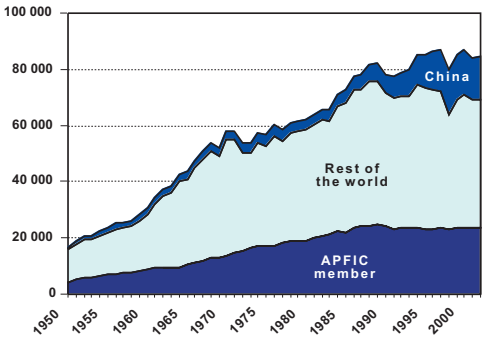
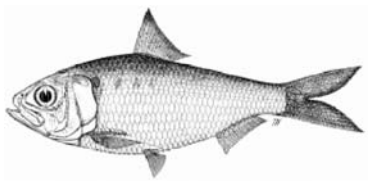
ASIA-PACIFIC FISHERY COMMISSION

Status and potential of fisheries and aquaculture in Asia and the Pacific 2008





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Status and potential of fisheries and aquaculture in Asia and the Pacific 2008

By

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Foreword

The Asia-Pacific Fishery Commission (APFIC) is committed to acting as a regional consultative forum, providing its member countries, regional organizations and fisheries professionals in the region with the opportunity to review, discuss and decide on actions and challenges facing the region's fisheries sector. As part of this function, APFIC has prepared the *Status and potential of fisheries and aquaculture in Asia and the Pacific 2008.* This is the latest in a series of biennial reviews provided for the deliberations of the biennial APFIC regional consultative forum meeting and the regular sessions of the commission.

The current volume 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.

Two key areas have also been identified by the commission for its biennial work programme, namely livelihoods in fisheries and the ecosystem approach to fisheries, and they are reviewed here to help members prepare for the commission's programme of regional consultative workshops to be convened during the coming biennium.

This document also contains a regional review of the FAO statistics supported with other information from regional partner organizations of the commission as well as trade, environmental and other arrangements. This information is organized around key resources and attempts to show the trends in the production of these resources. Future volumes will aim to provide more information regarding the management status of these stocks and species groupings.

He Changchui
Assistant Director-General and Regional Representative
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Preparation of this document

This document was prepared for the thirtieth session of the Asia-Pacific Fishery Commission (APFIC), which was held in Sulawesi, Indonesia from 11 to 13 August 2008. 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 analysing 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 the emerging issues facing the sector.

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 sub-divided into the following subregions;

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

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

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

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

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

Production areas[1]

All catches made outside the subregional areas mentioned above are excluded from this review. The subregional areas cover the FAO major fishing areas (MFAs) as follows:

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)

Species

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

[1] If specifically mentioned, the data presented could also correspond to other production areas (e.g. "world production" might refer to all FAO major fishing areas).

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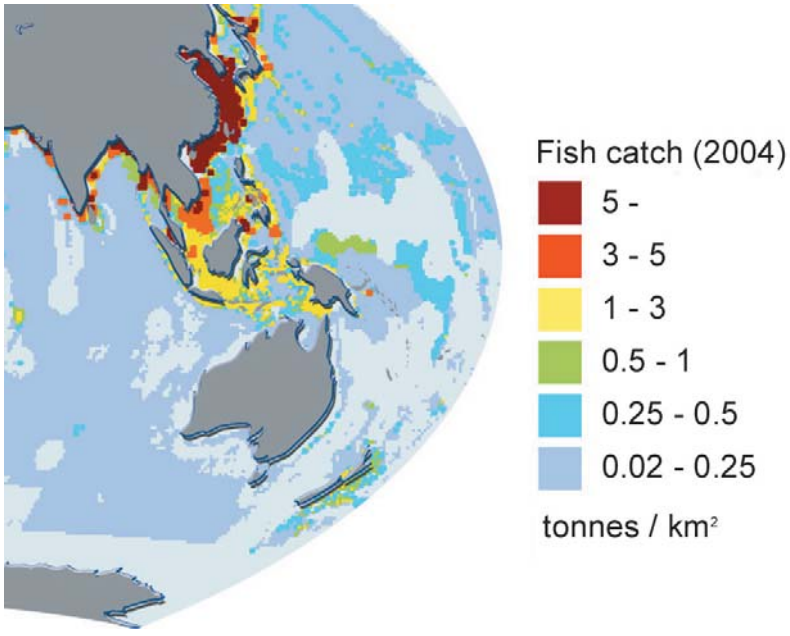
1. Contributions of fisheries and aquaculture in Asia and the Pacific region

In Asia and the Pacific region, capture fisheries have increased slightly in terms of production whereas aquaculture has continued to grow at a rapid rate since the publication of the previous APFIC biennial review *Status and potential of fisheries and aquaculture in Asia and the Pacific region 2006*. In terms of food security, revenue generation and employment, both capture fisheries and aquaculture sectors continue to be of fundamental importance to the region as can be seen by the tonnage and value produced.

In many of the countries of the region, catching or farming aquatic resources forms a vital part of rural people's livelihoods. Fisheries and aquaculture also have a deep cultural significance and are more than more just sources of income or food supply; traditional fishery products such as fish sauce and fish-based condiments have always been important ingredients of people's daily diets and are not easily substituted. All sizes and types of fish are utilized in a wide variety of ways and there is very little discarding or wastage.

The role that fish play in both the food security and nutritional security of many rural and coastal populations has often been underestimated in the past. It is also now increasingly recognized that fisheries and aquaculture are important contributors to the national economies of some APFIC member countries, especially those in the Asian region. In value terms, fish products are also the most heavily traded natural food commodity in the world and trade issues involving fish are becoming increasingly important.

Based on 2004 data, it has been estimated that Asia and the Pacific region is one of the heaviest fished areas in the world (Map A). Part of this effort can be handled by a highly resilient and productive ecosystem, but signs of overfishing are becoming more and more apparent in the region. The high mobility of regional fisheries fleets has so far kept the production high, but the unexploited areas are becoming fewer and fewer.



Map A: Fish catch (tonnes) by square kilometre, modified from UNEP. 2008. *In dead waters.*

Table 1 Contribution of capture fisheries and aquaculture to GDP (2006). Production value as percent of GDP[2]

Capture fisheries		Aquaculture	
Marshall Islands	62.8	Viet Nam	16.0
Kiribati	57.7	Myanmar	8.8
Vanuatu	37.6	Lao PDR	4.4
Maldives	26.6	DPR Korea	2.4
Solomon Islands	14.9	China	2.3
Tuvalu	13.6	French Polynesia	1.9
Cambodia	11.4	Bangladesh	1.9
Myanmar	9.9	Philippines	1.5
Viet Nam	9.5	Cambodia	1.3
Micronesia	7.0	Thailand	1.3
Papua New Guinea	4.6	Indonesia	1.0
Cook Islands	3.9	New Caledonia	0.6
Philippines	3.0	Nepal	0.5
Fiji	2.5	India	0.4
Bangladesh	2.0	Vanuatu	0.3
Indonesia	1.9	New Zealand	0.3
DPR Korea	1.6	Kiribati	0.3
Tonga	1.6	Malaysia	0.3
Thailand	1.6	RO Korea	0.2
Sri Lanka	1.3	Iran	0.2
Lao PDR	1.3	Pakistan	0.2
Malaysia	1.1	Sri Lanka	0.2
Palau	1.1	Japan	0.1
China	0.9	Fiji	0.1
New Zealand	0.7	Australia	0.1
India	0.5	Brunei	0.1

Table 2 Top five trading states in 2006 (World)

Import		Export	
	US$ (Million)		US$ (Million)
Japan	14 259	China	9 150
USA	13 400	Norway	5 544
Spain	6 378	Thailand	5 245
France	5 109	USA	4 190
Italy	4 746	Denmark	3 999

1.1 Contribution to national economies

Although not fully recognized as a major contributor to gross domestic product (GDP) in many countries, fisheries and aquaculture production is an important contributor to many national economies across Asia and the Pacific region.

Estimates of the capture production value[3] indicate that the contribution of capture fisheries to GDP accounts for more than one percent in many states in the region (Table 1). In particular, the fisheries sector plays a critical role in contributing to the national economies of small island developing states (SIDS). The economic contribution of capture fisheries production is less in Southeast and South Asian states, yet eleven of these states have fisheries that contribute more than one percent of GDP. It is worth noting that these figures for the value of capture fisheries are probably underestimated and do not adequately account for the artisanal part of the sector, especially of the inland sector. Overall it is clear that more policy attention should be paid to this important production sector and this issue will be explored further in Chapter 3. Aquaculture also makes an important contribution to GDP in the Asian region and it is increasing. In Asian and Pacific states, aquaculture production accounts for over one percent of GDP in eleven states. Statistics related to export income from aquaculture products are not generally available and this affects the estimation of the contribution to foreign currency earnings through exports of aquaculture products.

It can be seen that some of the states referred to under “Aquaculture” in Table 1 export considerable amounts of seafood products (Tables 2 & 3), many of which are aquaculture products, particularly shrimp. China is an exception in this case, since the majority of aquaculture products it produces are consumed domestically. Still, China is the biggest exporter in the world and there is an increasing trend towards export-focused products.

It should be noted that besides making a considerable contribution to the national economies in terms of earnings from export of products from fisheries and aquaculture, these figures often mask the real importance to the national economy in terms of poverty alleviation and nutritional benefits.

1.2 Employment, income and trade

There is only limited information available on employment in fisheries and aquaculture in Asia and the Pacific region and only a few states report the number of fishers and fish farmers. Despite this, there are clear indications that fisheries and aquaculture play a substantial role in providing vital income generation opportunities to the people of the region.

[2] ESCAP’s *Statistical Yearbook for Asia and the Pacific 2007*. Available from http://www.unescap.org/stat/data/syb2007/

[3] The data to quantify the value of capture production is not readily available for many states. As an indicative figure, a unit value of US$1.0 per kg was applied for this estimation of capture production value.

FAO (2006)[4] estimated that Asia accounted for 87 percent of the total global number of persons engaged in fisheries and aquaculture production (total 41.4 million). China, the country with the highest number of fishers and fish farmers, had an estimated 13.0 million engaged in fisheries in 2004, accounting for 31.4 percent of the world's total. In Indonesia, 6.2 million people were directly engaged in fishing and fish farming. These figures typically represent full-time fishers and those for whom fishing is a highly significant activity and also full-time aquaculture farmers. The figures for people involved in fisheries seasonally or as a supplemental part of a more diverse livelihood (i.e. occasional fishers) are difficult to estimate and are often not even recorded. Figures, therefore, represent lower thresholds.

Although the number of people employed in fisheries and particularly in aquaculture has increased in several countries in the region, the number in developed countries has declined (e.g. Japan recorded a decline of 58 percent between 1970 and 2004). In addition to those people involved directly in the primary production sector, there are a number of people who are engaged in the supporting industries of fisheries and aquaculture such as boat building, ice making, feed manufacturing, processing, marketing and distribution of fisheries and aquaculture products. As demand outstrips supply, the price of fish is increasing worldwide and fish is becoming a "cash crop". In many cases, the more marketable fish are being sold to provide income that is used to purchase other more affordable food items. Fisheries and aquaculture therefore both help to secure nutritious food for rural and coastal populations and alleviate their poverty.

Table 3 Top ten seafood trading states in 2006 (APFIC region)

Import		Export	
	US$ (Million)		**US$ (Million)**
Japan	14 259	China	9 150
China	4 189	Thailand	5 245
RO Korea	2 768	Viet Nam	3 363
Hong Kong SAR	2 058	Indonesia	2 020
Thailand	1 573	India	1 769
Australia	933	Japan	1 457
Singapore	757	Taiwan POC	1 442
Malaysia	580	RO Korea	1 049
Taiwan POC	580	Australia	940
Viet Nam	281	New Zealand	876

China has been the top exporter in the region since 1999, with exports reaching US$9 200 million in 2006. Thailand is the second largest exporter, followed by Viet Nam exporting US$5 200 million and US$3 300 million tonnes respectively in 2006 (Table 3). Of these exports, the main commodities (by value) are: fish fillets, shrimps and prawns and molluscs (China); shrimp and prawns and tuna (Thailand); shrimp and prawns and catfish fillets (Viet Nam) and shrimp and prawns (Indonesia and India). Within the region, Japan is the main market followed by China, Republic of Korea and Hong Kong SAR.

Within the top ten states in the region, exports totalled US$27 300 million, whereas imports totalled US$28 000 million. Many of the countries now import large quantities of fish meal. The top five fishmeal importing countries in the region are China, Japan, Taiwan POC, Indonesia and Viet Nam (a total of 1.8 million tonnes) whereas the top five fishmeal exporting countries are Thailand, Viet Nam, Malaysia, New Zealand and Japan (a total of 0.17 million tonnes). Hence there is a net import of fish meal to the region to fuel its aquaculture growth.

Many developing countries have now become net exporters of fish, rather than net importers, a trend most evident in the Southeast Asian region. In contrast, the quantity of imported fisheries products in China exceeded that of exported products in 2006 (Figure 1); however, China achieved a remarkable trade surplus of US$5 800 million from fisheries products, which is an increase of more than US$2 000 million from 2002. This is indicative of the strong value adding that occurs in the process.

Trade for fish is particularly important in SIDS where land-based resources are very limited, e.g. the contribution of fisheries products can be as high as 80 percent of total exported commodities of these states. Other countries with a high trade surplus are the big net exporters such as Thailand, Viet Nam, Indonesia and India.

[4] FAO SOFIA, FAO, Rome, 2006

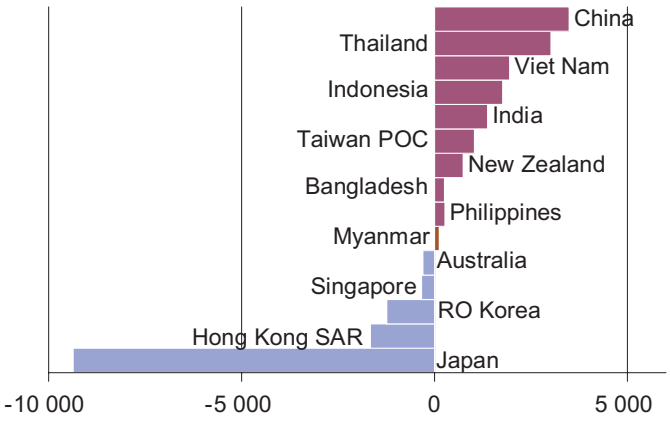


Figure 1 Net exporters (red bars) and net importers (blue bars) of fishery and aquaculture products in the APFIC region for 2006 (in millions of US$).

1.3 Contribution to poverty alleviation and food security

Importance of the fisheries sector in poverty alleviation

Although rapid economic growth in the region, especially in India and China, has lifted a large number of people out of poverty, 34 and 10 percent of Indian and Chinese populations, respectively, still live below the US$1 a day level.[5] Bangladesh, Cambodia, Lao PDR and Nepal are other countries in the region that still have a high percentage of the population living below US$1 per day (43, 34, 27 and 24 percent respectively). Almost all analyses of poverty alleviation conclude that economic growth by itself will not be sufficient to alleviate poverty and reduce food insecurity, and that it must be accompanied by targeted pro-poor interventions. In this context, FAO[6] advocates a vision in which the potential of small-scale fisheries to contribute to sustainable development is fully realized. FAO recommends greater emphasis on legislation and policy to support the poor and advocates: (i) better management that includes managing small-scale fisheries; (ii) making markets work for the poor; (iii) financing poverty alleviation programmes; and (iv) appropriate information, research and communication.

Importance of fish in human nutrition

In a few countries in the world, fish consumption can contribute up to 180 kcal per capita per day, but reaches such high levels only where there is a lack of alternative protein foods grown locally or where there is a strong preference for fish, e.g. Japan and some small island states.[7] In industrialized countries, fish provides on average 20 to 30 kcal per capita per day. Additionally, fish proteins are essential in the diet of some densely populated countries where the total protein intake level is low, and are very important in the diets of many other countries. The fact that fish is of high nutritional value is well known. Less well known is the significant contribution that it makes to the diet of many fish-consuming communities in both the developed and developing world. Fish, especially marine fish, provides high quality protein and a wide variety of vitamins and minerals, including vitamins A and D, phosphorus, magnesium, selenium, and iodine. Fish is also a valuable source of essential fatty acids and its protein is easily digestible.

Even in small quantities, fish can have a significant positive impact on improving the quality of dietary protein intake by complementing the essential amino acids that are often present in low quantities in the rice and vegetable diets typical of many developing states. In particular, fish is a rich source of lysine which is an essential amino acid that is often deficient in rice diets with little animal protein.

Recent research shows that fish is much more than just an alternative source of animal protein. Fish oils in fatty fish are the richest source of a type of fat that is vital for brain development in unborn babies and infants. This makes all fish and especially fatty fish, such as tuna, mackerel and sardine, particularly good components of the diet of pregnant and lactating women. It is therefore apparent that fish makes a valuable contribution to the nutritional quality of the diets of the populations of many developing countries in Asia and the Pacific region.

One disconcerting point in relation to the above mentioned benefits is recent reports that the usage of vegetable oil in feeds instead of fish oil has meant a 50 percent reduction in Omega-3 fatty acids

[5] ESCAP's *Statistical Yearbook for Asia and the Pacific 2007*. Available from http://www.unescap.org/stat/data/syb2007/

[6] FAO. 2005. *Increasing the contribution of small-scale fisheries to poverty alleviation and food security*. FAO Technical Guidelines for Responsible Fisheries 10.

[7] http://www.who.int/nutrition/topics/3_foodconsumption/en/index5.html

(DHA and EPA) in some cultured products.[8] The same report also concluded that this reduction affected a number of known risk factors for heart diseases. Moreover, a higher fatty content of fish means a higher risk (prevalence) of stored toxins (e.g. heavy metals). The main source of mercury exposure, especially in populations that rely heavily on consumption of predatory fish, is consumption of contaminated fish and shellfish.[9] Hence, the pros and cons of the fatty content of fish are still debated. However, more recently several health departments have concluded that the benefits of seafood consumption greatly outweigh the risks.

[8] Sverre Seierstad.2008. PhD dissertation, 2008 Veterinary University of Norway.

[9] http://www.who.int/phe/news/Mercury-flyer.pdf

2. Contemporary regional issues

This section deals with the issues currently facing the sectors, and that have been addressed by APFIC in the last biennium. In Asian inland waters, most fisheries are small-scale activities where the catch per capita is relatively small and used mainly for subsistence purposes. There are some notable exceptions, e.g. where there are fishing concessions such as the "fishing lots" and the *dai* or bag net fisheries of Cambodia, the fishing *inns* of Myanmar and reservoir marketing concessions. The lack of accurate reporting of small-scale fisheries operations makes it difficult to describe their status, but it is generally felt that they are under considerable pressure from loss and degradation of habitat as well as overfishing. There are consistent reports of declining catch and declining catch per unit effort. The size and quality of landings from inland capture fisheries is also generally declining. There are a few places where fisheries enhancements and restocking may be contributing to increased catch (such as enhanced reservoir and lake fisheries, or some of the fishing *inns* in Myanmar), however these are relatively limited volumes when placed against the total production from inland waters.

In marine waters there has been a significant shift in the perception of what the important issues are. After a long period of heavily emphasizing increasing fishing effort and production, there is now an apparent growing realization that we have entered an era where there is an urgent need for improved fisheries management. The two chief targets of this are identified as the need to reduce fishing capacity in coastal and nearshore fisheries and to tackle the extensive problem of IUU fishing. The trend of decentralization of government in many countries, including in the management of natural resources, is also challenging institutions and ways of working, offering opportunities for more effective local management (so called co-management systems). This is set within a broader problem of lack of resources and experience as to how to start up the significant task of empowering and mobilizing resource users to take advantage of the opportunities presented by these changes.

In aquaculture there are clear challenges to meet the growing demand for fish and this can be translated into opportunity if the conditions are right. It is not a straightforward process as feed and fuel prices are spiraling upwards and the demands for land and water in the region make finding suitable sites for aquaculture increasingly difficult. Mariculture offers great opportunities if the challenge of constrained marine-based feeds can be overcome. The environmental restrictions on aquaculture also require more innovative efforts to produce products that are acceptable to markets that are increasingly sensitized to production practices and methods. Certification and branding of aquaculture products have seen rapid gains in the past two years and these are now clearly becoming major areas of interest for accessing marketing chains, especially for export markets.

2.1 Inland fisheries – food security and data requirements

The inland fisheries in Asia and the Pacific region, and especially in Southeast Asia, are increasingly being recognized as very important for food security and the livelihoods of poor people in rural areas.[10] In the rural areas, almost all households, regardless of whether they are farmers or fishers, engage in fishing or collecting aquatic organisms at some time of the year. In cultural terms, aquatic resources also mean more than a mere source of income or food supply as they often play a central role in traditional dishes and food of the region and even in festivals where these enormous inland fisheries resources exist.

Furthermore, the high population density in Asia makes the per capita availability of freshwater the lowest in the world. Hence, there is a high demand for and competing uses of freshwater which have a major impact on fisheries. In this region, most inland fisheries are small-scale activities where the catch per craft (or catch per capita) is relatively small and the catch more often than not is disposed of on the same day. The main exceptions are the industrialized fisheries concessions in the lower Mekong Basin such as the "fishing lots" and the *dai* fisheries in the Tonle Sap of Cambodia and on some of the large rivers and the fishing *inns* of Myanmar.

[10] FAO 2007, *Report of the 3rd regional workshop – Addressing the Quality of Information in Inland Fisheries*, 20–23 March, Padang, Indonesia, TCP/RAS/3013, Field Document 17.

Unfortunately, inland fisheries are often poorly recognized and given low priority by governments, since they are not a visible part of income generation and staple food production. There is an urgent need for information that adequately reflects these realities. A recent review of current fisheries statistics in Southeast Asia highlighted that there were serious discrepancies between the current statistics and the reality.[11] One reason for these discrepancies is that the involvement of millions of rural people in small-scale activities is not included in most current national statistics.

Data requirements

Part of the problem is the undervaluation of inland fisheries as a food resource, especially for rural people. In the official country statistics, the inland catch is systematically underreported and hence the marine catch appears to be more important for the domestic food security of the country. Inland fish are also usually not as highly priced as marine fish, mainly because of the lower catch and fuel costs, and the tendency to be landed in a diffuse manner (unlike marine capture which might be landed at a port) and hence don't draw so much attention. In combination, these facts add up to the fact that in many countries inland fisheries may be more important than marine fisheries from a food security or nutritional perspective. Moreover, in calculations of domestic protein supply, which is a frequently cited FAO calculation, this gives a distorted picture. That this is unrecognized has meant that interest in managing these resources has been low or non-existent.

China and other developing countries accounted for 94.5 percent of the global inland catches in 2004 as reported by FAO.[12] In 2006 the figure was 90.6 percent, with China being the biggest producer followed by Bangladesh and India. Furthermore, the lack of inclusion of recreational 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 bias trend analysis by species or species groups of the inland catch data. In 2006, global inland catches classified as "freshwater fishes not elsewhere included"[13] again exceeded 50 percent (57.2 percent) of the total, and about 74 percent in Asia and the Pacific region. A most worrying trend is that these figures are actually increasing both globally and in the region. As most fisheries management schemes require species level data to function optimally, the fact that they are unavailable is a major obstacle for successful inland fisheries management. Consequently, in countries where inland fisheries are significant for food security and economic development, as in Asia, the mismanagement of inland fisheries could lead to economic losses far greater than the expenditures needed to improve significantly the quality and detail of inland catch statistics.[14]

There have been two major increases in the Southeast Asia regional inland capture fisheries statistics in the last 15 years, namely in Cambodia and in Myanmar (Figure 2). Part of the rapid increase in these two countries probably can be explained by improved reporting of fisheries statistics. Hence, over that last 15 years the trend is that production has been stable in Southeast Asia. We can also interpret this as suggesting that inland fisheries are not being measured and thus estimates are not varying from year to year. We do know that inland fisheries are highly sensitive to the rainfall and flooding-monsoon seasons and that these vary between years thus giving clear fluctuations in catch between years that are rarely reflected in national statistical reporting. Additionally, a recent estimation of Thailand's inland capture fisheries production came up with the figure 1.0 million tonnes for the current production, compared to 0.2 million tonnes reported earlier[15]. Hence, it can be expected that Thailand will revise its official statistics for inland capture production in the coming years. Again, although probably a few years away, this jump in the statistics does not reflect a real increase in production, but really just reflects an improvement/change in how the statistics are collected.

APFIC Recommendation

MEMBER COUNTRIES SHOULD ATTEMPT TO DERIVE MORE SUBSTANTIVE INFORMATION REGARDING WHETHER THE GENERAL TRENDS IN INLAND FISHERIES CATCHES ARE INCREASING OR DECREASING.

[11] Coates, D. 2002. *Inland capture fishery statistics of Southeast Asia: current status and information needs*. RAP Publication No. 2002/11. FAO. Bangkok.
[12] FAO. 2007. *The state of world fisheries and aquaculture 2006*. Rome.
[13] This refers to a conglomerate of many freshwater species.
[14] FAO. 2007. *The state of world fisheries and aquaculture 2006*. Rome.
[15] Lymer, Funge-Smith et al. 2008. *A review and synthesis of capture fisheries data in Thailand*. RAP Publication (in progress). FAO. Bangkok.

There is therefore no room for complacency about inland fisheries. In reality we are not seeing a major trend of increasing production from the inland fisheries, but more a general revision upward to what the fisheries are actually producing. The real trend may well be a decline, as we know that inland fisheries, although quite robust (in terms of total production) when faced with increasing fishing effort, are very sensitive to environmental changes. Water flow modification, river training, wetland conversion and floodplain developments, agricultural transformations all have subtle or even dramatic effects on the behaviour of inland fisheries and can result in sudden and significant changes in the quality and quantity of the fish catches.

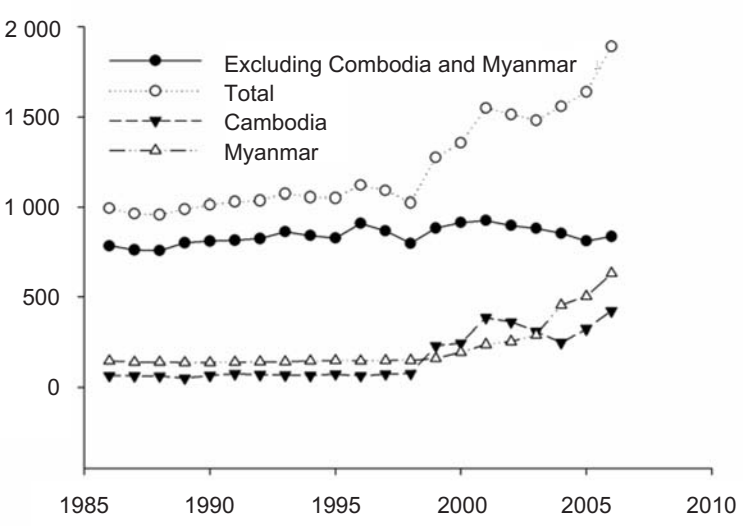


Figure 2 Trend in the reported inland capture fisheries in Southeast Asia during the last 20 years of inland capture fisheries (thousand tonnes).

A critical starting point is to estimate the actual production of the fisheries. One way has been to look at consumption figures and back calculate this into what actually has been caught.[16] This helps us know the yield of the fishery and in this specific case the underreporting by official statistics of actual catch. The Mekong River Commission has used this method to estimate the production in the Mekong Basin and concluded it was four times higher (on average) than officially reported. These revised estimates have implications for official statistics, since once they are more formally reflected in officially submitted statistics, the increased values will reflect the change in the collection methodology and not represent a real production increase. Nevertheless, all these historical and tentative revisions highlight the importance of inland capture fisheries for food security and rural livelihoods.

Aggregated production statistics are useful in highlighting the role and importance of inland fisheries to the economy and food security. They are not particularly useful for management decision-making. A critical challenge is how to get the right information to manage these fisheries. The small diffuse and high participatory fisheries of Southeast Asia can, by their nature, not be measured by traditional information gathering systems. Traditional information gathering systems that require a specific landing place and possibly registration by fisher/fishery/ or gear simply does not catch the high number of low-level and dispersed fishers. However, management actions and decisions relating to the management of the fishery cannot be undertaken without such information.

APFIC — A REGIONAL CHALLENGE

IF THE PROBLEM IS THAT INLAND FISHERIES ARE UNRECOGNIZED FOR THEIR CRITICAL ROLE AND IMPORTANCE TO FOOD SECURITY, HOW CAN THIS BE CORRECTED?

A recently concluded FAO project (AQUIIF) with several case studies on inland fisheries in the region, used alternative methods to generate information about inland fisheries. Although different approaches were used, a common feature of all was that the methods explored in the project focused on people, institutions and the link between fish, people, organizations and the ecosystem. The project concluded that it is important to look outwards from the fishery sector to engage with other stakeholders in aquatic resources management. In fact, this was probably the most important feature for management. These other non-fishery sectors include environmental stakeholders and also those involved in basin and flood plain management, flood management and stakeholders whose actions affect connectivity (as for example road planning, drainage, river training). A specific example in road planning could be how many culverts

[16] Hortle, K.H. 2007. *Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin*. MRC Technical Report No. 16, Mekong River Commission, Vientiane. 88 pp.

to use per kilometre of newly developed road to try to maintain connectivity between the floodplain and the river. Other areas of interest are the deliberate retention of water bodies within a drained system to sustain some re-recruitment to the fishery.

When we look at this expanded view of fisheries management it is clear that the information needs go far beyond simple information about the fishery resource production. The use of the ecosystem approach to fisheries management[17] is intended to ensure the inclusion of all stakeholders in the management of aquatic biological systems. To date, the application of the ecosystems approach in an FAO context has only been applied to marine ecosystems.[18] When it comes to inland fisheries there may actually be more examples of the application of the ecosystem approach, although often referred to under different names. The closest resemblance is probably integrated river basin management (IRBM)[19] which also focuses on the inter-sectoral interactions with respect to water. IRBM "is the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems."[20] The main difference here is that the ecosystem approach to fisheries management focuses on the management of fisheries, whereas basin management, watershed management etc. uses water as the principle focus. New approaches place fisheries, biodiversity and living resources at the centre of the planning process since these resources are excellent indicators of the health and integrity of the environment (e.g. European Union water framework directive).

Information generation needs to focus on the information needs for management. This information will be of a wide variety of types covering resources, value, use and human and sectoral interactions. The process of using information needs to be changed. It is not adequate to simply print and publish data expecting it to be utilized. There is the need to communicate the meaning of the information and put it into the broader context. This requires clear engagement of the fishery sector in broader planning initiatives and the recognition of the services that are delivered by the fishery. Some key steps in this process are:

- national fisheries information strategy developed;
- resourcing of information collection addressed in the strategy;
- identification of key relationships between sectoral institutions (planning, environment, water management etc.) and development of formal arrangements for communication;
- identification of information needs according to the types of fishery;
- preparation of the information into a form that can be used by the stakeholder (i.e. impact predictions for water management discussions, trends for fisheries management groups);
- prioritization of the information collection process (including monthly, annual or periodic collection); and
- contingency plans for unforeseen episodes that require rapid focussed assessment (e.g. localized impact, pollution events, EIA etc.).

Importance of fisheries in the Lower Mekong Basin (LMB)

The fisheries in the Mekong River are immense, even by world standards. Recent studies have shown that the yield from the fisheries and aquaculture (including aquatic animals other than fish) is between 2 to 3 million tonnes per annum. To put some perspective on that figure, the capture fishery yield from the Mekong is approximately 2 percent of the total world marine and freshwater capture fishery.

Extrapolation from average prices for capture and aquaculture product gives a first sale value for the fishery of at least US$2 000 million. This figure is very conservative and probably an underestimate because of the increasing price of fish and the rapid expansion of aquaculture in the Mekong delta in

[17] The ecosystem approach to fisheries management "…is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystem." FAO. 2003. *The ecosystem approach to fisheries.* FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome. 112 pp.

[18] FAO. 2005. Putting into practice the ecosystem approach to fisheries. Rome, FAO. 2005. 76 pp.

[19] http://www.panda.org/about_wwf/what_we_do/freshwater/our_solutions/rivers/irbm/index.cfm

[20] Adapted by World Wide Fund for Nature (WWF) from Integrated Water Resources Management, Global Water Partnership Technical Advisory Committee Background Papers, No. 4, 2000. See www.panda.org

Viet Nam in the last few years. The multiplier effect of trade in fisheries products would increase the value of the fishery markedly.

There are about 1 000 species of fish in the Mekong freshwater system, with many more marine migrants occasionally entering freshwaters. In terms of fish biodiversity, the Amazon River contains the most fish species of any river in the world, but the Mekong probably ranks second along with the Zaire River. The Mekong has more families of fishes than any other river system. About 120 fish species are regularly traded.

The fisheries are nutritionally important for the people of the LMB. Fish are the primary source of animal protein, and a major supplier of several micronutrients, notably calcium and vitamin A. Consumption of fishery products is about 46 kg/person/year as fresh-fish-equivalent, or 34 kg/person/year as actual consumption. There are no readily available foods to substitute for fish in the diets of people in the LMB. Hence, fisheries are extremely important for food security.

The bulk of the production comes from the river fishery, which is a renewable resource, available every year, unlike other natural resource industries like mining and petroleum. In addition, relatively little capital input is required in the river fishery to generate the product when compared to other natural resource or manufacturing industries.

Maintenance of the flood pulse and migration routes is fundamentally important for the health of the fisheries. The annual flood inundates vast areas of wetlands, creating highly productive fisheries habitats. The receding waters facilitate capture of the fish, some species of which are undergoing annual migrations to spawning grounds up-river. Many of the important commercial species (63 percent of the catch in the Cambodian river fishery) migrate long distances between spawning and nursery/feeding grounds. Barriers to migration, for instance irrigation weirs and hydropower dams, have severe impacts on the survival of the highly migratory species, and thus on fisheries productivity.

The LMB is home to approximately 60 million people. The increase in population places huge pressures on the fishery, both directly through increased fishing pressure and habitat loss, and indirectly through modification of water quality and quantity. Most fisheries in the LMB are under some form of community management and regulation. However, access for subsistence and income by an increasingly young, landless and unskilled population is largely unrestricted.

From a fisheries perspective, the Mekong is not just another river. It is immensely important for the livelihoods of people of the LMB, particularly in terms of its vast fisheries resources. Management agencies face difficult decisions in balancing the needs for development (for instance hydropower dams with their focused income streams and easily recognized benefits) with maintenance of fisheries (which are a form of traditional, communal wealth with generalized benefits that are not readily appreciated).

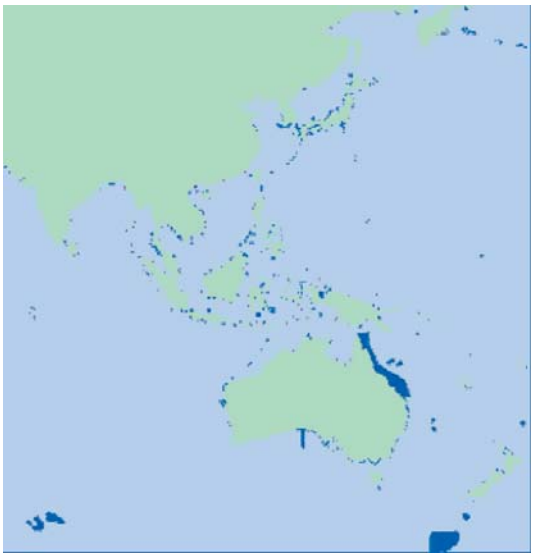
Table 4 Fish consumption in selected Mekong River areas, based on populations in the year 2000 (kg/capita/year as actual consumption)

	Cambodia	Lao PDR	Thailand	Viet Nam	Total
Inland fish	32.3	24.5	24.9	34.5	29.3
Other aquatic animals (OAAs)	4.5	4.1	4.2	4.5	4.3
Total inland fish and OAAs	36.8	28.6	29.0	39.0	33.7
Estimated consumption (tonnes/year as fresh whole animal equivalents) of inland fish and other aquatic animals					
Inland fish	481 537	167 922	720 501	692 118	2 062 077
Other aquatic animals (OAAs)	105 467	40 581	190 984	160 705	497 737
Total inland fish and OAAs	587 004	208 503	911 485	852 823	2 559 815
The total tonnage of fish consumed in the LMB is a surrogate measure of yield in the LMB. However, the consumption figures for each country are not indicative of the yields within the countries as they do not account for the trade of fisheries products between countries.[21]					

[21] Hortle, K.G. 2007. *Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin*. MRC Technical Paper No. 16, Mekong River Commission, Vientiane. 87 pp.

2.2 Marine fisheries policy: marine protected areas, IUU fishing and capacity

Marine protected areas as a tool for fisheries management: promises and limitations[22]



Map C Blue dots represent MPAs as recorded in a global database (2005)[23]

The notion that marine protected areas (MPAs) are a useful tool for fisheries management has developed over the last 15 to 20 years. Although MPAs may have clear benefits as a management tool, without broader fishery management measures and without being integrated in a wider management environment their use remains questionable. However, it is apparent that MPAs are part of a strong belief system with a steadily growing number of adherents both inside and outside the marine and fisheries science communities.

Real or assumed failures of conventional fisheries management approaches and the fashionable, but probably misunderstood and therefore distorted, understanding of ecosystem approaches to fisheries management have led to a growing emphasis on the role of MPAs as an appropriate and effective fisheries management tool. This section seeks to challenge the assumption that fisheries management requires MPAs. This will be done by questioning what MPAs can actually do and what they cannot do and what benefits they produce, where and for whom. More specifically we ask:

- Does the status of a fishery really depend on habitat condition?
- Are the benefits derived from MPAs greater than those derived from reduced effort?
- Do MPAs address excess effort in a fishery?
- Do the assumed benefits from spill-over and dispersal compensate for the loss to a fishery or even exceed the loss to a fishery through the reduction of the potential sustainable harvest from any given stock?

