papua New Guinea also have crocodile farms. This production is rarely reported in fishery or aquaculture statistics.

Niche aquaculture species

There are a number of niche aquaculture species that this review does not cover. These species are either cultured at the pilot/experimental level or simply not reported by many states. Some of the species are not food type commodities (e.g. sponge and pearls, ornamental shells, ornamental fish) and are therefore not routinely monitored by the authority reporting fisheries information (Table 47).

Table 47 Niche aquaculture species, 2008

Species	Tonnes
Aquatic invertebrates nei	143 650
Japanese sea cucumber	92 567
Jellyfishes	47 405
Sea squirts nei	18 526
Sea urchins nei	3 023
Sea cucumbers nei	279

Subregional trends

South Asia

South Asia's aquaculture production has seen major increases in the last 20 years, from 1.1 million tonnes in 1988 to 4.6 million tonnes in 2008. The majority of production comes from inland waters and hence the growth of the sector has been mostly because of increasing freshwater culture (Figure 15). This increase is probably not heavily dependent on marine sources of feed and therefore a real contribution in terms of food security. There has been a major increase in rohu and catla production since 2003. Although Indian carps (rohu, catla and mrigal carp) have been the main group cultured in the region, there have been notable increases in the production of introduced Chinese carps in recent years. There are more recent unverified reports of significant increases in Pangassius production in India.

Silver carp production also increased almost fivefold in two years (1999–2001) and became the top cultured species in 2001. Since then, the production has declined by half, but is now up to almost the 2003 quantity again (Figure 16). Production, of giant tiger prawn and penaeid shrimp increased steadily up until 2006 when it reached 210 000 tonnes but has since declined significantly (145 000 tonnes in 2008). In general, the level of diversification of cultured species is relatively low in this area and there has been very limited reported marine finfish production in the past, but it has increased to 37 000 tonnes in the last years for which statistics are available.

[13] The taxonomy for *Eucheuma* is confusing. The name *cottonii* is a general word used to describe a number of *Eucheuma* species (Zuccarello *et al.,* 2006). Recent taxonomic revisions have added to the confusion. *Eucheuma striatum var. tambalang* and *E. alvarezii* var. *tambalang* are now *Kappaphycus alvarezii* [common name "tambalang"], *Eucheuma striatum var. elkhorn* is *Kappaphycus striatum* [common name "elkhorn"], *Eucheuma cottonii* is *Kappaphycus cottonii*, and *Eucheuma spinosum* is now *Eucheuma denticulatum* [common name "spinosum"] source: Eldredge, 1994.

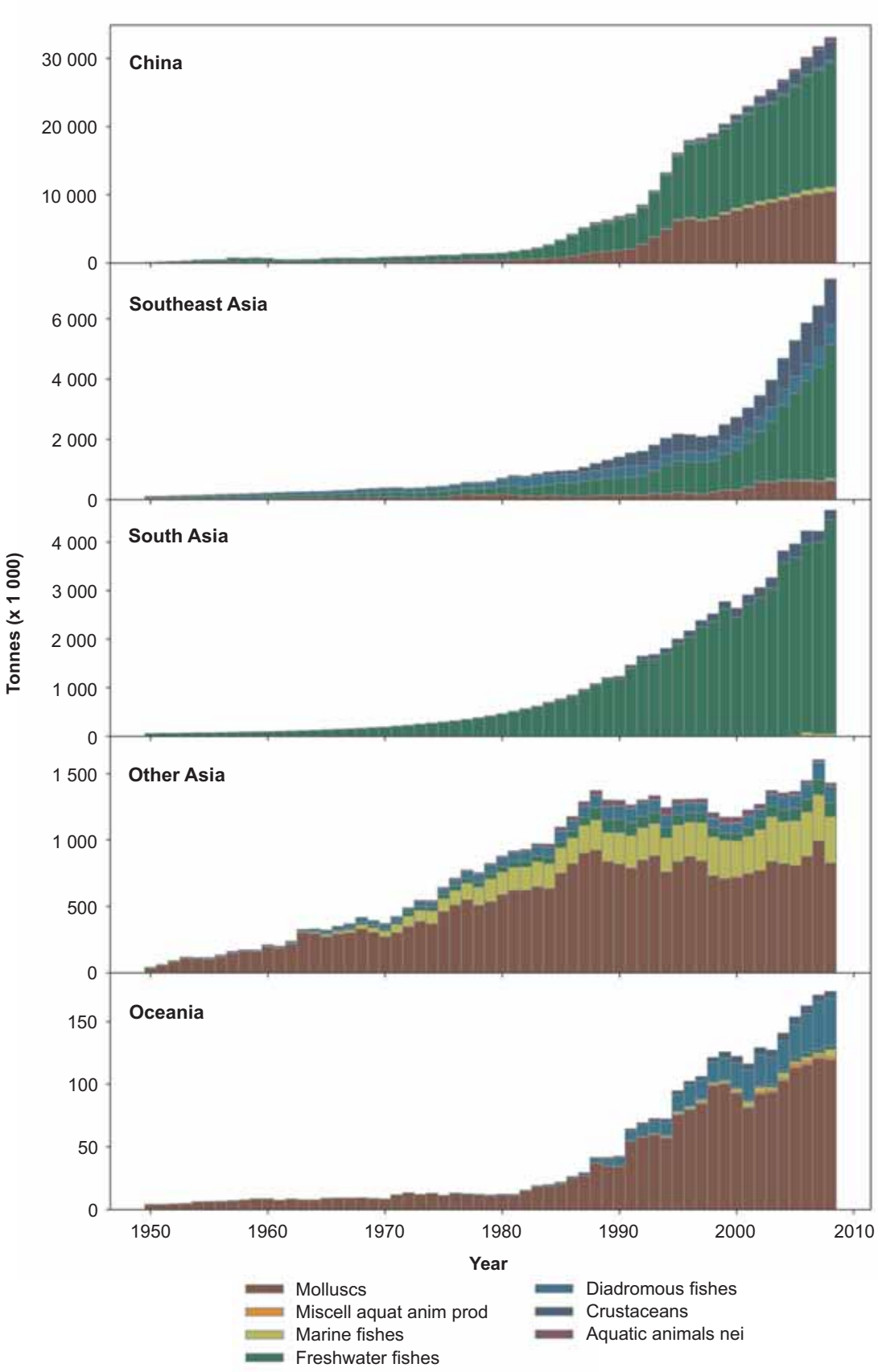


Figure 15 Trends in aquaculture production in Asia by major species groups (excluding aquatic plants)

