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## **Trend of Fisheries and Aquaculture in Southeast Asia: Call for Regional Fisheries Management**

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### **ABSTRACT**

Fish is by many the preferred source of food and considered to be low in cholesterol with high nutritional value. In 2005, the Southeast Asian countries share 14.74% (23,000,000 metric tons) of the world total fisheries production (capture and culture combined). Aquaculture is mostly done as a national operation, which is well within national policy frameworks. In terms of aquaculture, particularly shrimps, Thailand is one of the leading producer countries in world with a global share of around 20%. Indonesia and Vietnam are also among the top five countries producing shrimps from aquaculture. From the point of view of capture fisheries, most of the landings of marine fisheries products are caught within the EEZs of the countries in the region. Taking into account the migratory nature of the fish stocks, the fishing licenses provided to foreign vessels and the mobility of fishing crews, the need to address the management of capture fisheries at regional level becomes very apparent. Illegal, unreported and unregulated (IUU) fishing by foreign vessels has, in addition to “domestic” problems, been receiving increasing attention in the region and there are incidences or conflicts related to fisheries leading to trans-boundary concerns. Therefore, calls for regional and sub-regional fisheries management mechanisms are increasingly being pushed forward.

A process is now underway for the establishment of an ASEAN Regional Fisheries Management Mechanism (ARFMM) covering both marine and inland fisheries. While it is expected that the ASEAN broad mechanism would be more general and will not address stocks or species in particular, dialogues are also ongoing at the sub-regional level focusing more on specific habitats and fish species. Apart from the archipelagic waters and “domestic” inland waters, a number of fairly distinct sub-regional fishing areas have been identified, namely: (1) the Lower Mekong River Basin (LMRB) which is a very important freshwater and floodplain fisheries area, shared by Cambodia, Laos PDR, Thailand and Vietnam (CLTV); (2) the Gulf of Thailand sub-regional area which features a large amount of small-scale and coastal fishing operations, large-scale fishing as well as reported IUU fishing and unreported landings across boundaries, shared by Cambodia, Malaysia, Thailand, and Vietnam (CMTV); (3) the Eastern and Southern South China Sea and Sulu Sulawesi Sea sub-regional area characterized also by a large amount of small-scale and coastal fishing, small-scale vessels, large-scale fishing, and IUU fishing, bordered by Brunei Darussalam, Indonesia, Malaysia, Philippines and Vietnam (BIMPV); (4) the Timor-Arafura Sea sub-regional area which features small-scale traditional fishing, industrial fishing for larger pelagic fish including licensed fishing by foreign vessels and IUU fishing, bordered by Australia, Indonesia, Papua New

Guinea and Timor Leste (AIPT) (note that Australia, Timor Leste and Papua New Guinea are not members of ASEAN); (5) the Andaman Sea (and Malacca Straits) sub-regional area which shows the same pattern of small-scale, large-scale fisheries and IUU fishing, is shared by India, Indonesia, Malaysia, Myanmar and Thailand (IIMMT) (India is not a member of ASEAN). The management needs were brought forward in reports reflecting the post-tsunami situation; and (6) the Northern South China Sea and the Gulf of Tonkin have similar characteristics as that of the Gulf of Thailand, is shared by China, the Philippines and Vietnam (CPV) (China is not a member of ASEAN).

Each sub-region has its specific profile and challenges to address, but the common elements to work on for each sub-regional area management mechanism would include, as major aspects, information exchange on: fisheries activities (officially recognized fishing and IUU fishing), shared and migratory stocks, results from port monitoring activities (landings by foreign vessels), social mobility of fisheries-related workforce, and laws and institutional arrangements. Other aspects for cooperation at the sub-regions could include networking on Monitoring Control and Surveillance (MCS), mutual support in the implementation of port state and flag state measures, as well as consultations and agreements on the design and zoning of special “management” areas (refugias, protected areas, etc). The fisheries agencies should also push for, while recognizing that this is outside their mandate, the settlement and definitions of maritime boundaries within the area.

While recognizing the dominating role of the Southeast Asian countries in the international seafood trade, it can be envisaged that after establishing sub-regional management mechanisms this would help the ASEAN countries to better manage the fisheries and with due recognition by countries around the world help to maintain and increase their exports of fisheries products. In the process, good systems for traceability, certification and labels (such as eco-labels) should also be established. Whatever management measures, the fisheries resources need to be managed and a key element is to limit the fishing capacity while IUU fishing by foreign countries and domestic sources should be prevented.