Arguments for establishing MPAs for fisheries management

The faith in MPAs as a suitable fisheries management tool is founded on a handful of arguments that challenge the wisdom of conventional fisheries management approaches. It is argued that conventional fisheries management, with its focus on single species and maximum sustainable yield, is incapable of dealing with the complexities of marine ecosystems and food webs. MPAs are suggested as an alternative that seeks to protect these complex and unpredictable systems and to provide the organisms living within them with refuges in which they are safe from human exploitation.

Modelling of the biological benefits of MPAs clearly shows how the removal of human activity from an ecosystem results in some immediate benefits and then a series of longer term changes that see the ecosystem restore itself to a new equilibrium, with higher biological diversity and increased abundance. The assumptions are that with these gains inside the MPA, there are concomitant impacts on a broader area. The benefits within the MPA are seen to be the opening up of new opportunities for "non-

Box 1 A note about MPA terminology:

"Marine protected area" is usually understood to be a generic term that describes various forms and levels of protection of a marine water body. Definitions abound, and various terms are being used to describe different types of MPAs: marine park, sanctuary, conservation zone, closed area, marine reserves. For the sake of argument, in this report we use the term MPA for marine areas that are fully closed to any activities that extract animals and plants or modify habitats. Such strictly closed areas often constitute the core of wider and more generic MPAs and are assumed to generate far higher biological benefits as they provide more comprehensive levels of protection.

[22] Prepared by Theo Ebbers.
[23] Available from http://www.seaaroundus.org/ecosystemsmaps/images/mpaglobal_worldmap.pdf

extractive" type activities that are based on the "natural value", the most obvious being the potential for tourism and tourism-related activities (diving etc.) Based on this model, proponents of MPAs are quick to point out the benefits of MPAs for fisheries. The predictions of the model have been confirmed by numerous case studies around the world, confirming that marine areas closed to fishing have the potential to produce huge biological gains within the protected area.

Biological benefits within MPAs

Summarizing some research findings from around the world, PISCO's[24]. *The science of marine reserves* seeks to dispel any reservations about the biological gains that can be achieved within, what they call, a marine reserve. A global review of studies of 124 of such marine reserves revealed that fishes, invertebrates, and seaweeds had the following average increases inside marine reserves:

- biomass, or the mass of animals and plants, increased an average of 446 percent;
- density, or the number of plants or animals in a given area, increased an average of 166 percent;
- body size of animals increased an average of 28 percent; and
- species diversity or the number of species increased an average of 21 percent in the sample area.

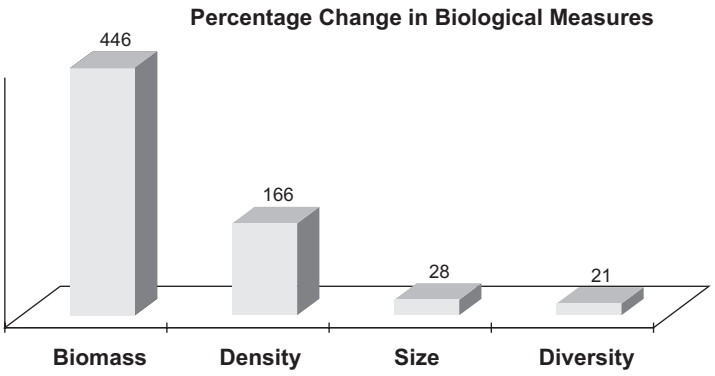


Figure 3 Biological gains within MPAs

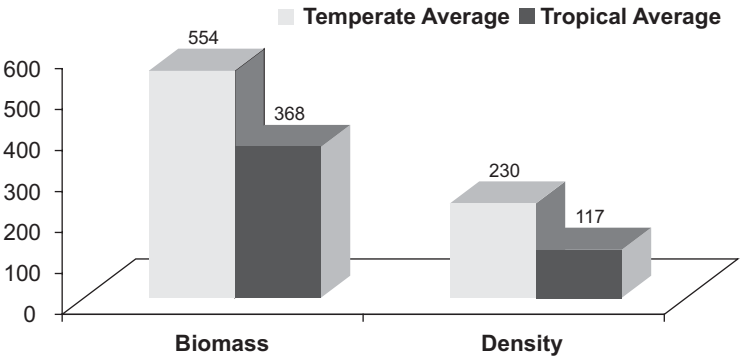


Figure 4 Biological gains in tropical and temperate MPAs

The researchers maintain that "[h]eavily fished species often showed the most dramatic increases. Some fished species had more than 1 000 percent higher biomass or density inside marine reserves." A comparison of increases in biomass and density between tropical and temperate marine reserves showed that MPAs in temperate waters have slightly higher average gains than tropical areas.

These differences between temperate and tropical areas are one of the many examples showing that there are variations between different reserves in different locations. Although the overall biological impacts of closing an area are positive, case studies of fish sanctuaries in the Philippines for instance show significant variations in how various fish species react differently within the same area. These studies also clearly show that the success of an MPA in terms of generating biological gains within the closed area are dependent on several local factors, of which size, enforcement and fishing effort outside the area seem to be the most important.

Benefits outside the protected area

Whereas the benefits inside a closed area are clear and rather obvious, the question of how this closure benefits the wider fishery and those that rely on it is less obvious. One of the principal assumptions of the wider benefit of closed areas is that the fishery resources within the area will disperse or "seed" into the surrounding areas, thus benefiting fishers and other resource users. This is because the MPA boundaries are not physical and fish can move in and out of the area. This "spillover effect" from marine

[24] Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). 2007. *The science of marine reserves.* 2nd edition. Available from http://www.piscoweb.org/outreach/pubs/reserves

reserves has often been used as an argument to convince fishing communities and fishery managers that the establishment of MPAs is in their own best interest. Because of such spillover effects, MPAs have been compared with “fish banks”, with the fish inside the MPA being the “principal” that produces the “interest”, i.e. the fish that swims out of the MPA area that can be used by the fishers.

Though such spillover effects are less well documented than the biological gains inside the area, there are some studies that confirm significant dispersal rates for various fish species and other marine organisms. Several studies from the Philippines confirm an increase in catch rates in areas surrounding the protected area; these fishing gains, however, decrease with increasing distance from the area. As such increases have also been observed in comparable control areas, where there is no MPA, it is actually difficult to establish a causal relationship between a protected area and gains in fisheries. The evidence for such fishing benefits of MPAs mostly comes from interviews with fishers who were fishing in these areas; observed improvement of catches may well be caused by the general decrease of destructive fishing methods like fishing with explosives and cyanide.

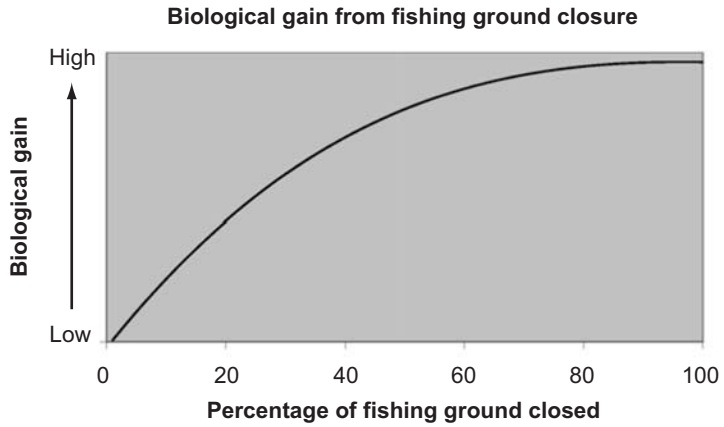


Figure 5 Effect of fishing ground closure on biological gains inside and outside a protected area

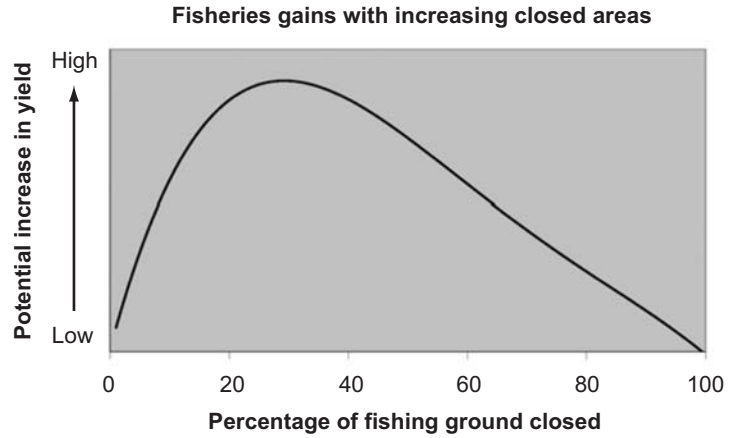


Figure 6 Gain and subsequent reduction in fisheries benefits with increasing area closure

As most of the available studies on MPAs focus on biological impacts and not on socio-economic benefits, there are only a few documented examples of fishery gains that support the overwhelming opinion of MPA benefits to a fishery. Of special interest in this context would be the cost and benefit distribution of the area across local communities and fishers. The few available studies show that, not surprisingly, fishers close to the protected area receive greater benefits than those further away. Studies in the Philippines show that the biological gains generated by MPAs often are insufficient to create economic benefits that would provide adequate incentives for local fishers and communities to maintain and manage the area and would enable responsible agencies to effectively enforce the closure. Benefits in other coastal sectors such as tourism, can be significant, but often do not reach local fishing communities. On the contrary, the establishment of protected areas often is promoted by tourism interests, which create conflicts with local fishers who do not want their fishing grounds to be closed.

Such irregular distribution of revenues and the direct benefits to local fishers and communities are among the main reasons why out of more than 439 MPAs in the Philippines only 44 seemed to be working and were well managed. Another reason is the size of the protected areas: many of these so-called fish sanctuaries that were established during the 1990s are too small to have any significant impact.

Size does matter

To produce significant biological gains both inside and outside the protected area, it has to be quite large. Many of the closed areas established and studied in the Philippines are smaller than 20 hectares. It is clear that as reserve size increases, more species will be protected; biomass, density and diversity

will increase to the point of "carrying capacity" of the area (Figure 5). With this increase, the potential fisheries benefit from recruitment and spillover will also increase.

However, after a certain point, the reserve becomes so large that spillover and export no longer offset the losses to fisheries resulting from the reduction in fishing grounds (Figure 6).

Case studies of such small protected areas often show similar results of biological and fishing benefits for protected areas and non-protected control areas; both positive and negative biological impacts have been observed, i.e. some of the protected areas failed to build up biomass or density of fish populations; in other areas, similar biological gains were observed inside the protected area and outside.

MPAs versus conventional approaches to fisheries management

It was concluded that the benefits to biological diversity and biomass inside the closed areas and the leakage and fisheries benefits outside were dependent on several factors. The overall size of the protected area had an effect, but, more importantly, the prevalent fishing rules and regulations in the areas studied were also shown to be important factors. These studies show that the closure of a fishing ground or part of it, does not address one of the root causes of overfishing and declining fish populations, namely excess fishing capacity and effort. In fact, a protected area that is successful in generating significant biological gains beyond its boundaries may actually stimulate an increase in fishing effort within the remaining fishing grounds.

If capacity and effort are not regulated, harvesting pressure outside and especially along the boundaries of the MPA will increase and spillover benefits will be quickly dissipated. Certainly, the equity issues in who benefits from the closed areas will become more questionable as benefits in the immediate vicinity may greatly outweigh benefits, or even declines in fishing opportunity, farther from a closed area. As the fishing area is reduced, the increased competition and effort by fishers to capitalize on the benefits generated by the MPA may tempt fishermen to adopt new fishing practices that yield higher private return under the new MPA constraints; this also could increase the amount of habitat destruction in the remaining fishable water, thus negating most or all of the positive benefits of the MPA.

MPAs as part of an ecosystem approach to fisheries management

Experiences with MPAs from around the world clearly demonstrate their value as conservation tools. However, their actual value for fisheries is much less clear. Most of the studies of marine reserves and fish sanctuaries that address the issue of fisheries benefits from MPAs conclude that MPAs are not a panacea for solving fishery problems.

APFIC Recommendation

Experiences with MPAs from around the world clearly demonstrate their value as a conservation tool, but less clearly their value as a fishery management tool. It is suggested that states review MPAs more rigorously as to their scales and contributions to fisheries management.

MPAs do not address the most urgent issue of overfishing caused by excess fishing capacity and effort. MPAs do reduce and probably stop fishing effort in specified areas, but may induce increased effort outside. From a systems perspective to fisheries and marine resources management, it is obvious that MPAs alone are not sufficient to protect marine ecosystems and critical coastal habitats from fishing and other activities taking place outside an MPA. It is also clear that poorly planned or overlarge MPAs may negatively impact fishers' livelihoods.

To be effective, MPAs need not only to be supplemented by conventional fishery management approaches that seek to reduce fishing effort and capacity, but also need to be integrated in comprehensive ecosystem-based fisheries and ocean management approaches. Ecosystem-based management in this context is far more than just establishing MPAs that claim to protect (and manage) whole ecosystems; within a process-oriented, adaptive ecosystem approach (rather than a location-fixed, habitat-focused approach), MPAs would be designed not only to contribute to ecosystem well-being but also to human well-being (see section 3.2 Ecosystem approach to fisheries management).

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 specifically cover fisheries or be indirectly related 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.[25]

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)
- United Nations Fish Stocks Agreement (UNFSA)
- FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention on Biological Diversity (CBD)
- (In process) Agreement on Port State Measures
- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 (specifically Annex V)).

The United Nations Convention on the Law of the Sea (UNCLOS) 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). There are still some countries in the region that have not signed and/or ratified this convention (Table 5). 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 main purpose of the United Nations Fish Stocks Agreement 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). The agreement entered into force on 11 December 2001, but there are still many countries that have not signed or ratified the convention (Table 5).

The FAO Compliance Agreement 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 and entered into force on 24 April 2003, but has still to see acceptance instruments from many of the countries in the region (Table 5).

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is 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.

The Convention on Biological Diversity (CBD) has been ratified and/or signed by all countries in the region and is 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.

[25] www.apfic.org/modules/addresses

Table 5 Review of parties to the binding global conventions and agreements (n = 47). (sign = signed; rat = ratified; ac = accessed; acc = accepted; * through European Union)

	UNCLOS		UNFSA		FAO C A	CBD		CITES	MARPOL Annex V
	sign	rat/ac	sign	rat/ac	acc	sign	rat/ac/acc	sign/ rat/ac/acc	
South Asia									
Bangladesh		2001	1995			1992	1994	1981	X
Bhutan	1982					1992	1995	2002	
India	1982	1995		2003		1992	1994	1976	X
Maldives	1982	2000	1996	1998		1992	1992		X
Nepal	1982	1998				1992	1993	1975	
Pakistan	1982	1987	1996			1992	1994	1976	X
Sri Lanka	1982	1984	1996	1996		1992	1994	1979	X
Southeast Asia									
Brunei Darussalam	1984	1986					2008	1990	
Cambodia	1983						1995	1997	X
Indonesia	1982	1986	1995			1992	1994	1978	
Lao PDR	1982	1998					1996	2004	
Malaysia	1982	1996				1992	1994	1977	X
Myanmar	1982	1996			1994	1992	1994	1997	
Philippines	1982	1984	1996			1992	1993	1981	X
Singapore	1982	1994				1992	1995	1986	X
Thailand	1982					1992	2004	1983	
Timor-Leste							2007		
Viet Nam	1982	1994				1993	1994	1994	
Other Asia									
Iran	1992			1998		1992	1996	1976	X
Japan	1983	1996	1996	2006	2000	1992	1993	1980	X
Kazakhstan						1992	1994	2000	X
DPR Korea	1982					1992	1994		X
RO Korea	1983	1996	1996	2008	2003	1992	1994	1993	X
Mongolia	1982	1996				1992	1993	1996	X
Tajikistan							1997		
Uzbekistan							1995	1997	
Oceania									
Australia	1982	1994	1995	1999	2004	1992	1993	1976	X
Cook Islands	1982	1995		1999	2006	1992	1993		
Fiji Islands	1982	1982	1995	1996		1992	1993	1997	
Kiribati		2003		2005			1994		X
Marshall Islands		1991	1995	2003		1992	1992		X
Micronesia		1991	1995	1997		1992	1994		
Nauru	1982	1996		1997		1992	1993		
New Zealand	1982	1996	1995	2001	2005	1992	1993	1989	X
Niue	1984	2006	1995	2006			1996		
Palau		1996		2008			1999	2004	
Papua New Guinea	1982	1997	1995	1999		1992	1993	1975	X
Samoa	1984	1995	1995	1996		1992	1994	2004	X
Solomon Islands	1982	1997		1997		1992	1995	2007	
Tonga		1995	1995	1996			1998		X
Tuvalu	1982	2002				1992	2002		X
Vanuatu	1982	1999	1996			1992	1993	1989	X
China									
China	1982	1996	1996			1992	1993	1981	X
Taiwan POC									
Other APFIC									
France	1982	1996	1996	2003	1996*	1992	1994	1978	X
UK		1997	1995	2001/2003	1996*	1992	1994	1976	X
USA			1995	1996	1995	1992		1974	X
Total A-P region	***33***	***34***	***19***	***20***	***6***	***33***	***43***	***31***	***25***
% APFIC	*80*		*45*		*40*				

The FAO Agreement on Port State Measures to combat IUU fishing lays out in greater detail the commitments and obligations that port states have relating to the use of their ports by fishing vessels and the vessels which service the fishery. The measures have yet to come into effect and are currently under discussion within FAO with a view to them becoming a binding agreement that could be open for signing in 2009. Once port state measures become a binding agreement this 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:

- FAO Code of Conduct for Responsible Fisheries (CCRF)
- FAO international plans of action for the management of fishing capacity (IPOA-Capacity)
- FAO international plans of action to prevent, deter and eliminate illegal, unreported and unregulated fishing (IPOA-IUU)
- SEAFDEC Regional Code of Conduct for Responsible Fisheries
- The Regional Plan of Action for Responsible Fishing
- APEC Bali Plan of Action
- Coordinating Body for the Seas of East Asia (COBSEA).

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 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 environment 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 Compliance Agreement (see above) is an integral component of the Code.

APFIC Recommendation

MEMBER COUNTRIES SHOULD ASSIST APFIC SECRETARIAT IN UPDATING THEIR STATUS WITH RESPECT TO THE AGREEMENTS THAT RELATE TO FISHERY ISSUES IN THE REGION

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. It is still unclear how many countries have initiated the NPOA planning and implementation process in the region, although there are increasing reports of countries starting the process (Table 7).

The FAO international plans of action 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.

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. For Pacific Island states, a specific model scheme has been developed to help in the formulation and implementation of the NPOA.[26]

[26] Brown, C. 2005. *Model plan for a Pacific Island country. National plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing.* Rome, FAO. 43 pp.

Table 6 Countries' membership and participation in regional fisheries bodies and other arrangements that are related to fisheries

		Regional Fisheries Bodies													Regional Arrangements/Cooperation/Networks/Projects																							
		Regional Fishery Management Organizations						Fisheries Advisory Bodies							Scientific Bodies			Economic Cooperation					Fisheries/Environmental Arrangements													Scientific Networks			
		IATTC	IOTC	IPHC	NPAFC	PSC	WCPFC	APFIC	BOBP-IGO	FFA	MRC	RECOFI	SEAFDEC	WIOTO	INFOFISH	NACA	SPC	APEC	ASEAN	BIMSTEC	PIF	SAARC	BOBLME	COBSEA	PEMSEA	PSAP	SACEP	SCS	SPREP	YSLME	CTI	RPOA	IOC/WESTPAC	GoFAR	NPRF	PICES
Southeast Asia	Brunei Darussalam												X					X	X						X							X				
	Cambodia							X			X		X		X	X			X					X	X			X				X		X		
	Indonesia		X					X					X		X	X		X	X				X	X	X			X			X	X	X	X		
	Lao PDR										X		X			X			X						X									X		
	Malaysia		X					X					X		X	X		X	X				X	X	X			X			X	X	X	X		
	Myanmar							X					X			X			X	X			X													
	Philippines						X	X					X		X	X		X	X					X	X			X			X	X	X	X		
	Singapore												X					X	X					X	X							X	X			
	Thailand		X					X			X		X		X	X		X	X	X			X	X	X			X				X	X	X		
	Timor-Leste																								X						X	X				
	Viet Nam							X			X		X			X		X	X					X	X			X				X	X	X		
South Asia	**Bangladesh**							X	X						X	X				X		X	X				X									
	Bhutan																			X		X					X									
	India		X					X	X					X	X	X				X		X	X				X							X		
	Maldives								X						X							X	X				X									
	Nepal							X								X				X		X					X							X		
	Pakistan		X					X							X	X						X					X							X		
	Sri Lanka		X					X	X						X	X				X		X	X				X							X		
Other Asia/China	**China**		X				X	X								X		X						X	X			X		X		X	X	X	X	X
	Taiwan POC						X											X																			
	Iran		X									X				X																		X		
	Japan	X	X		X		X	X					X		X			X							X							X	X		X	X
	Kazakhstan																																				
	DPR Korea							X							X	X									X					X			X			
	RO Korea	X	X		X			X								X		X						X	X					X			X	X	X	X
	Mongolia																																				
	Tajikistan																																				
	Uzbekistan																																				

Notes: States in bold are APFIC member countries.

Table 6 Countries' membership and participation in regional fisheries bodies and other arrangements that are related to fisheries (cont.)

		Regional Fisheries Bodies													Regional Arrangements/Cooperation/Networks/Projects																							
		Regional Fishery Management Organizations						Fisheries Advisory Bodies							Scientific Bodies			Economic Cooperation					Fisheries/Environmental Arrangements												Scientific Networks			
		IATTC	IOTC	IPHC	NPAFC	PSC	WCPFC	APFIC	BOBP-IGO	FFA	MRC	RECOFI	SEAFDEC	WIOTO	INFOFISH	NACA	SPC	APEC	ASEAN	BIMSTEC	PIF	SAARC	BOBLME	COBSEA	PEMSEA	PSAP	SACEP	SCS	SPREP	YSLME	CTI	RPOA	IOC/WESTPAC	GoFAR	NPRF	PICES
Oceania	**Australia**		X				X	X		X						X	X	X	X			X			X				X			X	X	X		
	Cook Islands	X					X			X							X				X					X			X							
	Fiji						X			X							X				X					X			X				X	X		
	Micronesia						X			X							X				X					X			X							
	Kiribati						X			X							X				X					X			X							
	Marshall Islands						X			X							X				X					X			X							
	Nauru						X			X							X				X					X			X							
	New Zealand						X	X		X							X	X			X								X				X	X		
	Niue						X			X							X				X					X			X							
	Palau						X			X							X				X					X			X							
	Papua New Guinea						X			X					X		X	X			X					X			X		X	X		X		
	Samoa						X			X							X				X					X			X				X	X		
	Solomon Islands						X			X					X		X				X					X			X		X		X	X		
	Tonga						X			X							X				X					X			X				X			
	Tuvalu						X			X							X				X					X			X							
	Vanuatu	X	X				X			X							X				X					X			X				X			
Other	**France**	X	X				X	X									X												X				X			
	UK		X					X									✕																X			
	USA	X		X	X	X	X	X									X	X											X				X		X	X

Acronyms:

- Inter-American Tropical Tuna Commission (IATTC), Indian Ocean Tuna Commission (IOTC), International Pacific Halibut Commission (IPHC), North Pacific Anadromous Fish Commission (NPAFC), Pacific Salmon Commission (PSC), Western and Central Pacific Fisheries Commission (WCPFC)
- Asia-Pacific Fishery Commission (APFIC), Bay of Bengal Programme Inter-governmental Organization (BOBP-IGO), South Pacific Forum Fisheries Agency (FFA), Mekong River Commission (MRC), Regional Commission for Fisheries (RECOFI), Southeast Asian Fisheries Development Center (SEAFDEC), Western Indian Ocean Tuna Organization (WIOTO),
- Inter-governmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia-Pacific Region (INFOFISH), Network of Aquaculture Centres in Asia-Pacific (NACA), Secretariat of the Pacific Community (SPC)
- Asia-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), Pacific Islands Forum (PIF), South Asia Association for Regional Cooperation (SAARC)
- Bay of Bengal Large Marine Ecosystem Programme (BOBLME), Coordinating Body for the Seas of East Asia (COBSEA), Partnership for Environmental Management in the Seas of East Asia (PEMSEA), Strategic Action Program of the Pacific Small Island Developing States (PSAP), South Asia Cooperative Environmental Programme (SACEP), Reversing Environmental Degradation Trends in the South China Sea and the Gulf of Thailand (SCS), South Pacific Regional Environment Programme (SPREP), Yellow Sea Large Marine Ecosystem (YSLME), Coral Triangle Initiative (CTI), The Regional Plan of Action for Responsible Fishing (RPOA)
- Regional IOC Sub-Commission for Western Pacific (IOC/WESTPAC), The Asia-Pacific Group of Fisheries and Aquatic Research (GoFAR), North Pacific Rim Fisheries (NPRF), North Pacific Marine Science Organization (PICES)

Table 7 Countries implementing the FAO IPOA through development of an NPOA or other measures equivalent in national planning documents. The symbols used denote the following: (x) = NPOA; (draft) = draft NPOA; (N) = measure/policy on national level addressing the specific issue.

	IUU Fishing	Capacity	Sharks	Seabirds
	NPOA	NPOA	NPOA	NPOA
South Asia				
Bangladesh				
Bhutan				
India		N		
Maldives				
Nepal				
Pakistan	N			
Sri Lanka		N		
Southeast Asia				
Brunei Darussalam				
Cambodia				
Indonesia	X	Draft		
Lao PDR				
Malaysia		N	X	
Myanmar				
Philippines		N		
Singapore				
Thailand		N		
Timor-Leste				
Viet Nam				
Other Asia				
Iran				
Japan	X		X	X
Kazakhstan				
DPR Korea				
RO Korea	X			
Mongolia				
Tajikistan				
Uzbekistan				
Oceania				
Australia	X	N	X	X
Cook Islands	Draft			
Fiji	Draft			
Kiribati	Draft			
Marshall Islands			Draft	
Micronesia	Draft			
Nauru				
New Zealand	X			X
Niue	Draft		Draft	
Palau	Draft		Draft	
Papua New Guinea	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			
USA	X			
Total				
NPOA	8	0	3	3
Draft NPOA	11	0	4	
National equivalent	2	7		

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.

The Regional Plan of Action for Responsible Fishing[27] (2007) is a voluntary instrument and 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 the following key areas of fishery management:

- collecting statistics and exchanging data;
- managing fishing capacity and effort;
- flag state responsibilities;
- regional market measures;
- regional capacity building to develop core competencies for fisheries research, management and compliance;
- strengthening monitoring, control and surveillance (MCS) systems; and
- managing transshipment at sea.

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.

The Coordinating Body for the Seas of East Asia (COBSEA) is 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 main components of the East Asian Seas Action Plan 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. The East Asian Seas Action Plan is steered by COBSEA. The East Asian Seas Regional Coordinating Unit (EAS/RCU) serves as the Secretariat for COBSEA.

[27] This is a regional plan of action (RPOA) to promote responsible fishing practices (including combating IUU fishing) in the region.

IUU fishing

Promoting long-term sustainable management of marine capture fisheries in the APFIC region by addressing illegal, unreported and unregulated fishing[28]

Illegal, unreported and unregulated (IUU) fishing[29] impacts the long-term sustainable management of marine capture fisheries in the APFIC region. Through national action and regional collaboration, Commission Members are addressing IUU fishing in a range of ways with a view to improving the manner in which the region's fish stocks are harvested and utilized.

In combination with efforts to strengthen public and fisheries sector governance, the 1995 FAO Code of Conduct for Responsible Fisheries (CCRF) provides a framework for countries to promote greater responsibility and long-term sustainability in fisheries and aquaculture. This is especially important because the productivity of capture fisheries in the APFIC region has declined over recent decades, primarily because of high and unregulated levels of fishing effort.

In addition to excess fleet capacity, overfishing, open-access fisheries and the use of destructive fishing practices in the APFIC region, IUU fishing presents major challenges. In common with other regions, IUU fishing in Asia is widespread and problematic. It undermines national and regional efforts to manage fish stocks sustainably and inhibits efforts to rebuild them. It is characteristic of all capture fisheries, irrespective of their location, scale, gear type or species targeted. To maximize revenue and profits, most IUU fishers act ruthlessly, targeting high-value species that have a strong market demand and fishing areas where the chances of being apprehended are lowest (i.e. in the more remote high seas areas and the EEZs of developing countries).

In 2004 and 2006 two FAO regional workshops on the elaboration of national plans of action to prevent, deter and eliminate illegal, unreported and unregulated fishing (Penang, Malaysia, 10 to 14 October 2004 and Bangkok, Thailand, 19 to 23 June 2006)[30] considered a range of IUU fishing problems prevalent in Asia and developed priority listings of problems by country.[31] In turn, a prioritized ranking of issues for the region was developed. Participants also proposed actions to be taken to prevent and deter the IUU fishing problems identified.[32] The outcomes of the workshops were important in that they confirmed the existence of extensive IUU fishing in the APFIC region. Significantly, the problems identified and the solutions proposed were similar to the challenges and solutions found and proposed in other regions.

In a subsequent initiative, countries considered the relationship between excess fleet capacity, overfishing and IUU fishing at the APFIC regional consultative workshop on managing fishing capacity and IUU fishing in the Asian region (Phuket, Thailand, 13 to 15 June 2007).[33] Two key messages came out of

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[28] Prepared by David J. Doulman and Michele Kuruc, Fisheries and Aquaculture Department, FAO. Rome.

[29] IUU fishing refers generally to fishing without proper authorization in the exclusive economic zones (EEZs) of countries or in an unregulated manner on high seas fisheries, especially in areas covered by regional fishery bodies (RFBs) such as the Indian Ocean Tuna Commission (IOTC). It is not confined only to high seas fisheries: IUU fishing is also common among fishers having proper authorizations to operate in EEZs and RFB-managed fisheries.

[30] (a) FAO. 2004. *Report of the FAO regional workshop on the elaboration of national plans of action to prevent, deter and eliminate illegal, unreported and unregulated fishing: Southeast Asian subregion*. FAO Fisheries Report No. 757. FAO. Rome. 88 pp. (b) FAO. 2006. *Report of the FAO regional workshop on the elaboration of national plans of action to prevent, deter and eliminate illegal, unreported and unregulated fishing: South Asian subregion*. FAO Fisheries Report No. 809. FAO. Rome. 68 pp.

[31] The rankings developed in the workshops had no official standing and did not represent national positions. However, the exercises revealed a detailed picture of the scope and intensity of IUU fishing in the Asian region.

[32] In general, discussion of the main IUU fishing issues in the workshops reflected the real problems that countries were encountering. It was evident that many of the IUU fishing problems were similar although their severity varied among countries. The workshops pointed to the merits of adopting both "hard" (e.g. confiscation of catch and vessels) and "soft" (awareness building) approaches to combating IUU fishing, recognizing that a mix of measures was needed depending on national policies and conditions and on whether nationals or foreign fishers were involved in infringements. The workshops stressed the importance of bilateral and regional cooperation in matters relating to IUU fishing, citing activities such as the sharing of information about IUU fishers and vessels and joint enforcement programmes. It was noted that such programmes had proven to be effective in facilitating coordinated monitoring, control and surveillance arrangements and reducing the incidence of IUU fishing in some cases. The use of prohibited gears and fishing methods generated considerable discussion. It was pointed out that some countries had introduced innovative measures to address these problems including the imposition of travel/movement restrictions on persons found using dynamite for fishing and requiring persons in possession of dynamite to justify why they had dynamite in their possession. However, the participants in the workshops were of the view that the use of prohibited gears and fishing methods was symptomatic of deeper-seated social and economic problems that should be addressed concurrently if the fisheries problems were to be alleviated.

[33] FAO/RAP. 2007. *APFIC regional consultation workshop: managing fishing capacity and IUU fishing in the Asian Region*. RAP Publication 2007/18. FAO. Bangkok. 46 pp.

that workshop: that overcapacity and IUU fishing threatened economic development and food security and that pro-active tackling of overcapacity and IUU fishing would deliver concrete benefits throughout the fisheries sector and the economy at large. The workshop also agreed on a set of strategies for managing fishing capacity, IUU fishing and information needs.

The international community recognizes that IUU fishing should be dealt with forcefully and in a multi-pronged manner. Indeed, this approach was foreseen in the 2001 FAO international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing (IPOA-IUU). It is also recognized that one of the most effective means of addressing IUU fishing is to block the revenue flows to persons and companies engaged in, and supporting, such fishing and related activities. This recognition led to the United Nations General Assembly (UNGA) and the FAO Committee on Fisheries (COFI) to call for the adoption of different but related measures to block IUU-caught fish from entering international trade, thereby depriving IUU fishers from benefiting from the sale of their stolen product. Some of these measures build on existing initiatives and include the elaboration of national and regional plans of action on IUU fishing as foreseen in the IPOA-IUU, principally as a means of assembling coherent and comprehensive national and regional policies and measures to combat IUU fishing; negotiation of a binding agreement on port state measures; development of a global register for fishing vessels, refrigerated transport vessels and supply vessels; development of criteria for flag state performance and the adoption of measures to be taken when a state fails to meet the agreed criteria, and strengthening of monitoring, control and surveillance (MCS), including vessel monitoring systems (VMS) to prevent, deter and eliminate IUU fishing.

Adherence to international instruments and reporting on activities germane to combating IUU fishing

The IPOA-IUU (paragraphs 10 to 15) encourages all countries to ratify, accept or accede to international instruments, as a matter of priority, and in turn, to implement them fully. The ratification and implementation of these instruments are considered to be essential for laying firm foundations for promoting long-term sustainable fisheries management and for dealing effectively with IUU fishing.

A review of ratification and acceptances for key instruments by APFIC Members shows that three countries in the Asian region have not ratified the 1982 UN Convention on the Law of the Sea, 11 countries have not ratified the 1995 UN Fish Stocks Agreement and 12 countries have not accepted the 1993 FAO Compliance Agreement (Table 5). This is despite the fact that some of these APFIC Members authorize their vessels to fish outside their national jurisdictions in the EEZs of other countries and on the high seas.

Importantly, the 2007 regional ministerial meeting on promoting responsible fishing practices that adopted the regional plan of action to promote responsible fishing practices including combating IUU fishing (RPOA-IUU) and the joint ministerial statement (Bali, Indonesia, 2 to 4 May 2007)[34] *inter alia* called the attention of countries to the need to implement the international fisheries instruments referred to in the review (Table 5), noting that the instruments contained the structures and measures upon which to build long-term sustainable fisheries. Ministers emphasized the importance of the 1982 UN Convention on the Law of the Sea, the 1995 UN Fish Stocks Agreement, the 1993 FAO Compliance Agreement, the Code of Conduct for Responsible Fisheries and other FAO international plans of action. This means that the international call to ratify and accept these instruments in the IPOA-IUU has been reinforced by regional agreement to comply with the global call in the RPOA-IUU.

The pattern of ratifications and acceptances of key international instruments points to the need for APFIC Members to review their commitment to national and regional fisheries management and to take appropriate action. This situation is especially important for those countries that authorize their flag vessels to fish beyond zones of national jurisdiction.

[34] Governments of Indonesia and Australia. 2007. *The regional ministerial meeting on promoting responsible fishing practices in the region*. Government of Indonesia. Jakarta. 20 pp. Countries participating in the process include Indonesia, Australia, Brunei Darussalam, Cambodia, Malaysia, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste and Viet Nam.

National and regional plans of action, port state measures, global register of fishing vessels, flag state performance and monitoring control and surveillance including vessels monitoring systems

National and regional plans of action

An integral component of the IPOA-IUU is the development of national plans of action to combat IUU fishing (NPOA-IUU). The purpose of the national plans, as referred to in paragraphs 25 to 27 of the IPOA-IUU, is to give full effect to its objectives. Based on the information available to FAO, most Asian APFIC Members have not developed a NPOA-IUU, even though several countries have indicated that they are in the process of finalizing an NPOA-IUU (Table 7). Disappointingly, and despite FAO capacity building efforts, the Asian region is the only region in the world where not all countries have taken action to elaborate NPOA-IUU. However, it is also noteworthy that several of the countries that do not have an NPOA have a national equivalent in their planning documents.

The development of NPOA-IUU is an important means for assessing what actions are already being taken by countries to combat IUU fishing and what action and measures still require to be implemented. It has been noted by countries in other regions that the process of developing NPOA-IUU has been an especially productive and valuable exercise because it has enabled them to identify gaps in existing policy and measures. The process has also facilitated a logical and parallel approach in dealing with IUU fishing and related activities.

Despite the lack of action at the national level, certain countries in the Southeast Asian region have collaborated to develop a RPOA-IUU, with leadership and support coming from the Government of Indonesia and the Government of Australia.[35] This outcome has been a landmark achievement and it is highly commendable. In adopting the RPOA-IUU the ministers of the participating countries *inter alia* agreed that regional cooperation among countries to promote responsible fishing practices and to combat IUU fishing was essential, particularly in order to sustain fisheries resources, ensure food security, alleviate poverty and to optimize the benefits to the region's people and economies.

The ministers endorsed the RPOA-IUU as a sign of tangible regional commitment to conserve and manage fisheries resources and the environment in the areas of the South China Sea, Sulu-Sulawesi Seas and Arafura and Timor Seas. As a follow-up activity, it was agreed to establish a coordination committee that would monitor and review the effective implementation of the measures agreed in the RPOA-IUU. It was agreed also that an interim secretariat would be established in 2008, hosted by the Government of Indonesia.

As a second step in the process, countries will proceed to develop their respective NPOA-IUU. The national plans will be consistent with the thrust and intent of the RPOA-IUU and support its implementation.

Port state measures

The implementation of port state measures, primarily to block the movement of IUU-caught fish, is one of the most cost-effective and safe means of preventing the import, transshipment or laundering of illicitly harvested products. In 2005 at COFI, FAO Members endorsed the model scheme on port state measures to combat illegal, unreported and unregulated fishing (model scheme).[36] This is a non-binding instrument that focuses on general considerations relating to port state measures, inspections, action to be taken, information and other matters. The model scheme also contains a number of important technical annexes. Some countries and RFBs have taken steps to implement the instrument, as have APFIC Members participating in the RPOA-IUU: they agreed to adopt port state measures based on the model scheme, which is a highly encouraging development.