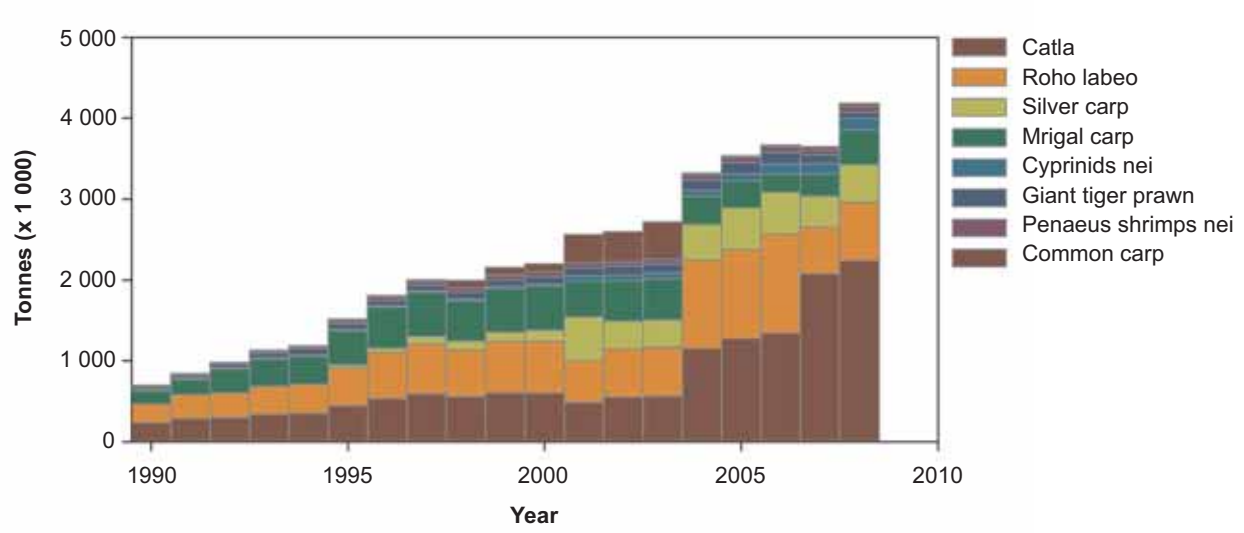


Figure 16 Aquaculture production of major species in South Asia

Southeast Asia

Aquaculture production in Southeast Asia is highly diversified and in 2008 production of ninety-four different species was reported. The number of cultured species and the details of reporting have increased rapidly in the last years, increasing from 70 and 80 (1996 and 2003 respectively). In terms of value, highly-priced crustaceans have an increased share of 43 percent of the total production, followed by freshwater fish at 41 percent. The main difference is that the relatively low volume of crustaceans gives a high value in return, whereas freshwater fishes have a relatively high value but a large quantity is produced. In contrast, the large production of aquatic plants results in a relatively small value. Freshwater finfish culture has increased from 0.6 million tonnes in 1991 to 4.4 million tonnes in 2008. In the mariculture subsector, the production of aquatic plants has shown a surprisingly strong growth. Crustaceans have been a major cultured species throughout the subregion, with rapid growth in recent years (Figure 17).

Box 4 Top cultured species in Southeast Asia, 2006

Top ten cultured species in Southeast Asia (by quantity, excluding aquatic plants) were pangas catfish nei, whiteleg shrimp, Nile tilapia, milkfish, giant tiger prawn, roho labeo, Cyprinids nei and common carp.

Eucheuma cottonii is still the most widely cultured aquatic plant in the region with a production of 1.9 million tonnes in 2008 (increased from 1.05 million tonnes in 2006). It is closely followed by *Zanzibar seaweed* with 1.4 million tonnes (increased from 1.3 million tonnes in 2006). The massive growth of aquatic plants in this region reflects the strong promotion and good conditions in the islands of Philippines and Indonesia. But it is also partly because of improvement and development of market chains. Apart from aquatic plants, Pangas catfishes nei is the top produced species, and has very recently surpassed the previous top species, whiteleg shrimp (*P. vannamei*) and giant tiger shrimp (*Penaeus monodon*).

China

Although production growth from China during 2006–2008 has slowed down to 9.6 percent from 12.2 percent during 2004–2006, China's aquaculture production still increased by 2.9 million tonnes and has now reached 33 million tonnes (Figure 15) or 63 percent (43 million tonnes) of the total world aquaculture production in 2008 (including aquatic plants). Growth in inland culture has continued, mainly from increased production of finfish culture and crustaceans. This increase is being achieved through the intensification of existing systems rather than any significant increase in production area.

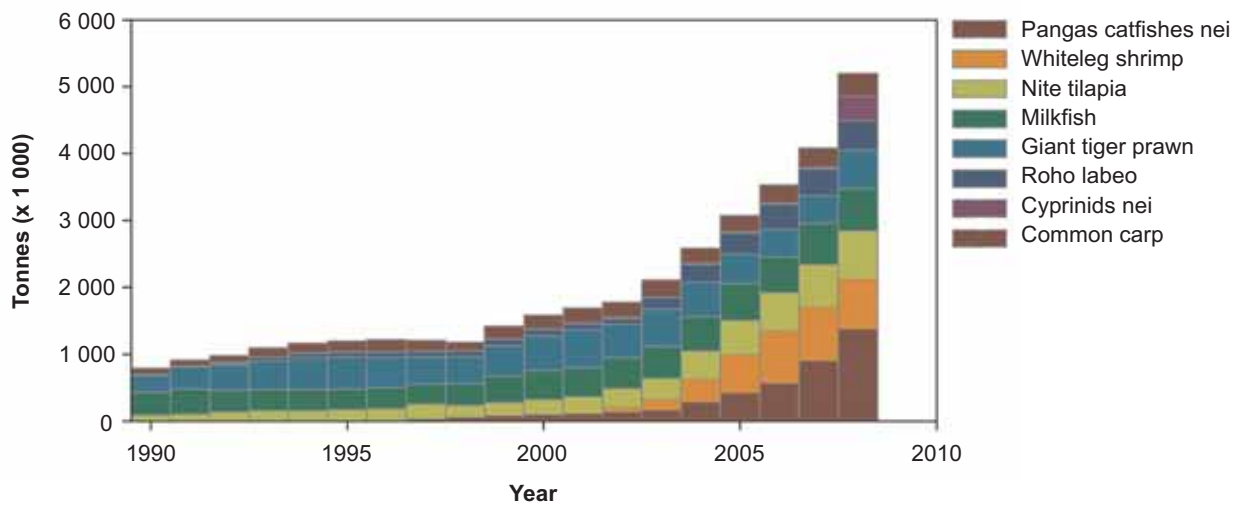


Figure 17 Aquaculture production of major species in Southeast Asia

Carps have always been the most important species group cultured in China. As the result of species diversification and faster development of culture of higher value finfish and crustaceans in the past two decades, the contribution of carps to the total production declined to 33.6 percent in 2008 from 40.9 percent in 1998. Nevertheless, production of cultured carps from China still increased by nearly one million tonnes between 2006 and 2008 and reached 14.5 million tonnes. Carp will remain a major source of fish products for consumers of different income classes in China in the foreseeable future.

Diversification of cultured species is a very unique feature of the Chinese aquaculture industry. China is currently reporting to FAO the production data of some 110 cultured species/species groups. The species diversification has been oriented towards high value species and indigenous species newly developed for aquaculture. The former include mainly carnivorous marine and freshwater fish species and freshwater and marine/brackish crustaceans, which have been well captured in earlier analyses. The latter are usually reported as freshwater/marine finfish nei. It is expected these species will be reported as identified species in the future.

Among the four major cultured groups, crustaceans achieved outstanding growth (29 percent) in production during 2006–2008. Which is followed by finfish (10 percent). Comparatively, increases in the production of aquatic plants and molluscs were much less significant with rates of 5 percent and 4 percent respectively.

Growth in production from marine waters has been driven by molluscs and aquatic plants in the past, however, the production of aquatic plants has levelled off in the last two years (Figure 18).

The production of most cultured species continued to increase. However, there are a number of species worth highlighting, as follows:

- **Japanese kelp** (*Laminaria japonica*): growth in its production is remarkable, increasing from 1.2 million tonnes in 1990 to 4.0 million tonnes in 2008 in line with production figures of 3.7 million tonnes in 2006 and 3.5 million tonnes in 2002.
- **Miscellaneous aquatic plants:** this massive volume of aquatic plants is not reported at the species level. However, production jumped from 0.2 million tonnes in 1990 to 3.4 million tonnes in 2002. The large decline in aquatic plant production in 2003 is explained by improved reporting at species level by China. The reported figure for aquatic plant production in 2008 is 2.4 million tonnes. As a result of the improved reporting by China, wakame (*Undaria pinnatifida*) has become the second largest cultured plant with a total of 1.3 million tonnes in 2008. Most of the Chinese plant production is for food purposes.
- **Cupped oysters nei:** this is another cultured species group that has achieved outstanding growth, increasing from 0.5 million tonnes in 1990 up to 3.4 million tonnes in 2008. Mollusc production is also difficult to intensify and increased production suggests the development of

new production areas as in the case of aquatic plants (Figure 19). Additionally, the production of sea snails has increased in recent years, from 0 tonnes in 2002 to 225 000 tonnes in 2008; again this might reflect improved reporting and not necessarily increased production.