## 1. Introduction

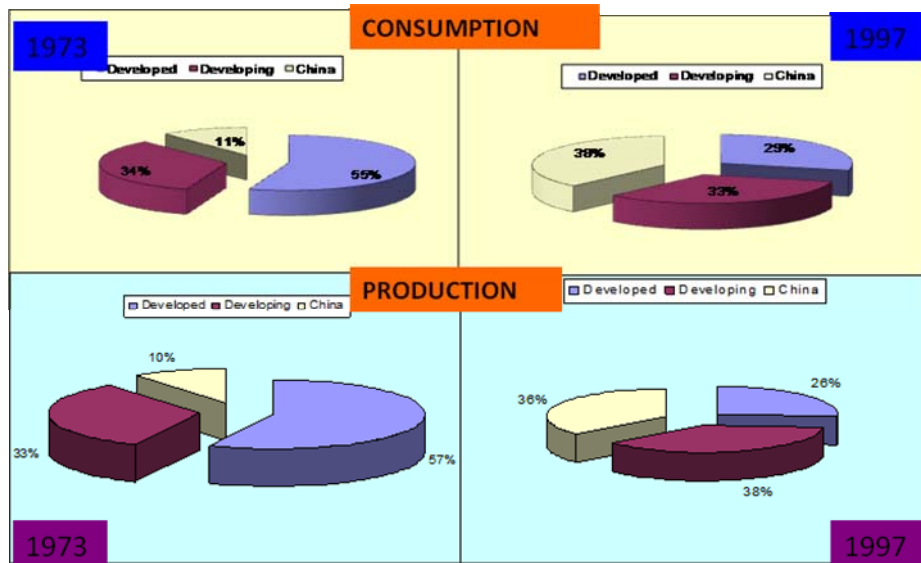
The global population is increasing and people are more concerned about health and are looking for good nutritional products. As we know seafood is low in cholesterol and good for human digestion. Seafood has become a preferred choice by many people around the world. The world food fish production was around 156 million metric ton in 2005 (FAO Yearbook, 2005) (Table 1). 9 million metric ton was from inland capture fisheries while 83.5 million metric ton was from marine capture fisheries. The remaining 63 million metric ton came from aquaculture (Fishery Statistical Bulletin, 2005). World demands imply an extra 40-60 million metric ton of food fish by 2020 (Del Silva, 2008)

Table 1: World fisheries production in 2005

Fishing area	Capture Fisheries		Aquaculture (t)
	Inland (t)	Marine (t)	
Africa	2,388,998	4,984,079	656,370
America North	175,683	7,791,304	862,160
America South	428,509	16,307,654	1,165,435
Asia	6,165,158	39,669,752	57,956,101
Europe	359,587	13,437,423	2,140,442
Oceania	17,369	1,387,979	159,256
<b>Total</b>	<b>9,535,304</b>	<b>83,578,191</b>	<b>62,939,764</b>

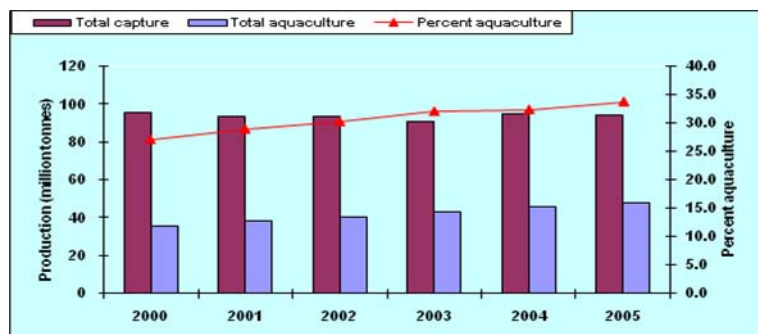
There are major global changes taking place in the fisheries and aquaculture sector. First in terms of production and consumption, it has changed from being dominated by developed countries to a sector dominated by developing countries. In 1973, the relative consumption in developed countries was 55% of global production and by 1997 the relative consumption in developed countries was reduced to 29% (Fig 1). In comparison the relative consumption in China increased from 11% to 38% during the same period while other developing showed a fairly stable relative consumption (indicating a real increase). In similar way production pattern varied between developed and developing countries leading to the present situation where developing countries (including China) now have more than 60% of global production.

Figure1: Major, Global changes taking place in the fishery sector

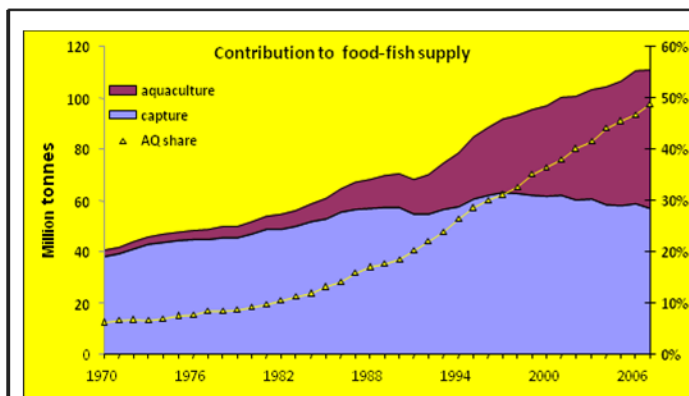


When we look at contribution to total fish supplies since early 1970 we see that the production from capture fisheries production has been almost static. The contribution from aquaculture production has been increasing (Fig 2).