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[35] Ministers and their representatives agreed on a common and collaborative approach to promote responsible fishing practices and to combat IUU fishing in the region where these states are located, with a focus, in particular, on the South China Sea, the Sulu-Sulawesi Seas and the Arafura and Timor Seas. It was reaffirmed that the region's shared fish stocks were very important as a source of food and for trade. It was noted that overfishing and IUU fishing depleted seriously the region's fish stocks.

[36] FAO. 2005. *Model scheme on port state measures to combat illegal, unreported and unregulated fishing*. FAO. Rome. 46 pp. It is a non-binding instrument.

In 2007 COFI revisited the issue of port state measures. It agreed to move forward with the development of a legally binding instrument based on the IPOA-IUU and the model scheme. At COFI, many FAO Members stressed that the new instrument would represent minimum standards for port states, with countries having the flexibility to adopt more stringent measures. An expert consultation to consider a draft text of a binding instrument was convened by FAO in 2007 (Washington DC, 4 to 8 September 2007).[37] This draft, with certain additions by the FAO Secretariat, was to be tabled at the forthcoming FAO Technical Consultation (Rome, Italy, 23 to 27 June 2008). The outcome of the consultation will be reported to COFI in 2009.

The elaboration of a binding international instrument of port state measures represents an important development in international law because Article 218 of the 1982 Convention on the Law of the Sea refers to port state enforcement in relation to pollution. The new instrument will extend port state measures and enforcement only to support long-term sustainability, enhanced ocean governance and strengthened fisheries management. APFIC Members are urged to participate fully in the process for the elaboration of the instrument and to pro-actively facilitate its implementation after it is concluded.

Noting that some APFIC Members have already committed themselves to the implementation of the model scheme, with the progression towards the conclusion of a binding instrument on port state measures that builds on, and consolidates, the provisions of the IPOA-IUU and model scheme, it is anticipated that APFIC Members will move to accept the more stringent measures reflected in the binding instrument.

Global register of fishing vessels

Another potential new tool in the fight against IUU fishing received endorsement from a team of experts convened by the FAO (Rome, Italy, 25 to 28 February 2008) to study its future development, following a recommendation from the 2007 session of COFI that FAO further explore the concept.[38] The tool, a comprehensive global record of fishing vessels, refrigerated transport vessels and supply vessels, is envisioned as a global database where data from many sources would be gathered in a single location. The proposal of a global record was advanced initially by the 2005 Rome Declaration on Illegal, Unreported and Unregulated Fishing.[39] The concept was also the subject of an FAO feasibility study that concluded that a global record was technically feasible if a number of conditions were met.

One of the major obstacles faced by fisheries enforcement bodies is the lack of access to information on fishing vessel identification, ownership and control. Currently there is no single source where basic information about fishing vessels of all sizes is contained. The proposed global register would fill that void.

There is a sense of urgency about the need to develop this tool. Expectations are that work on its development might be started quickly and proceed in phases. Moreover, for maximum utility the global record should be extensive in scope: for this reason a very broad definition of “vessel” was proposed at the expert consultation although it was recognized that this would have implications for the size of the database. It was acknowledged that IUU fishing was a problem both on the high seas and in EEZs and that smaller-scale vessels should be included as well. Mandatory, unique vessel identifiers would be needed to be assigned on vessels.

In addition to providing information to fisheries enforcement agencies, the global record could improve the traceability of vessels and products regarding IUU fishing detection; enhance transparency of vessel information and operation; strengthen risk assessment for both governments and industry at all levels, and support decision-making on a broad range of issues including fleet capacity, fisheries management, safety at sea, pollution, security, statistics and related issues.

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[37] FAO. 2007. *Report of the expert consultation to draft a legally-binding instrument on port state measures*. FAO Fisheries Report No. 846. FAO. Rome. 22 pp.

[38] FAO. 2008. *Report of the expert consultation on the development of a comprehensive global record of fishing vessels*. FAO Fisheries Report No. 865. FAO. Rome. 68 pp.

[39] FAO. 2005. *Rome declaration on illegal, unreported and unregulated fishing*. FAO. Rome. 2 pp.

Flag state performance

Reflecting the impatience of the international community with the failure of some flag states to exercise effective control over their vessels in accordance with international law, the 2007 session of COFI addressed the matter of "irresponsible flag states" and many FAO Members suggested the need to develop criteria for assessing the performance of flag states as well as examining possible actions against vessels flying the flags of states not meeting such criteria. Subject to the availability of funding, it was proposed that FAO take the matter forward by organizing an expert consultation.[40]

As an initial step, the Government of Canada, in cooperation in FAO and with support from the European Commission and the Law of the Sea Institute of Iceland, hosted an expert workshop on flag state responsibilities (Vancouver, Canada, 25 to 28 March 2008). Its objectives were to identify criteria to assess performance of flag state responsibilities; appropriate instruments and mechanisms to ensure commitment and implementation of the criteria; compliance mechanisms; possible actions against vessels in the event of non-compliance and avenues for assistance to developing countries to assist them in meeting commitments under these criteria.

The workshop was the first step towards identifying definitive actions that might be taken to improve flag state performance. Experts were invited to present and consider a number of papers on the subject and to identify performance assessment criteria, compliance mechanisms and appropriate instruments to promote implementation, as well as possible actions against vessels that are non-compliant. The workshop also considered avenues to assist developing countries meet their flag state obligations.

A report of the meeting is being prepared and the presenters of the papers agreed to take comments into account for follow-up revisions. Discussions were vibrant and wide ranging. The workshop agreed that it would be necessary to focus on concrete issues to ensure that real progress could be made on flag state issues. The complementarily of port state measures and flag state performance was recognized in the workshop.

Table 8 Respondents to FAO questionnaire (* through the European Union)

Members	1995 FAO CCRF (2006)	FAO VMS (2007)
Australia	X	X
Bangladesh		
Cambodia		
China	X	X
France*	X	
India		X
Indonesia		
Japan	X	X
RO Korea	X	X
Malaysia	X	X
Myanmar		
Nepal	X	
New Zealand	X	X
Pakistan	X	
Philippines	X	X
Sri Lanka		
Thailand		
UK*	X	X
USA	X	X
Viet Nam		
Total (%)	**12**	**10**
APFIC (%)	**60**	**50**

The RPOA-IUU encourages countries to be at the forefront in implementing sustainable fishing practices and to combat IUU fishing through exercising flag state responsibilities. Countries are urged to ensure that vessels flying their flags do not undermine the effectiveness of conservation and management measures by engaging in, or supporting, IUU fishing. These provisions are derived from the IPOA-IUU.

Monitoring, control and surveillance including vessel monitoring systems

Vessel monitoring systems (VMS) are influential tools in the MCS arsenal and have gained rapid acceptance because of their value to fisheries authorities. Continued expansion of VMS and extension of their uses are foreseen and encouraged. Market forces are reducing the costs of installation and operation, making acquiring VMS more feasible. VMS enable data about vessel positions to be known in near real time, making patrol deployment much more cost-effective, as target vessels are identified in advance.

An FAO expert consultation on the use of monitoring systems and satellites for fisheries

[40] FAO has scheduled an expert consultation on flag state performance for November 2008 at FAO Headquarters in Rome. However, the meeting will proceed only if it is possible to secure extra-budgetary funding to support it.

monitoring, control and surveillance (Rome, Italy, 24 to 6 October 2006)[41] brought together legal, technical and operational experts to provide FAO with advice in these areas. The consultation concluded that VMS have been inappropriately overvalued by some authorities as the ultimate MCS tool. The consultation recognized that VMS data should be integrated with other data, such as vessel registrations, licenses, management data, electronic logbook data and others if their potential is to be fully realized. But concerns remain about the need for increased data sharing among nations and RFMOs, as well as concerns about tampering, data quality and harmonization.

The 2006 expert consultation further considered whether a new binding international instrument on VMS would be appropriate. Given the current widespread use of VMS, the potential disruption of existing practices a new instrument could cause and the judgment that the current international legal frameworks are adequate, the consultation recommended against a new instrument, but advised that other mechanisms might be considered to address gaps in implementation such as an international plan of action, a declaration or strategy or other means, although COFI 2007 did not move forward on any of these suggested mechanisms.

Finally, the twenty-second session of the coordinated working party on statistics in 2007[42] requested a broad VMS inventory in advance of its consideration of an international standard for electronic data transmission. FAO agreed to undertake this inventory and make it publicly available. An extensive questionnaire was developed and distributed to more than 150 countries in June 2007. A response rate in excess of 50 percent has been achieved. Responses are still being encouraged to facilitate global and regional analyses and the development of a database and directory of VMS coordinators.

APFIC Members that have responded to the questionnaire are shown in Table 8. Those who have not responded yet are encouraged to do so as soon as possible so as to permit a comprehensive regional VMS analysis to be undertaken.

Capacity building

In 2004 and 2006 FAO conducted workshops to assist APFIC Members elaborate NPOA-IUU. The capacity building was comprehensive in that all APFIC Members participated in one or other of the regional workshops together with some countries that are not APFIC Members. No further training of this nature is envisaged, though technical assistance may be needed in some cases to support the development of NPOA-IUU.

To enhance the implementation of the 2005 FAO model scheme and after COFI in 2007 and to sensitize countries about the possibility of the conclusion of a binding instrument on port state measures, FAO embarked in 2006 upon a global series of capacity-building workshops.[43] They have been convened in conjunction with RFBs given that they will play a central role in developing and implementing regional port state measures schemes.

In 2008 a port state measures workshop was held in Bangkok, Thailand (31 March to 4 April 2008).[44] Convened in conjunction with the Southeast Asian Fisheries Development Center (SEAFDEC), it was considered to be a very successful meeting. Importantly, the workshop agreed on six key issues for future action and cooperation in strengthening and harmonizing port state measures to combat IUU fishing. The issues were: ensuring political will and support; harmonization and standardization; legal framework; regional and subregional MCS networks; training and human capacity building and information sharing; and activity coordination. Specific and concrete actions for each of the issues were identified. It is anticipated that other workshops will be undertaken in 2009 to include those APFIC Members that did not participate in the Bangkok workshop.

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[41] FAO. 2007. *Report of the expert consultation on the use of vessel monitoring systems and satellites for fisheries monitoring, control and surveillance*. FAO Fisheries Report No. 815. FAO. Rome. 68 pp.

[42] FAO. 2007. *Report of the twenty-second session of the coordinating working party on fishery statistics*. FAO Fisheries Report No. 834. FAO. Rome. 45 pp.

[43] Their purpose is to develop national capacity and promote bilateral, subregional and/or regional coordination so that countries will be better placed to strengthen and harmonize port state measures and, as a result, implement the relevant IPOA-IUU tools and the FAO model scheme and contribute to the development of a legally-binding instrument on port state measures. In this way, the workshops will contribute directly to the implementation of the call to develop port state measures contained in the 2007 RPOA-IUU adopted by certain Southeast Asian and other states to combat IUU fishing.

[44] FAO. 2008. *Report of the FAO/APFIC/SEAFDEC regional workshop on port state measures to combat illegal, unreported and unregulated fishing*. FAO Fisheries Report 868. FAO. Rome. 79 pp.

At the 2008 Expert Consultation on the Development of a Comprehensive Global Record of Fishing Vessels, it was urged that consideration be given to establishing capacity-building mechanisms to provide financial assistance and technical support to developing countries. The consultation noted that this was especially important because some countries do not maintain fishing vessel records, not even for their large-scale flagged vessels. Consequently, capacity building and technical support would be required on many levels to ensure that the global record is comprehensive and implemented fully.

Capacity-building requirements to support the implementation of flag state performance criteria will depend on the outcome of the deliberations within FAO, if and when they take place. Nonetheless, it is recognized that there will be capacity-building needs and they will have to be fined tuned to the requirements of the criteria and follow-up action that might be ultimately agreed.

In 2004 FAO convened the Southeast Asia Vessel Monitoring Systems Workshop (Bangkok, Thailand, 6 to 8 October 2004).[45] Eight APFIC Members participated. The workshop addressed the history and future of MCS and the IPOA-IUU, fisheries issues and RFBs in Southeast Asia, fishing vessel monitoring, institutional options for VMS, implementing VMS, legal issues related to VMS, the use of electronic logbooks and satellite observation of fishing vessels and recent technological developments. There were also country reports and working groups addressed issues relating to VMS cooperation in the region, in what fisheries and for what fleets VMS might be applied, the type of VMS/MCS cooperation required, and the most appropriate forum for pursuing regional cooperation in VMS/CS in Southeast Asia.

Further specific VMS/MCS capacity building initiatives are not planned at this time for the APFIC region but it is anticipated that APFIC Members will benefit from the global and regional analyses resulting from the VMS inventory, especially if it is comprehensive for Asia.

Challenges for APFIC Members in implementing measures to combat IUU fishing

The most significant challenge for APFIC Members with respect to the IPOA-IUU will be the implementation of their NPOA-IUU and the RPOA-IUU. Moving from words to action is always a major and difficult step and the development of strategies and concrete measures to give life to national and regional plans will test the capacity and resolve of countries. Given the enormity of the problems facing Asian marine capture fisheries, especially in terms of the need to reduce fleet overcapacity and implement management measures to promote long-term sustainability, including measures to reduce the incidence of IUU fishing, it is to be expected that progress will be achieved in incremental steps rather than in large strides.

If FAO Members agree to conclude a binding international instrument on port state measures, countries that accept it will be required to put national policies and measures in place to implement it. This will require legislative adjustment to give legal force to national action. Implementation will also involve administering a number of technical measures. These measures would include the collection and processing of information provided by vessels in advance of port calls, the inspection of vessels when they are in port, reporting on inspections, the establishment of information systems relating to inspections and the training of inspectors. It is likely that some countries will require technical assistance to implement the policies and measures underpinning the instrument.

The 2009 session of COFI will consider developments on the global register and provide direction for further action. It is premature, therefore, to seek to identify specific challenges for APFIC Members. However, while awaiting COFI's decision, countries should focus attention on the state of their national vessels registers and commence internal discussions among relevant agencies on how they might be improved and strengthened.

Some APFIC Members operate open registers and are considered by the international community to offer "flags of non-compliance". If action is not taken to ensure that effective flag state control is exercised in accordance with international law over the vessels flagged by these countries, they will certainly be the target of international action. This action could have serious commercial consequences and include the negative listing of "flag of non-compliance" countries and their vessels and the closure of important

[45] FAO. 2005. *Reports of the regional vessel monitoring systems workshops: Southwest Indian Ocean, the Caribbean, Central America and Southeast Asia*. FAO/FishCode Review No. 4. FAO. Rome. 91 pp.

markets to fish harvested by the vessels or exported from these countries. It is not premature for APFIC Members to review their national positions with respect to the flagging of fishing and associated vessels so as to ensure that they are compliant with international standards and norms.

Maximizing the potential of VMS in the APFIC region includes not only utilizing VMS data in conjunction with other fisheries and non-fisheries data streams, but also working on a regional basis to facilitate VMS data exchange. This activity requires consideration of harmonized formats and compatibility whenever possible. Coordination among MCS officials and administrations and regular exchanges of data and experiences enable the technology benefits to be applied with maximum utility in the fisheries enforcement context.

These types of exchanges of data, experiences and regular contact among MCS staff in the APFIC region are encouraged on MCS issues in general, especially in light of the shared fish stocks in the region and the high level of unmanaged fishing activity. These types of activities are already being promoted actively in Southeast Asia within the framework of the RPOA-IUU.

Follow-up activities

APFIC Members should undertake periodic assessments to determine the extent to which NPOA-IUU and the RPOA-IUU are being implemented, i.e. whether the instruments are achieving their goals and the purpose for which they were concluded. The IPOA-IUU (paragraph 26) calls on countries to review the implementation of their NPOA-IUU at least every four years. The purpose of this review process is to ensure that NPOA-IUU remain living documents, capable of addressing new and changing circumstances. Similarly, in the section on implementation, it is stated that the RPOA-IUU will be reviewed from time to time by the coordination committee.

In undertaking assessments of their NPOA-IUU and the RPOA-IUU, countries are encouraged to establish a set of realistic indicators against which progress on implementation can be measured. The indicators, if constant over a reasonable period of time (e.g. ten years), will facilitate unbiased national and regional evaluations.

It is anticipated that a binding instrument on port state measures will be concluded prior to COFI in 2009. APFIC Members that opt to ratify the instrument will need to undertake a number of policy and legal measures to give effect to the instrument. There will also be capacity-building implications to ensure that vessel inspectors are equipped to undertake the tasks required in relation to port state inspections.

Further analysis of the viability of the global record is likely to occur during the remainder of 2008, and in March 2009, proposals regarding its further advancement will be submitted to COFI. In the event that COFI endorses the proposals, development and implementation of the global record will remain conditional on the availability of funding to ensure the viability of the project. Funds will also be required and employed to assist some countries in the development of their national registries and/or records.

The outcomes of FAO's work on flag state performance will need to be followed up in the APFIC region once the outcomes have been agreed and adopted. APFIC Members should participate in meetings to address this issue and monitor developments carefully, acknowledging that commercial impacts could be anticipated in some important markets.

APFIC Members that have not already done so are requested to complete the VMS questionnaire that was despatched in 2007 to all FAO Members and return it as soon as possible to FAO. Without these responses FAO will not be able to undertake a comprehensive VMS analysis in the APFIC region. This lack of information will also inhibit the global VMS analysis that is being undertaken.

Conclusion

Open access, poor management and IUU fishing are characteristics of fisheries in the APFIC region. Fish stocks are heavily fished and IUU fishing in EEZs and on the high seas by national and foreign small- and large-scale operators, both authorized and unauthorized, are common. Indeed, the nature and scope of the IUU fishing problems and challenges are similar to those encountered in other areas of the world.

Some APFIC Members, through their involvement in the RPOA-IUU, have a head start in dealing with IUU fishing. Providing a comprehensive and flexible framework and platform for action, the RPOA-IUU marshals into a single instrument the key elements of the IPOA-IUU and the model scheme. This is highly beneficial as many other regions do not have equivalent springboards to support the implementation of these instruments. However, although regional issues are being addressed adequately at the present time, national initiatives and implementation are lagging. APFIC Members are encouraged to devote greater attention to this matter as stronger and more decisive regional outcomes depend, to a large extent, on resilient underpinning national measures.

APFIC Members are encouraged to review their status with respect to the international fisheries instruments and seek to resolve impediments that might inhibit the acceptance and ratification of certain instruments. Moreover, countries are urged to respond to FAO's periodic requests for information so that complete regional and global analyses can be undertaken. The outcomes of these analyses are important not only as a means of assessing progress and achievement but also as a means of indicating to the international donor community priorities for technical assistance.

The development and implementation of NPOA-IUU and the implementation of the model scheme, the binding instrument on port state measures, the global register of fishing vessels, the criteria for flag state performance and MCS and VMS will tax the resources and capacities of APFIC over the next five years. Follow-up activities to these initiatives will be important and will require ongoing efforts to strengthen national capacity.

IUU fishing is entrenched in all marine capture fisheries and creative and innovative ways are needed to prevent IUU fishers from benefiting from their criminal activity. IUU-caught fish in most instances is stolen product and the blocking of market access is central to denying IUU fishers financial gain. Port state measures will prevent the landing, transshipment and laundering of IUU catches whereas the global register of fishing vessels, tighter flag state performance measures and more effective and diffuse MCS and VMS will facilitate better and more focussed enforcement measures against IUU fishers and their associates.

Assessment and management of offshore resources

The fisheries of Asia and the Pacific region underwent unprecedented growth during the second half of the twentieth century. This was largely a result of the widespread capacity increase, motorization, huge expansion of trawl fisheries and the shift of fishing effort from temperate waters into the tropical zones. This expansion was largely unregulated, even in many cases promoted, and the different fisheries within the region have seen a trend of expansion and subsequent decline as resources have been sequentially over-exploited.

This pattern continues to this day and fisheries still operate in all the waters of the region. However, feedback from the fishers, the increasing numbers of vessels tied up in port and the declining quality of the catch all point to the inevitable conclusion that overfishing is widespread and fishing is becoming increasingly uneconomic in most coastal fisheries.

There has been a significant shift of effort into the tropical offshore fisheries. This has seen the movement of effort from temperate waters to the tropics in pursuit of tunas and even across oceans from one side of the Pacific to the other as fleets shift their attention as their usual stocks decline.

Overcapacity, declining catch, spiralling fuel prices and increasing conflicts between trawlers and larger operators and the small-scale sector are placing pressure on governments to relieve poverty and the crisis in coastal and nearshore fisheries. Alongside subsidies and other temporary measures to alleviate pressure or short-term crises, is a general policy trend in the region to move part of the nation's fishing capacity away from the coastal area. This is being driven by a number of factors. Perhaps the main driver is the assumption that there are abundant fisheries away from the coast that remain open for exploitation. The second driver is the perception that other fishing nations are already exploiting these resources and this represents a lost opportunity to the country to access these valuable resources.

Moving fisheries away from the coast is not a simple matter of larger boats and gears. There must be the fish present to make this profitable, the numbers of fish needed are greater and fishers must have

the skills to exploit the resources cost effectively. There are already experiences of where this policy direction has backfired, resulting in vessels returning to nearshore areas and further pressuring the coastal fishery. In other cases, the vessels have moved out of range of the national controls and contributed to illegal fishing.

It is clear that responsible fishing practices will be a key to long-term viability of offshore fishery development, inside or outside of a country's EEZ and fisheries agencies, governments and regional fisheries organizations need to plan the checks and balances required to ensure this.

A recent FAO workshop on offshore resource management[46] recommended that the following three areas are especially important for the management of offshore resources: 1) improving information; 2) addressing the challenge; and 3) improving fisheries management.

Regarding improving information, it was highlighted that it was important to address the information gaps and it was considered that it would be very useful to:

(i) compile a full list of surveys carried out in the region;
(ii) share information (taking into account confidentiality issues) among countries; and
(iii) conduct regional collaborative analyses of existing data through extensions of regional databases such as TRAWLBASE.

Good information is available in some countries, e.g. India, and could be used to build a better regional picture. Also, noting that an enormous amount of information already exists (exploratory fishing, assessment surveys, past joint ventures and current fishing), existing information should be compiled and made available in a form that is useful for planning and management. Information and expertise on technology development should be shared among countries in the region and exploratory surveys to find new resources involving new technologies to harvest and preserve fish quality should be conducted in the offshore areas nationally and with regional coordination. Finally, regular monitoring of the status of the resources, through standardized survey techniques should be conducted along with regular analyses of catch and effort statistics.

The best way to address this challenge is for countries to initiate desk studies to evaluate the social and economic potential of selected offshore resources and, on the basis of the regional consultations on offshore fishing, any fishery development should be accompanied by strengthening responsible fishing technology and practices as well as the fish handling and post-harvest capacity. Where social and economic benefits of fishing can be demonstrated, countries should proceed to pilot-scale fisheries projects, based on sound planning and a vision for the fishery and returns to fishing and livelihood of fishers should be improved by reducing post-harvest losses and increasing of fish quality to meet market requirements. Furthermore, it should be recognized that a move offshore will require new skills. Indeed, there is a need to increase the technical skills of all involved right from harvesting through to marketing. Safety at sea should be improved also with the adoption of safer vessels, technologies and human capacity building.

To improve fisheries management, countries must engage in developing national strategies for the sustainable utilization of offshore resources, including a future vision for offshore fisheries and objectives shared by the key stakeholders. This will be based on the best available knowledge and include costs, opportunities and risks. Furthermore, the entire system of fishery information collection, dissemination and its use will, in many cases, need to be revamped to include offshore fisheries. This may require the blending of indigenous and scientific knowledge and the development of appropriate information products for decision-making at different levels. Access rights to offshore resources will need to be determined to ensure proper resource management and equitable distribution of resources. In the offshore EEZ this will be between fisher groups within the country (especially small-scale and large-scale units), noting that RFMOs may also allocate rights under certain circumstances. On the high seas, this will be between:

(i) coastal states within the region; and
(ii) between coastal states in the region and those from outside the region.

[46] FAO/SEAFDEC/APFIC workshop on assessment of the offshore resources of South and Southeast Asia and the management of the fisheries exploiting them. Bangkok, 17 to 19 June 2008.

Fisheries management at the national level requires the development of an adaptive co-management system with strong participation from relevant stakeholders and the development of appropriate structures at all levels backed by suitable legislation. Developing coastal states in the region need to strengthen their negotiations with distant water fishing nations and with other coastal states to improve their access to highly migratory and shared fish stocks. Where unknown, shared demersal stocks in the region and the relevant states and stakeholders involved in their management need to be identified. Where appropriate, states and regional bodies should form fishery management arrangements that will guide the future management of shared stocks. Finally, regional cooperation needs to be strengthened to ensure that the national management systems are effective and do not clash with those of other nations.

2.4 Aquaculture

Aquaculture makes an important economic and social contribution to APFIC member countries. Production figures are increasing and this has the potential to increase the benefits derived from aquaculture, but also carries the risk of adverse impacts on the environment. Questions typically arise about the sustainability of the production, both in terms of environmental carrying capacities and social criteria, and about the quality and safety of the products. Some of the current developments over the last couple of years in the APFIC region are described below.

Development in certification of aquaculture

Certification of aquaculture products is seen as one of many tools to control and manage aquaculture. Certification relates both to food safety issues, social issues, animal welfare issues, and environmental issues.

APFIC Regional recommendations

Fisheries and aquaculture certification can offer tangible benefits to APFIC member countries.[47] However, a number of issues needs to be taken into account and addressed. These issues concern:

- **Regional involvement in certification**
- **Small-scale fisheries and farmers**
- **Harmonization and equivalence of certification schemes**
- **Costs and benefits of certification schemes**
- **Governance and stakeholder involvement**
- **Capacity building at both regional and national levels.**

The APFIC region accounts for a significant proportion of global aquaculture production and represents a wealth of technical knowledge on sustainable aquaculture that is of relevance to certification. This capacity has prompted the development of a number of national certification schemes that are tailored to the socio-economic status of producers, especially small-scale producers. There are also an increasing number of international certification schemes being introduced to the region.

The Food and Agriculture Organization of the United Nations (FAO), through the Committee on Fisheries Sub-committee on Aquaculture, was requested by its member countries to develop guidelines for aquaculture certification. Within the context of the application of the FAO Code of Conduct for Responsible Fisheries (CCRF), the Sub-Committee requested FAO to organize an expert workshop/consultation to make recommendations regarding the development of harmonized shrimp farming standards and review certification procedures for global acceptance and transparency. This would also assist in elaborating norms and reviewing the diverse options and relative benefits of these approaches.

Likewise, at the Sub-Committee on Trade held in Spain 2006 it was also recommended that work should be done related to certification and harmonization. The Sub-Committee on Trade supported future work by the FAO: to widen and expand the implementation of the Hazard Analysis Critical Control Point (HACCP)-based safety and quality systems and the use of risk assessment as the basis for the development of fish standards; to promote equivalence and harmonization; to monitor the border sanitary and quality controls used to regulate, restrict or prohibit trade, including their economic consequences.

[47] See the report of the APFIC Regional Consultative Workshop on *certification schemes for capture fisheries and aquaculture*. FAO/RAP PUBLICATION 2007/26, 32 pp. Bangkok.

FAO has therefore, in close partnership with the Network of Aquaculture Centres Asia-Pacific (NACA), held a series of expert workshops to gather the best possible information on aquaculture certification and how to make best use of this tool in aquaculture development and management. The APFIC Secretariat has actively taken part in this process and raised issues of special importance to the APFIC region. A successful APFIC consultative workshop was held in September 2007 where member countries were able ask questions and discuss aquaculture certification. It should be noted that the workshop recommended that this capacity and experience be used by APFIC members to develop a regional certification scheme, to which other schemes operating in the region should be harmonized. It should be noted that APFIC emphasizes that any certification schemes and/or systems that are developed or operating in the region should be in compliance with the forthcoming FAO Guidelines for Aquaculture Certification.

Aquaculture zoning, information management and traceability

Aquaculture zoning and planning are not new in themselves; however, in recent years there has been an increased need to improve aquaculture zoning and its implementation. For many states in the region, the development policies for aquaculture have been directed towards the intensification and expansion of the sector. However, problems relating to environmental degradation and production losses as a result of health problems in production facilities have started to emerge. Such problems have been dealt with either by government regulation or by modifications in production techniques by the sector itself. An example where difficulties have been addressed can be seen in the restriction and subsequent banning of shrimp farm development in mangrove areas because of concerns over mangrove losses in Thailand and other states. The restriction of inland brackish water shrimp culture is another example of government action taken to address possible salination of agricultural lands.

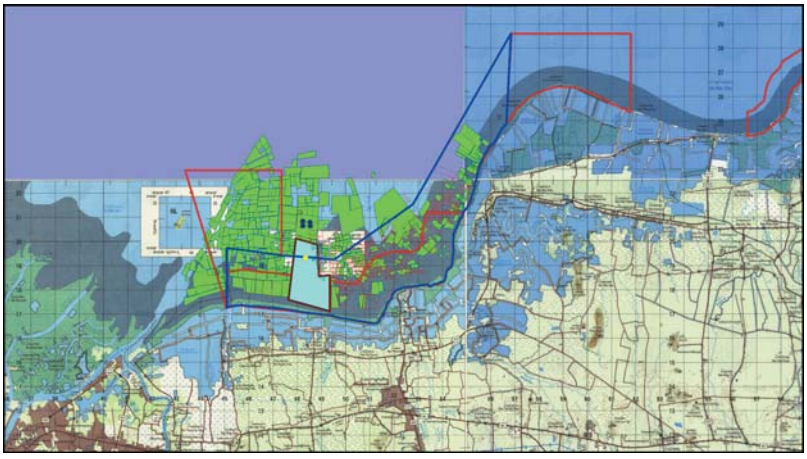


Figure 7 Example of GIS used for aquaculture zoning in Southern Thailand (Source: DOF Thailand)

Many of the problems aquaculture has faced as a result of its own expansion and because of increased activity by other sectors and stakeholders could effectively be resolved through a comprehensive aquaculture planning, zoning and management information system that would facilitate the formulation of strategies and planning for aquaculture development and sustain existing aquaculture systems. Local governments would be specifically targeted to enable informed decisions on aquaculture management and development.

Alongside the control requirements for addressing environmental impacts of the sector and management of disease and movements are the increasing requirements for traceability of aquaculture products. These are becoming a mandatory aspect of assuring food safety, and to some extent quality, for exported products. However, the need for tracing products consumed internally can be anticipated also. For example, illness from consuming seasonally contaminated shellfish is a health issue and also causes “bad press” with subsequent economic losses among producers.

Traceability systems are highly dependent on having effective information systems based in the geographic locations of producers, processors and marketers and efficient documentation processes to ensure that products are clearly identified from their point of production to point of sale. Mixing of products is a persistent problem and undermines efforts to provide effective traceability schemes as well as limits the ability to track problems back to the point of production.

Again, an aquaculture management information system will assist with the comprehensive identification and characterization of existing production areas and individual sites in order to track production from the producer through the chain of processing, transporting and marketing to the consumer.

Fish meal and low-value or "trash" fish

Fish meal

The world's fisheries have produced between 20 and 30 million tonnes for the last 30 years.[48] From this, 5 to 7 million tonnes of fishmeal and 1 million tonnes of fish oil have been produced. About 40 percent of this production comes from two countries in South America (Chile and Peru), although subject to rapid changes partly because of El Niño effects. The largest market for the fishmeal produced is China, which uses around 2 million tonnes annually, 75 percent of which is imported (2005). The rapid price rise of fishmeal during 2006 and the increased number of disease-affected pig populations have meant a reduction of Chinese fishmeal usage in 2007 to about 1.2 million tonnes. The price has since fallen, but the projected fishmeal usage in China remains at the same level as in 2008.

As fishmeal production is relatively fixed and the aquaculture sector is still expanding it is very likely that the price of fishmeal will increase again in the coming years. Additionally, fishmeal will become a more strategic ingredient in special diets such as starter feeds, broodstock diets and finisher diets.

Box 2 General principles of using fish as feed

Principle 1: Aquaculture should not utilize resources from unsustainable fisheries.

Principle 2: Guidelines for responsible fisheries should be employed where wild aquatic organisms are harvested for use as feed (with reference to CCRF).

Principle 3: Reduction fishery and fisheries for feed operations should not significantly impact on the environment or create significant negative ecosystem level impacts, including impacts on biodiversity.

Principle 4: Using fish as feed should not adversely impact the livelihoods and compromise the food security of poor and vulnerable groups.

Principle 5: The use of fish as feed should not be permitted to be governed by market forces alone.

Principle 6: Formulation of policies related to the use of fish as feed should not exclude other users of this primary resource.

Principle 7: Aquaculture should be encouraged to make a progressive move from using wet fish for feed to formulated feeds.

Principle 8: The use of fish as feed should not compromise food safety and the quality of aquaculture products.

Principle 9: The use of alternative raw materials (both animal and plant) should not compromise food safety and the quality of aquaculture products.

Principle 10: Management of fisheries requires a sound knowledge base and a decision-making process based on the participation of different stakeholders (e.g. capture fishery operators, traders, fish meal producers, aquaculture operators).

The use of fish as aquaculture feeds

An FAO expert workshop[49] on the use of fish as aquaculture feeds was convened in India in collaboration with the country's Marine Products Export Development Authority (MPEDA).

Problems of definitions (e.g. "trash" fish, low-value fish, reduction fisheries, feed fish, forage fish etc.) were raised and identified for follow-up by the secretariat but not dwelled upon during the discussions. It was recognized that the guidelines and principles agreed upon should apply to aquaculture and other wild fish uses to the same extent. The influence of markets in governing wild fish uses, and the importance of the role of governments in formulating and implementing policies that preserve the interests of the poor and vulnerable groups who rely on the consumption of low-value fish were highlighted. The workshop concluded that the use of fish as feed continues to be acceptable, but should be governed by some general principles in order to ensure that this use is responsible (Box 2).

The principal outputs of the workshop were:

- a revised draft of the technical guidelines;
- the two reviews and the eleven species background papers will be edited and collected into one document and released in the FAO Fisheries Proceedings series; and
- it is expected that the workshop proceedings will be published early in the first quarter of 2008.

[48] Jackson, Andrew. 2007. The Global Production of Fishmeal and Fish Oil, FAO Workshop Kochi, India, 16-18 November 2007.

[49] Use of wild fish and/or other aquatic species to feed cultured fish and its implications to food security and poverty alleviation. Kochi, India, 16 to 18 November 2007.

Capture-based aquaculture review

The project "Towards sustainable aquaculture: selected issues and guidelines" (GCP/INT/936/JPN) funded by the Government of Japan, through a trust fund arrangement, aims at addressing selected key issues of sustainability in global aquaculture practices and development. With due recognition of the recommendations of the FAO Committee of Fisheries Sub-committee on Aquaculture (COFI-SCA) during its first two sessions, the use of wild fish and fishery resources for aquaculture production has been identified as a priority for targeted action. This is one of four project components.

The project aims at collating and synthesizing available information on the above thematic area. Based on the available and analyzed information, the project will further aim to examine general and specific contexts of possible management regimes and options for targeted response measures in relation to the specific issue of concern, including constraints and problems, and with due consideration of feasibility and affordability of the possible implementation of such measures, as identified in the course of the project. The outputs to be generated by this project will assist FAO member countries in the promotion and implementation of the provisions of the Code of Conduct for Responsible Fisheries (CCRF).

Aquaculture Outlook

Asian aquaculture produces a major share of world aquatic production providing basic food supply and contributing to national economies through livelihoods and foreign exchange earnings. The quantity produced by the aquaculture sector in Asia is the largest in the world and is still expanding. Not only does it supply a basic food commodity for many people in the region it also supports economic activity through exports inside and outside the Asian region. There is a high demand for aquaculture products in the region, as fish is culturally prized in most Asian food cultures with prices varying from equivalence to pork and chicken at the basic end of the market to highly-prized and high-priced delicacies. As global trade in aquaculture products from Asia increases there are increasing constraints and standards to be met in order to export outside the region.

Box 3 The major issues facing Asian aquaculture

(i) The increasing intensification of existing systems results in higher demands for manufactured feeds and fishmeal, and requires improved aquafeeds affordable to small-scale farmers and the use of new feed resources.

(ii) The international trade in fishery and aquaculture products will more and more demand, from both consumers and exporters, high standard of freshness, quality and safety.

(iii) The organization of small-scale aquafarmers is necessary to allow them to produce quality products and make them competitive in the market.

(iv) Sector governance, particularly licensing and registration programmes, is required to support traceability, certification, zoning and other requirements and finally sector integration in the broader water, land and other natural resources planning.

The issues facing the expanding and increasingly valuable aquaculture sector in Asia are diverse according to the species and system (Box 3). In the face of limited areas for expansion, growing production from the sector is strongly driven by intensification of existing systems rather than development of new aquaculture sites. This intensification process is leading to rising demand for manufactured feeds and fishmeal in particular. Modernization and growth in the sector is further hindered by the fact that many farms are still family-scale businesses with limited economic and technical sophistication, with many of these operations being operated through least-cost production methods and the use of simple feed inputs. Continued expansion of production will therefore demand improved aquaculture feeds at a price affordable to smaller operations, thus maintaining viable economic returns to these smaller operations.

There is already a trend that fish feeds based on marine reduction fisheries (e.g. fish meals and low-value/trash fish) are rapidly increasing in price. This is being driven by soaring demand coupled to increased fuel prices. Furthermore, there is increasing pressure from the international sector to reduce fishing for trash/low-value fish and demands for demonstrated sustainability in marine reduction fisheries, which will further limit supply and drive prices upwards. Recent initiatives and innovative ways to use a higher degree of terrestrial input in feed can prove to be a way around the problem, but still requires additional research coupled with significant efforts at popularization. Use of new feed resources (e.g. livestock offal) has enormous potential but raises unique challenges with respect to assuring health

and safety in the aquaculture system and in ensuring that these products do not enter livestock. When these factors are taken across the aquaculture sector, the scenario is one of rapid change in feeding technologies coupled with the need to restructure farming operations to maintain competitiveness and assure food safety.