- **Carnivorous species:** Rapid growth in production of high value carnivorous species such as mandarin fish, Chinese mitten crab and marine finfish started to occur in 1995. More recently there have been large increases in the production of snakehead and grouper. Many of the carnivorous species show very similar patterns of growth in production (Figure 20).

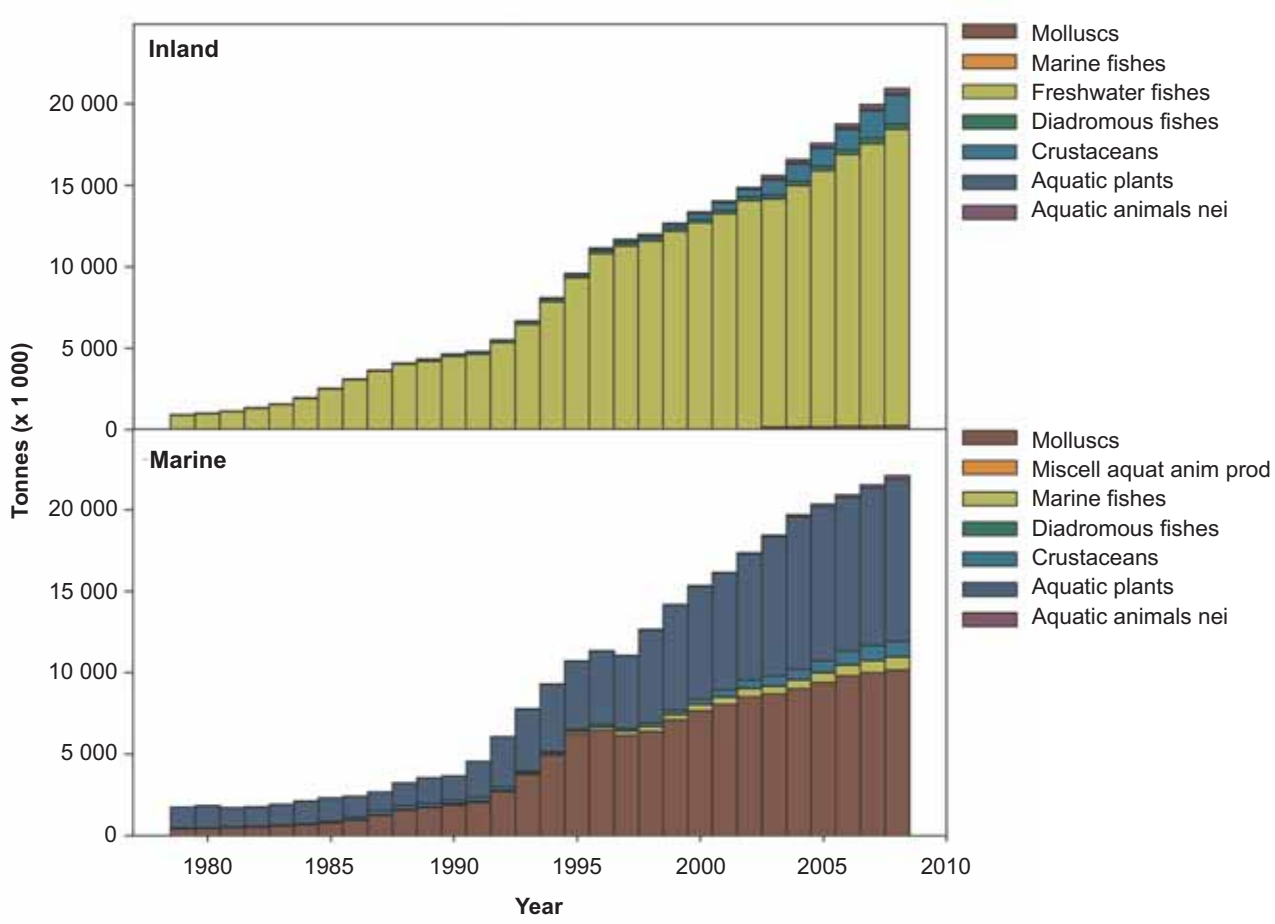


Figure 18 Trends in aquaculture production in China by environment, 1980–2008

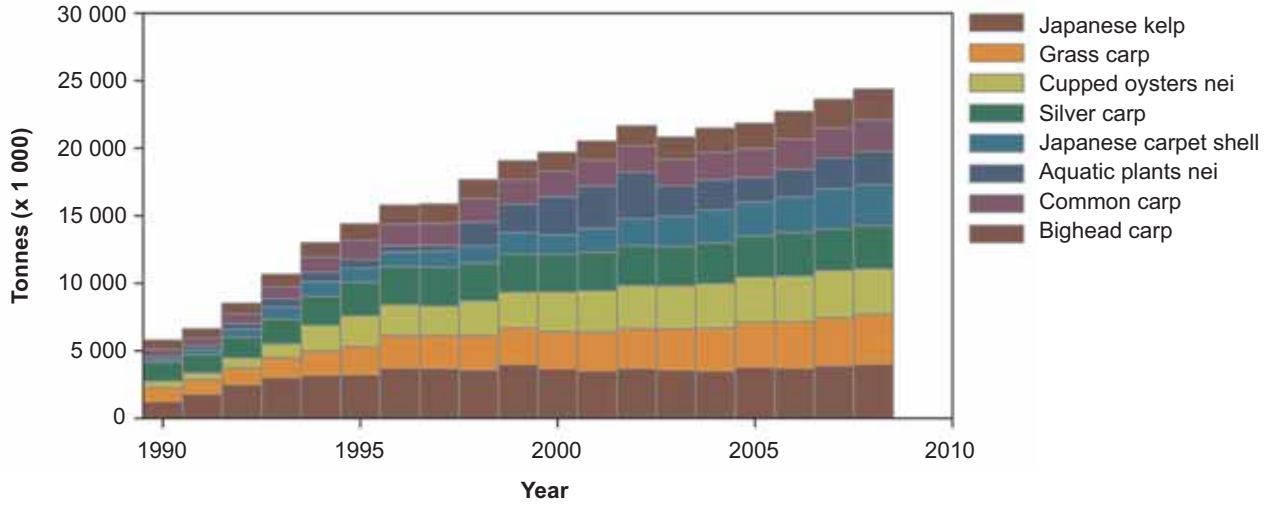


Figure 19 Trends in top eight cultured species in China (aquatic plants and molluscs included)