Figure 2: Contributions to total fish supplies



~ 35% to total supplies

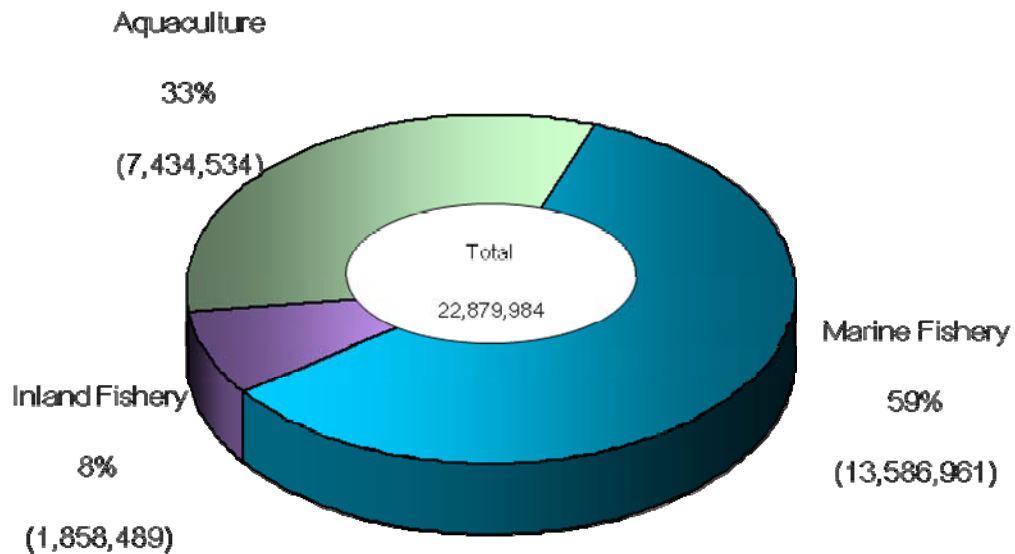


~ 50% to food fish consumption



In 2005, the relative fisheries production for Southeast Asia showed 8% for inland capture fisheries, 59% for marine capture fisheries and 33% aquaculture production (Fishery Statistical Bulletin, 2005). The total production was about 23 million metric ton with the main part coming from marine capture fisheries and aquaculture. It should also be noted that inland fisheries production is highly underestimated (Fig 3).

Figure 3 Southeast Asia Fishery Production by sub-sector in 2005



Southeast Asia provides 22.04% of total production in Asia and 14.74% of the total production in the world. Indonesia has shown the highest production in Southeast Asia with about 22.05% followed by Philippines 18.19% and Thailand 18.06% of the total Southeast Asian production, respectively (Table 2). A note on inland capture fisheries : Production figures are in general highly underestimated and for example, the Mekong River Commission have for only the Mekong River Basin estimated a production of 2,5 to 3 million tons per year (MRC Annual Report, 2007).

Table 2 Southeast Asia Fisheries Production in 2005

Country	Capture Fisheries		Aquaculture (MT)
	Inland (MT)	Marine (MT)	
Brunei Darussalam	10	2,390	703
Cambodia	444,000	60,000	42,000
Indonesia	297,370	4,408,499	1,941,096
Malaysia	4,583	1,209,601	188,220
Myanmar	631,120	1,375,670	574,990
Philippines	143,806	2,122,216	1,895,847
Singapore	...	1,920	5,917
Thailand	198,800	2,615,565	1,318,481
Vietnam	138,800	1,791,100	1,467,300
<b>Total</b>	<b>1,858,489</b>	<b>13,586,961</b>	<b>7,434,534</b>

## 2. Constraints facing Aquaculture and Capture Fisheries

Oil price has increased very rapidly and significantly with impact on all sectors, including Aquaculture. This has led to increases in costs for input material and other costs such as feed and transportation. The additional costs make it difficult for fish farmers. The aquaculture production has been increased, while the farm gate price is decreasing. The result being that farmers get less profit and the whole aquaculture operation is getting more risky. Increased stocking density in the ponds lead is followed by more frequency of diseases outbreaks. On top of this the farmers has to face the impacts of other natural disaster, such as floods and storms Recent demands, by retailers and consumers, to be able to trace the products (traceability) throughout the production chain has led to a demand for products that are labeled, such as eco-labels (Ekmaharaj, 2006). This in turn adds more costs for farmers while at the same time if they are successful provide some market opportunities. Furthermore some improvements on farm routine practices are needed, with potentially more investment costs, in order to mitigate environmental impacts and to address social concerns.

Increased oil prices also as hits hard on those involved in capture fisheries. Nevertheless, throughout Southeast Asia signs of decreasing resources are seen and there are frequent reports on over-fishing leading to calls for improved management and reductions in the fishing effort. Instances of IUU are wide spread and have led the countries of the region to get together under a Regional Plan of Action (RPOA) in combating IUU fisheries. The requirements to be able to trace catches, to certify the products (for various reasons) increasing flora of labels are things that the fishing industry have to face and cope with. For the ones that catch up and are doing that well there might be new avenues to better market opportunities. Global, regional and national requirements are becoming more stringent in terms of demands to mitigate impacts on the environment. With the high level of mobility (across borders) of fish workers and the large number of people involved in the fishing sector (fishing and processing) the sector is increasingly being scrutinized in terms of social performance and social well-being and, subsequently, new “demands” can be expected.

A short review of some leading ASEAN aquaculture countries shows that there responses and opportunities ahead for the aquaculture business. Thailand has been the world leader in shrimp aquaculture since 1994 with around 20-25% of the world market (Ekmaharaj, 2006). The total cultured area is around 70,000 ha. The total production is 1,385,801, metric ton and out of this shrimp production is 480,000 metric ton annually. A reduction in the farm gate selling price for shrimp has led to a point where the aquaculture area is decreasing. The use of the pond area is now diversified and now includes oil palm, rice or other fish species, such as seabass or even freshwater prawn. However, Thai farmers have over the years had good experiences in farm practices. The finished products are now also showing diversity including frozen product and a whole range of value added product that is expected provide better chances for marketing.

As for Indonesia there are around 51,252 ha of aquaculture farm areas. The total aquaculture production is 1,290,000 metric ton/year and shrimp production is 279,539 metric ton (Fishery Statistical Bulletin, 2005). Aquaculture is mostly operated by traditional or semi-intensive practices. These could be developed into intensive systems but to do that farmers would needed training in culture technologies. Overall yields (kg/ha) can be increased and Indonesia could be the leading country of the world with the next 5-10 years in terms exports of cultured shrimps.