The international trade in fishery products (including aquaculture products) has always demanded a high standard of freshness and quality. Against this backdrop, there are now increasingly stringent demands for other food safety aspects to be assured. Aquaculture production presents additional challenges that are not found in the capture fishery sector, since the method of production is controlled by the farmer and inputs to the system through management and also the environment external to the farm can all influence the final quality and safety of the product. Sustained growth in export-focused aquaculture products challenges Asian countries to systematically address these quality and safety issues and there is a need to improve regulation of this diverse sector. As these new requirements (e.g. food safety, traceability and other requirements from importers) will probably prove to be most difficult for the small-scale family businesses to meet, it can be foreseen that there will be a need for rationalization and organization of small farm operations if they are to continue to produce for export. Although this poses a real problem in terms of organizing small-scale farmers as associations (or other similar groupings), it promises long-term benefits such as common investment possibilities, e.g. in water treatment plants to meet environmental certification criteria. The spatial spread of production facilities for specific products will challenge certain areas of the region where there may already be overcrowding, although some may yet benefit from the existing clustered nature of their aquaculture operations. The outlook for smaller operations targeting domestic markets remains positive although even here there is a trend of rising expectations in terms of quality and safety. The extent to which the aquaculture sector is able to respond to these challenges is highly dependent on strategic support from the state in providing the appropriate regulatory framework and the sector itself responding with the necessary investments and rationalization. It is impossible to generalize across the whole of Asia and so it is fair to say that whereas some countries will be seeking to modernize the aquaculture sector, others may still be at a stage where aquaculture is just starting to take off. One thing is certain though: the development on one part of Asia will certainly impact elsewhere and it will be the improvement in the feed sector that will mediate this rate of change.

Regulation of the aquaculture sector needs to be improved in most countries of the region. This is to enable more effective management at watershed/basin or area level. Individual farms have control over their production management, but have little ability to control the aggregated impact of the farms in their area. Equally, they are all vulnerable to impacts or developments in the area, such as agricultural management changes, water management and the other factors that influence environmental quality, particularly water quality. Aquaculture has thrived as a family-level small-holder type operation and will remain competitive for some time to come, however there is a need for basic levels of farm registration or/and licensing to ensure the implementation of traceability, certification, zoning and other requirements (e.g. environmental) for the continued sustainability of the sector. Aquaculture cannot consider itself in isolation and must fit into the broader integrated area planning of water and land, both onshore and in coastal areas.

The region has been very innovative in tackling these issues, mainly through the flexibility and adaptability of small farm operations, a history of innovation and diversification of the sector and the ability to meet international expectations in the production of the key export commodities. There is an increasing number of species being cultured, especially high-value niche species, offering ways for farms to remain competitive. Aquaculture does not easily lend itself to industrial production technology requiring hands-on management. This gives the smaller farm unit an advantage and limits the emergence of high-output industrial type farms. Nonetheless, the focus on the quality and safety of the products from aquaculture requires farmers to adapt and professionalize. If the region is alert and willing to change and adopt new requirements, the outlook remains bright for Asian aquaculture to continue to dominate production and maintain its large share of global aquaculture value.

3. Emerging regional issues

Each biennium APFIC highlights two very important regional issues. For the biennium 2008 to 2009 it is suggested that the two most important regional issues are livelihoods in fisheries and the ecosystem approach to fisheries. This chapter provides an introduction to these issues and looks at the way forward.

3.1 Livelihoods in fisheries

Fishing for livelihoods: opportunities and challenges of strengthening the resilience of fishing communities[50]

Fishing communities, particularly in the Asian region, are increasingly becoming caught in a poverty trap: they depend on a resource base that is under increasing pressure and declining quality and therefore need to continuously intensify their efforts to exploit it. This drives the resource down even more quickly. Set against this is a trend of economic development, inflation and rising costs of fuel, food and the other livelihood necessities. This dependence on a shrinking, fragile and unpredictable resource makes fishing households vulnerable to the internal and external processes that impact their livelihoods. The inter-relationship between resource use and dependence and the socio-economic drivers is rarely considered in conventional fisheries management.

Conventional fisheries management tends to focus on the fishery resources, i.e. the stocks of fish. In the most conventional forms of management, this focus may even be on single stocks under management. Some of the limitations of this sort of management approach in the context of multi-species, multi-gear diverse fisheries are explored in the section “Ecosystem approach to fisheries”. The need to address fisheries both from a fisheries resource perspective and a socio-economic perspective, demands a shift to an ecosystem approach to fisheries management. Instead of formulating fishing rules that address certain aspects of a specific fish stock, the ecosystem approach to fisheries seeks to establish practices, agreements and rules that reduce the impact of fishing on the ecosystem’s status while preserving the socio-economic benefits of the fishery.

Although this shift in focus towards ecosystems reflects the many hard lessons fishery managers had to learn from the failures and limitations of single species approaches to fisheries management, the centre of attention is still the welfare of fish and aquatic resources. A modern, ecosystem approach to fisheries management, however, that addresses the issues of sustainable development and the Millennium Development Goals requires an equal focus on human welfare.

In seeking to reconcile the human and the ecological dimensions of fishery systems for sustainable development, an ecosystem approach to fisheries management thus won’t focus on managing a well-defined ecosystem within clearly defined geographical boundaries; instead it is a flexible, adaptive and iterative process of problem solving that is based on a collaboratively developed vision of desired future conditions that merge ecological, social and economic perspectives through participatory decision-making about managing human behaviour. This focus on managing human behaviour requires both an understanding of people’s livelihoods and the creation of diversified livelihood options, as people’s behaviour is a consequence of their livelihood strategies.

A livelihood from fishing: understanding why people fish the way they fish

Fishing communities are vulnerable because of their dependence on the fishery resource base. Small-scale fishing communities often lack institutional and financial safety mechanisms that can cushion the impacts, not only of disasters such as cyclones, but other unexpected events and processes over which they have no control.

The result of this is that fishing activity is often driven by various external forces (quality of the resource base, competition, weather, financial insecurity, etc.) rather than by choice. Fishers typically have few options to generate income and reduce their vulnerability. This is particularly true for people and communities in developing countries who engage in small-scale, coastal fishing activities. It is this

[50] Prepared by Theo Ebbers.

dependence on fish and other aquatic resources that drives their fishing activities and the way they fish, which in turn drives the processes of overfishing and degradation of aquatic resources and habitats.

This contextual understanding of fishing suggests that achieving the goal of improving the livelihoods of coastal communities will require:

1) improving the resource base the fishers depend on; and
2) creating or promoting alternative or additional sources of income to diversify coastal dwellers' livelihoods and thus to reduce their dependence on fish and other aquatic resources.

These two challenges are closely interlinked. The achievement of the first challenge requires the formulation and implementation of changes in behaviour, rules and regulations that prevent the further degradation of the resource base, or even initiate its recovery. However, the immediate outcome of this will typically lead to short-term reductions in catch and therefore reduced income. The diversification of livelihoods or the creation of other opportunities for income generation are the most commonly promoted mechanisms for addressing this. Unfortunately, the solutions found are frequently simplistic or too narrow and fail to meet the objective of genuinely and sustainably contributing to the improvement of fishers' livelihoods. Some of these issues and opportunities will be explored in the following sections.

Reducing vulnerabilities and strengthening resilience: options and approaches

Strengthening a community's resilience entails institutional changes such as the acknowledgement of a community's rights and responsibilities, access to credit and capital or a supporting legal framework. However, it is clear that for these changes to be usefully adopted, the creation and provision of additional sources of income remain crucial.

Opportunities for wealth creation arise from within a community and its locality and from outside. They can be resource dependent or arise from the exploration of resource-independent income-generating opportunities. Exploring these opportunities and turning them into actual livelihood improvements requires an understanding of their respective limitations and the criteria used to judge their success, which in turn will reveal the close interdependence of both.

Resource dependent livelihood improvements

Providing other ways of generating income and sustaining a livelihood is often not as straightforward as it may first appear. Fishing communities based around water bodies may have limited land resources and typically very little capital or assets that could be "cashed in" to support a change in employment or provide the start-up capital needed for a new enterprise. The geographical location of fishing communities is also a constraint, as it is frequently distant from urban and commercial areas, lacking communications and proximity to places where alternative or supplementary employment can be found. Fishing families are often not able or willing to move away from their homes to work and in some extreme cases have migrated to the fishery because of the inability to reside elsewhere. Rural transformations often see a drift to cities for employment, but it is equally the case that people drift to the coasts as a last resort.

Finding supplemental forms of income, enhancing incomes and creating wealth, are often confined to trying to base the options around the existing natural resource base. This is something which fits with existing activities and the location of the household. It also benefits from the familiarity of people with the resource itself. Initiatives that seek to boost income from the existing natural resource base can be termed "resource-dependent livelihood interventions".

Improving livelihoods through resource enhancement and management

Resource-dependent activities relate to the improved yield from a resource through interventions of enhancement or conservation or creation of key habitats, and are expected to arise from resource enhancement and conservation efforts such as establishing conservation zones or refuges and rules that reduce fishing effort. Fish and other aquatic resources may be enhanced through aquaculture and re-stocking, and aquaculture in itself is often seen as an option for additional income and a way to reduce fishing effort. Two basic approaches can be employed to improve the resource base for fishing communities:

1) direct and active interventions in fishery ecosystems that aim at enhancing fishery resources and habitats critical to them; and
2) efforts to manage and regulate the ways fishery resources are used.

Managing the resource through conservation or enhancement

Fishers and fishery managers have long had knowledge of and employed measures that seek to enhance both fishery resources and ecosystems. Direct enhancement seeks to increase the amount of or concentration of fish. The most common of these are the deployment of artificial reefs (providing habitats and preventing large-scale gear use such as trawls), fish aggregating devices (FADs), and the release of hatchery bred stock into the wild (restocking or stock enhancement).

Many traditional fishery systems, particularly in areas of the South Pacific, are based on various forms of fishing ground closures, which provide fish populations with a refuge in which they are permanently or temporarily protected from fishing activities. This is also quite common in traditional inland fisheries management. More recently, marine protected areas (MPAs) have gained prominence as a form of resource enhancement through conserving a core area (no take zone) and relying on "leakage" of resources and new recruits into the surrounding areas to restock and enhance the fishery. This is dealt with in detail in Sub-section 3.2 on MPAs.

All of these and other manipulative interventions in coastal and inland ecosystems that aim to enhance resources are not without controversy: questions are raised not only about their real effectiveness and benefits to the fishery sector (e.g. MPAs and artificial reefs), but also with regards to management issues, such as:

- who is establishing and managing such resource enhancement measures and who has the right to access the benefits derived from them;
- whether the benefits derived from these measures are sufficient to justify the investment and/or ensure that they are sustainable;
- how management responsibilities, costs and benefits are shared among involved and affected stakeholders; and
- in the case of MPAs or closed areas, how losses of fishing opportunity are compensated.

Limitations to these approaches are well known, but often overlooked by enthusiastic proponents. Thus it is not clear, whether and to what extent the establishment of reserved areas and other measures aimed at re-building degraded resources create sufficient benefits to sustain such efforts. More often than not the costs involved in implementing such measures are far higher than the benefits derived from them. At the same time, the environmental impacts of some these resource enhancement and income generating measures need to be re-examined. The value of both artificial reefs and fish aggregating devices is questionable as both attract fish to a specific location and thus make it easier for fishers to catch them. What fishers perceive as "enhanced" fish resources in terms of more and bigger fish around these structures may just reflect the disappearance of fish from surrounding fishing grounds.

Similarly, aquaculture activities may negatively impact nearby fish populations and habitats. Not only does the farming of carnivorous species drive fishing activities to generate the feed for the farmed fish, but even the culture of other fish, shellfish and even seaweeds may cause ecosystem changes (e.g. smothering/pseudofaeces and shading of reefs/lagoon seabed) that cascade through food webs and change the species composition and quality of nearby habitats.

As outlined above, the often promising looking resource dependent livelihood activities need to be augmented by management approaches that are based on user and access rights as well as effort regulations that are designed to ensure that aquaculture, ARs, FADs, reserved areas, stocking and other resource enhancement measures can deliver on their promises.

Managing the people who exploit the resource

These questions touch upon issues that are at the core of developing broader and better functioning fishery management systems that are rights-based and capable of regulating fishing capacity and effort. In recent years the concept of comanagement has emerged as a new paradigm that is believed to provide the most suitable framework for establishing sustainable fisheries management systems. Such

a partnership arrangement in which resource user communities, government and other stakeholders share the responsibility and authority for the management of the fishery, is assumed to be able clearly define access and use rights for the resources in question. In such a system, the way people are allowed to participate in a fishery and the respective roles of fishers and state would be clearly described. These rules and regulations have to be coupled to some form of enforcement either using local custom or peer group related mechanisms, or more formally through the intervention of an enforcement body such as the judicial system or management authority. The typical rules and regulations are designed to:

- regulate the type and number of fishing gear and techniques that can be deployed;
- delineate seasonal or permanent reserved areas to protect important species during critical stages in their lifecycles;
- set standards on the size, type and amount of fish that can be taken; and
- effectively manage fishing capacity through rules of inclusion and exclusion.

Such a comanagement system requires well-organized communities that have the capacity needed to engage government and other partners in the fishery management discourse. Experiences from comanagement experiments and related community organizing efforts, however, show that there seems to be a relationship between people's livelihoods and their willingness to engage in community organization processes for fisheries management. There is a correlation between a community's vulnerability or resilience, the benefits it derives from engagement in resources management and its motivation and capacity to take part in comanagement arrangements. Communities that are in situations of severe vulnerability or crisis (economic or otherwise) are less able and less willing to enter this sort of management arrangement. Unless risks can be reduced and the vulnerabilities addressed, there is little prospect for the widespread adoption or implementation of successful resource comanagement by local stakeholders.

Value chain improvements

Another resource-dependent approach that is commonly introduced to augment resource enhancement and management efforts is value addition or improved marketing. Interventions based on this seek to ensure better use of the catch through improved processing and marketing. Reducing post-harvest losses through improved handling and processing can significantly increase the value of fishery products and thus the income of fishers. Adding value to the caught fish through processing and the development of new fish-products has been proven to have the potential of creating substantial additional income for fishing households and communities that engage in such activities. These approaches are often seen as an opportunity for women to generate income and are highly complementary to management approaches that focus on male fishers. Where fisheries are in good condition and fishing pressure is not the principle threat to the fishery, this type of intervention can greatly improve the livelihoods of fishers and find rapid uptake and adoption.

Unfortunately the successful development and marketing of improved fish products may lead to increased fishing effort and thus drive further resource degradation. This can lead to increased pressure on the fishery and even decline, which can critically undermine conservation efforts. This situation is more typical where products find ready markets and the fishery is already under heavy exploitation pressure. It is clear that value chain interventions need to be in initiated with a good understanding of the resource status and likely additional pressure that will result from the intervention. Ideally, there are strong linkages between the resource management component and the marketing/value chain activities. This re-emphasizes the importance of the linkage between community resource management and community wealth creation.

Resource-dependent non-extractive activities

Alternatives to income generation and wealth creation that rely on the extraction of the natural resource base do exist. Good examples of these are tourism-related interventions. The development of tourism within a system of resource conservation, habitat improvement, marine protected areas, offers the potential to capitalize on the value of the natural resource, without directly exploiting it through production. This is a highly attractive approach on the surface and has been quite successful in some areas. However, there are a number of prerequisites for this to be a viable option. Perhaps the first requirement is that there is already a tourism industry to encourage. Location and easy access are critical, accommodation

and services are also important, but vary according to the type of tourism being encouraged. Security is also another important concern.

Although there may appear to be many successful examples of tourism and wealth creation in coastal areas, this often hides the reality of who is actually benefiting. Tourism development requires capital and the investors are typically outsiders. The need for tourism services also tends to attract outsiders who have previous experience or who are perhaps more entrepreneurial than the local population. Boat operators who are ex-fishermen may not be independent beneficiaries of the activity. Often they operate within a system where income and profits must be shared with owners or the "licensed operator", typically a wealthier individual who has to cover insurance costs and address local licensing issues.

Tourism development therefore may not actually provide increased income generation to the fishing communities and may actually increase pressure on some resources, putting up prices of food, land and other basic commodities and other essentials. This echoes the questions regarding who are the primary beneficiaries of marine protected areas and how benefits are spread within the community. Increasing demands for luxury seafood items does offer opportunities for fishermen to increase the value of the catch, but this is a resource-dependent extractive activity and therefore does not share the same features as tourism generally as a non extractive activity.

Resource-independent activities

Where the development of resource-dependent livelihood options is clearly not going to be sustained or will actually contribute to the problem rather than alleviate it, a different strategy is required. Resource-independent livelihood options need to be identified to generate additional income, without the further degradation of aquatic resources or the natural resource base. Typically, these falls into the categories of handicrafts and services and often focus on individual households or small (women's) groups who start engaging in such activities. Developing such activities can significantly increase local incomes and contribute to the strengthening of local livelihoods without increasing the pressure on scarce natural resources.

Although not dependent on the natural resource base and therefore environmental sustainability is not an issue, there are still questions of economic sustainability. With the initial investment and business initiative usually coming from some outside agency, these types of small group or household-oriented activities depend on such outside support for their economic success. Capacity building and business skill development, equipment and other necessary investments that are provided by such outside agencies, are often not included in the balance sheets that indicate the profitability of the endeavour. Additionally, the income generated may not be re-invested in the business (e.g. for buying supplies) as the outside support would provide the necessary funding for such expenditure.

Where there are direct interventions to support or promote livelihood diversification of income generation there is a broader consideration of benefit distribution throughout the community. This is not confined to livelihood interventions and is a challenge to any development-related activity. Livelihood activities that target individual households naturally benefit these first; one might like then to ask how other households will derive benefits from these initiatives. If this is not adequately addressed, or benefits are not distributed equitably, this can seriously undermine the initiative through conflicts, jealousies and even deliberate destruction or inference in the activity. Non-beneficiaries may also be driven to activities that undermine broader conservation efforts or other areas of the natural resource base.

To have a broader impact and some assurance of benefit distribution throughout the community, many of these activities focus on small groups, often, but not exclusively, of women. Similar to the questions about people's engagement and motivation to get involved in fisheries comanagement processes, the success of such group-based economic activities to a large extend depends on the benefits each individual member can derive from the group.

Capital access and credit

An important factor determining the vulnerability of fishing communities that is also important to the success of these livelihood strategies is the availability of capital and access to credit. Fishing communities usually do not have any property that can be used as collateral for loans, and their

productive capital consists of the fishing gear and boats they own. Conventional banking institutions are hesitant to provide capital against the unpredictable harvests or assets that can easily be lost and destroyed in a natural disaster or through accidents. This inability to access financial services sustains the fishing communities' dependence on informal sources of credit such as local moneylenders and fish traders; it also prevents investment in alternative activities that would reduce this dependence.

Approaches to address this issue are often based on revolving funds, alternative credit and micro-finance or saving schemes that are centred on a community group. These schemes can provide the necessary basis for investment and allow purchasing services that are needed to build local businesses. Crucial to the success of such alternative credit and finance schemes is the existence of functioning community groups on which these schemes are based. Like comanagement systems for fisheries and aquatic resources discussed earlier, effective community organization is a critical precondition for improving livelihoods and the resilience of fishing communities.

Fishing households often lack the same assets or typical features of agriculture households. This may be one of the factors that defines their poverty. Agriculture households may have land, draught animals, even machinery that can be used as collateral for borrowing. Fishing households often only have a fishing boat as their principal asset for use as collateral. In the poorest fishing households they do not even have this. The standardization of financial services and the prerequisites for borrowing or access to credit may exclude fishing households and deter financial institutions from trying to extend services to this group. There may also be perceptions of the higher risk of fishing households because of the uncertain nature of income and the dangers of the occupation. Financial institutions cite the lack of a savings mentality in fishers and a tendency to live from day to day. Although some of these preconceptions may have some basis, where savings and credit schemes have been successfully introduced the change in this behaviour is evident and should by no means be used as an excuse not to adapt the system to be more appropriate for the livelihoods of fishing households. It does underline the importance of understanding the context of the fishers' livelihoods and the fact that one size fits all rural credit and financial services may not be accessible to this group without some modification.

Conclusion: an ecosystem approach to local economic development

The interdependence of the various options for strengthening fishing communities' livelihoods outlined makes it clear that comprehensive and integrated approaches are needed to positively and sustainably impact vulnerable fishing communities, increase their resilience and capacity to adapt to change and increase their contribution to and benefit from overall national and global development.

Local economic development (LED) is a concept that has been promoted by the International Labour Organization (ILO) and some other institutions as a process of local dialogue and participation that seeks to connect people and their resources for better employment and a higher quality of life. The approach follows a participatory and adaptive planning and implementation process that seeks to enable local communities to effectively respond to the challenges of globalization. In the words used above, it is a concept that aims at improving local communities' resilience in the face of economic and environment processes that they cannot control, through mobilizing local resources, local capacity building and employment generation. As such, LED constitutes an integral component of an ecosystem approach to resources management and development. Integrating the participatory mechanisms of LED with the comanagement principles of fisheries and ecosystem management ensures the integration of the human and environmental paradigms as envisioned in the ecosystem approach.

3.2 Ecosystem approach to fisheries

Implementing the FAO Code of Conduct for Responsible Fisheries through an ecosystem approach to fisheries[51]

Acknowledging the global decline in the world's fishery resources and the need to take action, the United Nations World Summit on Sustainable Development (WSSD) in 2002 set a number of ambitious targets for nations and organizations to work towards. One of these important targets was to introduce the ecosystems approach to marine resource assessment and management by 2010.

[51] Prepared by Derek Staples and Simon Funge-Smith.

But what does this mean and how do countries go about meeting this target? To assist its member countries and regional organizations, the Food and Agriculture Organization (FAO) has produced a number of technical guidelines outlining how to apply the ecosystem approach to fisheries management.[52] These publications emphasize that the ecosystem approach to fisheries (EAF) is a way to implement the concept of sustainable development and show the linkages to the principles contained in the FAO Code of Conduct for Responsible Fisheries (CCRF). What becomes clear is that EAF does not really introduce new methods for fisheries management, but is more of an outline of a strategy to implement fisheries management in accordance with the CCRF and within the context of sustainable development. If we accept that ecosystem approaches are a framework to implement sustainable development, and in the fisheries context, EAF is the framework to implement CCRF and sustainable development, it follows that we must:

1) understand the basic principles of the CCRF;
2) learn more about how EAF can assist in implementing the CCRF;
3) find practical ways to make this operational;
4) acknowledge the differences and similarities of fisheries in Asia and the Pacific region and decide on institutional changes and reforms that will be needed to bring about EAF; and
5) examine what sorts of regional arrangements would facilitate the implementation of EAF.

Basic principles of the CCRF and ecosystem linkages

The CRRF sets out some important principles for responsible fisheries (see Box 4 for those relating to fishery resources and their management). These principles require that fisheries managers embrace some important concepts. First, they should endorse the concept of sustainable development and promote the maintenance of fishery resources in sufficient quantities for both present and future generations. Second, they need to consider the three dimensions of sustainable development: ecological, economic and social, not just the biological/ecological dimension.

Box 4 Main principles of the FAO Code of Conduct for Responsible Fisheries relating to fishery resources and their management[53]

- Fisheries management should maintain fishery resources for present and future generations.
- States should prevent overfishing and excess fishing capacity to ensure that fishing effort is commensurate with the productive capacity of the resources.
- Conservation and management measures should be based on the best scientific evidence (environmental, social and economic) available, also taking into account traditional knowledge.
- The precautionary approach should be applied — the absence of adequate scientific information should not be used as a reason for postponing actions.
- The rights of fishers and fishworkers, particularly those engaged in artisanal small-scale fisheries, should be protected to ensure a just livelihood as well as preferential access, where appropriate, to traditional fishing grounds.

The principles also cover some important ecosystem concepts (see Box 5 for a summary).

Box 5 Main principles of the CCRF relating to the ecosystem

- Management measures should not only ensure the conservation of target species but also species belonging to the same ecosystem.
- States should facilitate consultation and effective participation of all stakeholders.
- All critical habitats, such as wetlands, mangroves, reefs, lagoons, nursery and spawning areas, should be protected and rehabilitated.
- States should ensure that their fishery interests are taken into account in the multiple uses of the coastal zones and are integrated into coastal area management.

[52] FAO. 2003. *Fisheries Management – 2: The ecosystem approach to fisheries*. FAO technical guideline for responsible fisheries 4, suppl. 2. Rome. A simpler version was released in 2005, see FAO. 2005. *Putting into practice the ecosystem approach to fisheries.* Rome.

[53] These principles are paraphrases of the original clauses in the FAO Code of Conduct for Responsible Fisheries. Code of Conduct for Responsible Fisheries, 1995: FAO, Rome Italy.

All of these CCRF principles were agreed when the CCRF was endorsed by all FAO member countries in 1995. In doing so, they set in place the basic building blocks for ensuring healthy fisheries that optimize the social and economic benefits that can be derived from harvesting and processing fish. The challenge since then has been to make this operational. Some descriptions or methodologies of EAF reiterate these principles, but this is not really necessary as they were already quite well-formulated and articulated in the CCRF. More important is that EAF should focus on what needs to be done to make the high-level principles operational and functional.

There are many other principles in the CCRF that are relevant to improving the ecosystem in which the fisheries resources exist, including using selective fishing gear, optimizing energy use, protecting the marine environment,[54] protecting the atmosphere, conserving biodiversity[55] and reducing adverse environmental impacts of human activities. The CCRF also recognizes the special requirements of developing countries, especially in the areas of financial and technical assistance, technology transfer, training and scientific cooperation and in enhancing their ability to develop their own fisheries as well as to participate in high seas fisheries, including access to such fisheries.

Benefits and costs of implementing the CCRF

Many countries in Asia and the Pacific region are now experiencing the impact of not implementing the CCRF principles over the past few decades. These include:

- depleted fishery resources;
- degraded coastal environment and critical fisheries habitats;
- declining catches and incomes;
- dissipated resource rents;
- illegal fishing;
- inequitable distribution of benefits from harvest and post-harvest activities;
- intra- and inter-sectoral conflicts; and
- poverty in small-scale artisanal fisheries.

All these issues come with a huge cost both to governments and societies. Fish resources are inherently valuable, in many cases extremely valuable. The harvesting of fisheries resources is capable of generating substantial amounts of wealth on a sustainable basis. However, the costs of mismanagement are high and it has been estimated that the annual return now wasted at a global level is in excess of US$50 billion. The other side of the loss resulting from lack of management is that governments often have to provide inputs or subsidies to offset or sustain fisheries. One study estimates that world fisheries are currently subsidized by between US$30 billion and US$34 billion per annum per year.[56] It seems a simple question for society to ask: Why should governments continue to pay over US$30 billion a year to support fisheries when they could earn at least US$50 billion more in resource rent that could be re-invested in other activities, especially to reduce poverty in fisheries-dependent areas?

Implementing the CCRF through EAF and comanagement

What is the ecosystem approach to fisheries?

An important first step to understanding the ecosystem approach is to understand that the concept of sustainable development has now replaced previous policies that focused only on economic growth. Sustainable development has been defined by the World Commission on Environment and Development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs."[57]

Put simply, this can be thought of as a way of finding a balance between ecological well-being and human well-being so that development does not destroy the natural resource base on which it depends. This

[54] e.g. MARPOL 73/78.

[55] See the Convention on Biological Diversity.

[56] Sumaila, U.R. & Pauly, D. 2006. Executive Summary. In Sumaila, U.R. & Pauly, D. (eds.). *Catching more bait: a bottom-up re-estimation of global fisheries subsidies*. Fisheries Centre Research Reports 14(6), 2 pp. Fisheries Centre, the University of British Columbia, Vancouver, Canada.

[57] *Report of the World Commission on Environment and Development: Our Common Future*. Chapter 2: Towards Sustainable Development. Available from http://www.un-documents.net/ocf-02.htm#I

ensures that activities based on natural resources will be sustained into the future, and not exploited or drained to a point of no return (a typical result of economic growth and production focused development). The phrase "ecosystem approach" was first coined in the early 1980s, but found formal acceptance at the Earth Summit in Rio in 1992 where it became an underpinning concept of the Convention on Biological Diversity and was later described as *"*[a] strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*."*

Applying the ecosystem approach helps us to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. FAO, in applying this concept of the ecosystem approach to fisheries, defined it as follows:

> *"An Ecosystem Approach to Fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries."* [58]

Or more simply put, EAF is a way of managing fisheries that balances the different objectives of society (e.g. ecological and economic objectives), by applying an integrated approach across geographical areas that reflect natural ecosystems. In applying this integrated approach it uses the knowledge and the uncertainties that we have about such systems. All these definitions have several key words and principles that underpin sustainable development and the ecosystem approach. These are:

1. promoting management to ensure sustainability of development into the future;
2. achieving an integrated approach (i.e. considering the system as a whole not just one part); and
3. balancing objectives (both ecological and human).

It is worth noting that the three principles listed above were already contained in the CCRF that was developed in parallel during that time.

Given that the main objective of EAF is the sustainable use of the whole system, not just single species, both ecological well-being (e.g. habitat protection and restoration, pollution reduction and waste management, sustainable harvesting of fishery resources) and human well-being (e.g. improved wealth generation with associated equitable distribution of the wealth and social benefits such as improved livelihoods) need to be considered (Figure 8).

Parallel evolution of approaches and jargon

The adoption of sustainable development as a core concept provided a framework for discussion and action that could be embraced by all sectors, including environmentalists, economists, commercial enterprises and small-scale rural activities alike. As a result, many sectors/disciplines have started to look at approaches they could use to implement sustainable development. Because all of these approaches are based on the same concept, they all tend to end up with the same principles. Although the principles are often similar, these approaches often differ in two main respects:

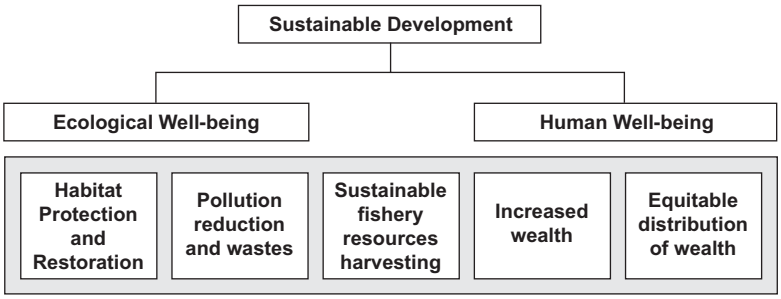


Figure 8 Ecosystem approach to fisheries framework

1. differing interpretations of the balance between ecological well-being or human well-being; and
2. the number and scope of sectors being considered.

[58] FAO. 2003. *Fisheries management – 2. The ecosystem approach to fisheries*. Fisheries Technical Guidelines for Responsible Fisheries 4. Suppl. 2. FAO. Rome.

As an example of the first point, ecosystem-based fishery management (EBFM) advocates that ecological integrity is the basis for sustainable development, whereas wealth-based fisheries management (WBFM) argues that management should focus on increasing wealth and that ecological well-being will follow as a result. As an example of the second point, integrated coastal management (ICM) and large marine ecosystem management (LME) both consider all sectors equally (e.g. fisheries, mining, tourism, conservation, environment, industry), unlike EAF, EBFM or WBFM that consider the other sectors through a fisheries lens (i.e. all discussions and dialogue is based on the other sectors' impacts and relationships to the fishery).

From a fisheries institution point of view, EAF may be preferable since it allows prioritization of issues and objectives to be agreed by the stakeholders and can cover EBFM or WBFM, depending on those priorities (see below), but remains focused on the fisheries-relevant aspects.

Meeting the challenges — moving from principles to actions

The theory of EAF as a management mechanism is attractive. It involves a balance between production and conservation and it takes account of sustainability and ensures that different stakeholders' views are listened to as part of decision-making. But, how do we take EAF and the CCRF principles and apply them at a fisheries management level?

To do this, we have to "convert" the high level principles of the CCRF into policy goals, and then develop management objectives and actions to achieve the goals (Figure 9). How to do this is explained in the next section "Formulating objectives through a risk assessment process".

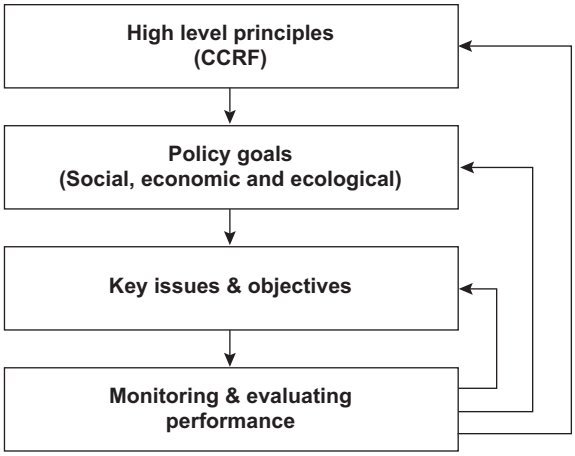


Figure 9 Moving from principles to objectives. Redrawn from FAO (2003)

From principles to policy goals. The principles underpinning EAF cover a broad range of economic, social and ecological considerations of sustainable development. However, many of the characteristics of ecosystems, such as ecosystem health, integrity, resilience, energy flows, are relatively abstract concepts that are not fully understood. Typically, we do not have a full understanding of how these systems work. In other cases, there are principles that are so generic that they cannot really be implemented. This is not a constraint to good EAF, provided these can be turned into higher-level policy goals that make sense, such as:

- conserving biodiversity;
- maintaining fishery habitats;
- protecting important food chain functioning; and
- ensuring employment and livelihoods, and so on.

From policy goals to implementation. These higher-level policy goals then need to be turned into more specific issues, each with its own objective so that actions can be taken to contribute to the goal. Typically, that action will be through applying a management measure. These management measures need to be designed at a practical operational level, and be inclusive for target stocks, habitat, by-catch, protected species, income and social aspirations of the fishers etc. As long as there is a clear linkage between the CCRF principles and the objectives, then the CCRF will be operationalized through implementation of the objectives.

Making EAF participatory through comanagement

Implementing the EAF must balance ecological needs and well-being with socio-economic needs and human well-being. This places a great deal of emphasis on the participation of stakeholders and in particular the relationship between government and resource users. Comanagement is the tool to make EAF more participatory. It describes the spectrum of shared management between the extremes of

exclusively community-based management (with full devolution of responsibility to communities/fishers) through to central government management (with full responsibility controlled by government) (Figure 10[59]). Fisheries comanagement is:

> "*A partnership approach where government and the fishery resource users share the responsibility and authority for the management of a fishery or fisheries in an area, based on collaboration between themselves and with other stakeholders.*"[60]

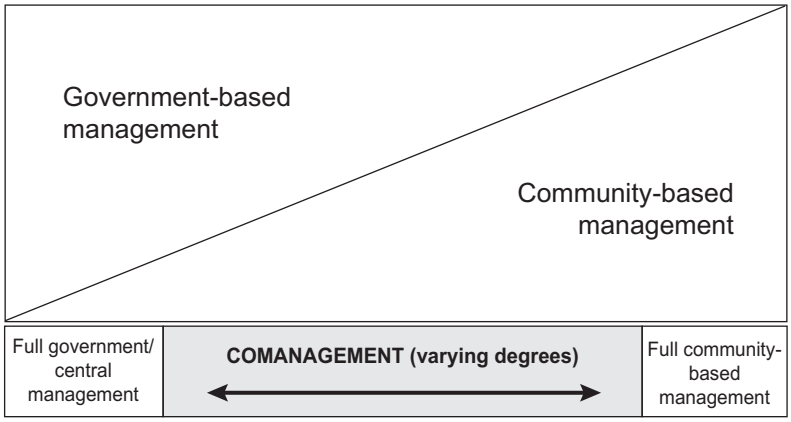


Figure 10 Comanagement between government and stakeholders

Comanagement is not just a concept that involves the rural poor and local communities. It must incorporate all types of fishing and impacts on the resources. If the management system focuses only on small-scale artisanal fisheries, there is a high risk that even if there is good stewardship of coastal resources by local communities, these same resources could be exploited by larger vessels from other localities (the "outsider" problem). This will inevitably lead to the breakdown of the local management system. This highlights the need for locally-based management to be supported within a framework that addresses the larger geographical scales and interactions between them. This requires the comanagement to involve stakeholders such boat owners associations too since it often lies beyond the power of local level groups or individuals to take affective action.

Key actors and stakeholders in EAF

The network of stakeholders that needs to be involved in EAF can be complex (Figure 11), both in terms of vertical linkages (national to local), horizontal linkages (between different users of the natural resources) and in terms of geographic coverage or scales.

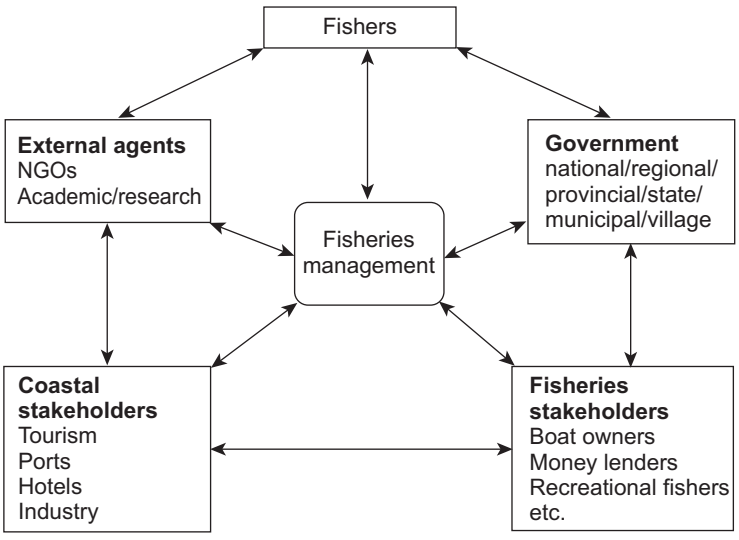


Figure 11 Key players in comanagement and EAF (after Pomerory & Berkes, 1997)

Effective communication and information exchange is critical for success. Institutional arrangements, both in terms of how the players will be organized and the rules and regulations governing their activities must be set up and understood by all. For example, in many cases decentralization of management also allows for (some) decentralization of fiscal authority. This gives the management agency the authority to collect revenue/recover costs towards a management of the fisheries within its jurisdiction. A local management agency may have the right to employ enforcement officers or to pursue offenders through the courts. Equally, disputes between different stakeholders may be

[59] Redrawn from Pomerory, R. & Berkes, F. 1997. Two to tango: the role of government in fisheries comanagement. *Marine Policy. Vol. 21(5)*, 465–480 pp.