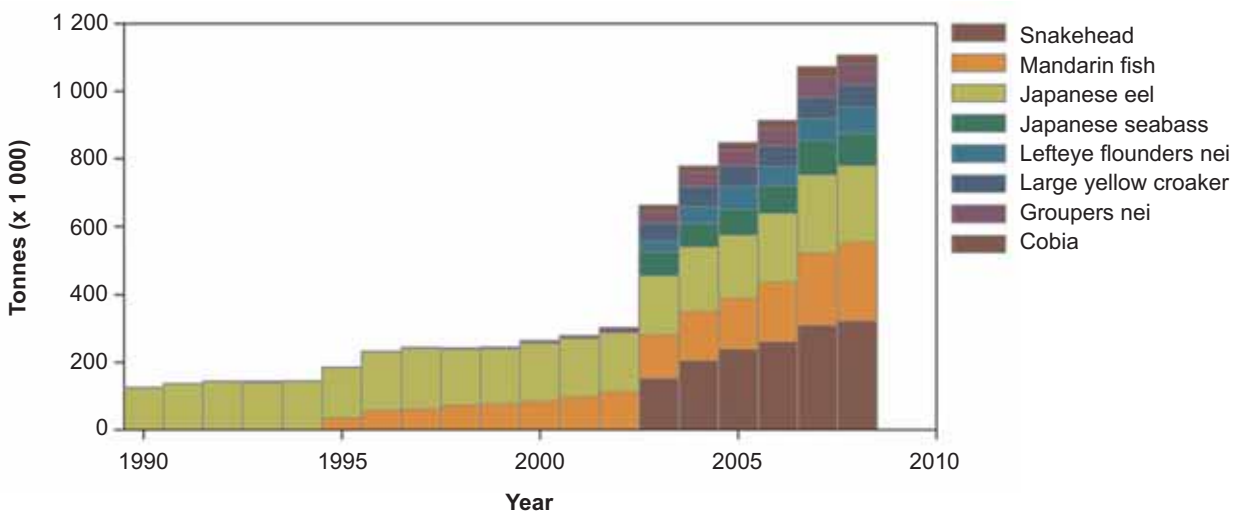


Figure 20 Production trends of major cultured carnivorous species in China

Other Asia

Aquatic plants continue to dominate aquaculture production in Other Asia, particularly in East Asian states (Figure 21). They account for 56 percent of total production. This is followed by molluscs (25 percent) and marine finfish (11 percent). However, the high economic value of marine finfish makes this species group the largest contributor in terms of value, constituting 43 percent of total production value.

Excluding aquatic plants, the aquaculture production in this region has been very stable; most of the major species groups have been maintained at the current level of production for the last ten years (Figure 15). The exception is aquatic plant production, which peaked in 1993 at 2.3 million tonnes then decreased by almost 35 percent to 1.3 million tonnes in 2000, but has since steadily increased and was 1.8 million tonnes in 2008.

It is notable that the percentage of carnivorous fish in the total for fish production is very high in this subregion (72 percent in 2008) compared with South Asia, Southeast Asia and China, which all have much lower levels (all below 10 percent).

The estimated aquaculture production from the Democratic People's Republic of Korea (DPR Korea) in FAOSTAT was about 0.5 million tonnes for 2008, which was mainly composed of Japanese kelp and marine molluscs. The government of DPR Korea is strongly promoting the culture of marine molluscs and finfish in the country. Supported by FAO technical assistance, a significant increase in marine molluscs and finfish production may be expected in the coming years because of the country's abundant natural resources.

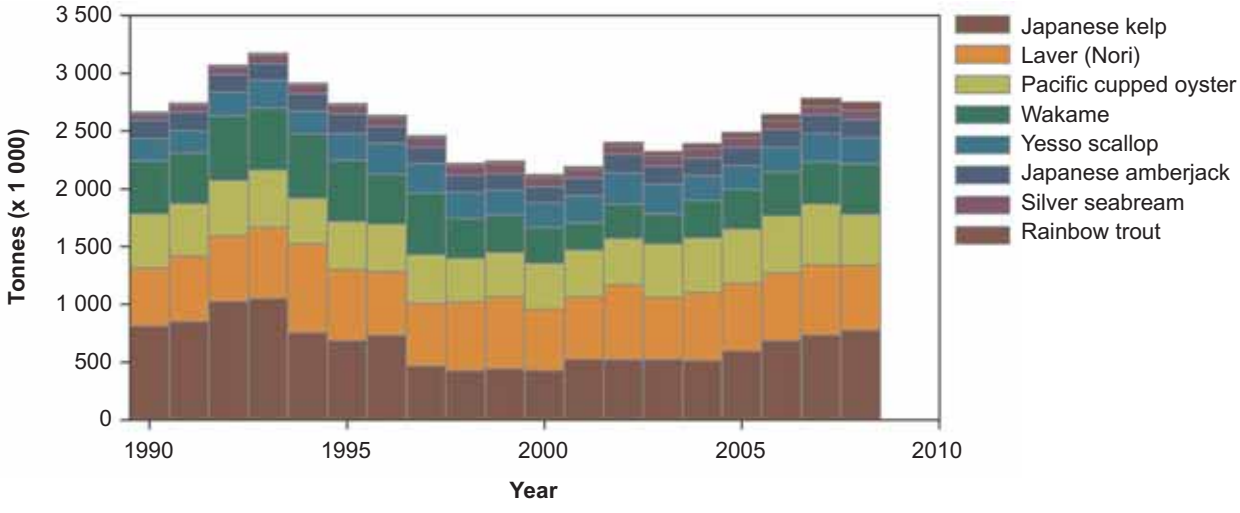


Figure 21 Aquaculture production of major species groups in Other Asia

Oceania

Aquaculture production in Oceania is relatively limited. The production (excluding aquatic plants) was 174 000 tonnes in 2008 (Figure 15) almost exclusively from New Zealand and Australia. Molluscs and diadromous fish are the main cultured groups.

The main cultured species are New Zealand mussels and different salmon species, and this also makes up the bulk of the production (Figure 22). However, live reef fish, aquarium fish and pearls bring significant income to some Pacific Islands, although relatively low in quantity. Although the target species are mostly caught from the wild, there is an increasing desire for culture-based sources. Giant clam culture for the ornamental trade is widespread throughout the region and the total export is probably in the range of 30 000 to 50 000 pieces/annum. The Pacific is also a major supplier of "live rock" (rock encrusted with coralline algae) with approximately 50 000 pieces of live rock currently being cultured in the Fiji Islands.

Euchema cottonii seaweed (Zanzibar weed) culture is well established in the Kiribati atolls and is being rejuvenated in the Solomon Islands and Fiji. Interest in inland freshwater aquaculture is growing, particularly among the larger Melanesian states such as Fiji and Papua New Guinea.