In the third country, Vietnam, there are around 580,464 ha of aquaculture farm areas. The total aquaculture production is 1,660,000 metric ton per year and shrimp production is providing 237,880 metric ton (Fishery Statistical Bulletin, 2005). There is diversity in the species cultured: temperate species *Peneaus indicus* is cultured in the northern part; *P. vannamei* is cultured in the middle part; and *P. monodon* is cultured in the southern part. However, on average each family only has a small pond for culture. Given the small size it is very difficult to have seawater storage and effluent treatment pond for each of the small units. Disease outbreaks are a related problem. However, farmers are very active and enthusiastic to learn new technology.

### 3. Calls for Regional Fisheries Management Strategies

Most of the fisheries production comes from fisheries within the EEZ's of countries in the region. There are some trans-boundary conflicts with illegal fishing from foreign vessels. IUU fisheries are causing problems to the region and the RPOA is an attempt to help countries to cooperate to combat IUU fisheries. To live up to the ambitions more work are needed in follow up to the action plan for combating IUU fishing together with attempts to implement port state measures (based on international standards) and flag state measures that are related tools to apply to reduce IUU fisheries. In general the countries of the region need to get together, at regional and sub-regional level, to develop common strategies to improve fisheries management and combat IUU fisheries. In spite of the general picture of depleted resources there are some areas in the region where resources are still available such as in Myanmar waters and the eastern part of the Indonesian archipelago.

There is a huge regional freshwater fisheries in the Mekong River Basin with a production of around 2.5-3 million tons per year, as mentioned previously. Products are already very important for local/regional consumption and there is a substantial regional export, although export/import statistics is limited. The potentials for increased export – in the region and elsewhere – are good. The Mekong is one of the world's most important rivers in terms of aquatic biodiversity and the Mekong provides habitat for the world biggest freshwater fish (Giant Catfish, *Pangasianodon gigas*). The Giant Catfish is on the IUCN and CITES lists for being highly endangered. A Commission, the Mekong River Commission “for the sustainable development of the Mekong River Basin” is established. The agreement is signed by Cambodia, Lao PDR, Thailand and Vietnam, thereby, presently, including the countries of the Lower Mekong River Basin (LMRB). The agreement includes calls for fisheries management as being one of the key sectors under the MRC Agreement, and for the region. There are some fisheries management arrangements, based additional agreements, such as on fishing quota for Giant Catfish in the Lower Mekong River Basin. , China and Myanmar are the only riparian states that have not signed the MRC Agreement, but they have an observer function at official MRC meetings.

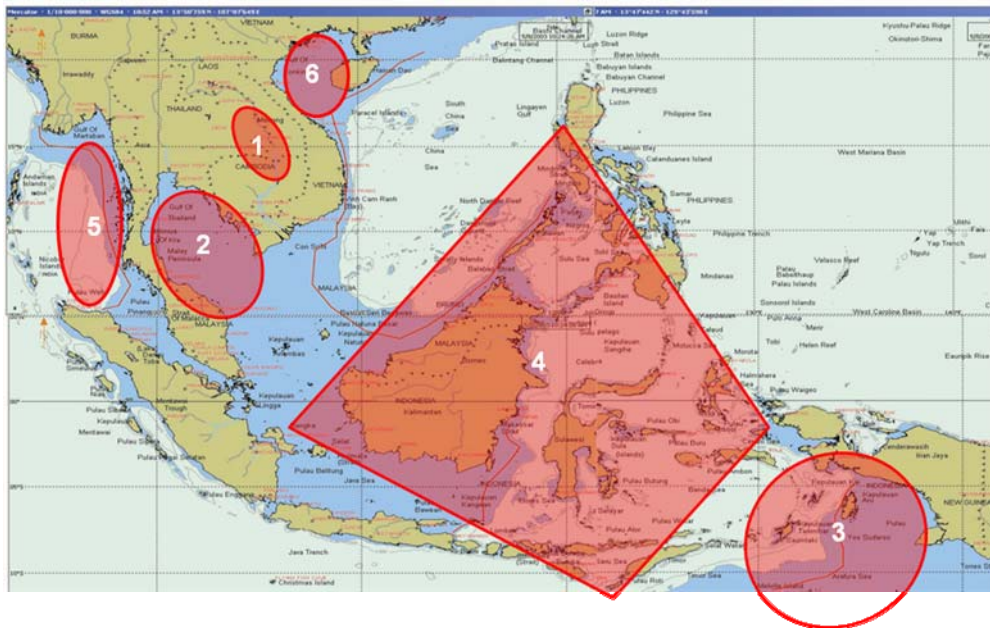
The purpose for Regional Fisheries Management Strategies is to provide a framework for better management and to provide a platform for cooperation within a region, or sub-region, and to live up to requirements under international instruments and in order to facilitate the implementation of international standards/procedures. An ASEAN Fisheries Consultative Forum (AFCF) is being developed within the institutional framework of ASEAN. Sub-regional management arrangements are being considered to better accommodate management needs, habitats functions and type of fisheries in a defined water area in ways that an ASEAN wide mechanism would not be able to accommodate in a smooth way.