[60] FAO. 2005. *Report of the Regional workshop on mainstreaming fisheries comanagement* held in Siem Reap, Cambodia from 9 to 12 August 2005. RAP Publication 2005/23. Bangkok. 48 pp.

more effectively dealt with at a local level, but benefit from technical or scientific advice from a provincial or national agency.

Making EAF operational

Scale of implementation

There are various entry points for the EAF processes. EAF initiatives can be taken at various administrative levels and by different stakeholder groups ranging from:

1. small/local — a single community or a group of communities wishing to improve the management of inshore fisheries;
2. provincial/national — a government deciding to adopt EAF widely in its fishery policy; or
3. large/regional — a group of countries and/or a regional body wanting to develop high-level management of shared stocks at a large marine ecosystem scale.

This range of application requires the EAF to cater for both bottom-up and top-down processes. Ideally, within a region there would be a "nested" structure for fisheries management. Such a structure would include a regional organization or agreement based on fairly large-scale regional seas or identified large marine ecosystems (LMEs) or marine eco-regions (e.g. the Bay of Bengal, South China Sea, Gulf of Thailand, Sulu-Sulawesi marine eco-region). This would provide the mechanism for development of integrated management plans by a regional advisory council (RAC) and serve as the basis for centralized decision-making. These large regions would be further subdivided into national or bilateral management units. Within countries, the system would be based on local levels, typically based on administrative boundaries where the local districts could serve as the basis for devolved management (there are cases where geographical features may make more sense such as large inter-district water bodies, large bays and rivers, spawning/nursery grounds etc.). The existing LMEs form a natural boundary for such a nested system and LME projects could be more orientated to meeting this ideal.

EAF for inland fisheries

EAF is just as relevant and appropriate for inland fisheries as it is for marine fisheries. In particular, EAF includes considering the impact of habitat changes on fisheries, often an important driver in inland fisheries. Inland fisheries are far more connected to the water regime at watershed and floodplain level and ecosystem–type approaches are well developed for water management. River basin or watershed management approaches exist and water allocation processes and inter-disciplinary dialogues are standard features. It has to be said, however, that fisheries may not receive a particularly high priority with these approaches, as the more visible uses of water for agriculture, irrigation or urban rural water supplies tend to attract more attention. Fisheries are a non-consumptive use of water and are often left out of water planning and decision-making. This is inappropriate because fisheries are extremely sensitive to the flow regimes and connectivity of the water, and are often seriously affected by water management and allocation decisions. There may be good justification for applying EAF with its fisheries focus to planning processes and to strengthen advocacy for fisheries services in larger water and basin planning processes.

EAF can also be applied to aquaculture where there is often a tendency to focus only on the target species being cultured and ignore ecosystem effects created by the production system. The requirement to look more broadly at the factors external to aquaculture can greatly improve the sustainability of aquaculture systems as well as enable aquaculture to argue more effectively for the right to operate. Abstraction of water and the creation of effluent discharges are all related to the broader ecosystem services or supply and absorption of waste. These are not "free environmental goods and services" and increasingly planning and management requires these to be factored into decision-making about aquaculture development.

When applied to inland fisheries, rivers and water bodies and even aquaculture operations, the process of making EAF operational (see next section) can lead to better management of inland fisheries and aquaculture.

Integrating fisheries management with integrated coastal/catchment management (ICM)

It has been mentioned that EAF takes the ecosystem approach and places fisheries at the centre in order to achieve management goals. However, there are other stakeholders in watersheds and coastal areas who are not interested in fisheries considerations. Effective EAF therefore requires coordination, consultation, cooperation and joint decision-making not only between different fisheries operating in the same ecosystem or geographical area, but also between the fisheries management agency and the other sectors that have an impact on fisheries or are affected by fisheries (Figure 12). If the coastal planning system is based on a system of ICM, it makes sense for fishery managers to become more active in the ICM process. This provides a broader sectoral setting for the different stakeholders to get together, and most importantly, work together to attain common goals. It also provides the opportunity for fisheries stakeholders to protect their interests against impacts from development or decision-making in other sectors.

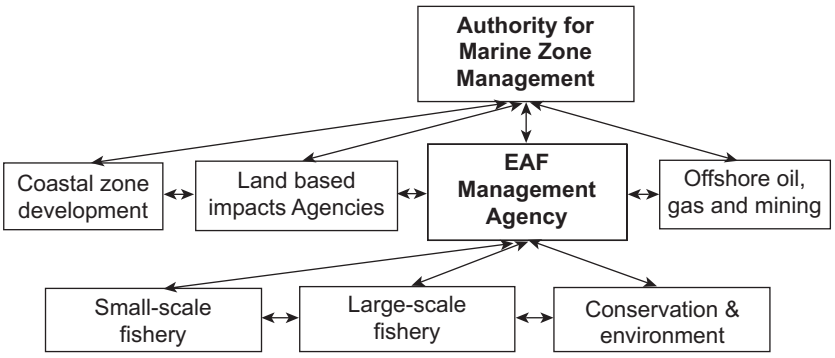


Figure 12 An ideal inter-agency cooperation and consultation system within an ICM framework (redrawn from FAO, 2005)

Such an ICM framework may not exist in the area where EAF is being applied. In these cases it will be up to the fishery agency to reach out and contact agencies that are responsible for other uses of the marine/inland environment. A key agency will always be the environmental agency as it is normally responsible for conserving biodiversity, protecting and rehabilitating habitats and protecting vulnerable species, all of which are important EAF actions. This is particularly important during the planning phase (see next section), after which each agency can continue its day-to-day functions with periodic reviews.

At a more local level, activities and agencies responsible for these different activities are often much better integrated than at the national or even provincial levels where ministries and departments are usually organized along sectoral lines. At the local level, therefore, it is often easier to implement EAF, especially when one local government is concerned with all aspects of the livelihoods of local communities.

The key to EAF — A participatory management system and good planning

EAF cannot be achieved unless a good fisheries management system exists that facilitates the cycle of planning, implementing and monitoring. In general, it will be the fishery agency that will build this capacity and initiate the process in cooperation and consultation with other agencies and major stakeholders, including non-government organizations (NGOs).

Because of the different time scales involved in the process of developing and monitoring a management plan, it may be necessary to have at least two components to the plan, e.g. a higher level strategic plan that states the broad management objectives and measures to achieve them (reviewed on a three to five year cycle), and an annual plan (reviewed through an annual cycle) to cover setting and reviewing specific objectives, indicators and performance measures. Over time, as objectives become more stable, the latter could be formally included in the higher-level plan.

Developing and monitoring EAF through a comanagement plan – six steps

Six steps are required to apply EAF to construct a fisheries comanagement plan (Figure 13).

Steps 1 to 3: Scope the fishery, identify issues and prioritize.

The first step is to identify the fisheries management unit (FMU) that will form the geographical basis for the plan. The final choice of FMU and geographic area for a management plan will depend on a number of practical considerations, but at the very least it should cover all harvesting sub-sectors, both small-scale artisanal and large-scale industrial.

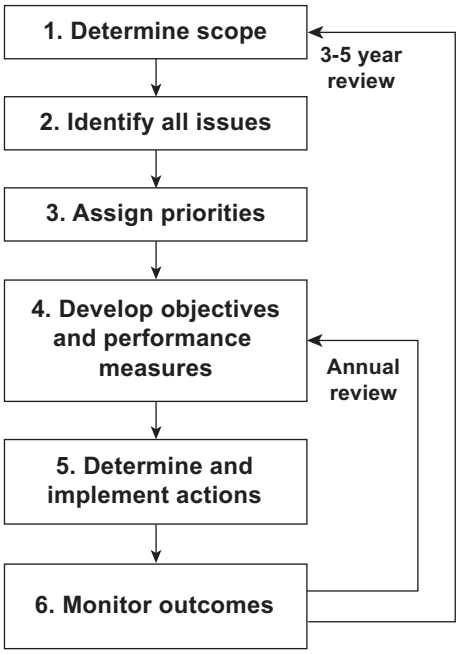


Figure 13 Six steps needed to develop an effective fisheries management plan (from FAO, 2003)

Box 6 Important tip — Stick with the basics!

It is necessary to get back to basics — first identify the real problem and then fix it. For example, by-catch in itself is not a problem that can be fixed by management. However, one specific issue, for example, the capture of vulnerable and protected species can be addressed by management measures. Over capacity is very difficult to address directly. But breaking it down to more specific issues such as too many boats makes action more directed and feasible.

The next step is for stakeholders to undertake an initial evaluation of issues associated with the fishery. This should cover economic, social and ecological considerations and be guided by the high-level policy goals set at the national or regional level.[61]

Starting with each broad issue, these are further divided into more specific issues that can be tackled through a management intervention of some sort. This process is likely to result in many potential issues being identified, but there is a practical limit to how many issues a management system can deal with.

One approach to prioritization of specific issues is to conduct a risk assessment. This can be either qualitative and opinion-based, or highly quantitative and data-based. There are many ways to carry out a qualitative risk assessment. One way of doing this would be to score both the likelihood (risk) and consequences of failure (impact) in relation to each issue on a scale of, for example, 1 to 5. High-priority issues to address first are those with a high likelihood of occurrence and high impact.

Steps 4 to 5: Set objectives, indicators and benchmarks (performance measures) and management actions to meet the objectives.

All specific issues should be dealt with in the comanagement plan, but in a manner commensurate with the related risk. High-risk issues are elaborated into detailed objectives. Some medium-risk issues might require identification of a mechanism in the plan for ongoing review and some form of contingency plan. Low risk issues might be noted in the plan, explaining why they are considered low risk.

Box 7 Participatory process for comanagement planning

Identifying issues and finding solutions is best done during a meeting/workshop where all relevant stakeholders are gathered. It is important to get input from as many people as possible. The fewer people involved at this stage increases the chances of some issues being missed and also reduces subsequent ownership of the process. The process can be made very interactive with a few basic media aids or simply draw on paper and clip boards or use pictures.

If the specific issue has been well articulated, it should not be difficult to create an objective on how to address it. Objectives need to state what will be achieved in a general sense *e.g. minimize the impact on turtles.* The stakeholders will also need to decide on how to assess whether the objective is being achieved. This is done through setting indicators and benchmarks.[62]

It is common to find that in the process of developing objectives, the conflicting nature of these will become apparent. Resolving these differences lies at the heart of getting the balance right and agreeing on what management is really trying to achieve. For example, is it increasing wealth, rebuilding stocks or providing employment for all and a social safety net? Not all these objectives can be realized.

[61] Several useful frameworks and tools for guiding this process have been developed (see FAO, 2003 cited earlier, for example).

[62] Indicators need to be linked to objectives and benchmarks so that they form a valid means of assessing management performance. Some indicators may increase over time and some may decrease, but whether this trend is good or bad will depend on what the managers are trying to achieve and the nature of the agreed benchmark.

From the wide range of fisheries and ecosystem management tools that are available, the most appropriate management intervention(s) to meet the specific objective need(s) to be selected. Often the same tool (e.g. setting up an MPA, introducing a capacity reduction programme) can meet several objectives.

Where possible, it is important to try and agree about what might happen if the intervention doesn't work and how to counteract this before it happens. This provides some certainty for all the players and the rules are known and understood. The rules state what management action should be taken under different conditions, as determined by its performance. In a small-scale fishery context these need to be pragmatic (e.g. relating to stricter enforcement if a particular measure is not working etc.).

Step 6: Monitor, assess and review

The comanagement plan must also specify regular reviews in which the success of the management measures in attaining the objectives is appraised. These reviews will benefit from data that has been collected by an effective and well-directed monitoring programme and analyzed by appropriate technical experts. Such a review should be carried out under guidance from a designated stakeholder group, to which regular reports should be made.

Both short-term and long-term reviews should be conducted. Short-term reviews, for example as part of an annual cycle, should report on indicators measured during, for example, the assessments of the status of key stocks, changes in catch composition, assessments of impacts of the fishery on habitats, changes in employment and demography and profit. Importantly, reviews will cover both ecological and social well-being benefits and impacts created (Figure 14).[63]

Longer-term reviews should also be conducted on a regular basis (three to five years). These reviews should include consideration of the full management arrangements such as:

- data collection and/or resource monitoring;
- comprehensive re-assessment;
- reappraisal of decision rules; and
- progress towards meeting longer-term objectives.

Longer-term reviews may provide evidence that an objective set earlier (e.g. recovery to a certain species abundance level by a particular date) is no longer appropriate.

Management reports based on the reviews

Short-term reviews should be summarized in an annual report that is easy to read and digested and that links with the fishery comanagement plan. In general the report will contain:

- objectives
- status of the indicator
- performance assessment
- management implications.

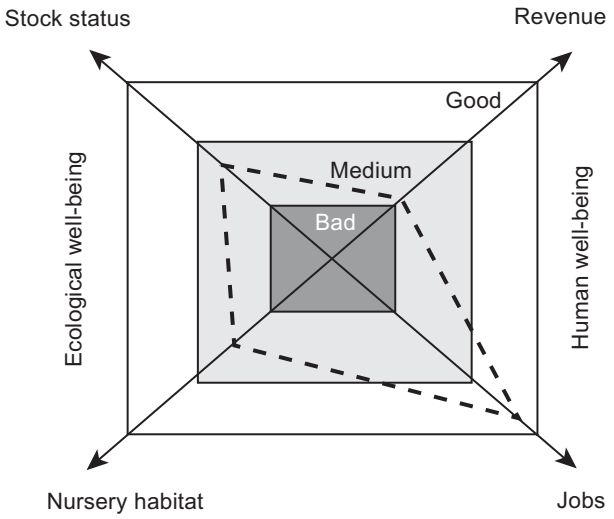


Figure 14 Kite diagram showing ecological, economic and social dimensions. Redrawn from FAO, 1999.

Obviously, the report should include all the agreed high priority ecological, social and economic objectives and be a "triple bottom line" report. There are a number of tools available to summarize the results. One method is to use indicator "traffic lights" — green if performance is satisfactory, red if not satisfactory and orange to indicate that things are not progressing very well and caution is needed. Another commonly used system is a kite diagram (Figure 14).

[63] Redrawn from FAO. 1999. *FAO Technical Guidelines for Responsible Fisheries: Indicators for sustainable development of marine capture fisheries*. Rome.

EAF in the context of Asia-Pacific fisheries

Uniqueness of Asian fisheries

Asia's capture fisheries make up about 50 percent of the global production. Although there are often strong claims made about the differences of Asian fisheries (e.g. their multi-gear/multi-species nature etc.), in essence all fisheries have similar characteristics, similar issues and similar challenges. The main difference is that the challenges are generally greater in Asian fisheries because the once highly productive fisheries have spiralled so deeply into decline that it will be a difficult task to restore them.

The issues facing Asian fisheries in both inland and marine environments stem from two main policy drivers: "increased production" and "open-access". For many countries, following World War II, there was a drive to increase the production of capture fisheries. This is the same policy that has also driven agriculture development (often the same Ministry and Minister), without critically appraising its relevance to a fish resource that has natural limits on productivity. Production increases were mainly achieved through "modernization" (increased catching power and efficiency) based on the introduction of new technology: fishing gear, vessels, motors and fish-finding devices. The uptake of the new technology was often accompanied by subsidies to facilitate their use in the form of soft-loans, tax incentives, fuel subsidies etc.

This policy combination of "increased production" and "open access" has been a recipe for disaster for Asian fisheries as in most cases this as been implemented without any plan to actually control or limit the expansion. As a result, there has been massive fishing pressure on nearshore resources and increasing competition between the artisanal small–scale sector and the higher powered more commercial vessels. Asian coastal fisheries present a major source of livelihood for the millions of people dependent on fisheries. As the quality of fisheries has declined and with few alternatives to supplement their incomes, this decline is being manifested in boats lying idle along the coasts and ports, high unemployment, lower profits, longer fishing trips (with increased safety risks), and migrations of fishers to find work either in their own countries or overseas. Inland fisheries have seen similar changes, not through competition within the sector, but through decline in the environmental services which sustained inland fisheries.

Key changes to policies

The most significant reform that is needed is a paradigm shift in policy from "production increase" to "benefits (social and economic) increase" and from "open access" to "limited access". Many of the more developed countries of the region (e.g. Japan, Republic of Korea) are already moving in this direction and are capturing the wealth that the harvest and selling of a natural resource such as fish can bring. Other countries (e.g. China and Cambodia) are also tackling the twin evil of "production increase" and "open access" by reduction of fishing effort through dramatic reduction in fishing vessels in the case of China and introducing community-based rights systems in Cambodia. Several other countries are taking hesitant first steps towards capacity reduction, but the rate of progress seems frustratingly slow.

Adopting an EAF approach to the overall management of fisheries is an effective way to change policies, especially in those countries where the "increase production at all costs" paradigm is still firmly entrenched. Any consultative process that looks towards better protection of the environment and a focus on increasing the social and economic benefits of fishing would quickly show the failure of current policies and the need to change. Because this would come both from the grassroots and from the policy makers, it would be much more easily accepted by politicians and senior bureaucrats. Starting an EAF process at any level is not difficult, although it will require people-orientated and participatory assessment skills not normally found in a fishery officer who is more likely to have been educated in the biological and other sciences.

Key institutional changes. The main institutional change is for a ministry/department to take the lead in changing fisheries policies and management throughout Asia. This will require commitment to change and the passion to lead others through this change. Although in many political contexts this will mean taking risks, the fallout from taking these risks will be outweighed by the benefits. The status quo is not an option.

Legal requirements. Internationally, the instruments for EAF are mainly contained in voluntary instruments including:

- Rio Declaration on Environment and Development, Rio de Janeiro, Brazil, 1992;
- Agenda 21 of the UN Conference on Environment and Development, Rio de Janeiro, Brazil, 1992;
- FAO Code of Conduct for Responsible Fisheries, Rome, 1995;
- Jakarta Mandate on Marine and Coastal Biodiversity, Jakarta 1995; and
- Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystems, Reykjavik, 2001.

As a result, few fisheries organizations and national policies and legislation actually make explicit recognition of EAF, although this is now changing. At the national level, EAF may require that existing legal instruments and practices that interact or impact with fisheries need to be considered, and adjustments made where necessary. In the future, it may be necessary to regulate the inter-sectoral interactions through primary legislation, e.g. laws controlling coastline development.

However, EAF processes can begin with existing legislation in most cases. Getting stakeholders together and agreeing on issues and management actions is not a complicated legal practice. As policies evolve and the need for better enforcement evolves, legislation can be change to meet the new policies.

Regional arrangements for EAF — A role for APFIC?

At the regional level, APFIC could provide support to:[64]

1. launch a media campaign that provides a high level of awareness of the issues in current fisheries and the fact that APFIC Members are intending to address them;
2. facilitate the building of subregional fishery alliances among countries who share the same regional sea, using existing mechanisms such as SEAFDEC and LME projects (these exist for the South China Sea and Gulf of Thailand, Sulu-Sulawesi Sea, Yellow Sea, and probably soon, the Bay of Bengal;
3. use the subregional alliance to set broad policy goals for their subregions and use them as a way of assisting all participating countries to move forward;
4. assist in building the capacity of staff in fishery agencies at all levels in terms of: (i) raising understanding of the causes and consequences of current fishery issues; (ii) improving familiarity with EAF as a solution; and, especially for district staff, (iii) helping them become more competent to facilitate the EAF process, especially in using participatory tools (e.g. hierarchical tree process);
5. assist countries to develop national and provincial (state) strategic fisheries management plans. Note: this would necessitate resolving conflicting objectives, something that has not been attempted in the past (this would involve determining first whether the fisheries in the subregion are being managed to promote wealth generation for a limited number of participants that will flow on to others, or, being managed to provide increased regional employment, or, being managed to reduce poverty of fishery-dependent communities (i.e. pro-poor policies and management etc.);
6. provide support through the numerous activities that are being undertaken at the local level (including the many comanagement pilot projects that are already being funded) to facilitate better planning and EAF implementation at the local level; and
7. set up a regional reporting system based on key indicators of progress that feeds back into APFIC's annual flagship publication, *Status and potential of fisheries and aquaculture in Asia and the Pacific* (note: the Pacific Islands Forum Fisheries Agency is currently looking at ways to implement EAF and could be an important partner to Asian activities).

[64] Note: Many of these actions at the different scales could be carried out in parallel, but ideally with strong linkages.

4. Trends in fisheries and aquaculture

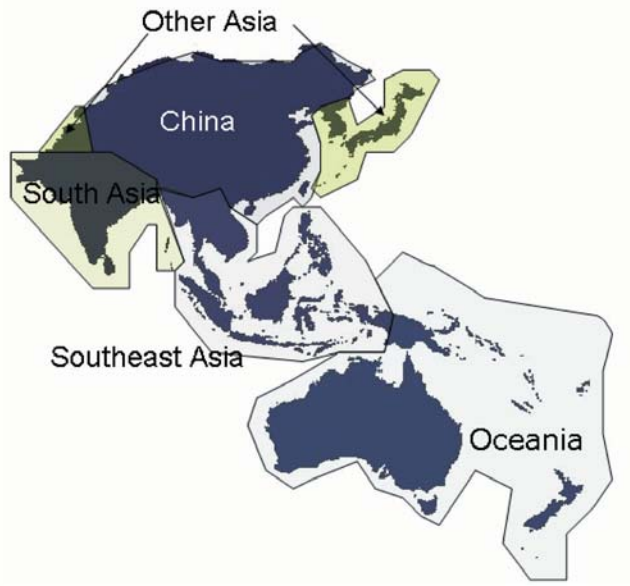
Asia and the Pacific region continue to be the world's largest producer of fish. In 2006, this amounted to 94.2 million tonnes[65] — 47.9 million tonnes from capture fisheries and 46.3 million tonnes from aquaculture (excluding aquatic plants). This represents 52 percent and 90 percent of the global production, respectively. When aquatic plants are included in the total aquaculture figures, aquaculture production outstrips that of capture fisheries for the first time (total aquaculture production of 61 million tonnes and 92 percent of the world's production). Capture fisheries increased by 3.5 percent over that of 2004 (driven mainly by growth in Southeast Asia) and 13 percent for total aquaculture (driven mainly by growth in China and Southeast Asia). Of the top ten producers of capture fish, six states were from Asia and the Pacific region (China (1st), Indonesia (4th), Japan (5th), India (7th), Thailand (9th) and the Philippines (10th)). For aquaculture, China is reported to have produced 70 percent of the world's aquaculture production (about six times greater than the fisheries production of Peru, the number two fisheries producer in the world).

Box 8 China's revised statistics

Based on the 2006 agricultural census, China has adjusted its fisheries and aquaculture production figures. For marine and inland capture fisheries the estimated production is decreased by 13.3 and 13.6 percent respectively. Similarly for aquaculture, the decrease is 12.6 and 13.7 for marine and freshwater respectively.

As these figures were adjusted after reporting to FAO, the data analyzed in this report is the higher reported figures. Additionally, China will work on reviewing historical data back to 1996 when the previous agricultural census was performed. Hence, as China is such a major part of regional and global trends it is expected that major changes will occur. One conclusion is that using revised data a decline in global and regional marine capture production will be seen.

The capture fisheries of Asia and the Pacific region are dominated by pelagic species – in many subregions it is small pelagics that are the dominant group. The proportion of low-value/trash fish is increasing in many areas, a trend that is meeting the growing demand for these fish for use as feeds for livestock and aquaculture. Freshwater fish dominate aquaculture production.



Map B Asia and the Pacific region and an imprecise outline of the subregions analyzed in this report

As expected, there is considerable variation in general trends among the five main subregions of Asia and the Pacific region. Production from China, South Asia and Southeast Asia continues to grow. Capture fisheries production from Japan and Democratic People's Republic of Korea have shown a steady decline over many years, partly because of declining stocks,[66] whereas aquaculture production has remained relatively stable. Oceania's production is minor compared with the other subregions, and has seen a steady increase until last year when there was a sudden decrease. Many of the fisheries in the Pacific small island developing states, which operate at subsistence level, are not recorded.

4.1 Capture fisheries — trends in Asia and the Pacific region

Production from Asia and the Pacific region's capture fisheries has increased by 1.6 million tonnes since 2004 and totalled 47.6 million tonnes in 2006. This represents an overall increase of 3.5 percent over 2004. Inland capture fisheries production increased by 19 percent whereas that of marine capture fisheries increased by only 1.3 percent. The respective figures in the previous biennium were 5 and 2.5 percent, hence, although marine capture production is still increasing, it is at a lower rate.

[65] Including all FAO Fishing Areas.
[66] http://www.fao.org/fishery/countrysector/FI-CP_JP/en

Box 9 Top capture producers 2006

Top ten producers of capture fish in 2004 were China, Peru, USA, Indonesia, Japan, Chile, India, Russian Federation, Thailand, and Philippines. Six of these are in Asia and the Pacific region. The top ten producers amount to 60 percent of the total global production.

The region has been the world's largest producer of fish for decades, and has further increased to 52 percent of global capture production in 2006, from 49 percent in 2004. Of the top ten producers of capture fish in the world, six states are in Asia and the Pacific region. Total capture fisheries production in the region has steadily increased since 1950, mainly from the marine capture fisheries sector (Figure 15), whereas global capture fisheries catches levelled off already in the mid 90s (including regional catches). In inland waters, the regional share increased to 65.9 percent (62.4 in 2004). China is still by far the largest producer in the region with a reported production of 17.1 million tonnes in 2006, representing 40 percent of regional production. This is more than 3.6 times greater than the second largest producer in the region, Indonesia, and four times higher then the third largest producer, Japan.

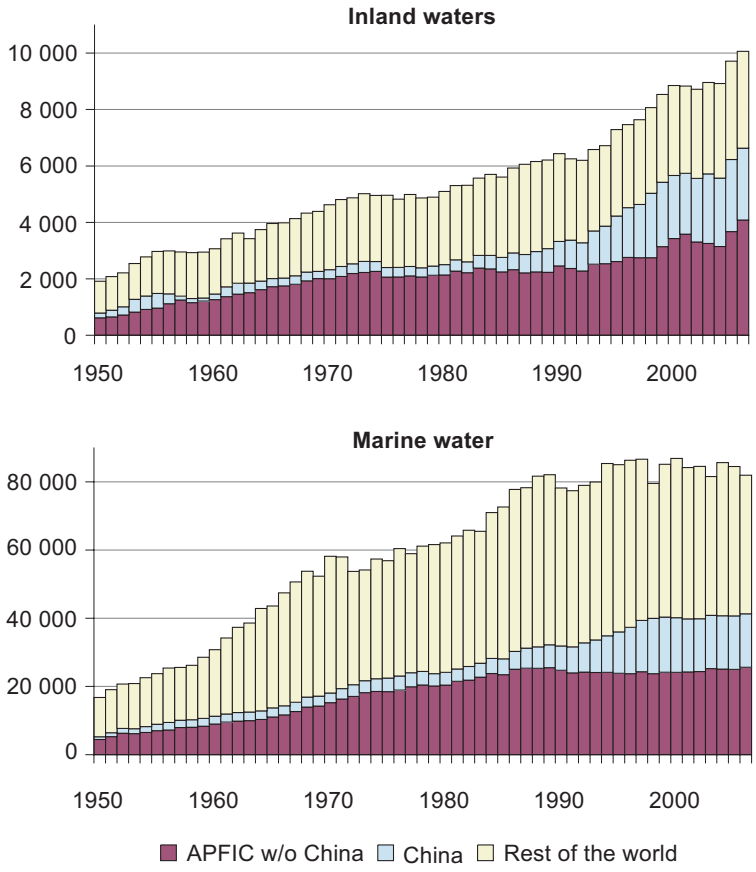


Figure 15 Trends in global capture production (1 000 tonnes)

Because of this enormous scale of production, China[67] is treated as a distinct subregion in this review.

Marine Waters

Excluding China, total capture fishery production from marine waters has recorded its highest catch ever, with 25.6 million tonnes in 2006. The previous peak in total catch was 25.4 million tonnes in 1989, which then gradually declined. However, there has since been a gradual increase in recent years.

Southeast Asia has continued to increase its production and has maintained the largest share (excluding China) of the APFIC region since 1994 (Figure 16a). Growth in South Asia has occurred but is relatively slow. The subregion Other Asia used to be the top contributor to the region, but has experienced a serious and continuous decline in production since 1988 that now show signs of levelling of. This can partly be explained by the fact that the Japanese and Democratic People's Republic of Korea fisheries are not decreasing at the same rate as in previous years and that the Republic of Korea catch is increasing.

The increase in marine capture fisheries since 2004 has occurred mainly in Southeast Asia, in particular Myanmar (+21 percent) and Cambodia (+ 8 percent), but also in Viet Nam (+5 percent). Major decreases have been reported by Sri Lanka (-30 percent), Australia (-17 percent), New Zealand (-14 percent) and Pakistan (-9 percent). The decrease in the Sri Lankan catch was even more pronounced in 2005 with an unrivalled 51 percent decrease, followed by a 43 percent increase in 2006. The decreases in Australian and New Zealand catch are mainly a result of the decreased catch of demersal marine fish that make up a large fraction of total production.

[67] In the following sections, unless otherwise indicated, "China" refers to the subregion that includes China, Hong Kong SAR, Macao SAR and Taiwan POC.

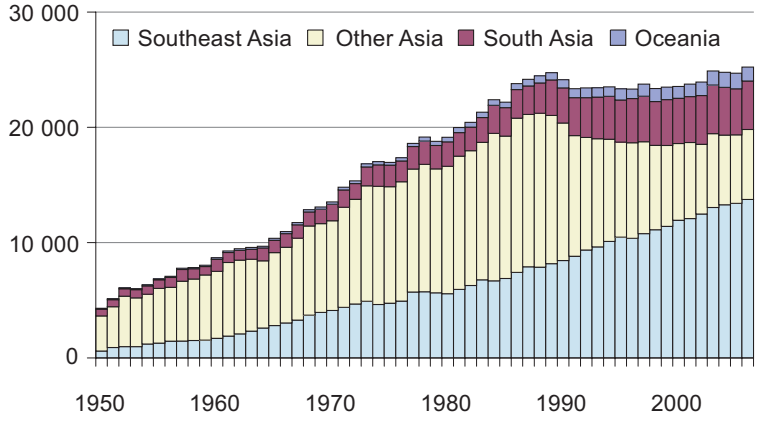


Figure 16a Trends in marine capture production by subregion outside China (1 000 tonnes)

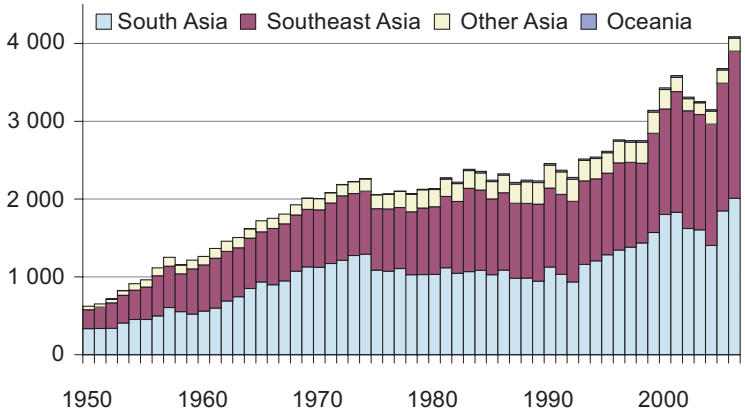


Figure 16b Trends in inland capture production by subregion outside China (1 000 tonnes)

Inland waters

Excluding China, total inland production of the region reported in 2006 was 4.8 million tonnes (3.1 million tonnes in 2004). The increase over that of 2004 has come mainly from Cambodia (69 percent), India (63 percent), Pakistan (49 percent), Myanmar (39 percent) and Bangladesh (31 percent). China reported an increase of 124 000 tonnes, which corresponds to an increase of 5 percent, compared to 2004. South Asia and Southeast Asia contributed the greatest amount of production compared with other subregions (Figure 16b) and combined was almost as high as the inland capture catch of China (79 and 74 percent, respectively). The increases in the South Asia states were mainly reported as freshwater fishes "not elsewhere included" (nei) and additionally India reported a major increase of cyprinids nei.

Large decreases were reported from inland capture production in Republic of Korea (37 percent), Japan (25 percent) and Indonesia (9 percent) since 2004. The Republic of Korea decrease is because of immense decrease in freshwater mollusc production compared to 2004 and for Japan the trend is mainly because of the decreased catch of salmon and molluscs.

The overall increase in inland fisheries is probably a result of more enhancement and growing effort that increases the yield. However, part of the increase is probably because of a significant re-evaluation of the contribution of inland fisheries that greatly revised the previous underestimates upwards. 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 is 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. There is still considerable uncertainty about inland production figures — the production from Southeast Asia has been estimated to be underreported possibly by a factor of between 2.5 and 3.6 and recent figures from MRC estimate the underreporting to be as high as four times on occasion.[68] Additionally, inland capture fisheries production in Thailand has been estimated to 1.0 million tonnes, compared to the reported 0.2 million tonnes.[69] Hence, in future years, increases in inland capture fisheries are expected, but these increases will mainly be attributed to adjusted data collection strategies and inclusion of rural and subsistence fisheries in official statistics. However, the large regional share of global catches could possibly reflect better reporting or estimates of inland catch compared to other regions, such as Africa and Latin America.

[68] Hortle, K.H. 2007. *Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin*. MRC Technical Report No. 16, Mekong River Commission, Vientiane. 88 pp.

[69] Lymer, D., Funge-Smith, S. et al. 2008. *A review and synthesis of capture fisheries data in Thailand*. RAP Publication (in progress). FAO. Bangkok.

4.2 Capture fisheries — species composition

The region's catch is dominated by pelagic marine species and in many subregions small pelagic species (e.g. Japanese jack mackerel, Japanese anchovy, chub mackerel, Pacific saury, Indian oil sardine, Indian mackerels and scads). The increasing catches of small pelagic species is a recent trend that can be explained by two factors: a) a more targeted fishing for these species (because of increased value); and, more seriously, b) as an effect of fishing down the food chain, i.e. when the large pelagic are less abundant the fishers target the small pelagics.

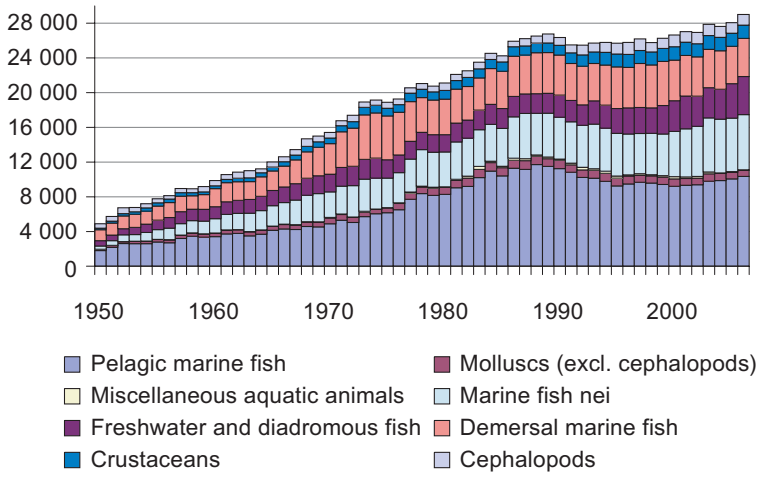


Figure 17 Trends in capture production by species group outside China

The catch of pelagic marine fish peaked at 11.7 million tonnes in 1988 and subsequently decreased to the production levels seen in the early 1980s (Figure 17). The catches have since started increasing and reached 10.3 million tonnes in 2006. Other species groups such as molluscs, crustaceans and cephalopods have levelled off whereas production of freshwater and diadromous fish continues to grown steadily.

Demersal marine fish production in Asia and the Pacific region peaked at 5.2 million tonnes as early as 1974 and declined to around 4.4 million tonnes where it has been relatively stable since 1991. These figures highlight the overfishing of demersal stocks in the region and their disappearance from the catch. The top 20 species in the region (Table 9) show considerable changes in rankings over time. It is significant that the reduction in catch of a single dominant species such as Alaska pollock in the early 1970s and chub mackerel in the late 1970s resulted in changes in the relative ranking of large pelagic marine species (i.e. skipjack tuna and yellowfin tuna) that has carried through to 2006 as these fisheries have increasingly expanded. When the Chinese figures are included, the large catches of largehead hairtail, akiami paste shrimp (*Acetes* spp*)* and marine molluscs have an increased importance in the overall rankings. It is important to note that Alaska pollock is a cold water species, whereas tunas are tropical species, indicating the shift of effort of fishing fleets from cold water fisheries to tropical waters fisheries in the region.

The proportion of low-value/trash fish in the catch is increasing throughout much of the region.[70] Unfortunately there are very few records of the amount of low-value/trash fish currently being taken in the APFIC region. This is partly because the term "trash fish" is still used to mean different things in different states making reporting difficult. It is also important to point out that in some countries (e.g. Cambodia) the term is not even used, as all the catch, independent of size and quality, is processed.

The percentage of low-value/trash fish recorded for some countries in the region ranged from 4 percent to 38 percent of the total marine capture landings.[71, 72] In some cases the percentage was in excess of 50 percent, especially in areas where low-value/trash fish are being targeted. The weighted average percentage across the region was 25 percent.

For 2006, the recorded Asian capture fishery landings amounted to about 38.3 million tonnes (for all carnivorous and omnivorous fish and excluding molluscs, crustaceans and seaweeds) and the latest estimate for discarding is 1.8 percent, giving a total capture figure of 39 million tonnes. Applying a 25 percent low-value/trash fish factor to the landed catch gives a figure of 9.6 million tonnes being used for livestock/fish, and 28.8 million tonnes being used directly for human consumption.

[70] In this report, this term refers to fish that are generally of relatively low economic value and typically small size.