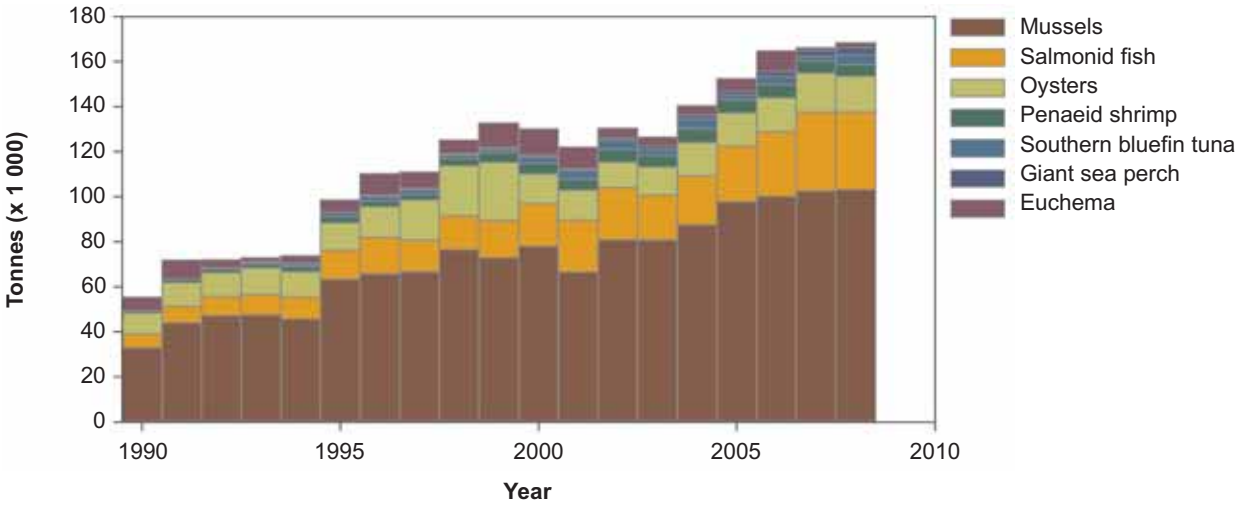


Figure 22 Top eight species produced by aquaculture in Oceania

Part 3
Regional policy issues

The impact of climate change on the fisheries sector in Asia

Because of the importance of fisheries in Asia and the Pacific region, any adverse climate change related impacts on the fisheries sector will have implications for the region's economic development, poverty reduction efforts and regional food security. The sector contributes significantly to national GDPs in many countries in Asia as well as plays a significant role in food security, and the Asian region currently is home to 87 percent of all people involved globally in fisheries and aquaculture (FAO, 2008). Existing marine and inland capture fisheries resources are typically fully utilized or overexploited and there is increasing reliance on aquaculture to supplement regional and international demand for fish. Asia's stake in the aquaculture industry is disproportionately high, accounting for about 90 percent of global volume and 80 percent of global value on average (FAO, 2006), thus negative impacts to this subsector will have far reaching repercussions.

There is now a considerable, credible body of evidence that human induced climate change is occurring and is causing changes in the earth's fundamental physical, chemical and biological processes (IPCC, 2006 and Meehl *et al.*, 2007). The future scale of this change will depend on what course of action the governments of the world take in reducing emissions over the coming decades.

As a sector highly dependent on natural resources and highly sensitive to environmental variables, the potential impact of climate change on the fisheries sector should be of great concern to policy makers in the region. Climate change is likely to have further negative impacts on capture fisheries systems already stressed by overexploitation and pollution as well as on the productivity and viability of aquaculture operations across the region. Climate change will also have profound consequences for related sectors such as agriculture, water management and coastal development, which will intersect with and have an influence on the fisheries sector.

Table 48 below summarizes the main pathways by which climate change could potentially have an adverse impact on the fisheries sector.

Table 48 How climate change could directly affect the fisheries sector

Drivers	Biophysical effects	Implications for fisheries and aquaculture
Changes in sea surface temperature	More frequent harmful algal blooms; less dissolved oxygen; increased incidence of disease and parasites; altered local ecosystems with changes in competitors, predators and invasive species; changes in plankton composition.	Impacts on the abundance and species composition of capture fisheries stocks. For aquaculture: Changes in infrastructure and operating costs from worsened infestations of fouling organisms, pests, nuisance species and/or predators; infrastructure and operating costs from worsened infestations of fouling organisms.
	In certain areas: Longer growing seasons; lower natural mortality in winter; enhanced metabolic and growth rates.	Potential for increased production and profit in certain localities, especially for aquaculture.
	Enhanced primary productivity.	Potential benefits for aquaculture and fisheries but perhaps offset by changed species composition.
	Changes in timing and success of migrations, spawning and peak abundance, as well as in sex ratios.	Potential loss of species or shift in composition in capture fisheries; impacts on seed availability for aquaculture.
	Change in the location and size of suitable range for particular species.	Aquaculture opportunities both lost and gained; potential species loss and altered species composition for capture fisheries.
	Damage to coral reefs that serve as breeding habitats and may help protect the shore from wave action.	Reduced recruitment of fishery species; worsened wave damage to infrastructure or flooding from storm surges.

Table 48 *(continued)*

Drivers	Biophysical effects	Implications for fisheries and aquaculture
Rising sea level	Loss of land.	Reduced area available for aquaculture; loss of freshwater fisheries.
	Changes to estuary systems.	Shifts in species abundance, distribution and composition of fish stocks and aquaculture seed.
	Saline intrusion.	Damage to freshwater capture fisheries; reduced freshwater availability for aquaculture; shift to brackish water species.
	Loss of coastal ecosystems such as mangrove forests.	Reduced recruitment and stocks for capture fisheries and seed for aquaculture; worsened exposure to waves and storm surges and risk that inland aquaculture and fisheries become inundated.
Changes in precipitation and water availability	Changes in fish migration and recruitment patterns and so in recruitment success.	Altered abundance and composition of wild stock; impacts on seed availability for aquaculture.
	Lower water availability for aquaculture; lower water quality causing more disease; increased competition with other water users; altered and reduced freshwater supplies with greater risk of drought.	Higher costs of maintaining pond water levels and from stock loss; reduced production capacity; conflict with other water users; change of culture species.
	Changes in lake and river levels and the overall extent and movement patterns of surface water.	Altered distribution, composition and abundance of fish stocks; fishers forced to migrate more and expend more effort.
Higher inland water temperatures	Increased stratification and reduced mixing of water in lakes, reducing primary productivity and ultimately food supplies for fish species.	Reductions in fish stocks.
	Raised metabolic rates increase feeding rates and growth if water quality, dissolved oxygen levels, and food supply are adequate, otherwise possible reductions in feeding rates and growth; potential for enhanced primary productivity.	Possible enhanced fish stocks for capture fisheries or else reduced growth where the food supply does not increase sufficiently in line with temperature; possible benefits for aquaculture, especially intensive and semi-intensive pond systems.
	Shift in the location and size of the potential range for a given species.	Aquaculture opportunities both lost and gained; potential loss of species and alteration of species composition for capture fisheries.
	Reduced water quality, especially in terms of dissolved oxygen; changes in the range and abundance of pathogens, predators and competitors; invasive species introduced.	Altered capture fisheries stocks and species composition; altered culture species and possibly worsened losses to disease (and so higher operating costs) and possibly higher capital costs for aeration equipment or deeper ponds.
	Changes in timing and success of migrations, spawning and peak abundance.	Potential loss of species or shift in composition for capture fisheries; impacts on seed availability for aquaculture.

Table 48 *(continued)*

Drivers	Biophysical effects	Implications for fisheries and aquaculture
Increase in frequency and/or intensity of storms **Drought**	Large waves and storm surges; inland flooding from intense precipitation; salinity changes; introduction of disease or predators into aquaculture facilities during flooding episodes.	Loss of aquaculture stock and damage to or loss of aquaculture facilities and fishing gear; impacts on wild fish recruitment and stocks; higher direct risk to fishers; capital costs needed to design cage moorings, pond walls, jetties, etc. that can withstand storms; higher insurance costs.
	Lower water quality and availability for aquaculture; salinity changes.	Loss of wild and cultured stock; increased production costs; loss of opportunity as production is limited.
	Changes in lake water levels and river flows.	Reduced wild fish stocks; intensified competition for fishing areas and more migration by fisher folk.
Changes in El Niño-Southern Oscillation	Changed location and timing of ocean currents and upwelling alters nutrient supply in surface waters and consequently primary productivity.	Changes in the distribution and productivity of open sea fisheries.
	Changed ocean temperature and bleached coral.	Reduced productivity of reef fisheries.
	Altered rainfall patterns bring flooding and drought.	See impacts for precipitation trends, drought and flooding above.

Source: Adapted from WorldFish (2007).

How Asia will be impacted by climate change

The impacts of climate change are likely to be far from uniform and it is expected that the Asian region will face very specific and locally variable challenges. Certain trends and impacts may be more pronounced in Asia (e.g. temperature increases are likely to be above the global norm in many parts of the region; a number of important river basins in Asia are threatened by further water stress; the number of people impacted by flooding in the region is likely to be disproportionately high; biodiversity losses will be greater in the tropics). Moreover, it is recognized that Asia is highly vulnerable to climate change because of the low capacity of countries in the region to respond and adapt; many countries cannot cope with current levels of climatic variability and extreme events, indicating that existing systems would be overwhelmed (Preston *et al.*, 2006). As a region that is still beset with poverty and low levels of development, it is likely that only sudden, disaster-related climate change related issues will be addressed (Michel and Pandya, 2010). There is a possibility that slower processes, such as rising sea levels and gradual shifts in agricultural and fisheries related production systems may be ignored, even if planning ahead for these changes will ultimately increase the chances of coping with negative impacts.