Areas suitable for sub-regional management arrangements, within the Southeast Asian Region, can be divided into six sub-region that each covers two or more countries (Fig.4), including one for inland fisheries, as follows;

1. Lower Mekong River Basin is referred to as it links to the Mekong River Commission. I including Cambodia, Lao PDR, Thailand and Vietnam (CLTV). The upper Mekong includes Myanmar and China. Myanmar and China are observer for MRC and all except China members of ASEAN.
2. Gulf of Thailand composes of Cambodia, Malaysia, Thailand and Vietnam (CMTV).
3. Timor-Arafura Sea composes Australia, Indonesia, Papua New Guinea and Timor Leste (ATPT). Australia, Papua New Guinea and Timor Leste are not member of ASEAN.
4. Eastern and Southern China Sea and Sulu Sulawesi Sea compose of Brunei, Indonesia, Malaysia, Philippines and Vietnam (BIMPC).
5. Andaman Sea composes of Indonesia, India, Malaysia, Myanmar and Thailand (IIMMT). Here, India is not a member of ASEAN
6. Northern South China Sea and Gulf of Tonkin comprises of China, Philippines and Vietnam (CPV). Again, China is not a member of ASEAN.

At present, initial discussions to set sub-regional area planning has been done for sub-regional area 1 (under the MRC), 2, 3 and 4. The sub-regional area no.1 for LMRB has a strong and active cooperation in technical and policy aspects under the MRC. With respect to sub-regional area no.5 there are some dialogue to build upon that has emerged from the post-tsunami activities and with respect to area no.6 most development have been through bilateral talks between China and Vietnam.

Figure 4: Calls for Regional Fisheries Management Strategies Reduce the size of block number 4 to cover only Sulu-Sulawesi Seas and the South and South Easter part of South China (and not to include parts of Indonesian Archipelagic waters)



Fisheries characteristic in each sub-regional area will be presented on the following topics;

- Fish stock resources
- Type of Fishery and social dimension
- Fisheries situation
- Problem, conflicts and opportunities

#### 4. Summary details for each Sub-regional management area

Summary details for each sub-regional management area can be described as follows;

##### 4.1 Lower Mekong River Basin

Mekong is one of the world’s most productive freshwater bodies with an estimated production of 2.5 – 3 million tons each year. The main characteristic is floodplain and riverine fisheries with a great variety of fishing gear. There is a very high involvement of rural people and farmers in part-time or full-time fishing. Critical for the reproduction of fish is the seasonal changes in the monsoon and the importance of the annual floods. The threat to the resource is more from infrastructure rather than the fisheries itself as that might affect the flooding pattern. In summary increasing populations (more people

involved in fishing) and infrastructure development (connectivity lost) is perhaps posing the major threats to the sustainability of Mekong fisheries. In addition there are conflicts within the fishery as well as over land for different uses. Opportunities lies in securing the seasonal flooding, fish migration paths and dry season management of brood stock.

#### **4.2 Gulf of Thailand**

Gulf of Thailand used to have one of the highest resources potential in the Southeast Asian region due to its shallow topographic bottom features that forms the Gulf into a large basin less than 85 meter deep. Many important rivers bring down nutrients into the Gulf, especially in the upper Gulf. Fisheries in the Gulf are diverse, with small-scale coastal fishing and large-scale fishing operating in the areas offshore. The focus is on shellfish, multi-type demersal species, small pelagic species such as Indo-pacific mackerel, round scads (Ekmaharaj, 2007). At present, due to failure of fisheries management and open access fisheries the resources, especially demersal resources, are depleted. All types of fishing in the Gulf are causing high pressure on the resources. The catch per unit effort (CPUEs) is a good indicator showing that 20 years ago the expectation was 300 kg/hrs while presently it remains only 20 kg/hour to be expected (DOF, 2007). In addition, due to depletion of resources, many problems are raised such as conflicts between groups of fishermen, IUU fishing and trans-boundary fishing. This in turn reduces the opportunities in domestic and export markets and impacts the livelihoods of fishermen.

#### **4.3 Timor-Arafura Sea**

The Timor-Arafura Sea has in addition to the coastal resources also a significant source of large pelagic species. The fisheries have two distinct features: 1) coastal traditional fisheries; and 2) large vessels (also licenses foreign) fishing large tunas, etc. Some fisheries are under high pressure while other resources are still in abundance. Similarly to the Gulf of Thailand there are conflicts among groups of fishermen, IUU fisheries and trans-boundary fishing. To strengthen the position for traditional fishermen there is a need to secure traditional rights to coastal lands and fishing. There are still good opportunities for export of large pelagic fish species if it is well managed and controlled.

#### **4.4 Southern and South Eastern South China Sea and Sulu-Sulawesi Sea**

The sub-regional areas can be separated into three parts as

- 1) The South and Southeastern part of South China Sea (SCS), and
- 2) Sulu Sea and
- 3) Sulawesi Sea: covering Banda sea, Molucca Sea, Flores Sea and Celebes Sea

This sub-regional area has a great biodiversity in coastal and offshore resources, it is noted that many important habitats exist here, such as marine turtle habitats, tuna breeding and spawning grounds (Tim L. O. Davis., 2008).

The topography of bottom features indicates that almost 80% of the sea areas are deep sea where the depths of water are in the range between 200-5,000 m. In coastal areas, most of the bottom areas are not suitable for trawling therefore demersal resources are underexploited. In addition, many fishing gear such as purse seine and ring-net are in use in the area targeting small pelagic fishes, namely neritic tuna, round scads and mackerel. Opportunities in the sub-region include the challenge to further explore the potentials of deep sea fisheries where oceanic squid is also one of the potential resources for future fisheries development.