[71] Funge-Smith, S., Lindebo, E. & Staples, D. 2005. *Asian fisheries today: The production and use of low-value/trash fish from marine fisheries in the Asia-Pacific region*, RAP publication 2005/16.

[72] Edwards, P., Tuan, L.A. & Allen, G.L. 2004. *A survey of marine trash fish and fish meal as aquaculture feed ingredients in Vietnam*. ACIAR Working paper 57.

Table 9 Top twenty capture production species in Asia and the Pacific region

	APFIC w/o China				APFIC	
	1960	1990	2006	(1 000 tonnes)	2006	(1 000 tonnes)
1	Japanese jack mackerel	Jap. pilchard	Skipjack tuna	1 708	Skipjack tuna	1 756
2	Flatfishes nei	Alaska pollock	Chub mackerel	810	Jap. anchovy	1 657
3	Jap. flying squid	Skipjack tuna	Jap. anchovy	682	Largehead hairtail	1 561
4	Alaska pollock	Nat. decapods	Scads nei	570	Chub mackerel	1 285
5	Jap. anchovy	Jap. anchovy	Yellowfin tuna	537	Scads nei	1 197
6	Chub mackerel	Scads nei	Nat. decapods	503	Marine molluscs nei	987
7	Pacific saury	Yellowfin tuna	Croakers, drums	457	Croakers, drums nei	798
8	Indian oil sardine	Chub mackerel	Sardinellas nei	425	Nat. decapods	748
9	Nat. decapods	Various squids nei	Jap. flying squid	387	Akiami paste shrimp	729
10	Yellowfin tuna	Croakers, drums	Indian oil sardine	338	Various squids nei	602
11	Scads nei	Pacific saury	Pacific saury	318	Threadfin breams	577
12	Indian mackerel	Indian oil sardine	Cephalopods nei	302	Yellowfin tuna	551
13	Sharks, rays etc.	Jap. flying squid	Cyprinids nei	298	Seerfishes nei	436
14	Clams, etc. nei	Cyprinids nei	Alaska pollock	293	Sardinellas nei	425
15	Ok. atka mackerel	Arg. shortfin squid	Clupeoids nei	288	Gazami crab	417
16	Yellow croaker	Sardinellas nei	Hilsa shad	280	Dag. pike conger	414
17	Skipjack tuna	Stol. anchovies	Indian mackerel	276	Freshwater molluscs	410
18	Bombay-duck	Clupeoids nei	Arg. shortfin squid	275	Silver pomfrets nei	396
19	Jap. carpet shell	Bigeye tuna	Short mackerel	275	South rough shrimp	392
20	Clupeoids nei	Jap. jack mackerel	Kawakawa	274	Jap. flying squid	387

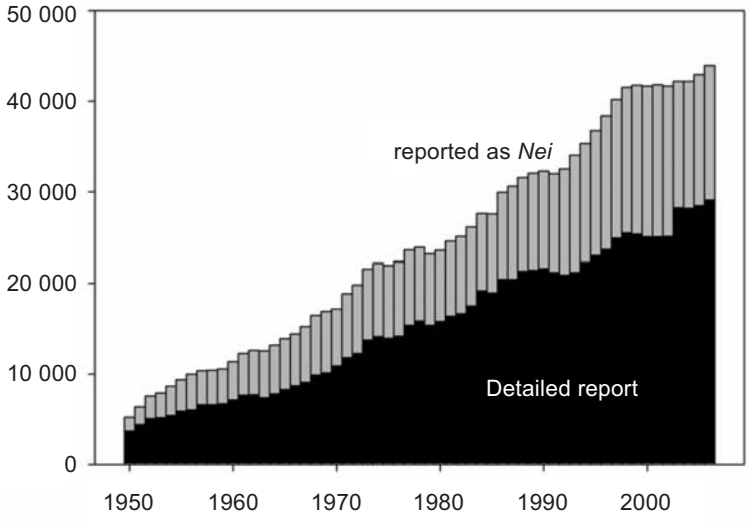


Figure 18 Capture production in Asia-Pacific region by detail of reporting

As aquaculture fish production is about the same, it is clear that the diversion of marine fish via aquaculture is still providing a very significant proportion of the total fish provided to human consumption (both within Asia and exported to other more developed countries). An increasing proportion of this production is high-value carnivorous species and hence the production is increasingly dependent on imported fish meal/oil.

There is still a considerable capture production that is not identified to the species level but instead recorded as marine/freshwater fishes nei,[73] marine/freshwater molluscs nei and marine/freshwater crustaceans nei (Figure 18). The quantity reported under these categories has for some subregions been increasing significantly in recent years, which indicates a worrying trend in the quality of the available statistical information. It may also reflect the trend towards smaller lower-value species, which are considered not worth reporting in detail (this especially hides the effects of overfishing on the capture of juveniles).

[73] Nei = not elsewhere included

APFIC Recommendation

Targeted surveys to assess composition of "nei" reports to get better estimates.

In 2006, 14.8 million tonnes or 34 percent of capture production was not identified to species, order, or family level. It is notable that China has improved its reporting on individual species. The reporting on nei species has been reduced by more than 3 million tonnes or from 52 percent on reported capture production in 2002 to 34 percent in 2006.

Temperate and tropical seas — fishing down the food chain

There is no doubt that the fisheries of Asian waters have been increasingly exploited since the late 1960s, but there remains a remarkable lack of comprehensive data as to whether these fishing activities in Asia and the Pacific region have affected the catch composition, with a tendency to find fewer larger fish in the catch and increased numbers of faster recruiting species. There seems to be empirical evidence of this and certainly the fishers themselves report this effect in many coastal fisheries, but to find this clearly documented is a challenge.

Table 10 World fishery fleet[74]

Year	Number of boats	% increase (since 1970)
1970	595 100	–
1975	702 500	18.0
1980	824 100	38.0
1985	984 400	65.0
1989	1 162 400	95.0
1990	1 202 300	102.0
1991	1 221 900	105.0
1992	1 225 700	106.0
1993	1 239 900	108.0
1994	1 238 200	108.0
1995	1 258 200	111.0

The practise of fishing for smaller and less-valuable species when the larger more-valuable species are fished out is sometimes referred to as "fishing down the food chain". Looking at the reported statistics for the region, there is no clear evidence of fishing down the food chain when the regional data are analyzed as a whole (Figure 10). This is almost certainly a result of the high level of aggregation of fishing areas (where continental shelf fisheries and pelagic fisheries are combined) as well as the often highly aggregated nature of reporting from some fisheries. The most extreme example is the reporting of significant amounts of the catch as nei. Despite these constraints, there are still indications when viewing groupings of species (according to ecology/feeding characteristics) that there has been a changeover in the catch from large pelagics, high-value demersals and high-value crustaceans to smaller-sized and less-valuable species (small pelagics and demersals), low-value crustaceans and increased catches of cephalopods (Table 9).

The history of fishing in the region must also be taken into account. Although it is certain that fishing capacity in the region and the world has increased over the past 50 years (more than doubled between 1970 and 1990, see Table 10), it is also clear that effort has shifted its focus too, as deeper water fisheries have been developed and the effort has shifted from temperate to tropical waters.

Splitting the reported data into the two distinct regions, temperate and tropical, allows a degree of analysis of the changes in composition of reported catch and some trends in the fisheries. Ideally, the reported areas would follow ecosystem type boundaries, allowing far more accurate analysis of the trends between and within ecosystems. The FAO reporting areas which cover temperate and tropical seas are still rather large, with FAO reporting areas 61 and 81 being temperate and the others being predominantly tropical (FAO areas 51, 57, 71 and 77). It is also important to include the reported catch of all countries fishing in the region (e.g. catch reportedly caught within the region by countries from outside the region is included in the analysis). To look at trends in broad groupings, the species were aggregated into some clear functional groups to illustrate better the effect of targeted fishing for larger or more valuable species.

The divisions used are as follows:

- Pelagics — split between large high-value carnivores, lower-value carnivores and plankton feeding species.
  - Large (tuna type species, seerfish, large mackerels).
  - Small (small mackerels, scads etc.).
  - Anchovies, herrings etc.

[74] FAO. 1998. *Bulletin of fishery statistics – fishery fleet statistics*, No. 35, Rome.

- Demersals — generally considered to be nearshore species or associated with bottom fisheries, reef fisheries, and not particularly migratory.
  - High-value (Alaska pollock, snappers, croakers, groupers, reef fish, flatfish).
  - Low-value (small species).
  - Sharks, rays etc. (maybe high- or low-value, but worth considering separately because of their size and sensitivity to fishing pressure.
- Shrimp, prawns, other crustaceans — can be divided into those with high value and specifically targeted and the low-value species caught as by-catch.
  - High value (*Peneaus* spp, lobsters, crabs).
  - Low value (especially Acetes, caught in huge volumes but low value).
- Squids and other cephalopods (carnivorous species, but often increase when their natural predators, the larger carnivores (pelagic/demersal) are fished down.

Temperate seas

The catch from the temperate seas in Asia and the Pacific region amounts to a total of 22.2 million tonnes, of which 11 percent is reported as marine fishes nei. The groups included in the analysis cover an additional 75 percent of the total catch (2006). From the trends there is a reasonably clear indication that there has been a "fishing down the food chain" effect in the temperate waters of Asia and the Pacific region (Figure 19). The trend of increasing total production of larger/high-value demersal species stopped in the mid 1980s and went into a decline subsequently (Figure 10).

The anchovy-herring fisheries peaked in the late 1980s (6.1 million tonnes, mainly Japanese catch of Japanese pilchard) and then rapidly declined by over 60 percent to 1.9 million tonnes in 1995. They later recovered and were up to 2.9 million tonnes in 1998 (mainly because of the

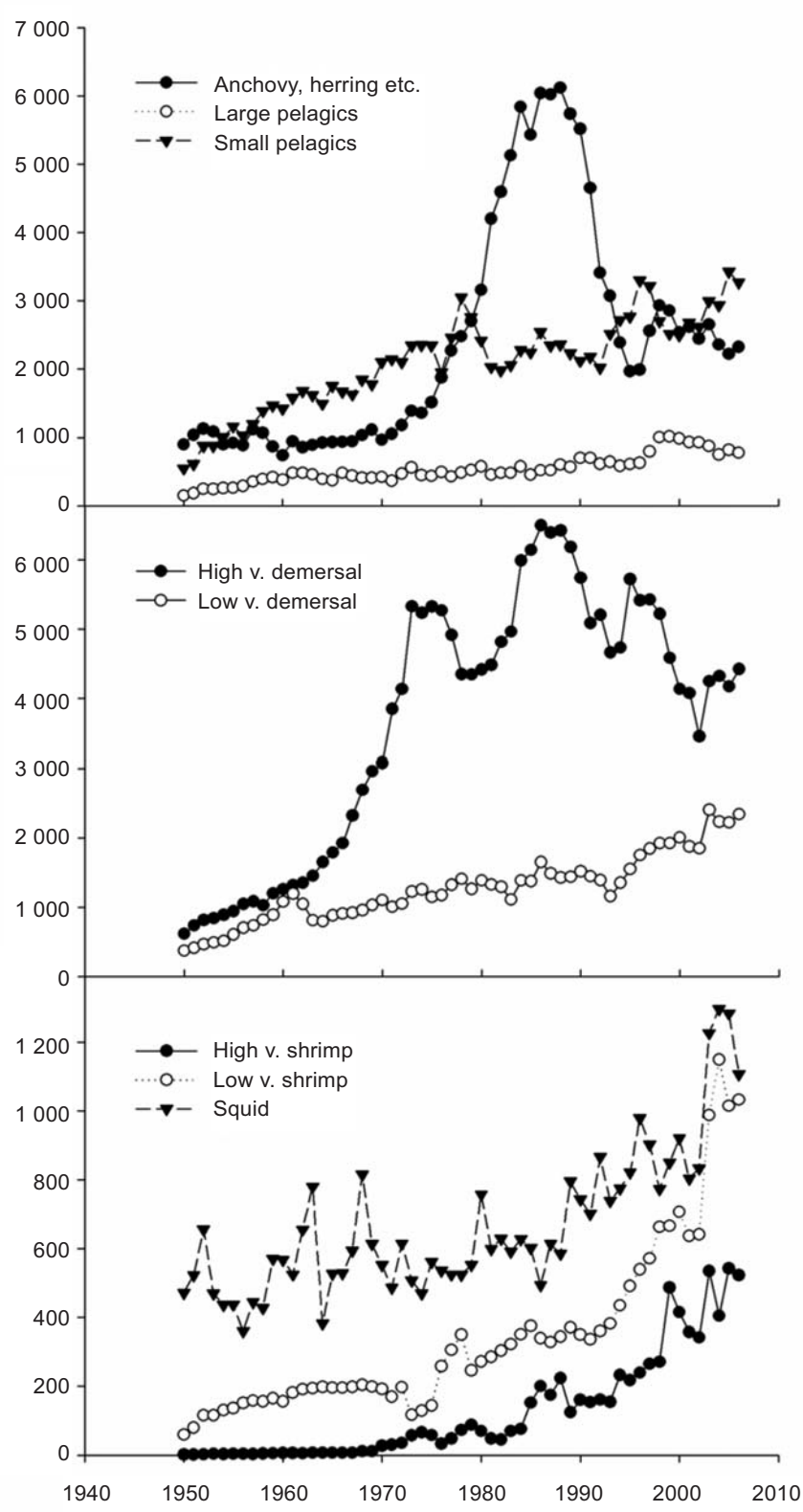


Figure 19 Catches (1 000 tonnes) divided into groups from all countries (world) in FAO areas 61 and 81 (temperate).

Chinese catch of Japanese anchovy), but have since declined again. The trend in "small pelagics" fisheries is the opposite of the anchovy-herring fishery, with a marked reduction when the anchovy-herring fisheries increased in the early 1980s and a rapid increase when the anchovy-herring fisheries declined in the early 1990s. As the small pelagic species to a large extent feed on the anchovies and herrings this trend is perhaps not surprising, but the connection has not been clearly reported.

The large pelagics show a steady increase up until 1996, when they suddenly increased by 60 percent in two years reaching 1.1 million tonnes in 1998. This increase can be explained by the increased production from China and Japan of seerfishes nei. The production has since fallen again to 0.8 million in 2006. The main changes in catches are decreased catches of seerfishes nei, but also decreased catches of skipjack tuna and albacore.

The high-value demersal species group has shown variations. The first rapid increase in the early 1970s was mainly because of increased catches by Japan and the Soviet Union of Alaska pollock. There was a sharp decrease in the late 1970s and then a rapid increase between 1981 and 1986, again largely caused by increasing catches of Alaska pollock by the Soviet Union. Catches subsequently decreased until 1994 when there was another rapid increase as a result of the increased catch from China and Russia of mainly Alaska pollock, and a greatly increased catch of largehead hairtail and croakers, drums nei. The demersal fisheries group has generally declined from its highest level in the mid 1980s to almost 40 percent to the current level of the reported catch in 2006 of 4.2 million tonnes.

The low-value demersal catch increased relatively slowly until 1993 when the production started to increase rapidly from 1.1 million tonnes to 2.4 million tonnes in 2004, hence more then doubling in ten years time. The main increases in catch have been in the catches of threadfin breams nei, daggertooth pike conger and Pacific sandlance.

The catches of high-value shrimps started to increase in the 1970s and there was an increase in the rate during the mid 1980s. Although fluctuating, the overall trend is still increasing and is mainly because of increased catches of southern rough shrimp and, to a lesser extent, fleshy prawn.

Low-value shrimp catches increased steadily until the early 1970s when the catch of akiami paste shrimp (*Acetes)* sharply dropped. It then recovered and increased from 13 000 tonnes in 1975 to 730 000 tonnes in 2006. The production of natantian decapods nei increased steadily until 1984 (150 000 tonnes) after which it started to decline until 2002 (50 000 tonnes). Then it increased rapidly and production is up to 460 000 tonnes in 2004 (increased catch almost exclusively from China). This trend is most likely a result of Chinese improvements in disaggregating their reported catch. The marine crustaceans nei catch drops from 1.2 million in 2002 to 0 in 2003 and has since remained at this level. Part of the recent increase in high-value shrimp can be explained also by this improvement in reporting.

The squid catch shows strong cyclical changes, but the main trend is a stable catch until the mid 1980s when the catch starts to increase more rapidly. The increase then levels off and stabilizes around 800 000 tonnes (2002) before increasing rapidly until 2004 (1.3 million tonnes). The increase in catch is reported as "various squids nei" and mainly by China. China only started reporting a squid catch in 1998; hence it is likely that this recent trend is the result of a targeted, recently developed squid fishery in China.

APFIC Recommendation

The uncertainty created by the 30 percent of catch reported as "marine fish nei", could to some extent be resolved by targeted sample surveys in those countries reporting high quantities of Marine fish nei. This would at least give an indication of the percentage composition and value of the species in this category.

Tropical seas

The total catch in the tropical areas of Asia and the Pacific region is currently 23.1 million tonnes and the trends of rise and decline seen in the temperate areas are less obvious in the tropical waters (Figure 20). In tropical waters, coastal stocks (typically the demersal and small pelagic species) may be more diverse and perhaps more resilient in the face of heavy fishing pressure (in terms of biomass) than in temperate waters. However, it is important to note that a relatively large proportion

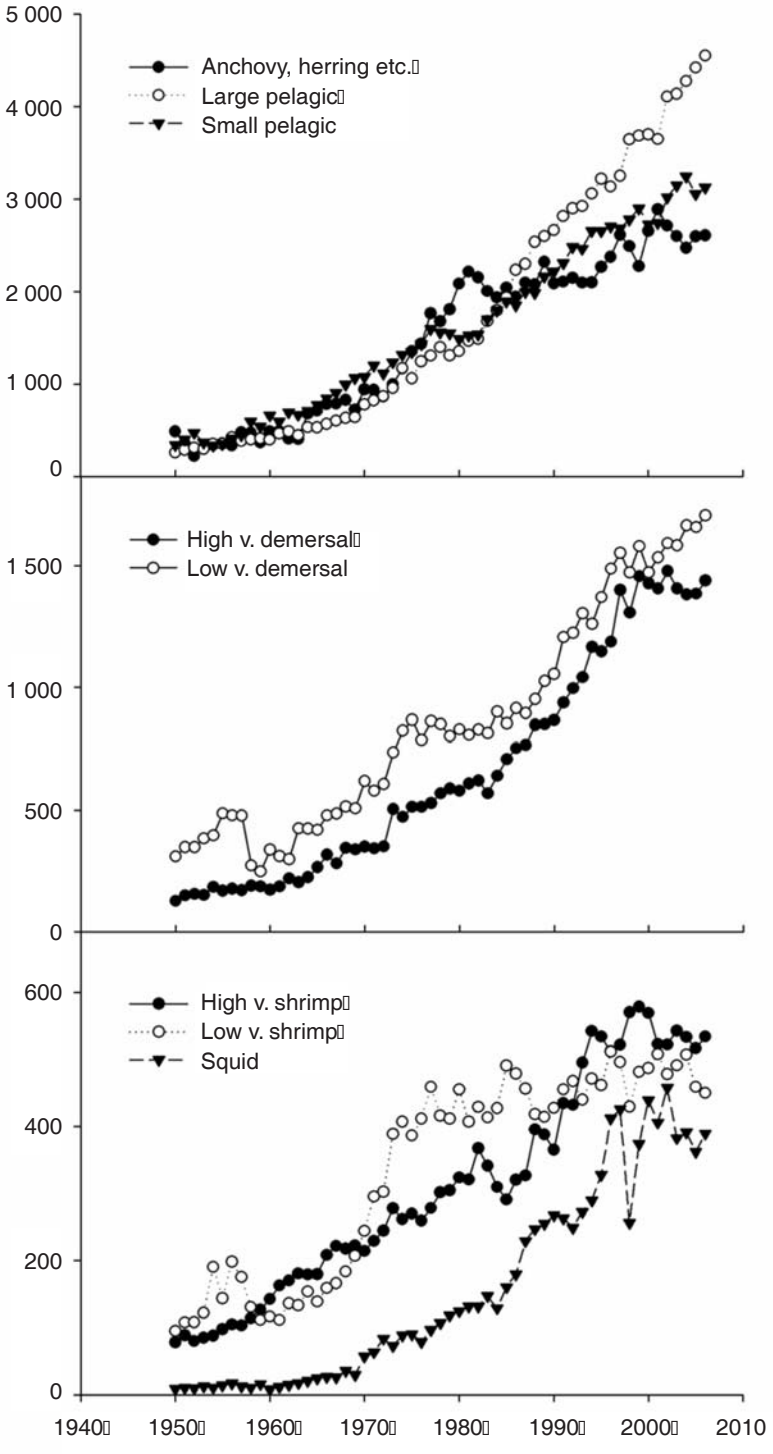


Figure 20 Catches (1 000 tonnes) divided into groups from all countries (world) in FAO areas 51, 57, 71 and 77 (tropical)

of the catch from tropical waters is reported as "marine fish nei" (almost 30 percent). Reporting in this category suggests poor reporting systems (which is a known feature of many of the tropical mixed fisheries), but also suggests that the catch is very small and mixed and does not lend itself easily to categorization into the larger higher-value species. It is therefore tempting to assume that the majority of this catch is actually small-sized low-value/trash fish and hence a strong indicator of an already fished down food chain.

The anchovy and herring fisheries have followed a cyclic pattern with re-occurring small increases and decreases (oscillations) that can be expected by species heavily dependent on natural variations in the environment (e.g. cyclical trends observed according to the El Niño). These fisheries showed a rapid increase in production until 1981 (2.2 million tonnes). Then levelled off and increased slowly to 2.6 million tonnes (2006) with a maximum production in 2001 (2.9 million). Another observation is that the oscillations in catch have become greater over the years, indicating that fishing pressure might be too high.

The catch in 1981 was mainly made up of California anchovy, Indian oil sardine, California pilchard, *Sardinellas* nei and *Stolephorus* anchovies and caught by Mexico (711 000 tonnes), India (419 000 tonnes), Indonesia (273 000 tonnes), Philippines (241 000 tonnes) and Thailand (150 000 tonnes). In 2006 the catch consisted mainly of California pilchard, *Sardinellas* nei, Indian oil sardine, anchovies, etc. nei and *Stolephorus* anchovies. The main countries catching these fish are Mexico (546 000 tonnes), Indonesia (488 000 tonnes), India (453 000 tonnes), Philippines (386 000 tonnes) and Thailand (257 000 tonnes).

The catch of large pelagics has increased at an accelerating rate with some marked increases in production in 1998 and 2002. The main species caught in 2006 were skipjack tuna, yellowfin tuna, bigeye tuna, kawakawa and longtail tuna by Indonesia, Philippines, Japan, Taiwan POC and Republic of Korea. The increase in 1998 and 2002 was mainly a result of the increase in catch of skipjack tuna.

The small pelagics component has increased steadily until 2006 with a short period of stable production between 1977 and 1982. The main catch in 2006 was scads nei (566 000 tonnes), Indian mackerels nei (275 000 tonnes), short mackerel (274 000 tonnes) and Indian mackerel (261 000 tonnes), mainly from Indonesia (1 002 000 tonnes), Philippines (814 000 tonnes),) and Thailand (416 000 tonnes).

The high-value demersal species increased steadily until 1999 when production levelled off about 1.4 million tonnes. The main species caught in 2006 were croakers, drums nei (415 000 tonnes) and the catch came mainly from India (408 000 tonnes) and Indonesia (385 000 tonnes).

The low-value demersals catch increased until 1975 (867 000 tonnes) when it levelled off until 1987 when it started to increase again (1.6 million tonnes in 2006). There was a rapid increase between 1972 and 1975 mainly because of the increased production from India, whereas the increase between 1987 and 1997 also included increased production from Indonesia, Thailand and Pakistan.

High-value shrimp increased steadily until 1982 when it suddenly decreased rapidly until 1985. Almost the whole drop can be explained by decreased production from Thailand of *Penaeus* shrimps nei (this coincided with the significant expansion of cultured *Penaeus monodon* in Thailand). The production then continuously increased until 1999 when it showed a small drop and levelled off at 534 000 tonnes. The increase in production is mainly from the increased catch of giant tiger prawn (*Penaeus monodon*) which makes up 50 percent of the production in 2006, mainly from India and Indonesia.

Low-value shrimp increased rapidly between 1960 and 1977 (460 000 tonnes) and has since levelled off. In 1977, more than 50 percentage of the catch came from India. In 2006, India is still the biggest producer, but now accounts for only 30 percentage of the catch. The catch is made up of more than 90 percent of natantian decapods nei.

The production of squid increased rapidly until the late 1980s when it levelled of for a few years before it almost doubled between 1992 and 1997, mainly because of the increased production of jumbo flying squid and opalescent inshore squid from Mexico and the United States of America. The production then rapidly declined in one year (40 percent), because of the decreased catches from Mexico and the United States of America. The catches again rapidly increased and have levelled off about 389 000 tonnes (2006), with the main catch coming from Thailand (85 000 tonnes). Interestingly, Thailand's increasing squid catch is associated with the decline in availability of large and more valuable species in the Gulf of Thailand.

Sharks

The catches of sharks show remarkable differences between the tropical and temperate seas of Asia and the Pacific region (Figure 21). The catches in temperate waters show a steady decline, where Japan has historically been the biggest producer until 2004 when Taiwan Province of China doubled its production of sharks nei, rays nei, skates nei. The tropical catches have in contrast displayed a steady increase until 2003 with the main producers being Indonesia and India, thereafter they fell drastically (2003 to 2005) mainly because of the decreased catch by Taiwan Province of China (from 48 to 8 000 tonnes or -82 percent), Sri Lanka (-77 percent), Spain (-77 percent), Thailand (-36 percent) and Pakistan (-31 percent). Also, the large producers, Indonesia and India, reduced the catch of sharks by 15 and 4 percent respectively. Again the species are not reported at a disaggregated level and the reduced

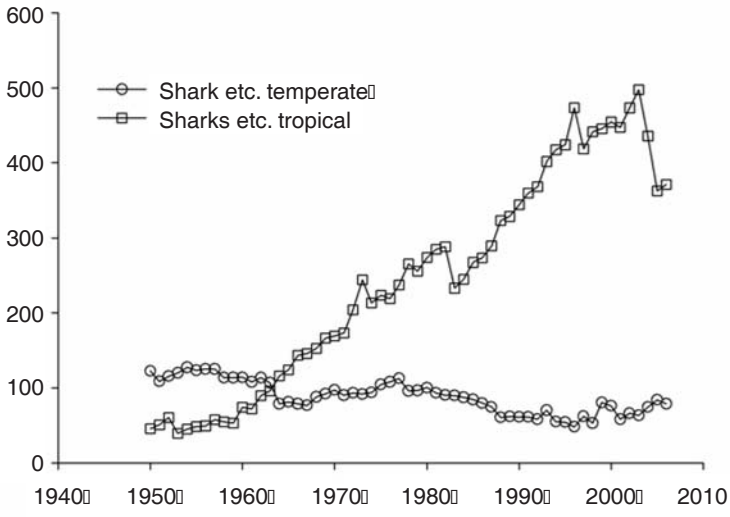


Figure 21 Sharks caught in either temperate (FAO areas 61 and 81) or tropical seas (FAO areas 51, 57, 71 and 77) in Asia and the Pacific region

catch is reported as sharks, rays, skates, etc. nei and rays, stingrays, mantas nei.

APFIC Recommendation

There needs to be an explaination of this reduction in catch. Is it caused by decreased effort, less targeting or improved catching techniques? Or is it because of reduced reporting or increased discarding?

Tuna

A most valuable and the largest tonnage part of the pelagic catch is the catch of tuna species. It is clear that tuna catches in temperate waters have declined steadily since 1965 in Asia and the Pacific region (Figure 22). The main reason is declining catches of bluefin, bigeye and yellowfin tuna in temperate waters. Whether the decline was entirely the result of fishing pressure or also linked to management controls and a general decline in temperate water fishing fleets and a shift to tropical zones is not clear. In contrast, the tropical tuna fisheries have increased production over the same period (perhaps reflecting this shift in effort from temperate to tropical waters), and yellowfin catches are still good, although declining. The bulk of the catch in both regions is today made up of skipjack and to a smaller degree albacore tuna in the temperate waters.

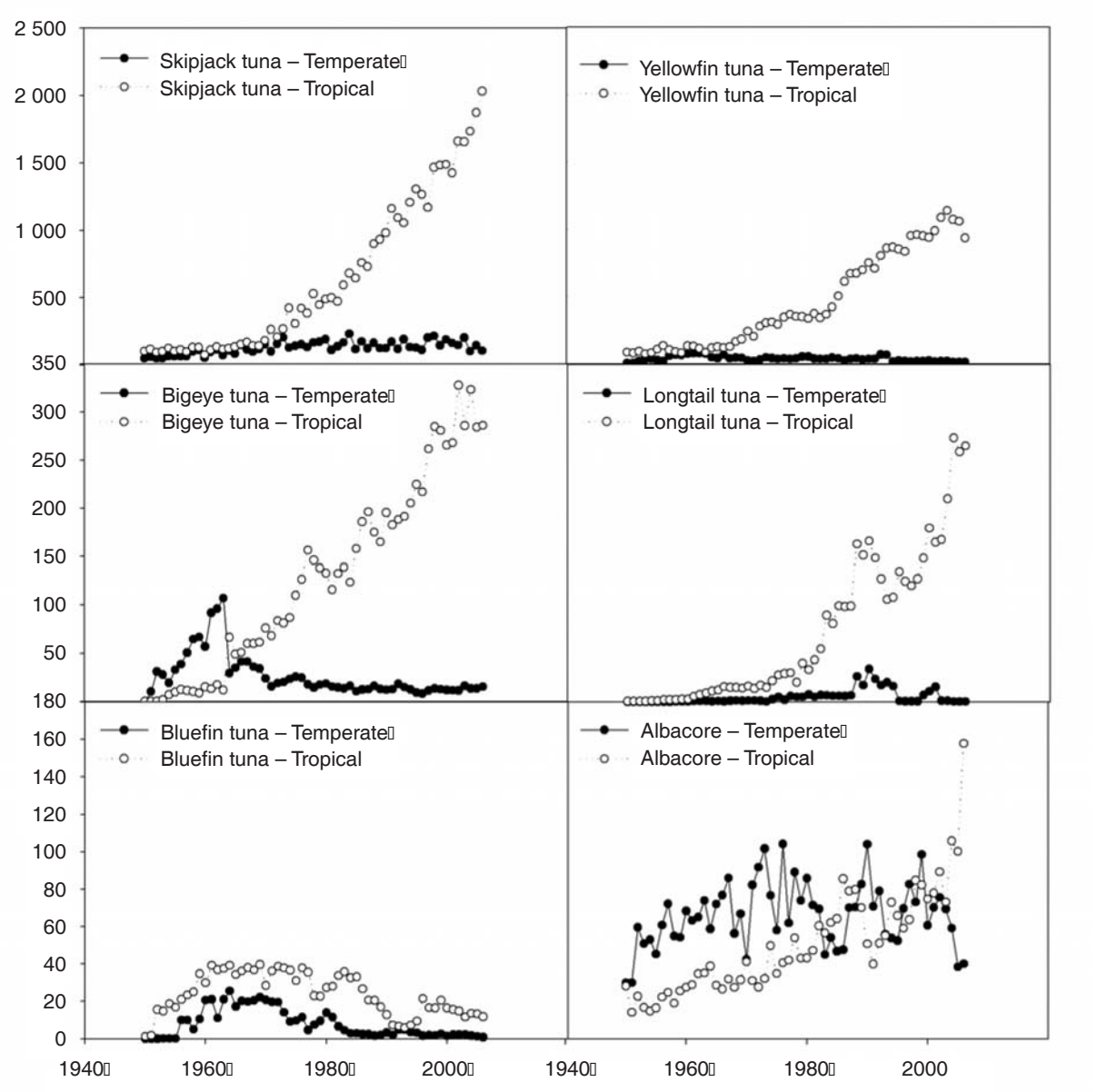


Figure 22 Tuna catches (1 000 tonnes) by species in temperate (FAO areas 61 and 81) and tropical seas (FAO areas 51, 57, 71 and 77) of Asia and the Pacific region

Globally, tuna catches are declining, but prices are rising[75] (2007 data). The main reason behind this is the increase in fuel prices, which make long tuna catching fishing trips uneconomical. The main decreases in catch came in the Eastern Pacific and in the Indian Ocean (20 to 30 percent decrease compared to 2006). The catch for Asia-Pacific countries in the Indian Ocean for 2006 was 921 000 tonnes (tunas, bonitos, billfishes). The top three species caught were skipjack (made up 39 percent of the total), yellowfin (15 percent) and kawakawa (12 percent).

The regional tuna stocks are managed by the Indian Ocean Tuna commission (IOTC) and the Western and Central Pacific Fisheries Commission (WCPFC). These organizations regularly follow up on the status of the regional tuna stocks, and the latest assessments show that bigeye is overfished in the Pacific Ocean and fully fished in the Indian Ocean (Table 11). Additionally, yellowfin is on the verge of being overfished in both regions.

Table 11 Tuna stock assessment 2008

Species	IOTC	WCPFC
Skipjack	Not overfished (likely underfished)	No overfishing
Yellowfin	Not overfished (likely fully fished)	High risk of overfishing
Bigeye	Not overfished (likely fully fished)	Overfishing occurring
Albacore	Not overfished (likely underfished)	No overfishing

To address the issue of overfishing and the sustainable management of the tuna stocks in the region the two principal regional fisheries management organizations, IOTC and WCPFC, have highlighted the following management measures that need to be implemented (Table 12).

Conclusion

There are many more countries fishing in the tropical region than in the temperate region (Table 13). Even so, the total catch in both regions is about the same — 23 million tonnes in the tropical region and 22 million tonnes in the temperate region.

Tropical coastal fisheries have mixed assemblages and the fishers exploiting them are able to utilize almost every species. This means that although biomass may continue to rise for the fishery these figures are certainly hiding some changes in species composition. The shift in composition towards faster recruiting small species is already clear from the quality of landings. The fisheries of the coastal regions in the Yellow Sea, the South China Sea, Timor and Arafura Sea and several other seas are also rather shallow and highly productive. This enables them to sustain significantly higher fishing pressure before stock collapses and there is a significant crash in the total catch.

The same cannot be said for tropical pelagic fisheries where ecosystem linkages to the lifespan of fish are probably far less resilient than in coastal waters. Here, overfishing can almost certainly be seen to impact stocks and the data available for several of the tuna species illustrates this. Skipjack tunas are considered to be rather resilient in the face of fishing pressure and is a faster recruiting species, nonetheless there are question marks raised about the status of this species in some fisheries.

[75] Tuna commodity update GLOBEFISH, May 2008 issue.

Table 12 Tuna management measures that need to be implemented according to IOTC and WCPFC

	IOTC	WCPFC
Target	IOTC considers the most important issue in management of tuna is to control fishing capacity.[76]	WCPFC is advocating the management goal of reducing fishing mortality on bigeye and yellowfin tuna with minimal impact on skipjack catches.[77]
Approach to achieve the target	The members of IOTC are leaning towards effort control, which is easier to enforce than catch quotas. Another factor in favour of this measure is that it produces less incentive to underreport.	▪ Meaningful restraint of small bigeye and yellowfin catches in Indonesia and Philippines. ▪ A reduction in small yellowfin and bigeye catches by purse seiners (ideally with minimal disruption to skipjack catches). ▪ Control of longline fishing effort targeting bigeye.
Measures	The IOTC is looking to freeze capacity for tropical tuna fisheries at 2006 levels, with the exception of: ▪ vessels already under construction; and ▪ vessels under fleet development plans for developing coastal states.	The way to achieve this goal is to implement a variety of management measures. Most of these have already been agreed by WCPFC and include: ▪ limited effort and/or catches to recent (high) levels — status quo; ▪ a three-month ban on floating object sets in PNA EEZs; ▪ permanent closure of the high-seas pockets; and ▪ full catch retention (no discarding) in PNA EEZs. Additionally, WCPFC is considering proposing the measure of a 25 percent reduction in bigeye —targeting longline effort.
Remarks	IOTC sees it as important to combat IUU fishing and highlights the important role of port state controls. As most boats are unregistered boats or registered in non-member states, the ways to improve the control of IUU fishing are: ▪ blacklisting of IUU vessels; ▪ control access to port facilities; deny unloading rights; deny licenses; ▪ control transshipment at sea; ▪ restrict access to markets for IUU products; and ▪ prosecution of nationals engaged in IUU fishing.	There remains a considerable disparity between scientific advice and the WCPFC response. Overfishing of bigeye and yellowfin is likely to continue, and possibly worsen, unless further measures are implemented. Current measures proposed by PNA/FFA could be effective in reducing or even removing overfishing. However, evolution of the purse seine fishery (FADs) is critical — any long-term solution will need incentives for industry to minimize catches of small bigeye (and yellowfin). Potential role for the Vessel Days Scheme.

Table 13 Number of countries reporting catch for the different groups in Asia and the Pacific region

	Temperate (Areas 61 & 81)		**Tropical** (Areas 51, 57, 71 & 77)	
	Total 1950 to 2006[78]	2006	Total 1950 to 2006[79]	2006
Pelagics				
Large	13	10	92	77
Small	15	10	83	57
Anchovies, herrings etc.	10	9	41	27
Demersals				
High value	13	10	59	46
Low value	13	10	57	40
Sharks, mantas etc.	9	9	68	49
Shrimp, prawns, krill etc.				
High value	5	5	27	22
Low value	9	8	45	25
Squid	15	10	31	19

[76] Tuna in the Indian Ocean: current status and new challenges. Presentation at the INFOFISH Tuna conference, Bangkok, May 2008.
[77] Status of tuna stocks and management challenges in the Western and Central Pacific Ocean. Presentation at the INFOFISH Tuna conference, Bangkok, May 2008.
[78] The Soviet Union and the Russian Federation are counted as one.
[79] The Soviet Union and the Russian Federation are counted as one.

4.3 Capture fisheries — subregional trends

South Asia

The South Asian subregion has shown continuous growth since 1980, with a small dip in production for 2004. The region has doubled its capture production from 3.1 million tonnes in 1980 to 6.2 million tonnes in 2006 and increased capture production by 14 percent since 2004 (Figure 23).