Implications for the fisheries sector in Asia

Non-climate related drivers are likely to have a greater impact on the fisheries sector in the short-term, but our ability to manage these will also determine the mid-term to long-term impacts that climate change will have. Poor practice in fisheries and ecosystem management as a result of inadequate governance are likely to have a greater influence on the fisheries sector in the short-term and currently pose a threat to fisheries-based livelihoods and economic growth. Through undermining the health of fisheries systems, current practices may be reducing the resilience of fishery systems to withstand climate change related impacts. Current management approaches therefore play a hand in determining possible outcomes for the sector in a climate changed future.

Though we have a good understanding of the general impacts of climate change, our ability to make specific predictions on the fisheries sector are limited. Nevertheless, trends regarding sea surface and

inland temperature changes, sea level rise, and changes to hydrological patterns can be estimated with a relatively high level of confidence and, given the projections for the region, such fundamental environmental changes will undoubtedly have some impact on fisheries operations. However, the specific effects that climate change, coupled with other anthropogenic drivers and underlying natural patterns, may have on particular fishery systems and localities over the next 10 to 40 years and beyond is extremely difficult to predict, indicating that flexibility in management systems and institutions is necessary and that decision-makers cannot expect to depend on prescriptive advice for the sector.

There are likely to be geographical shifts in productivity in both capture fisheries and aquaculture (Vivekanandan *et al.,* 2009) that present more challenges than opportunities for the region; there is expected to be a general poleward shift in catch potential for capture fisheries that may disadvantage many Asian countries, particularly tropical and subtropical countries (Cheung *et al.*, 2009). Similarly, aquaculture productivity is likely to experience geographical shifts in response to temperature changes, requiring support to areas that are currently heavily invested in aquaculture to adapt or exit the sector, in addition to support to new areas that could potentially expand into this subsector (De Silva and Soto, 2009).

Different countries in the region will face different kinds and levels of risks.

Risk analyses based on variables such as potential climate change impacts on the sector, relative economic and social dependency on the sector, and adaptive capacity, have identified parts of the region where climate change may have a variety of implications (Allison *et al.,* 2009):

Socio-economic impacts may have different emphases depending on the role of the sector at the national and local levels.

Nutritional dependence on fisheries resources is high in much of Southeast Asia as well as other countries, such as Bangladesh, Japan and Sri Lanka; countries with the largest fisheries landings in the region are China, Japan, Indonesia, India and Bangladesh; dependency on the fisheries sector for export income is highest in the coastal nations of Southeast Asia.

A nation's capacity to adapt to climate change will influence the magnitude of socio-economic disturbance experienced.

Pakistan, Bangladesh, Lao PDR, and Nepal are believed to have the lowest capacity in the region to adapt to climate change related impacts to the fisheries sector.

Countries that have a high dependency on the fisheries sector as well as a low capacity to adapt will be most at risk of serious socio-economic impacts.

The river dependent countries of Bangladesh, Cambodia and Pakistan have been identified as three of the most at risk countries in the region in this respect.

The poor are likely to be most affected.

Disruption to the fisheries sector may have a disproportionate impact on the large number of poor people in Asia who depend on the sector for their protein intake and employment, and who are likely to be more vulnerable to hazards and extreme events.

There is likely to be increased competition from other sectors for resources and space.

Cross-sectoral conflicts of interest are likely to be exacerbated by climate change. For instance, freshwater capture fisheries and aquaculture could lose out in competition with other sectors (e.g. hydropower, agriculture, domestic and industrial use) for diminishing freshwater supplies. The combined implications of sea-level rise, coastal erosion, population growth and shrinking agricultural land may also emerge as land-limiting factors that disadvantage aquaculture operations.

Mitigation opportunities associated with the sector could serve multiple functions.

Asia's contribution to emissions via the fisheries sector is considered to be relatively low, therefore there is unlikely to be much government emphasis on the sector in emission mitigation efforts. However, improved energy efficiency could complement other positive fisheries management goals for the region (e.g. reductions in fleet capacities, removal of perverse fuel subsidies). Good management of ecosystems crucial to fisheries systems (e.g. salt marshes, seagrass beds, mangroves and coral reefs) can also provide the dual benefits of maintaining systems efficient in sequestering carbon. Through actively pursuing mitigation activities, the sector could potentially generate revenue to fund adaptation actions (e.g. via carbon credits, activities under the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), possible future "Blue Carbon" initiatives which consider the potential of aquatic ecosystems in carbon sequestration).

Implications for governance

Good governance is essential for effective adaptation.

The need to reverse patterns of poor management and governance has never been greater. Fisheries governance processes that are meaningfully stakeholder inclusive, transparent, based on best practice (e.g. the implementation of international fisheries agreements and codes) and tackle issues of corruption and group marginalization, will provide the sector and those whose livelihoods and food security depend on it with a better chance of adapting to climate change. Tackling existing incentive structures that make bad practices lucrative may be an important component of this.

Flexibility and adaptability in governance and management are important components of good governance that need to be operationalized.

Given the high degree of uncertainty that surrounds climate change, flexible and responsive governance mechanisms and institutions will be crucial. The emphasis should be on building the adaptive capacity of communities and industries to be able to cope with unpredictable changes and events.

Support cross-sectoral governance.

Again, although this represents best practice that should be pursued irrespective of climate change, the specific challenges that climate change will present in constraining resources (e.g. freshwater, land) heighten the need to improve cross-sectoral coordination. Integrating disaster management into the fisheries sector, and vice versa, will be of particular importance given the high vulnerability of the sector to extreme events.

Actions for adaptation and mitigation

Ensure that the fisheries sector is clearly incorporated into mainstream climate change strategies and vice versa.

The fisheries sector should be involved in consultative processes towards the development of mainstream adaptive strategies as well as developing strategies at the sectoral level. Potential trade-offs and conflicts with other sectors should be carefully identified as part of these processes. For instance, adaptive strategies pursued by other sectors (e.g. coastal defence structures, dams and diversions) may have negative impacts on the fisheries sector. Opportunities for the fisheries sector to support cross-sectoral efforts (e.g. through integrating aquaculture with agriculture) should be pursued. Sectoral development plans for the fisheries sector should, conversely, integrate other sectors and climate change considerations.

Ensure that the opportunities and threats presented by climate change are understood and supported as part of adaptation measures for the sector.

Identify the winners and the losers in the fisheries sector. For instance, any geographical shifts in productivity should be identified and supported strategically; supporting the "losers" to diversify or exit the sector and the "winners" to capitalise more effectively on new opportunities.

High-risk countries and locations should be identified and supported.

Understanding of which countries and localities in the region will be most sensitive to climate change related changes to the fisheries sector needs to be improved. High-risk countries should be targeted and supported to explicitly tackle threats to the fisheries sector.

Build supportive economic and trade policies.

Given the considerable role of the sector in trade and export for the Asia region, changes in production patterns and trade opportunities will need corresponding changes in economic and trade policies. Product and export diversification should be pursued as part of this.

Pursue appropriate technologies.

Changing conditions will necessitate investing in new technologies and of course, adopting them. For certain subsectors such as aquaculture, this will be of crucial importance. A great deal of this knowledge and technology may be locally available and small-scale technologies should not be overlooked.

Pursue mitigation actions in a manner that supports the sector more broadly.