Problems of the sub-region include:

- 1) IUU fishing: this include the foreign vessel and neighboring IUU fishing vessels; there are also frequent illegal fishing targeting sea turtles, especially around the Turtle Islands in Sulu sea.
- 2) Small pelagic fisheries by purse seine with Fish Aggregating devices (FADs) is another problem as it include catches of juvenile yellow fin and bigeye tunas. This problem may affect to the tuna stock. Therefore responsible fishing technology and practices need to be enforced (Siriraksophon, 2008).
- 3) Most of the important pelagic fish species are straddling and highly migratory species which implies a need for joint approaches to management.

#### **4.5 Andaman Sea**

Andaman Sea is facing/connecting to the Indian Ocean, but still almost semi-enclosed due to the Andaman and Nicobar Islands that are “fringing” the Andaman Sea in the eastern part. The geographic and bottom features are quite distinct when compared to the Gulf of Thailand. The area includes a large continental shelf in the northern part, in Myanmar, and a deep basin down to 2,000 m. in the central part of the Andaman Sea. Many rip-currents occur where two water masses meet and this produce an abundance of small pelagic in offshore waters in this part of sub-region.

There is great biodiversity on the continental shelf and continental slopes, as well as further offshore. Many commercial fish species thrive on the continental slopes where the depth varies between 150-300 m, and there is an abundance of fish species in the Ayearwady delta. Even more offshore and into deeper waters, especially in the northern part in and close to Myanmar waters, there are also abundance of large pelagic species, such as yellow fin and bigeye tunas, sword fish, marlin, sailfish and thresher sharks (Promchinda S. and Siriraksophon S., 2007).

Seasonal changes such as the North-west Monsoon and the Southeast Monsoon are beneficial to and could be used to reduce rate over-exploitation and to build up conservative measures to allow fish stocks to recover as many fishing activities are stopped seasonally (during the Southeast Monsoon) and closed seasons could be introduced.



Consideration the tuna in the Andaman Sea, even through not large resources in the Thai EEZ, but to aggregate tuna or build up new fishing ground in Thai EEZ can be made.

Opportunities include exploring new Tuna fishing grounds, including potentials in the Thai EEZ, the development of deep sea fisheries on the continental slopes from 200-800 m. However, the potentials are limited and recovery rates, etc of deep sea resources are not fully know and there is a general need to closely monitor new developments to ensure long term sustainable use.

#### **4.6 Northern South China Sea and the Gulf of Tonkin**

The area is presently not singled out as a sub-regional focal area for the RPOA-IUU or other regional initiatives for Southeast Asia. For the Gulf of Tonkin part, dialogue and agreements are discussed between Vietnam and China. In terms of fisheries resources, type of fishery and social dimension the area would present similar features as the Gulf of Thailand. Subsequently, pressure on the resources and problems, conflicts and opportunities would show some similarities – albeit with different countries involved.

#### **5. Sub-regional management areas, opportunities for action**

Indications have been made that a regional management mechanism or forum covering the whole of ASEAN – inland and marine – need to be supplemented by arrangements at sub-regional level to address more area specific issues, such as habitats, fish species and trans-boundary potential conflicts. A sequence of consultations, initiating sub-regional arrangements, has been held in three sub-regions since 2008 and for the Mekong, under the Mekong River Commission, since 1995. Sub-regional working groups are starting to emerge and a Technical Advisory Body (TAB) have been actively working with the MRC Fisheries Programme. A number of key elements, to be addressed jointly by countries, in support of sub-regional management include:

- Agreements on information exchange among member countries on various important aspects relevant to fisheries and habitat management (including social aspects);
- Monitoring, the Control and the Surveillance (M, C and S) are key to common approaches that would be needed to combat IUU fishing;
- Provide a support system among members to implement port state measures (FAO Guidelines);
- Work out ways to address the implementation of flag state measures; and
- To work out framework for fishing vessel registration (vessel record and inventory).

The demands and requirements form markets around the world are moving towards increasingly detailed information on products with possibility to trace the movement of products from the fishing itself to the “plate”. Increasingly, documentations following the products should be linked to modes of certification. With these trends as a background

there is obvious need to upgrade the whole chain of management throughout the various stages of production. With the establishment and development of the sub-regional management arrangements (in support of ASEAN-wide Forum) countries will cooperate to make fishing operations more sustainable and through information sharing, improved port monitoring etc demands for traceability can be met. Better cooperation around management will improve possibilities to certify products, thus provide a better chance for ASEAN countries to develop and maintain the export opportunities for ASEAN fisheries products. Improved traceability and certification provides a good framework to develop various types of labeling schemes, such as eco-labeling. The fisheries resources can be managed by limiting fishing capacity within the sub-region and by integrating fisheries management into habitat management to open up for the wise use of fishery resources. Of growing importance is the need to build upon social responsibility. The sub-regional mechanism would need to address large migration of workforce employed in fisheries, both in capture fisheries and in processing plants. If working together IUU fishing from foreign countries can be prevented.