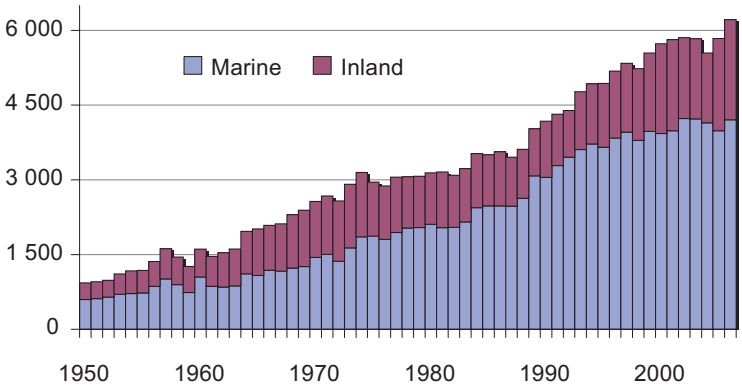


Figure 23 Trends in capture production of South Asia by environment

APFIC RECOMMENDATION

THERE NEEDS TO BE A DISAGGREGATION OF THE CATCH OF FRESHWATER FISHES NEI, AS THIS MAKES UP THE BULK OF TOTAL INLAND CATCH.

Most of the growth is a result of increased production in marine waters, but the last years have also seen a large relative increase in inland production (+43 percent since 2004). This increase can partially be accounted for by an increase in production of freshwater fishes nei in Bangladesh and India (60 percent of increase), but also by an increase in production of cyprinids nei from India (20 percent of increase). South Asia now has the largest share of inland capture production among subregions in Asia and the Pacific region (Figure 16) and is approaching the values of Chinese inland production (Figure 15). The bulk of this production (75 percent) is freshwater fish nei from Bangladesh, India and Pakistan (0.9, 0.4 and 0.3 million tonnes respectively).

After remaining relatively stable during the late 1970s and 1980s, inland production grew rapidly from the early 1990s. It reached the highest level of production at 1.8 million tonnes in 2001 and then decreased again. It has since started to increase and totalled 2.0 million tonnes in 2006.

In comparison with top production species of other subregions, the combination of South Asian species is unique in the sense that freshwater species (cyprinids nei: 3rd), diadromous species (hilsa shad: 2nd), demersal species (croakers/drums: 4th), crustaceans (natantian decapods: 8th) and pelagic species (Indian oil sardine: 1st) are all ranked high in the list (Table 14). This reflects the relative lack of offshore fisheries exploitation.

Among marine species, both pelagic fishes and demersal fishes showed almost parallel increasing trends with similar levels of production in 2006 (1 304 000 tonnes and 1 146 000 tonnes, respectively).

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 last few years (+37 percent since 2004). The marine fish production has been relatively stable since the 1990s with an increase of 1.5 percent since 2004. Crustacean production has been relatively stable and production levels of molluscs including cephalopods in this area are declining (Figure 24).

Table 14 South Asian capture fisheries production, top ten species (2006). Excluding all other species reported at species level

Species	(1 000 tonnes)
Indian oil sardine	320
Hilsa shad	277
Cyprinids nei	275
Croakers, drums nei	254
Giant tiger prawn	207
Bombay-duck	188
Skipjack tuna	184
Natantian decapods nei	170
Clupeoids nei	134
Hairtails, scabbard fishes nei	128
Freshwater fishes nei	1 421
Marine fishes nei	972

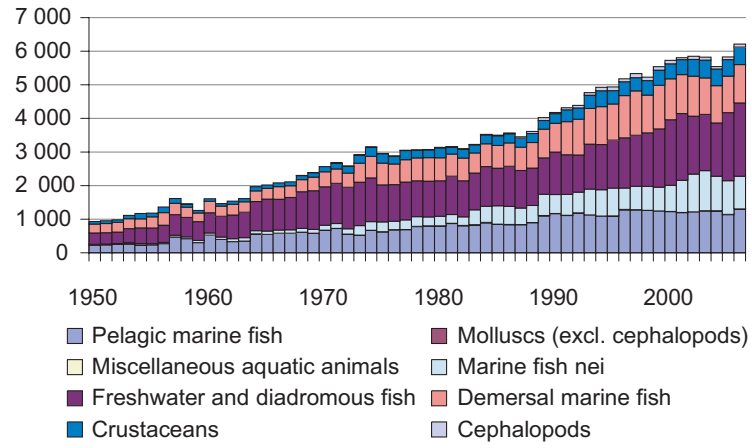


Figure 24 Capture production of South Asia by major species groups

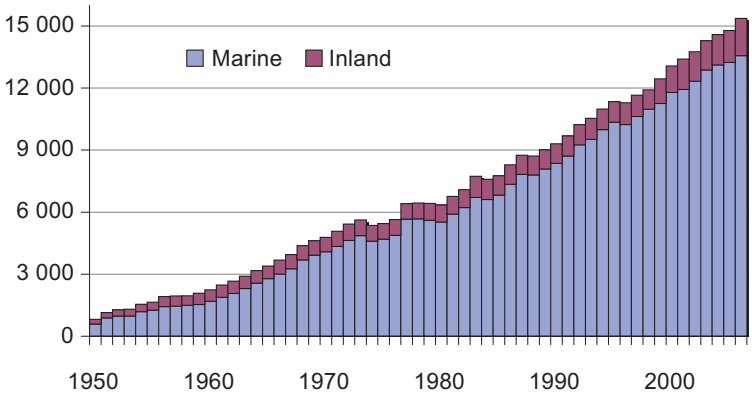


Figure 25 Trends in capture production of Southeast Asia by environment

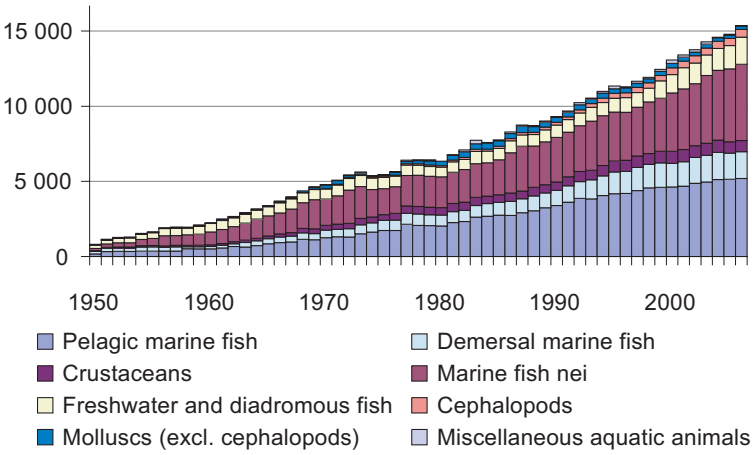


Figure 26 Capture production of Southeast Asia by major species groups

Southeast Asia

Production growth 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 2006 was 15.4 million tonnes, of which marine capture was 88 percent. Since 2004 the increase in marine production can be attributed to increases in production from Myanmar, Indonesia, Viet Nam and the Philippines, whereas Thailand and Malaysia saw a small drop in production (2 and 3 percent respectively).

Inland production increased by 22 percent since 2004 and reached 1.8 million tonnes in 2006. Even so, considering the rich freshwater resources in the area, it is likely that a figure of only 12 percent of total production[80] coming from inland waters is also a gross underestimate (Figure 25).

APFIC Recommendation

There needs to be a disaggregation of the catch of Marine fishes nei, as this makes up a large part of the total catch.

The main species groups are pelagic marine fish and marine fish nei. Marine fish nei, in particular, keep growing strongly (+9 percent) and is a major driving force of the overall production growth together with the recent increases (+24 percent since 2004) in freshwater and diadromous fishes (Figure 26).

Demersal fish, crustaceans and pelagic marine fish have maintained nearly the same share of production as in 2004. The proportion of unidentified marine fish (marine fish nei) is still notably high (33 percent of total production) in this subregion and has increased since 2004. It is even more pronounced in inland capture fisheries with 75 percent being unidentified. This indicates a declining size of the individual fish in the catch and a move towards very small species or nei species, which in most cases can be assumed to be increasing quantities of trash/low-value fish. As this catch usually is marketed as mixed catch, the statistics reported are not broken down to species level and thus usually reported as nei. If

[80] see footnote 8

Table 15 Southeast Asian capture fisheries production, top ten species (2006)

Species	(1 000 tonnes)
Scads nei	559
Skipjack tuna	437
Sardinellas nei	425
Natantian decapods nei	276
Indian mackerels nei	276
Short mackerel	275
Threadfin breams nei	248
Stolephorus anchovies	240
Kawakawa	223
Frigate and bullet tunas	206
Marine fishes nei	5 072
Freshwater fishes nei	1 366

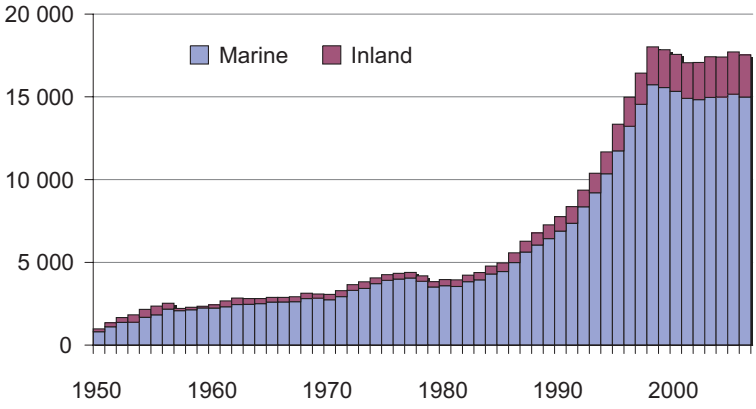


Figure 27 Trends in capture production of China by environment

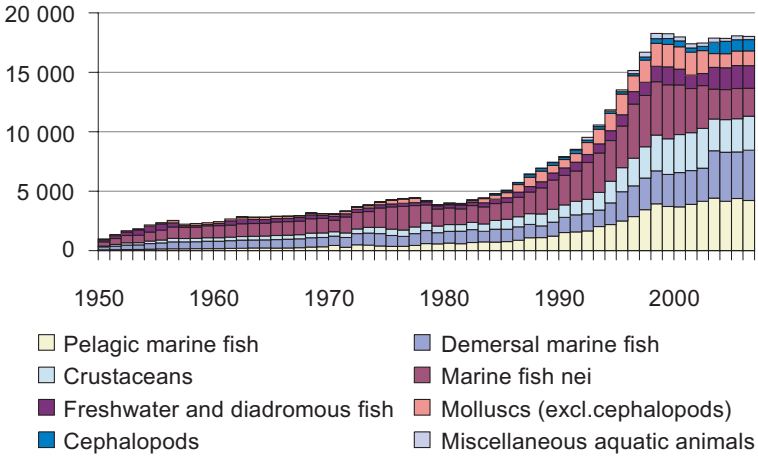


Figure 28 Capture production of China by major species groups

this is in fact the case, this is a clear indication that the Southeast Asian capture fisheries have come a long way in fishing down the food chain and this should require the immediate attention of the relevant authorities. Another reason may just be weak reporting by countries, but it is nevertheless an important issue to investigate and clarify.

Eight of the top ten production species are marine pelagic fishes and small pelagic fishes (scads and sardinellas) are found among the top three ranks (Table 15). Large pelagic fishes (skipjack tuna, frigate and bullet tunas) also feature high in the rankings. One factor confounding the figures is that a substantive share of the catch may come from outside the region and hence distort the real picture of the fishery.

China

The Chinese statistics show four periods with distinct trends (Figure 27). The first period, 1950 to 1985, has relatively low rates of growth, and all species groups exhibit very similar patterns, albeit with some annual fluctuations.

In the second period, 1986 to 1998, China reported very rapid and substantial growth in production in almost all types of capture fisheries (especially marine). Between 1993 and 1997, annual increments of total production always exceeded one million tonnes (the highest annual increment was 1.7 million tonnes in 1995). Subsequent to this amazing period, the third period started with the introduction of the zero growth policy in 1998; total production started to decline for the first time in almost twenty years with the degree of decline greater in marine production than in inland production. This continued until 2001 when a fourth period with small annual increase started. In 2006, total production was 17.5 million tonnes, almost back to the 18.0 million tonnes reported in 1998. However, as China has since revised the figures for 2006 (see Box 8) and is expected to revise data back to 1996, these trends are likely to be adjusted in the coming years.

The effect on trends in species composition is however believed to be minimal as in Chinese statistics species breakdown is calculated from fractions of total catch. Most species groups showed similar rapid growth trends during the second period. However, trends in the third and fourth periods varied widely. The proportion of marine fish nei group declined sharply, whereas the crustacean group continued to grow. During this period, molluscs maintained the same production level (Figure 28). However, the most

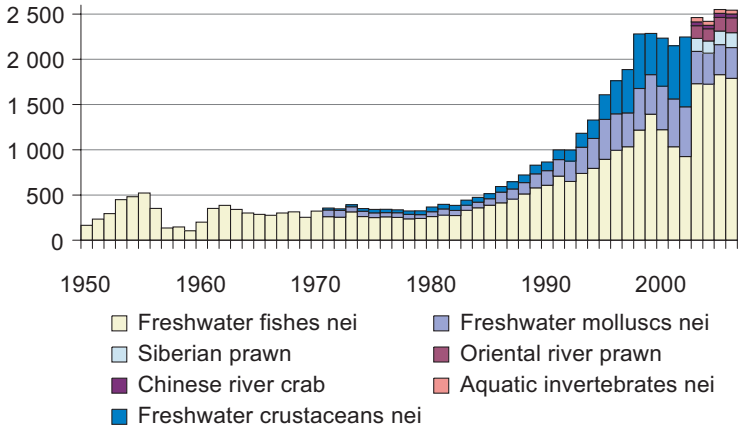


Figure 29 Inland water capture production of China by species

striking trend is the apparent rapid increase of demersal marine fish production since 2002, part of which can be explained by improved reporting at species level (there is a similar decrease in marine fishes nei).

For inland capture production, there was a rapid increase up until 1999 and then a decline until 2003 when it increased again (Figure 29). Up until 2003 the catch was disaggregated into three categories but is now disaggregated into eight categories. However, most of the catch is still reported as freshwater fishes nei and freshwater molluscs nei. China is, however, addressing this issue and improved species reporting for inland capture fisheries is expected within a few years.

Table 16 China capture fisheries production, top ten species (2006)

Species	(1 000 tonnes)
Largehead hairtail	1 429
Japanese anchovy	976
Akiami paste shrimp	721
Scads nei	632
Chub mackerel	530
Various squids nei	448
Gazami crab	407
Daggertooth pike conger	400
Seerfishes nei	398
Silver pomfrets nei	396

Table 17 Unidentified capture production in China (1 000 tonnes)

Species group	2002	2006
Marine fishes nei	3 512	2 287
Marine molluscs nei	1 376	904
Marine crustaceans nei	1 214	210
Freshwater fishes nei	924	1 788
Freshwater molluscs nei	551	340
Freshwater crustaceans nei	772	0
Total of “nei” groups	8 351	5 322
Total capture production	15 823	15 828
% contribution of “nei” groups	53	34

Catches of largehead hairtail and Japanese anchovy remained high in 2006 with the largehead catch approaching 1.5 million tonnes (Table 16). A second group includes a variety of species groups such as small pelagic fish (scads and chub mackerel), bentho-pelagic fish (silver pomfrets), crustaceans (akiami paste shrimp and gazami crab) and cephalopods.

The Chinese production figures show some notable differences compared with other subregions: a) Total quantity reported under unidentified groupings was 5.3 million tonnes in 2006 representing 34 percent of the Chinese total capture production (Table 17), which far exceeded that of the other subregions; b) a much smaller amount of small pelagic fish in the catch compared with other subregions, especially compared with South Asia; c) consistently high catches of some major species such as the largehead hairtail that hasn’t shown any signs of decreasing. In contrast, the Japanese anchovy is showing signs of decreasing catch again after its record increase between 1996 and 1997 (from 671 to 1 200 000 tonnes). However, this decrease could be part of a larger natural oscillation for the species in connection with climatic cycles (e.g. El Niño years);[81] and d) there is a disproportionately large catch of crustaceans compared to other regions, especially of the small akiami paste shrimp, indicating that fishers are fishing down the food chain.

Other Asia

Total production increased towards its peak production of 13.5 million tonnes in 1986, and thereafter decreased steadily, but now shows signs of levelling off (Figure 30). Of the countries within this region four dominate and account for 99.2 percent of the catch, namely Japan, Republic of Korea, Iran and

[81] Klyashtorin, L.B. 2001. *Climate change and long-term fluctuations of commercial catches: the possibility of forecasting*. FAO Fisheries Technical Paper. No. 410. Rome. 86 pp.

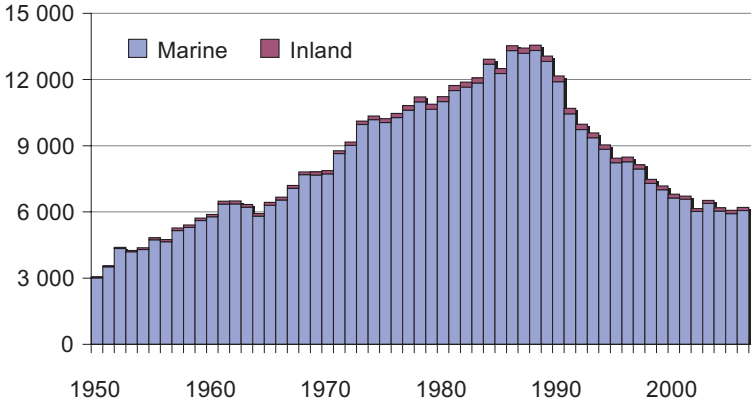


Figure 30 Trends in capture production of Other Asia by environment

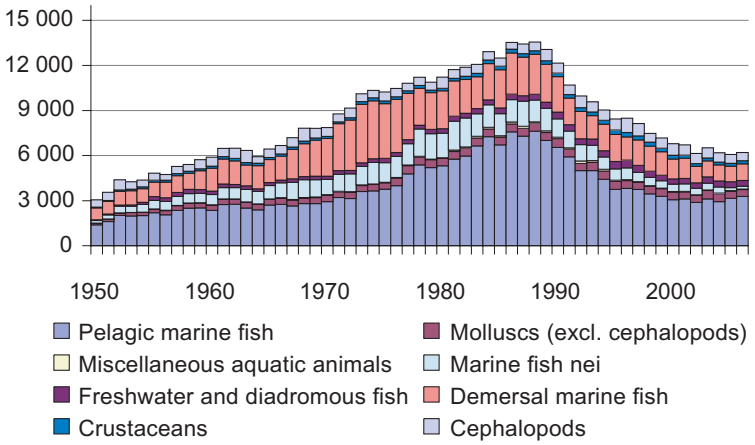


Figure 31 Capture production of Other Asia by major species groups

Table 18 Other Asia capture fisheries — top ten species (2006)

Species	(1 000 tonnes)
Chub mackerel	754
Japanese anchovy	681
Skipjack tuna	585
Japanese flying squid	387
Alaska pollock (= Walleye pollock)	293
Yesso scallop	272
Pacific saury	257
Chum (= Keta = Dog) salmon	243
Japanese jack mackerel	191
Argentine shortfin squid	149
Marine fishes nei	206
Marine crustaceans nei	63

Democratic People's Republic of Korea, in descending order. Hence, trends in this region are closely connected to developments in these countries, especially the Japanese fishery (65 percent of total). However, if inland catch is considered alone, Kazakhstan contributes significantly to the production also.

During the late 1960s to early 1970s, demersal fish became the most important production group with a very rapid growth rate, achieving a threefold increase in fifteen years (Figure 31). It started to decline, however, after the peak production of four million tonnes in 1974, gradually at first, but with a sharp decline after 1976. The current level of demersal fish production is now as low as in the early 1950s. This reduction was compensated for by increased production of marine pelagic fish until 1988, but then a similar decline to that of demersal fish production occurred. Current production levels of pelagic marine fish have dropped to three million tonnes, similar to those of the early 1970s.

In terms of major production species, pelagic species predominate in this area. It is also notable that there is high production of cephalopods (Japanese flying squid) and molluscs (yesso scallop) (Table 18).

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 32). In 2006 there was a rapid drop of almost 12 percent compared to the year before. The decrease can also be seen in the absolute values of pelagic marine fish, demersal marine fish and also crustaceans (Figure 33). Capture fisheries are often subsistence fisheries in many small island states and production may not be well represented in the official statistics. General trends in production are basically determined by a few larger states such as Australia and New Zealand with well established commercial fisheries sectors, with the exception of offshore pelagic fisheries. Rapid growth of pelagic marine fish production from the late 1990s has mainly come from skipjack tuna in Papua New Guinea (Figure 33). Commercial offshore production has also increased in many small island states and contributed to the increase in total production.

Many of the top ten species produced from capture fisheries in Oceania (Table 19) are from the temperate waters of New Zealand and Australia.

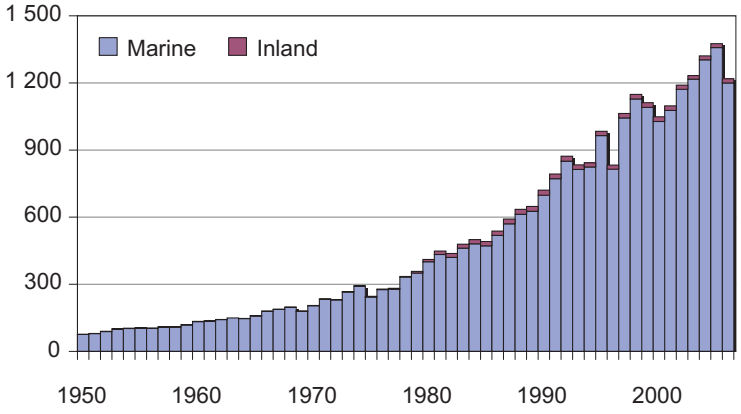


Figure 32 Trends in capture production of Oceania by environment

Table 19 Oceania capture fisheries production — top ten species (2006)

Species	(1 000 tonnes)
Skipjack tuna	303
Blue grenadier	109
Yellowfin tuna	83
Wellington flying squid	69
Albacore	44
Jack and horse mackerels nei	36
Clupeoids nei	34
Snoek	26
Southern blue whiting	23
Orange roughy	18
Marine fishes nei	106

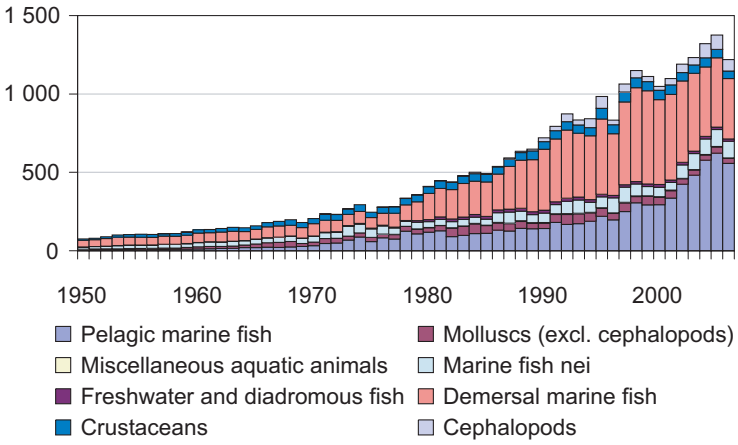


Figure 33 Capture production of Oceania by major species groups

4.4 Aquaculture — trends in Asia and the Pacific region

Asia and the Pacific region produced 46.3 million tonnes of aquaculture — 90 percent of global aquaculture production (total aquaculture production less aquatic plants).[82] In terms of value, the region's share is slightly less, but is still 78 percent of total value of global aquaculture. When aquatic plant production is included (the vast majority of which originates in Asia and the Pacific region), the region becomes even more dominant, representing 92 percent of global aquaculture production by quantity and 79 percent by value.

Table 20 Top ten aquaculture producer states in 2006 (excluding aquatic plant production)

By Quantity		By Value	
	(1 000 tonnes)		US$ (Million)
China	35 818	China	42 809
India	3 409	Chile	8 320
Viet Nam	2 365	India	4 946
Thailand	2 273	Viet Nam	4 377
Indonesia	2 150	Indonesia	4 272
Philippines	1 546	Thailand	3 930
Chile	1 459	Japan	3 105
Egypt	1 189	Norway	2 716
Bangladesh	1 056	Philippines	2 394
Japan	736	Mexico	2 296
Other	8 153	Other	24 414
Total	60 153	Total	103 578

Box 10 Top aquaculture producers 2006

Top ten aquaculture producer states by quantity (excluding aquatic plants) in 2004 were China, India, Viet Nam, Thailand, Indonesia, Philippines, Chile, Egypt, Bangladesh and Japan. Asian states hold the top six positions.

By value, China, India, Viet Nam, Indonesia, Thailand, Japan, and Philippines are among the top ten producer states (see Table 20).

The growth of aquaculture production in the region has continued to be very strong, reflecting the trend for the last 15 years. This results mainly from the

[82] However, see Box 1 about revised data for Chinese aquaculture.

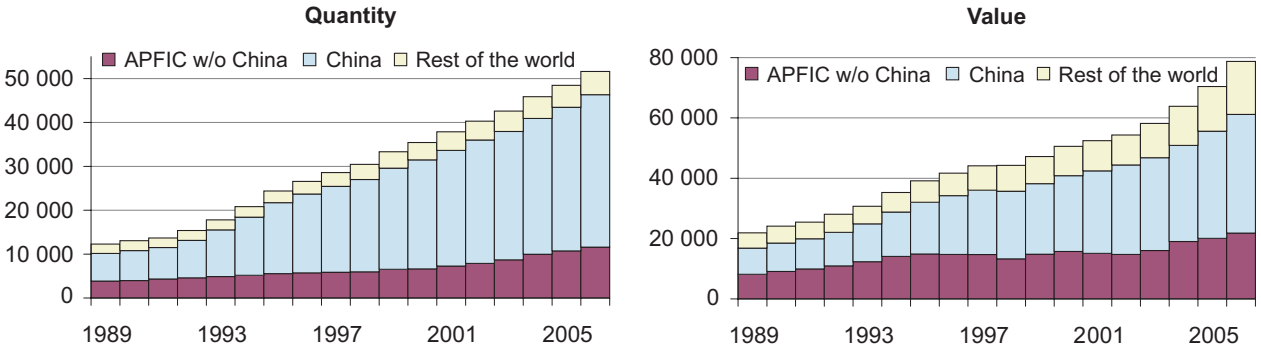


Figure 34 Trends in global aquaculture production

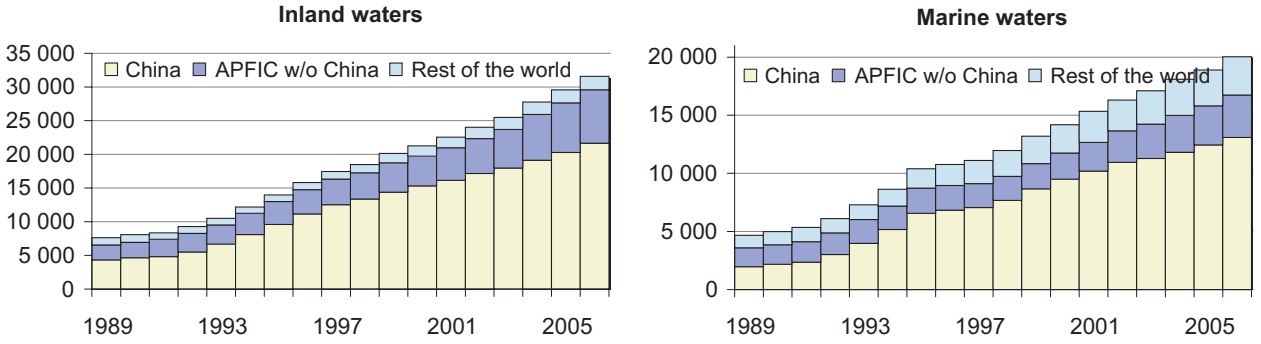


Figure 35 Trends in aquaculture production in Asia and the Pacific region by environment

continuously increasing production from China.[83] Between 2004 and 2006, production in China increased by 3.8 million tonnes (12.3 percent) in line with similar increase between 2002 and 2004 (12.8 percent).

In terms of tonnage, other countries that showed large increases included India (12 percent), Indonesia (24 percent), Republic of Korea (27 percent), Myanmar (44 percent), Philippines (22 percent), Thailand (10 percent), and Viet Nam (38 percent). Both inland culture and mariculture showed 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 34).

China[84] alone reported a production of 45.6 million tonnes or 68 percent of the world aquaculture production in 2006 (including aquatic plants). The production of China was 80 and 71 percent of world production in 2002 and 2004. Thus, although production is increasing, the world market share is decreasing. Since China is such a predominant producer, the scale of reported production can mask other regional trends and China[85] is treated separately in this report.

Box 11 Top cultured species 2006

Top five cultured species in 2006 were all freshwater carps (silver carp, grass carp, common carp, bighead carp and crucian carp) and their aggregated production was 15 753 000 tonnes accounting for 34 percent of total aquaculture production of the subregion.

APFIC Recommendation

Member countries should provide improved disaggregated reports of the production in aquaculture, as a large part of the total production is reported at group level.

If China 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 culture has more than doubled production from 2.6 million tonnes in 1991 to 7.9 million tonnes in 2006. Such advances far exceed the growth of aquaculture in the rest of the world (Figure 35).

[83] Growth rate for the period of 1991-2006 was 11.3 percent, excluding aquatic plants production.
[84] This figure is for all China, but the massive scale of China's aquaculture production challenges statistical collection and there are uncertainties regarding the quantities reported.
[85] See footnote 67

There has been little change in the top twenty cultured species[86] in the region between 1990 and 2006 (excluding aquatic plants and molluscs). The top species are all inland waters species, which are dominated by Chinese and Indian carps.

It is worth noting that the number of carnivorous species has increased during the past 15 years. In marine waters, major cultured species are generally dominated by high-value carnivorous species such as penaeid shrimp, jacks and sea breams. Productions of crabs as well as the whiteleg shrimp have made significant advances in recent years. Whiteleg shrimp is now the top production species in the region at 1.3 million tonnes (Table 21).

Table 21 Top fifteen cultured species in Asia and the Pacific region by quantity

Inland Waters				Marine Waters			
1990	(1 000 tonnes)	2006	(1 000 tonnes)	1990	(1 000 tonnes)	2006	(1 000 tonnes)
Silver carp	1 432	Silver carp	4 309	Giant tiger prawn	290	Whiteleg shrimp	1 300
Grass carp	1 042	Grass carp	4 002	Fleshy prawn	185	Giant tiger prawn	636
Common carp	678	Common carp	2 954	Jap. amberjack	162	Jap. amberjack	155
Bighead carp	672	Bighead carp	2 392	Milkfish	75	Pen. shrimps	107
Milkfish	359	Crucian carp	2 096	Silver seabream	52	Indo-Pacific swamp crab	107
Roho labeo	245	Nile tilapia	1 626	Banana prawn	33	Banana prawn	97
Catla	235	Roho labeo	1 332	Metapenaeus shrimps	29	Japanese seabass	96
Crucian carp	216	Catla	1 331	Sea squirts nei	28	Milkfish	91
Nile tilapia	199	White amur bream	594	Coho salmon	24	Swimming crabs	83
Japanese eel	164	Whiteleg shrimp	515	Penaeus shrimps	20	Silver seabream	76
White amur bream	162	Pangas catfishes	500	Aq. invertebrates	12	Jap. sea cucumber	76
Mrigal carp	160	Milkfish	495	Kuruma prawn	9	Large yellow croaker	70
Mud carp	80	Chinese river crab	475	Bastard halibut	7	Groupers nei	64
Tilapias nei	80	Mrigal carp	360	Indian white prawn	7	Lefteye flounders	63
Silver barb	47	Black carp	351	Jap. jack mackerel	6	Porgies	57
Freshwater fish	*800*	*Freshwater fish*	*2 042*				

4.5 Aquaculture — species composition

Aquaculture is an expanding sector in Asia and the Pacific region and very important for many economies in the region. The current trend and current expectations are that aquaculture will play an even more important role in the future, both in terms of a highly internationally traded and export-friendly sector, but also as an invaluable source of protein for both poor and rich in Asia and the Pacific region.

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 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.

[86] There is 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.

Carnivorous species or species requiring higher production inputs

Freshwater carnivorous species

Eels (order *Anguilliformes* and *Synbranchiformes)*

The global production of eels was 458 000 tonnes in 2006, which corresponds to a doubling of production since 2002 (Figure 36). Of this production, 98 percent was produced in Asian farms. Eel production in Japan (*Anguilla japonica*) has remained stable for the past five years at about 20 000 tonnes. The production of Taiwan Province of China has declined greatly to 23 000 tonnes in 2006, compared to the top production year in 1990 (55 000 tonnes). In contrast, production in China has risen steadily, reaching a new high in 2006 of 202 000 tonnes. Taiwan Province of China and Republic of Korea also produced some quantities of Japanese eel through aquaculture. All of this production is reported as Japanese eel. However, as China also imports European glass eels (*Anguilla anguilla*) some of this reported production is likely to include the European eel. Chinese swamp eel (*lai*) production is also high at 192 000 tonnes for 2006.

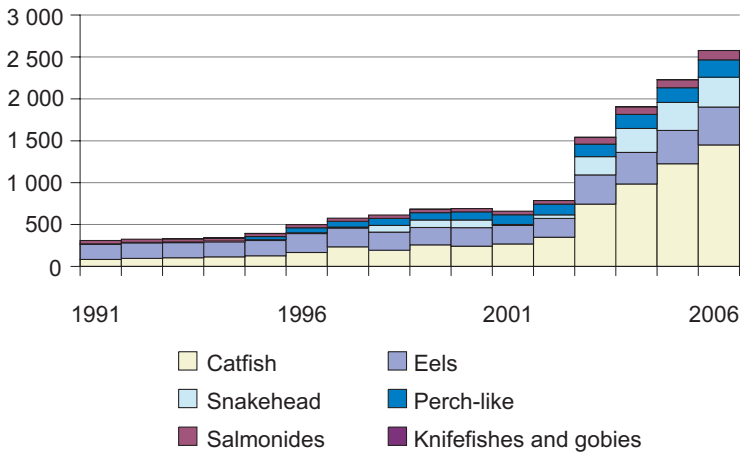


Figure 36 Changes in freshwater carnivorous species production, 1991 to 2006 (1 000 tonnes) in Asia and the Pacific region

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, amounting to 55 percent of all European Union eel exports outside Europe that year.[87] Correspondingly, the Chinese import of eel in 2006 was 213 tonnes. The recent listing of European eel under CITES Appendix II now means that export outside of Europe is restricted and thus 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.

Salmonids (family *Salmonidae)*

Freshwater production of salmonid species in the region has developed rapidly in the last four years. In part because of the development of the rainbow trout industry in Iran, which has almost tripled the production in four years (to 46 000 tonnes) and in part because of the salmonid (four species) production in China that now amounts to 44 000 tonnes (0 tonnes in 2002).[88]

Perch-like fishes (family *Percichthyidae)*

China reported a production of 202 000 tonnes for mandarin fish (*Siniperca chuatsi*) in 2006. The production has been steadily increasing since 1995 when it was first reported. Other reported species in this family are Murray cod 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. 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.

[87] TRAFFIC report. Available at http://www.traffic.org/dispatches/archives/march2001/eel.html
[88] No reported production, although probably included in nei group.

Catfish (order *Siluriformes*)

This is by far the most popular of the cultured freshwater carnivorous species group. The top five producing states are China, Viet Nam, Thailand, Indonesia and India. Total production in 2006 was 1.5 million tonnes, which is an increase of 47 percent since 2004. China started to report on this group in 2003 and now produces 41 percent of the total production in the region. Part of this increase can also be explained by the inclusion of Viet Nam's production of pangas catfishes.

The top five species are pangas catfishes, amur catfish (*Silurus asotus*), channel catfish, hybrid catfish (*C. batrachus x C. gariepinus*) and yellow catfish (approximately 90 percent of the total production for the group). The production of torpedo-shaped catfishes nei (*Clarias spp.*) is stable and has fallen out of the top five list because of increases in the other species.

Viet Nam have seen a dramatic increase in the production of tra (*Pangasianodon hypophalmus*) and basa (*Pangasius bocourti*), the two main catfish species cultured in that country. The production is mainly located in a few provinces in the south of Viet Nam in the Mekong River Delta. The production in 2006 reached a record 825 000 tonnes and it is forecasted that the production will surpass 1 million tonnes in 2008. The United States used to be the largest market for Vietnamese produced catfish, but during a trade dispute in 2003 the Vietnamese exporters 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.

Snakeheads (family *Channidae*)

The total production in 2006 was 358 000 tonnes in Asia and the Pacific region and the top four producing states are China, India, Thailand and Indonesia. China has just started to report snakehead production separately (as with the catfish) in 2003. In 2006 China produced 85 percent of the total Asian production.

The trend for this group is hard to define because 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 13 000 tonnes, but is again showing an increase to almost 35 000 in 2006. The production in China has increased by 27 percent to 203 000 tonnes since 2004.

The snakehead species, although generally popular in some countries do not enjoy a large export market, even within the region. There is certainly no intra-regional 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 pangasius and tilapia have effectively marginalized this species, which once had greater prominence as a cultured species.

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 is almost totally based on on-growing of wild caught fingerlings. The total production of knifefishes and marble goby was 814 tonnes in 2004 which is an increase by 600 tonnes since 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 orders. Thailand has shown a declining trend and in Malaysia the production has declined by half to about 100 tonnes in 2006, except for a peak in 2003 of 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

Amberjacks (family *Carangidae*)

Japanese culture of amberjack (*Seriola*) is the leader within this family with production stable at 155 000 tonnes in 2006 (Figure 37). The Japanese fishery for fingerlings for 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.