The sector could benefit from mitigation opportunities in a manner that strengthens fisheries management systems. For instance, ecosystem management for the dual purposes of carbon sequestration and fisheries management could be pursued; fleet capacity reduction and the removal of fuel subsidies for non-renewables would reduce emissions from the sector and reduce overexploitation. Support from mitigation schemes could provide resources for the sector to achieve this.

International and regional agreements

There are a variety of agreements that relate to different fishery issues in the region. The agreements come in different forms: binding and voluntary; global and regional. The agreements may cover fisheries specifically or be related indirectly through environment, biodiversity, labour or other international norms that relate to the fishery sector and its activities. More information on these can be found on the APFIC Website. To ensure that the participation of countries in these agreements is monitored, APFIC continues to confirm their participation with the help of its members as recommended in the 2008 *Status and potential* report.

Binding agreements

The binding agreements are usually adopted at global level; hence most of them are deposited in a UN organization. Among these, a few are of special importance:

- United Nations Convention on the Law of the Sea (UNCLOS)[14]
- United Nations Fish Stocks Agreement (UNFSA)[15]
- FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement)[16]
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[17]
- Convention on Biological Diversity (CBD)[18]
- Agreement on Port State Measures (*to come into effect*) [19]
- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 (specifically Annex V)).

There are still some countries in the region that have not signed and/or ratified the United Nations Convention on the Law of the Sea (UNCLOS) (Table 49) and none have done so since the last review in 2008. The agreement entered into force on 16 November 1994 and is today the globally recognized regime dealing with all matters relating to the law of the sea. The United Nations Fish Stocks Agreement entered into force on 11 December 2001, but there are still many countries in the region that have not signed or ratified the convention (Table 49), however, two countries from the region have ratified the agreement since the last review in 2008. The FAO Compliance Agreement entered into force on 24 April 2003, but has still to see acceptance instruments from many of the countries in the region (Table 49) and since 2008 there are no new signatories to the agreement in the region. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has been acceded by many countries and similarly the Convention on Biological Diversity (CBD) has been ratified and/or signed by all countries in the region.

The FAO Agreement on Port State Measures to combat illegal, unreported and unregulated (IUU) fishing lays out in greater detail the commitments and obligations that port states have relating to the use of

[14] Mainly deals with conservation, utilization and management of living resources, and the responsibility to deal with shared stocks and stocks of the high seas through regional mechanisms (e.g. regional fisheries organizations).

[15] The main purpose is to implement the UNCLOS. It further elaborates general principles concerning conservation and management of straddling fish stocks and highly migratory fish stocks and emphasizes the special role of regional fisheries management organizations in conservation and management. It also highlights the obligations of states with respect to vessels flying their flags on the high seas and regional fisheries management organizations (RFMO) or arrangements, e.g. the Indian Ocean Tuna Commission (IOTC) and the Western and Central Pacific Fisheries Commission (WCPFC).

[16] Places a general obligation on flag states to take such measures as may be necessary to ensure that vessels flying their flags do not engage in any activity that undermines the effectiveness of international conservation and management measures. In addition, it seeks to limit the freedom of vessels that have a bad compliance record to "shop around" for new flags. The Agreement applies to all fishing vessels over 24 metres in length used or intended for use for the commercial exploitation of living marine resources, including mother ships and any other vessels directly engaged in such fishing operations.

[17] An international agreement between governments. It aims to ensure that the international trade in specimens of wild animals and plants does not threaten their survival. Species are categorized according to the degree of threat to their survival and this classification determines the extent to which the species can be traded and/or moved.

[18] Dedicated to promoting sustainable development and was developed as a practical tool for translating the principles of Agenda 21 into reality. CBD deals with fisheries issues separately for inland, marine and coastal systems. In addition, CBD also covers issues relating to alien species introductions and movements.

[19] As of May 2010 there where 19 signatories out of the required 25 for the treaty to come into effect.

Table 49 Review of parties to global conventions and agreements

	Port State M.	UNCLOS		UNFSA		FAO CA	CBD	CITES	MARPOL Annex V
	sign	sign	rat/ac	sign	rat/ac	acc	rat/ac/acc	rat/ac	ac/acc
South Asia									
Bangladesh		1982	2001	1995			1994	1981	2002
Bhutan		1982					1995	2002	
India		1982	1995		2003		1994	1976	2003
Maldives		1982	2000	1996	1998		1992		2005
Nepal		1982	1998				1993	1975	
Pakistan		1982	1997	1996			1994	1976	1994
Sri Lanka		1982	1994	1996	1996		1994	1979	1997
Southeast Asia									
Brunei Darussalam		1984	1996				2008	1990	
Cambodia		1983					1995	1997	1994
Indonesia	**2009**	1982	1986	1995	**2009**		1994	1978	
Lao PDR		1982	1998				1996	2004	
Malaysia		1982	1996				1994	1977	1997
Myanmar		1982	1996			1994	1994	1997	
Philippines		1982	1984	1996			1993	1981	2001
Singapore		1982	1994				1995	1986	1999
Thailand		1982					2004	1983	
Timor-Leste							2007		
Viet Nam		1982	1994				1994	1994	
Other Asia									
Iran (Islamic Rep. of)		1992			1998		1996	1976	2002
Japan		1983	1996	1996	2006	2000	1993	1980	1983
Kazakhstan							1994	2000	1994
DPR Korea		1982					1994		1985
Republic of Korea		1983	1996	1996	2008	2003	1994	1993	1996
Mongolia		1982	1996				1993	1996	2003
Tajikistan							1997		
Uzbekistan							1995	1997	
Oceania									
Australia	**2010**	1982	1994	1995	1999	2004	1993	1976	1990
Cook Islands		1982	1995		1999	2006	1993		
Fiji Islands		1982	1982	1995	1996		1993	1997	
Kiribati			2003		2005		1994		2007
Marshall Islands			1991	1995	2003		1992		1988
Micronesia FSO			1991	1995	1997		1994		
Nauru		1982	1996		1997		1993		
New Zealand	**2009**	1982	1996	1995	2001	2005	1993	1989	1998
Niue		1984	2006	1995	2006		1996		
Palau			1996		2008		1999	2004	
Papua NG		1982	1997	1995	1999		1993	1975	1993
Samoa	**2009**	1984	1995	1995	1996		1994	2004	2002
Solomon Islands		1982	1997		1997		1995	2007	2004
Tonga			1995	1995	1996		1998		1996
Tuvalu		1982	2002		**2009**		2002		1985
Vanuatu		1982	1999	1996			1993	1989	1991
China									
China PR*		1982	1996	1996			1993	1981	1988
Other APFIC									
France		1982	1996	1996	2003	1996**	1994	1978	1981
UK			1997	1995	2001/2003	1996**	1994	1976	1986
USA	2009			1995	1996	1995	***	1974	1987
Total region**	**4**	***33***	***34***	***19***	***22***	***6***	***43***	***31***	***25***

Note: (n = 46); (sign = signed; rat = ratified; ac = acceded; acc = accepted;

* excluding Taiwan POC, Macau and Hong Kong SAR;

** Through European Union;

*** Signed in 1992;

**** Out of a total of 43 countries in the region (excluding France, UK, USA and see * above).

their ports by fishing vessels and the vessels which service the fishery[20]. The measures have yet to come into effect but have been open for signing since 2009 and four countries in the region has already signed the agreement (Table 49). Once port state measures become a binding agreement it will have an effect on fisheries trade between regions and particularly for those highly traded species from the high seas and from within the jurisdiction of the regional fishery management organizations.