## 6. References

- Department of Fisheries (DOF). (2007). Strategies for Marine Fisheries Management, Development of Fisheries, Thailand.
- De Silva, Sena. (2008). Climate Change and Aquaculture. Regional Consultation on Emerging Regional Fishery Policy, 15-16 July 2008, Bangkok, Thailand.
- Ekmaharaj, S. (2006). Aquaculture of Marine Shrimp in Southeast Asia and China: Major Constrains for Export. *Fish for the People*, 4(1): 38-43.
- Ekmaharaj, S. (2007). Responsible Fishery Technology and Sustainable Coastal Fisheries Management in Southeast Asia. *Fish for the People*, 5(1): 10-16.
- FAO Yearbook. (2005). Fishery Statistics Capture and Aquaculture Production. Food Agriculture Organization of the United Nations Rome Yearbook: 33-34.
- Fishery Statistic Bulletin. (2005). Fishery Statistic Bulletin for the South China Sea Area. Southeast Asian Fisheries Development Center Yearbook: 33-36.
- MRC Annual Report. (2008). Mekong River Commission Annual Report. Mekong River Commission: 33-34.
- Promjinda, S. and Siriraksophon, S. (2007). Executive summary on Large Pelagic Resources Survey in the Southeast Asia Waters. SEAFDEC, P.O.Box 97, Samutprakan, Thailand, 15p
- Tim L. O. Davis. (2008). "Size distribution of southern bluefin tuna by depth on their spawning ground - *Thunnus maccoyii* - Statistical Data Included". *Fishery Bulletin*. FindArticles.com. 01 Dec. 2008. [http://findarticles.com/p/articles/mi\\_m0FDG/is\\_2\\_99/ai\\_75434053](http://findarticles.com/p/articles/mi_m0FDG/is_2_99/ai_75434053)

Siriraksophon, S. (2008). Offshore Fisheries Management in the Southeast Asian Countries. First Meeting of the Regional Advisory Committee on Fisheries Management in Southeast Asia, 22-24 September 2008 Bangkok, Thailand, 5p. SEAFDEC, P.O.Box 97, Samutprakarn, Thailand.



# **The inter-Connectivity of Marine Fisheries and Habitats in Cambodian Coastal Water of the Gulf of Thailand**

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## **ABSTRACT**

The aims of the review are to find out the variety of marine ecosystems and their functions, living resources (fisheries) that depend on ecosystems, and their interconnectivity within 55,600 km<sup>2</sup> and 435 km long of Cambodian EEZ and coastline, respectively.

There are various coastal resources and ecosystems in the Cambodian coastal waters. There were 58,100 ha of 42 mangrove species belong to 20 families; 28 km<sup>2</sup> of 70 species coral reefs in 33 genera and 11 families with average live coral cover of 23% - 58%. Vast seagrass beds were accounted for 32,492 ha along the coast, and 10 species have been identified. There were various types of coastal wetlands including inter-tidal flats, estuaries, mudflats, peat swamps, non-peat swamp and lagoons. These habitats provide key nutrients, spawning and nursing grounds, and shelters for marine living resources including commercial fish; endangered species such as dugongs, dolphins, sea turtles and migration birds. These ecosystems provide as sources for cleaning pollution derived from agriculture run-off, cities and towns, and industries along the coastlines.

Coastal resources and ecosystems are very important by providing enormous goods and services to local population and national economy. Marine fisheries and aquaculture provide enormous incomes to millions coastal inhabitants. Coastal development and tourism are flourishing.

Marine resources and habitats are closely linked with each other. Each of which depends one another in order to balance in the marine ecosystems. When one component of either resource or ecosystem has been destroyed or removed, the whole components will be collapsed. Until that time, some components of resources and ecosystems have been under threats from over-exploitation, illegal fishing, cutting mangrove forests, unsustainable farming practices, pollution, and coastal development. Weak law enforcement occurred at responsible institutions; fish stocks have been declined and habitats have been lost from year to year.

It is required a clear understanding of the problems and taking appropriately collective actions, then these coastal habitats and resources can be preserved. The government managed to establish policy, institutional framework and legislations for management and conservation coastal resources and ecosystems into sustainable manner and improving

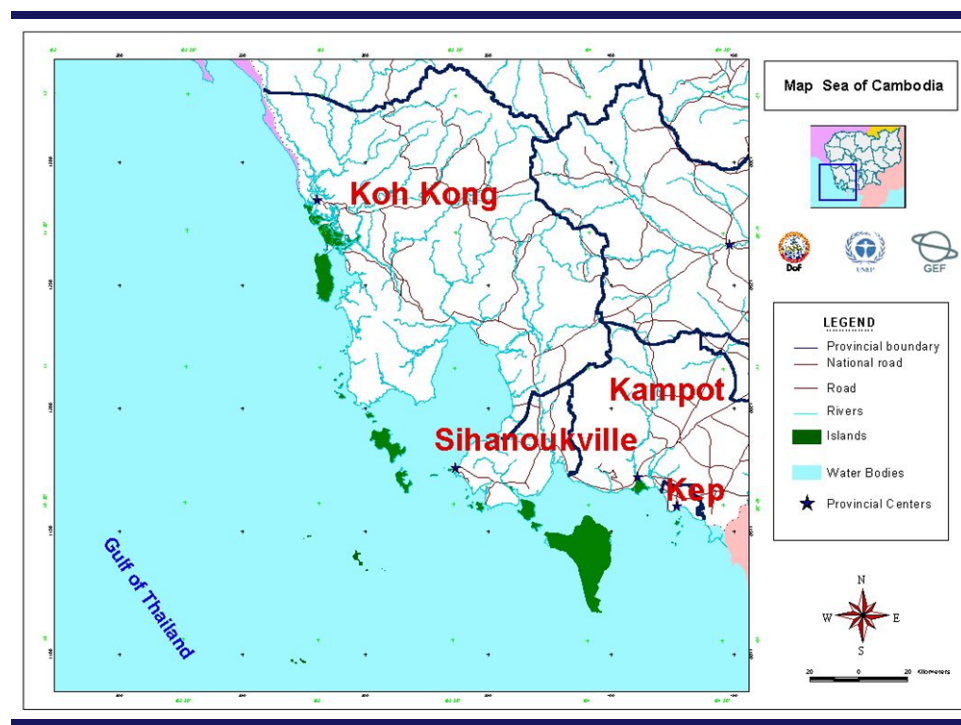
livelihoods of local people. However, there were outdated and conflicted implications among institutions and their legislations.