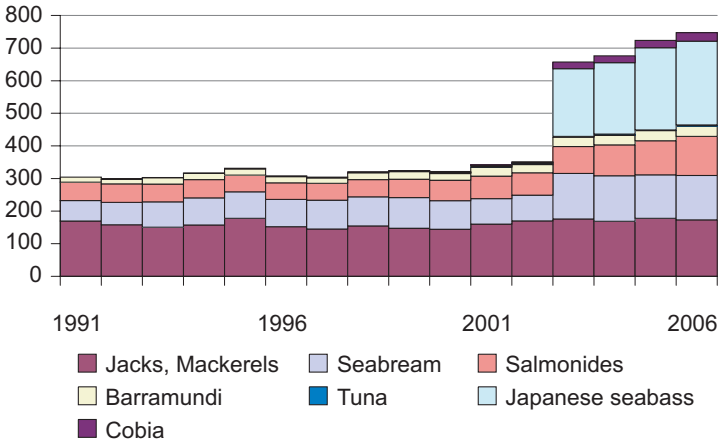


Figure 37 Marine and brackish water carnivorous species production in the last 15 years

Barramundi and Japanese seabass (family *Centropomidae* and *Percichthyidae*)

China reported large production of Japanese seabass (*(Lateolabrax japonicus)* starting in 2003 and 2004 (256 000 tonnes in 2006), which may be an effect of China's improved reporting on individual species (these species may have previously been reported under marine finfish nei). Also Republic of Korea is producing Japanese seabass — 1 600 tonnes in 2006). Barramundi (*Lates calcarifer*) is gaining ground with the regional total reaching 32 000 tonnes in 2006. Thailand has become the top producer in the region with a still increasing trend. There is some interest in other species within these families, especially the Nile perch (*Lates niloticus*) which has particularly white flesh and is widely traded as a commodity. *Lates calcarifer* does not have such good flesh colour, but may still offer some potential as an alternative in some markets. The recent declines in the Nile perch fishery in Africa's Lake Victoria have certainly enabled species such as pangasius and even barramundi to penetrate markets that had previously only been accessible to Nile perch.

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 41 000 tonnes. Japanese coho salmon culture peaked in 1991 and has declined sharply since, however in 2006 the production again increased and reached 12 000 tonnes. New Zealand's chinook salmon production has increased in the last two years and has now reached 7 700 tonnes. Over the past ten years the Australian Atlantic salmon industry has developed considerably to a current figure of 20 000 tonnes in 2006.

Grouper (family Serranidae)

Production of grouper has increased rapidly from 22 000 tonnes in 2002 to 69 000 tonnes in 2006. This increase is because China started to report on this species in 2003. The major producers include China, Taiwan POC, Malaysia, Indonesia and Thailand. In 2006, production of six different grouper species was reported, however the bulk production (91 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 countries, including Indonesia, Malaysia, Philippines, Taiwan, 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.[89] Grouper culture is also undertaken in India, Sri Lanka, Saudi Arabia, Republic of Korea and Australia.

[89] Sadovy, Y. 2000. *Regional survey for fry/fingerling supply and current practices for grouper mariculture: evaluating current status and long-term prospects for grouper mariculture in Southeast Asia*. Final report to the Collaboration APEC grouper research and development network (FWG 01/99). December, 2000.

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.[90] The grouper trade has come under the spotlight (see APFIC's *Status and potential of fisheries and aquaculture* published in 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 from some species and there is a contribution to supply fingerlings/juveniles from hatcheries, however reporting on this 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 desegregation 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) culture has increased rapidly from 13 tonnes in 1996 to 2 400 tonnes in 2002 and is now 25 000 tonnes in 2006. One main reason for the rapid increase is that China is reporting this species separately. Chinese production in 2006 was 22 000 tonnes whereas Taiwan Province of China reports a production of 2 900 tonnes. 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 Province of China. 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 currently rather high suggesting we are some way from industrializing its production. 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*)

Southern bluefin tuna culture in Australia has emerged as a significant industry for the country over the past ten years reaching 4 000 tonnes in 2002 and has stayed at this level in 2006. 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 value of the Australian southern bluefin tuna wild harvest component of the fishery was approximately US$50.5 million, and the value added from grow out of wild caught fish in sea cages is approximately US$97.3 million[91] (2002 to 2003).

Seabream (*Sparidae*)

Seabream production is confined to Japan, China, Taiwan Province of China, Republic of Korea and Hong Kong SAR. The Japanese production of seabream was 71 000 tonnes in 2006. China reported over 40 000 tonnes from 2003 (the first year figures for seabream production were reported), in 2006 the production was 53 000 tonnes. The production of this species was probably reported earlier as "other marine finfish nei".

[90] Tupper, M. & Sheriff, N. 2007. *Capture-based aquaculture for groupers*. A report to the FAO international workshop on technical guidelines for the responsible use of wild fish and fishery resources for capture-based aquaculture production, Hanoi, Viet Nam, 8 to 12 October 2007.

[91] http://www.afma.gov.au/fisheries/tuna/sbt/default.htm; http://www.australianaquacultureportal.com/PDF/industry_bluefin_1.pdf

Table 22 Aquaculture production reported under "marine fishes nei"

Country/Entitiy	Tonnes 2004	Tonnes 2006
China	202 587	278 970
India	8 000	18 510
Japan	6 951	5 930
Malaysia	1 458	3 276
Taiwan POC	3 027	3 122
Indonesia	1 602	826
Hong Kong SAR	493	728
Philippines	162	416
RO Korea	3	262
Singapore	55	40

Other marine finfish not elsewhere identified (*nei*)

Most of these fish are assumed to be carnivorous and are fed by trash fish from the Chinese capture fisheries. China's production of European turbot is estimated at about 3 000 tonnes, representing about 33 percent of global aquaculture production.[92]

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 (Table 22). The quantity of "marine fish nei" reported by China equals the total aquaculture production of Malaysia. Since the individual species are not reported, trends cannot be determined.

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 supplemental feeds and even complete feeds. As demand for fish increases and prices rise, further pressure on intensification and the use of feeding can be expected in many states.

APFIC Recommendation

MEMBER COUNTRIES SHOULD IMPROVE ESTIMATIONS OF THE EXTENT OF PRODUCTION FROM BACKYARD SYSTEMS IN ORDER TO ASSESS THEIR CONTRIBUTION.

Backyard ponds are an increasingly common sight in many states; however this production is frequently not captured in national statistical surveys, mainly because of the small unit size. In many cases ponds may be below the size required for registration and production from these ponds is not viewed as a significant economic activity. 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.

It has been suggested that the wide range of species that is currently produced from aquaculture will reduce as greater rationalization and aggregation of production operations focus on a small number of species. This lesson has been taken from the livestock sector and is considered to be an essential part of the "industrialization" of aquaculture. This trend does not appear to be the case so far in the region with farmers increasingly seeking out new species that give them a marketing or profit advantage.

Table 23 Tilapia top eight producer states (2006)

Country	Tonnes
China	978 135
Indonesia	189 570
Philippines	163 004
Thailand	109 742
Taiwan POC	83 435
Malaysia	28 635
Lao PDR	19 590
Myanmar	2 000

Tilapia

This "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. The top eight producers in the region together produced 1.6 million tonnes of tilapia in 2006 (Table 23).

Reported exports of tilapia are 14 percent of total regional production, which can be considered low. 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

[92] http://www.ices.dk/committe/acfm/comwork/report/2005/may/Wild%20cultured%20fish%20interactions.pdf

Table 24 Countries exporting tilapia (2006)

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

Table 25 Carps and barbs top ten producer states (2006)

Country	Tonnes
China	15 807 420
India	2 704 883
Bangladesh	642 554
Indonesia	287 737
Myanmar	263 000
Pakistan	121 740
Thailand	81 400
Iran	77 463
Lao PDR	58 410
Nepal	25 409

to the USA was China (mainland and Taiwan Province), accounting for 90 percent of total supply in 2006 (Table 24).[93]

Carps and barbs (*cyprinids*)

Carps and barbs continue to be the most popular species group among Asia-Pacific states. The top five cultured species are carps in freshwater production (Table 21). 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 maintained the highest production for decades. Grass carp was once in a distant second place but the gap between the two species closed in 2006. Common carp, bighead carp and crucian carp follow on the list. Common carp is literally the most commonly cultured species in the region with 20 states and areas having reported culturing this species (Table 25).

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 Middle 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 since 2003 and there was a reported 90 000 tonnes in 2006.

Freshwater fish nei

Latest reported statistics from China has seen the reduction of “freshwater fish nei” from 2 million tonnes in 2002 to less than 540 000 tonnes in 2004 and up again to 714 000 tones in 2006. These fish are now reported by species and interestingly are mostly carnivorous species with the exception of pirapatinga. The species which are now reported in detail 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), trouts (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.

Table 26 Milkfish top four producer States (2006)

Country	Culture Environment	Tonnes
Philippines	Brackish	220 602
	Marine	59 907
	Freshwater	34 565
Indonesia	Brackish	212 883
	Marine	49
Taiwan POC	Brackish	29 375
	Freshwater	26 760
Singapore	Marine	1 183

Milkfish

Milkfish culture is a strong tradition in the Philippines and this reflects the country’s preference for the species (Table 26). There are also traditions of milkfish culture in some of the

[93] http://www.eurofish.dk/indexSub.php?id=3529

Pacific Islands (Kiribati, Nauru, Cook Islands and Palau. Of these countries, only Kiribati reported production to FAO in 2006. Milkfish have typically been produced in brackish water ponds but there is an increasing trend in reported mariculture production, indicating the use of more intensive cage systems. These systems are fed with either pellets or trash 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 Province of China is reducing its production, possibly because of increasing attention to higher-value species. Singapore has steadily developed its mariculture of milkfish.

Mullet

Pond-based brackishwater culture of mullet is typical but Republic of Korea has been reporting increasing mariculture production since 2000, and the freshwater culture from 2006 is almost zero. Indonesia has the largest production of this species and although the country experienced a sharp decline in 1998, it has since shown a stable positive trend. Taiwan Province of China has seen a gradual reduction in production and Thailand has greatly reduced production in recent years. Although not reported as a separate species, China also has noteworthy production of mullet (reported as marine finfish nei).

Crustaceans

Although a large number of crustacean species are cultured, the predominant commercial species are brackishwater shrimps, freshwater prawns and freshwater/brackish water crabs.

Penaeid shrimp culture

Marine shrimp continued to dominate crustacean aquaculture, with two major species accounting for over 60 percent of the total crustacean production in 2006 (the whiteleg shrimp *Penaeus vannamei* and giant tiger shrimp *Penaeus monodon*). Whiteleg shrimp production in Asia and the Pacific region increased from 2 000 tonnes in 2000 to over a million tonnes in 2004 and was 1.8 million tonnes in 2006. A significant amount of this production comes from China (1.0 million tonnes) and Thailand (0.5 million tonnes) as well as increasing amounts from Viet Nam and Indonesia (increases of 275 and 165 percentage respectively). 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 ten years for the major producers (Table 27). 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 slowly recovered and has been increasing rapidly in recent years.

Table 27 Penaeid shrimp top ten producer states (2006)

Country	Tonnes
China	1 242 385
Thailand	500 800
Viet Nam	349 000
Indonesia	339 703
India	144 347
Bangladesh	64 700
Myanmar	60 000
Philippines	40 654
Malaysia[95]	34 973
Taiwan POC	12 571

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 WSSV.[94] 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.

Total production of *P. vannamei* in Asia was approximately 1.8 million tonnes in 2006 (1.1 in 2004). The main reason for importing *P. vannamei* to Asia has been the poor performance, slow growth rate and

[94] White spot syndrome virus.
[95] The figure of 34 973 has been changed to 34 612 since the data was submitted to FAO in 2007.

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 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 to 2003. There has been a trend of decreasing shrimp prices for a number of years now especially 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

China and India have recently increased the production of freshwater prawns (their respective productions were zero and 311 tonnes in 1994 as compared to 341 000 tonnes and 34 000 tonnes in 2006). Even Thailand and Bangladesh show increasing trends in production of freshwater prawns. Other producers have had relatively stable production figures (Table 28).

Table 28 Freshwater prawn top eight producer states (2006)

Country	Tonnes
China	341 159
India	34 154
Thailand	29 500
Bangladesh	20 810
Taiwan POC	9 878
Indonesia	1 199
Iran	270
Malaysia	194
Myanmar	50

Since it is not easy to intensify production of freshwater prawns because of their territorial habits and divergent growth effects, the development of this sector is reasonably slow. In some states the sector has shrunk as attention and resources have been diverted to brackishwater shrimp production. Although the principle species cultured in freshwater (*M. rosenbergii*) does not suffer the same problems with viral diseases that impact the brackishwater shrimp industry so severely, export markets for freshwater prawns are much smaller and less developed. This is because consumers in general are not as familiar with these species as with brackishwater shrimp. Freshwater prawns, however, enjoy good domestic markets especially in South and Southeast Asian states.

Crabs

Chinese river crab (*Eriocheir sinensis*) and Indo-Pacific swamp crab (*Scylla serrata*) constituted the major cultured crabs in the region in 2006. Indo-Pacific swamp crab has shown stable increasing production trends for the past decade. The reporting of marine crabs nei from China has declined from 178 185 tonnes in 2002 to around 15 000 tonnes in 2006. At the same time, Indo-Pacific swamp crab nei and swimming crabs nei increased from zero to 120 000 tonnes and 89 000 tonnes respectively.

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 1.25 million in 2002 to 1.05 million tonnes in 2006, which is still an increase of 0.2 million tonnes since 2004 (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 a large grouping such as marine molluscs nei. The IFPRI/WFC outlook on fish supply[96] projected increasing mollusc production, although this may have been based on current production trends rather than the resource potential. The issue of site availability is likely to constrain future development of mollusc culture in several states as can be seen in the cases of Japan and Republic of Korea (Tables 29 and 30). In these two states, the production of molluscs and seaweeds has been relatively stable for many years. This indicates that the suitable sites may now all be taken.

Table 29 Lower value molluscs top ten production (2006)

Country	Species	Tonnes
China	Japanese carpet shell	3 018 803
China	Constricted tagelus	679 010
China	Blood cockle	315 950
Thailand	Green mussel	272 901
New Zealand	New Zealand mussel	97 000
RO Korea	Korean mussel	81 617
Thailand	Blood cockle	66 062
Malaysia	Blood cockle	45 674
Philippines	Green mussel	19 690
Republic of Korea	Japanese carpet shell	14 327

Table 30 Higher value molluscs top ten production (2006)

Country	Species	Tonnes
China	Pacific cupped oyster	3 892 027
China	Yesso scallop	1 148 764
RO Korea	Pacific cupped oyster	283 296
Japan	Yesso scallop	212 094
Japan	Pacific cupped oyster	208 182
Taiwan POC	Pacific cupped oyster	28 547
Thailand	Cupped oysters nei	21 612
Philippines	Slipper cupped oyster	16 838
Australia	Pacific cupped oyster	7 924
Australia	Sydney cupped oyster	4 071

Unlike fish culture, the intensification of mollusc culture is quite difficult and probably not economically viable. 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.

Aquatic plants

Aquatic plant production can be divided into two distinct groups. The first group consists of seaweeds of temperate waters solely and traditionally used for food purposes and 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 (Table 31).

Table 31 Aquatic plants top ten producer states (2006)

Countries	Tonnes
China	10 867 410
Philippines	1 468 905
Indonesia	910 636
RO Korea	765 595
Japan	490 062
DPR Korea	444 300
Malaysia[97]	30 000
Viet Nam	30 000
Cambodia	16 000
Taiwan POC	5 949

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 production. Its production 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. Production

[96] Delgado, C.D, Wada, N., Rosegrant, M.W., Meijer, S. & Ahmed, M. 2003. *Fish to 2020. Supply and demand in changing global markets.* WorldFish Centre Technical Report 62. 226 pp.

[97] Malaysia now reports a production of 43 200 for 2006 and this will replace the FAO estimate of 30 000 in future communications.

Box 12 Top cultured aquatic plants

Major cultured aquatic plants in East Asia are Japanese kelp, Laver *(nori)* and *wakame*. They are all seaweeds for food purposes in contrast to those produced in Southeast Asia, which are mainly used as a source of commercially valuable biopolymers.

Table 32 Aquatic plants top ten cultured species (2006)

Species	Tonnes
Japanese kelp	4 923 618
Aquatic plants nei	2 423 265
Wakame	2 364 263
Laver (*nori*)	1 506 102
Zanzibar weed	1 299 642
Warty gracilaria	1 062 754
Red seaweeds	910 636
Fusiform sargassum	132 330
Eucheuma seaweeds nei	119 209
Elkhorn sea moss	85 634

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.

Recent detailed reporting from China has given a clearer picture of aquatic plant production (Table 32).

Seaweeds for biopolymers

This group[98] consists of *Eucheuma cottonii*, *Kappaphycus alvarezzi*, *Gracilaria spp.*, red seaweeds and others. The Philippines has the highest production of these aquatic plants and *Eucheuma cottonii* (also known as Zanzibar weed), production in the Philippines far exceeds the production of other seaweeds (1.3 million tonnes in 2006).

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, crocodiles and frogs. China has greatly increased its reported production of soft shell turtle in the past five years to a total production of 189 000 tonnes in 2006. Other states that reported production of turtles are Thailand, Taiwan Province of China and Republic of Korea. There are limited data on frog production, although frogs are being increasingly cultured in many states. China has reported a production of 74 000 tonnes of frogs in 2006. 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 which this review does not cover. These species are either cultured at the pilot or 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 33).

Table 33 Niche aquaculture species (2006)

Species	Tonnes
Japanese sea cucumber	75 725
Jellyfishes	37 678
Sea squirts nei	16 931
Sea urchins nei	9 780
Aquatic invertebrates nei	4 527
Sea cucumbers nei	96

[98] The taxonomy for *Eucheuma* is confusing. The name *cottonii* is a general word used to describe a number of *Eucheuma* species (Doty, 1988). 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: “Seaweeds” in “Introduction of commercially significant aquatic organisms to the Pacific Islands”, SPC.

4.6 Aquaculture — subregional trends

South Asia

South Asia's aquaculture production has tripled in the last 15 years, from 1.4 million tonnes in 1991 to 4.2 million tonnes in 2006. The majority of production comes from inland waters and hence the growth of the sector has been mostly because of increasing freshwater culture (Figure 38). This increase is probably not heavily dependent on marine sources of feed and therefore a real contribution in terms of food security.

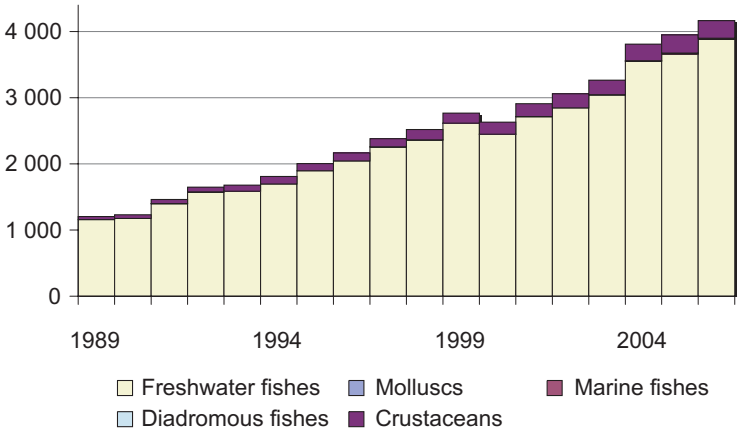


Figure 38 Trends in aquaculture production of South Asia by major species groups

There has been a major increase in roho and catla production since 2003. Although Indian carps (roho, 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. Silver carp production also increased almost fivefold in two years (1999 to 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 39).

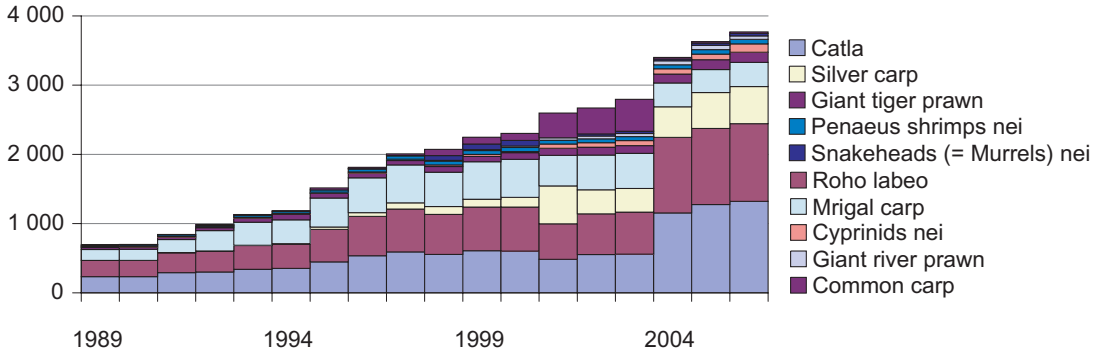


Figure 39 Aquaculture production of major species in South Asia

Marine crustacean production, giant tiger prawn, penaeid shrimp and giant river prawn, have increased steadily and reached 260 000 tonnes in 2006. 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 18 000 tonnes in the last years for which statistics are available.

Southeast Asia

Aquaculture production in Southeast Asia is very diversified and in 2006 production of eighty-three different species was reported. The number of cultured species and the details of reporting have increased rapidly in the last five years (Figure 40).

In terms of value, highly-priced crustaceans have an increased share of 45 percent of the total production, followed by freshwater fish at 41 percent (Figure 41). The main difference is that the relatively low volume of crustaceans gives a high

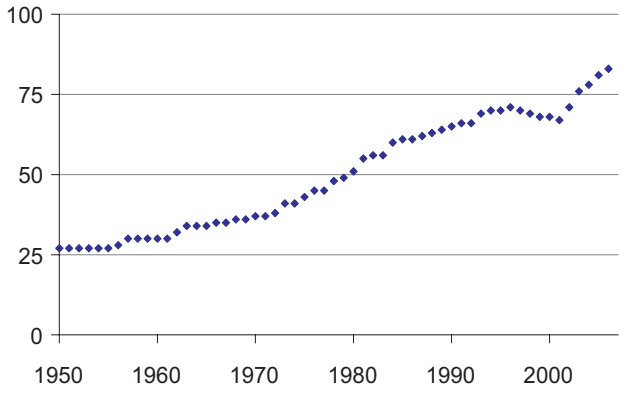


Figure 40 Number of species reported from Southeast Asian aquaculture

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.

Box 13 Top cultured species Southeast Asia 2006

Top ten cultured species in Southeast Asia (by quantity, excluding aquatic plants) were whiteleg shrimp, Nile tilapia, milkfish, pangas catfish, common carp, green mussel, giant tiger prawn, rohu catfish and silver barb.

Freshwater finfish culture has increased from 0.6 million tonnes in 1991 to 3.2 million tonnes in 2006, with an average annual increment of 0.17 million tonnes. In the mariculture sub-sector, 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 42).

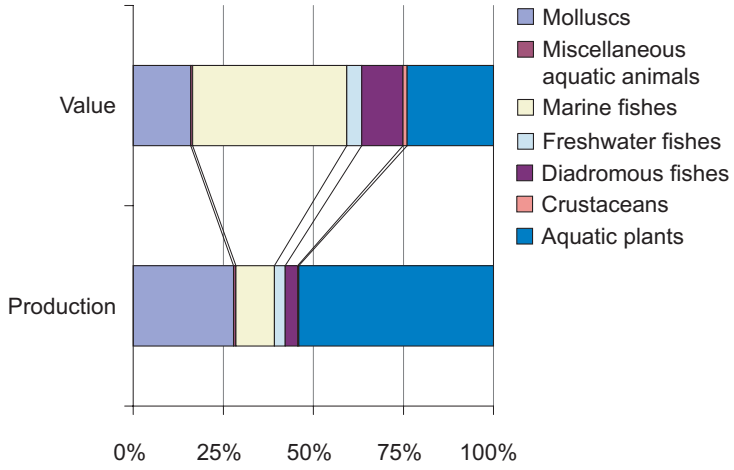


Figure 41 Aquaculture production of Southeast Asia: proportion of major species groups

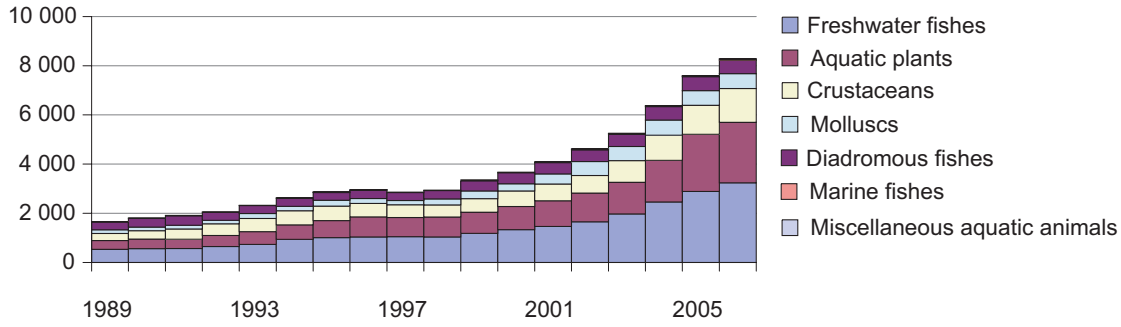


Figure 42 Trends in aquaculture production of Southeast Asia by major species groups

Eucheuma cottonii is still the most widely cultured aquatic plant in the region with a production of 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. The growth rate has, however, slowed down in 2006 after seeing two years with more than 30 percent growth (Figure 43).

Apart from aquatic plants, whiteleg shrimp (*P. vannamei* is the top produced species, and has very recently surpassed the previous top species, giant tiger shrimp (*Penaeus monodon*).

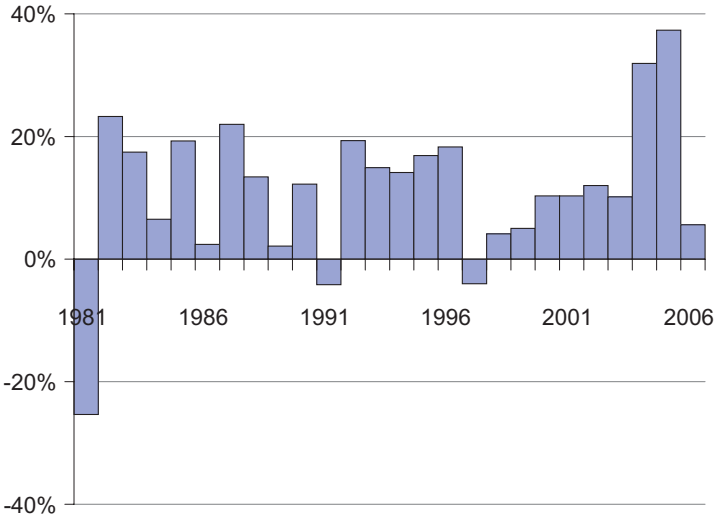


Figure 43 Growth rate (percent: year to year) the last 25 years in Southeast Asian aquatic plant production

China

China's aquaculture production has now reached 45.6 million tonnes or 70 percent of the world aquaculture production in 2006 (including aquatic plants). Growth in inland culture has continued, mainly from increased production of finfish culture, which has increased by an average of 9.2 percent since 2004. This increase is being achieved through the intensification of existing systems rather than any significant increase in production area. 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 44).

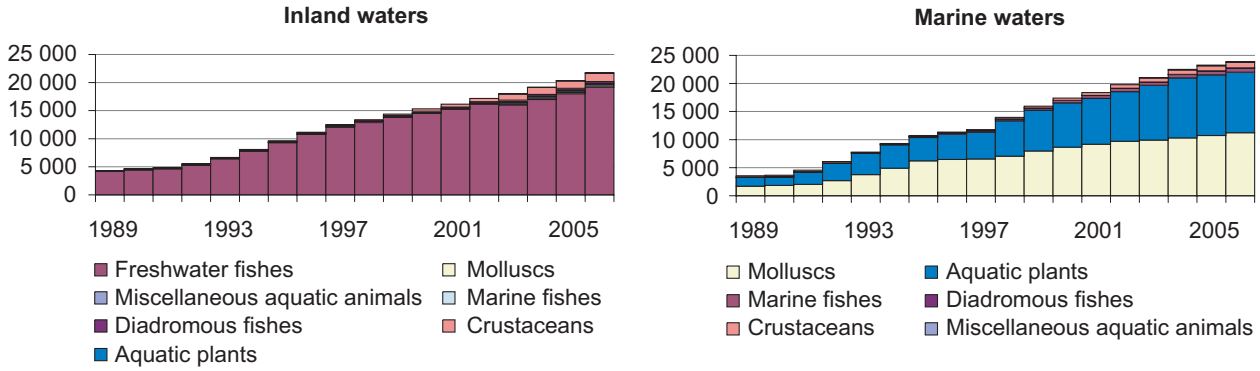


Figure 44 Trends in aquaculture production of China by environment

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 4.3 million tonnes in 2006 with a minor decline to 4.0 million tonnes in 2004, compared to the 2002 value of 4.3 million tonnes.

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 3.9 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 2006 is 2.3 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 2.0 million tonnes in 2006. Most of the Chinese plant production is for food purposes in contrast to other large producer regions (Southeast Asia) where most of the production is for processing.

Pacific cupped oyster: this is another cultured species that has achieved outstanding growth; increasing from 0.5 million tonnes in 1990 up to 4.6 million tonnes in 2004. Mollusc production is also difficult to intensify and increased production suggests developments of new production areas as in the case of aquatic plants (Figure 45). Additionally, the production of blue mussels has declined (-28 percent) and instead has been replaced by an increased production of Korean mussels (300 percent) and Chilean mussels (69 percent) since 2004.

Carnivorous species: Rapid growth in production of high value carnivorous species such as mandarin fish, Chinese river crab and marine finfish started to occur in 1995. More recently there have been large

increases in the production of snakehead, grouper and lai.[99] Many of the carnivorous species show very similar patterns of growth in production (Figure 46).

Other Asia

Aquatic plants continue to predominate aquaculture in Other Asia, particularly in East Asian states. They account for 54 percent of total production. This is followed by molluscs (28 percent) and marine finfish (10 percent). However, the high economic value of marine finfish makes this species group the largest contributor in terms of value, constituting 41 percent of total production value (Figure 47).

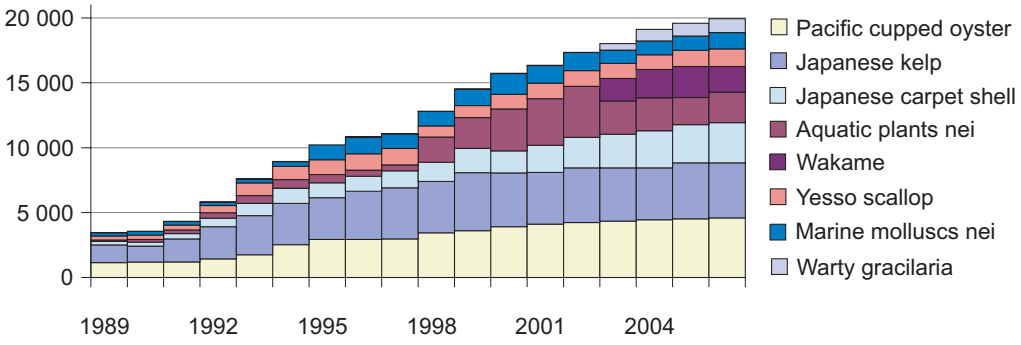


Figure 45 Trends in top eight cultured species in China (aquatic plants and molluscs included)

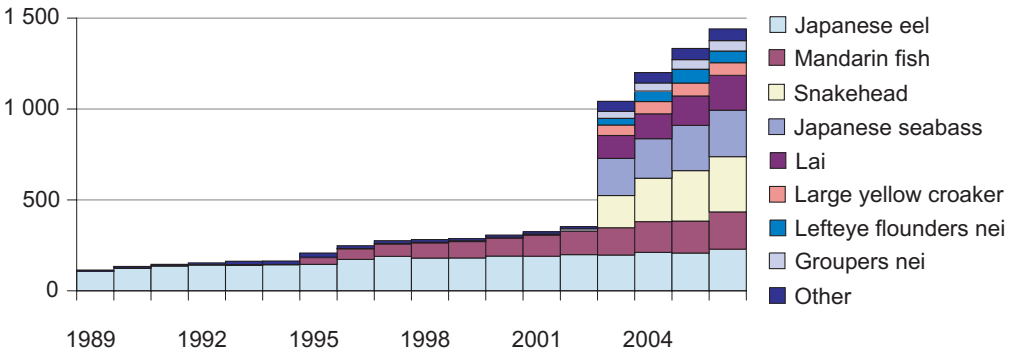


Figure 46 Trends in major cultured carnivorous species production in China

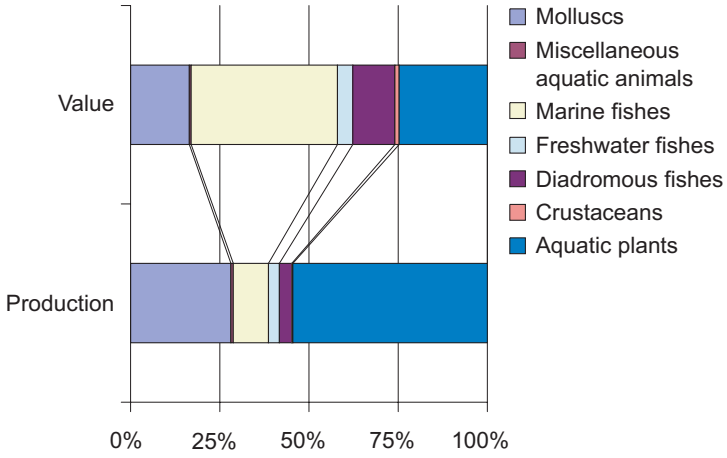


Figure 47 Aquaculture production in Other Asia: proportion of major species groups

[99] 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.

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. The exception then 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 is 1.7 million tonnes in 2006 (Figure 48).

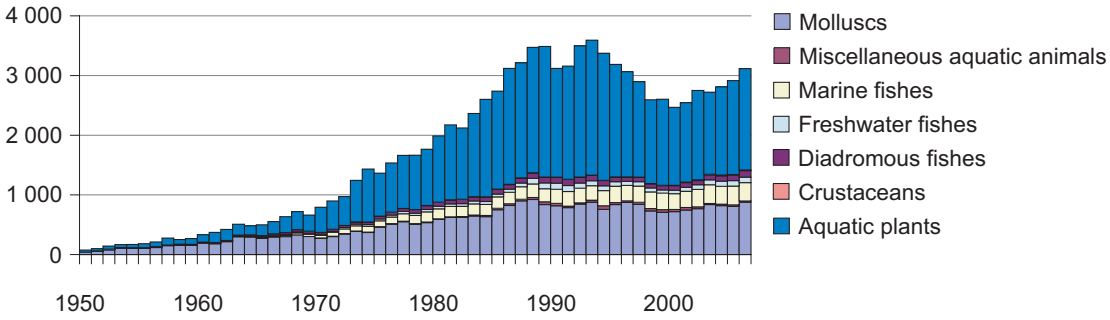


Figure 48 Trends in aquaculture production of Other Asia by major species groups

It is notable that the percentage of carnivorous fish in the total for fish production is very high in this subregion (77 percent in 2006) compared with South Asia, Southeast Asia and China, which all have levels below 10 percent (1, 2.3 and 7 percent respectively).

Oceania

Aquaculture production from Oceania is relatively limited. The production was 159 000 tonnes in 2006 (Figure 49) and out of this production New Zealand and Australia where responsible for 98 percent.

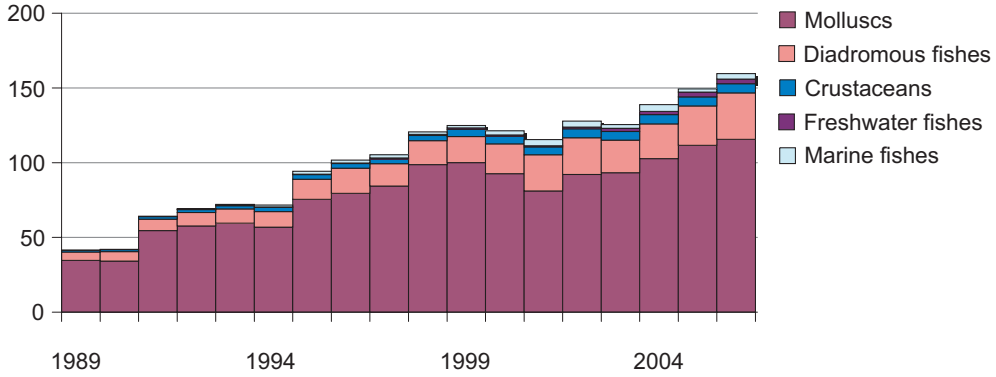


Figure 49 Aquaculture production in Oceania by major species group

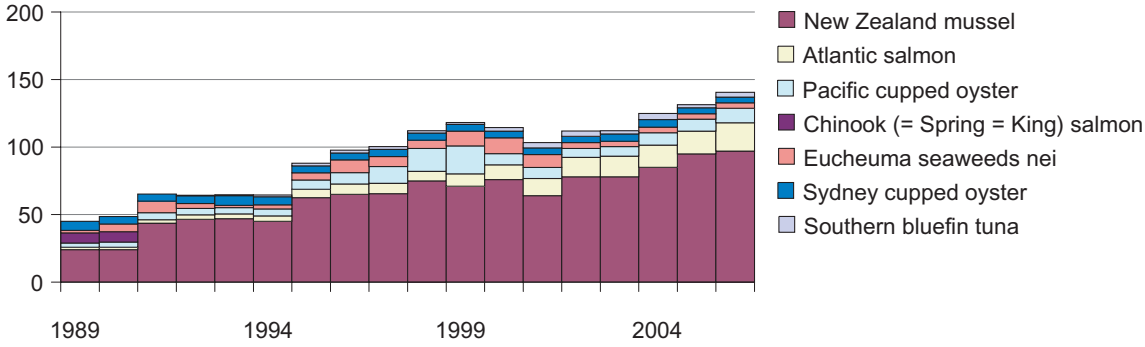


Figure 50 Top seven species aquaculture production in Oceania

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 50). 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.

Eucheuma 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. At present the most commonly farmed species is tilapia with about 400 tonnes produced in 2006.

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