Voluntary agreements

There are a number of voluntary (non-binding) international agreements that are of importance to fisheries in the region (see Lymer and Funge-Smith, 2008):

- FAO Code of Conduct for Responsible Fisheries (CCRF)[21]
- FAO international plan of action for the management of fishing capacity (IPOA-Capacity)[22]
- FAO international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing (IPOA-IUU)[23]
- SEAFDEC Regional Code of Conduct for Responsible Fisheries[24]
- The Regional Plan of Action for Responsible Fishing[25]
- APEC Bali Plan of Action[26]
- Coordinating Body for the Seas of East Asia (COBSEA)[27]

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[20] "Port state measures" generally refer to actions taken to detect illegal fishing when ships come to port. This can include undertaking inspections of documentation, catches and equipment when boats land to take on fuel and supplies or offload fish, or requiring vessels to make activity reports before entering port. Vessels found to be involved in IUU fishing can be denied docking rights, causing considerable financial losses to their owners. Such measures are among the most effective means of preventing the import, transshipment or laundering of illegally caught fish.

[21] Defines norms for responsible fisheries and sets out principles and international standards of behaviour for responsible practices to ensure the effective conservation, management and development of living aquatic resources. Respect for the ecosystem and biodiversity. is integral. The CCRF recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of all those concerned with the fishery sector. The CCRF takes into account the biological characteristics of the resources and their environments and the interests of consumers and other users. States and all those involved in fisheries are encouraged to apply the CCRF and give effect to it. The FAO Compliance Agreement (see binding agreements) is an integral component of the Code.

[22] The FAO international plans of action (IPOA) for the management of fishing capacity have the following objective "… to achieve worldwide, preferably by 2003 but no later than 2005, an efficient, equitable and transparent management of fishing capacity". It also highlights assessment and monitoring of fishing capacity and preparation and implementation of national plans.

[23] The objective of the FAO international plans of action to prevent, deter and eliminate illegal, unreported and unregulated fishing is to prevent, deter and eliminate IUU fishing by providing all states with comprehensive, effective and transparent measures by which to act, including through appropriate regional fisheries management organizations established in accordance with international law. The IPOA in particular encourages states to develop national plans of action to implement the IPOA-IUU.

[24] The SEAFDEC Regional Code of Conduct for Responsible Fisheries defines norms for responsible fisheries within the SEAFDEC region, it is derived from the FAO Code of Conduct for Responsible Fisheries.

[25] A voluntary instrument that takes its core principles from the above mentioned and already established international fisheries instruments for promoting responsible fishing practices. It is a commitment to implement those aspects of fisheries management that relate to combating IUU fishing. The coverage of the RPOA is the areas of the South China Sea, Sulu-Sulawesi Seas (Celebes Sea) and the Arafura and Timor Seas. The ministerial meeting to sign the RPOA was convened from 2 to 4 May 2007 in Denpasar, Bali, Indonesia and was attended by representatives of 11 countries: Australia, Brunei Darussalam, Cambodia, Indonesia, Malaysia, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste and Viet Nam. The countries signing the RPOA agreed to work together on key areas of fishery management.

[26] The main objectives of the APEC Bali Plan of Action (2005) are to ensure the sustainable management of the marine environment and its resources and to strengthen regional fisheries management organizations. Based on the commitment made by ministers in the 2002 Seoul Ocean Declaration, the Bali Plan of Action contains practical commitments to work towards healthy oceans and coasts for the sustainable growth and prosperity of the Asia-Pacific community. The APEC Bali Plan of Action (2005) seeks to balance conservation and management of marine resources with regional economic growth. It was adopted at the close of the second APEC ocean-related ministerial meeting. This new plan is intended to guide the work of APEC ocean-related working groups for the rest of the decade through domestic and regional actions in three key areas: ensuring the sustainable management of the marine environment; providing sustainable economic benefits from the oceans; and ensuring the sustainable development of coastal communities.

[27] A regional environmental agreement covering a large part of the marine area within APFIC's direct area of interest. The East Asia Seas region does not have a regional convention; instead COBSEA promotes compliance with existing environmental treaties and is based on member country goodwill. The Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the East Asian Seas Region (the East Asian Seas Action Plan) was approved in 1981 stimulated by concerns about the effects and sources of marine pollution. Initially, the action plan involved five countries (Indonesia, Malaysia, Philippines, Singapore and Thailand). In 1994, it was revised to involve another five countries (Australia, Cambodia, China, Republic of Korea and Viet Nam) and to this date the action plan still has ten member countries.

The FAO Code of Conduct for Responsible Fisheries (CCRF) defines norms for responsible fisheries and sets out principles and international standards of behaviour for responsible practices. The FAO Compliance Agreement is an integral part of CCRF. Furthermore, the international plans of action (IPOA) are voluntary instruments elaborated within the framework of the CCRF. They apply to all states and entities and to all fishers. Four IPOA have been developed to date, however two in particular are of interest to the region: management of fishing capacity and prevention and deterrence of IUU fishing. As part of its overall monitoring and reporting role, APFIC is attempting to monitor the state of planning and implementation of the NPOA within its region. Several countries have developed NPOA, however, it is still unclear how many additional countries have initiated the NPOA planning and implementation process in the region (draft or national equivalent to NPOA), although there are increasing reports of countries starting the process (Table 50). For the IPOA-Capacity, the implementation into NPOA has seen a variety of national equivalents to the NPOA and only a few countries have developed NPOA building on the IPOA. For the IPOA-IUU the implementation into NPOA has been started (and completed by several countries in the region). Specifically, for Pacific Island states, a specific model scheme has been developed to help in the formulation and implementation of the NPOA (Brown, 2005).

Other agreements in the region include: The Regional Plan of Action for Responsible Fishing which was signed by several countries in the region and also covers a large area of the seas in the region and complements the IPOA and NPOA on IUU fishing; the APEC Bali Plan of Action is directed towards promoting healthy oceans and coasts for sustainable growth and management of the marine environment and has a strong fisheries component; and the East Asian Seas Action Plan where the main components are assessment of the effects of human activities on the marine environment, control of coastal pollution, protection of mangroves, seagrasses and coral reefs, and waste management and is steered by the Coordinating Body for the Seas of East Asia (COBSEA)[28].

[28] The East Asian Seas Regional Coordinating Unit (EAS/RCU) serves as the Secretariat for COBSEA.

Table 50 Countries that have started the process of implementing the FAO IPOA through development of an NPOA or other measures equivalent in national planning documents

	IUU fishing	Capacity	Sharks	Seabirds
	NPOA	NPOA	NPOA	NPOA
South Asia				
Bangladesh	N			
Bhutan				
India		N		
Maldives				
Nepal				
Pakistan	N			
Sri Lanka		N		
Southeast Asia				
Brunei Darussalam				
Cambodia				
Indonesia	X (?)	X		
Lao PDR				
Malaysia		N	X	
Myanmar				
Philippines		N		
Singapore				
Thailand		N		
Timor-Leste				
Viet Nam				
Other Asia				
Iran (Islamic Rep. of)				
Japan	X		X	X
Kazakhstan				
DPR Korea				
Republic of Korea	X			
Mongolia				
Tajikistan				
Uzbekistan				
Oceania				
Australia	X	N	X	X
Cook Islands	Draft			
Fiji Islands	Draft			
Kiribati	Draft			
Marshall Islands			Draft	
Micronesia FSO	Draft			
Nauru				
New Zealand	X			X
Niue	Draft		Draft	
Palau	Draft		Draft	
Papua NG	Draft		Draft	
Samoa	Draft			
Solomon Islands				
Tonga	Draft			
Tuvalu	Draft			
Vanuatu	Draft			
China				
China	N	N		
Taiwan POC			X	
Other APFIC				
France	X			
UK	X		X	
USA	X	X	X	X
Region total*				
NPOA	5	1	4	3
Draft NPOA	11	0	4	
National equivalent	2	7		

The symbols used denote the following: (x) = NPOA; (draft) = draft NPOA; (N) = measure/policy on national level addressing the specific issue.

* Excluding France, UK and USA.

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