The implications are needed to be concisely and precisely identified and resolved in a coherent and synergetic way. Personal commitment and willingness of individuals, who are both responsible for management of these resources and ecosystems and using them, are indispensable for ensuring long term sustainability of resources for next generation.

## 1. INTRODUCTION

Geographically, the Kingdom of Cambodia coastal zone is located in the coordinates between 102°40' - 104° 35' East and 10°30' - 12°15' North, which has the coastline of 435 km extending on the South-western part of the country from the border with Thailand in the southwest to the Vietnamese border on the southeast (Figure 1). The country has total 69 islands; of which four main islands (Koh Kong, Koh Rong, Koh Rong Sanlem, and Koh Thmey) and a number of small islands are located near shore; while other three main islands, namely, Koh Tang, Koh Pring and Koh Polowai are off-shore. The marine boundary of Cambodia's coastal zone has been defined as the outer limit of the Exclusive Economic Zone (EEZ) of 55,600 km<sup>2</sup> about 23% of the country land's area located in the Gulf of Thailand (Nelson, 1999a). However, the landward boundary of the coastal zone has not yet been satisfactorily identified.

The Cambodia Coastal Zone is constituted of two administrative provinces of Koh Kong and Kampot and two administrative municipalities of Sihanoukville and Kep with a total territory of 1,723,700 hectares and the total population of 844,861 (National Institute of Statistics, 1998). These areas, as containing suitable soils and climatic conditions, allow having abundantly crucial coastal habitats along the coastline.



**Figure 1. Map of Cambodian Coastal Zone and its Administrative Border (FiA, 2003).**

Functionally, Cambodia's coastal zone is comprised of two inter-related systems, ecological and socio-economic systems. The ecological system includes the physical, chemical and biological parameters that provide natural resources, sequester pollutants and offer fundamental life-support functions (e.g. clean air and water) for humans and

other living organisms. These ecological systems are coral reefs, mangroves, seagrass beds and coastal wetlands; which are critical habitats that support a diverse range of residential and migratory fauna species, including those considered to be endangered and vulnerable.

The socio-economic system depends on the many functions and products of ecological systems. Ecological systems have abundant living resources, although their capacity to provide fish, timber, coral reef, seagrasses, clean water, and other goods and services used for socio-economic development is limited. Hence, it is not surprising that social demands for natural resources, as well as the increasing multiple use aspect of the coasts, has led to the escalation of conflicts within Cambodia's coastal zone.

Cambodia's marine fisheries depend significantly on habitat ecosystems. A large number of habitat dependent fish and shrimp species are highly valuable in both domestic and international markets. According to statistics of the Fisheries Administration, about 42,000 to 45,000 tonnes of marine fish and invertebrates are harvested from Cambodia's marine waters every year. However, some observers estimate that actual landings could be 10 to 20 times higher than the reported figure. The overall representation of habitat-dependent fish species in marine landings is unknown, but is most likely high.

The objectives of the review are to find out the variety of marine ecosystems and their functions, living resources (fisheries) that depend on ecosystems, and their interconnectivity within Cambodian marine border in the Gulf of Thailand. The results from this study will probably be demonstrated the indispensable significance of coastal ecosystems or so-called habitats, which will probably be included as marine protected areas or marine fisheries sanctuaries as the spawning, nursing and feeding grounds for various marine fauna. The study is also aimed at analysing the implication of current management policy, institutions and legislations in order to find out interested conflicts on the stewardship of marine ecosystems and resources.

## **2. Coastal Ecosystems Interconnectivity and Living Resources**

### **2.1 MANGROVE FORESTS**

Mangroves are the characteristic littoral plant formations of tropical and subtropical sheltered coastlines. They have been variously described as, coastal woodland, tidal forest, and mangrove forest. Mangroves are trees and shrubs growing below the high-water level of spring tides. Their root systems are thus regularly inundated with saline water, even though it may be diluted due to freshwater surface run-offs and only flooded once or twice a year.

Mangroves are reported to cover 85,100 ha along the Cambodia's coastline, estimated using satellite imagery and remote sensing. Of these, 63,700 ha are found in Koh Kong alone. There are also mangroves in Kampot and Sihanoukville (900 ha and 13,500 ha, respectively). The most well developed mangrove forests are found in the main estuaries of Peam Krasop, Andong Tuek, Sre Ambel, Chak Sre Cham and Prek Kampot.



There are 42 mangrove flora species belonging to 20 families has been identified (MoE, 1995). The dominant species belong to the genera *Rhizophora* (*Rhizophora mucronata* and *R. apiculata*), *Avicennia*, *Lumnitzera*, *Bruguiera*, *Ceriops* and *Xylocarpus* (Annex 1). In addition to mangrove trees, other associated species include nypa trees, *Nypa fruticans*.

Mangroves link marine and terrestrial ecosystems. They are of integral importance to the stability and maintenance of adjoining ecosystems such as seagrass beds and coral reefs. The organic matter (in the form of leaf litter and detritus matter) that originates from mangrove species is essential to aquatic inhabitants of lagoons and estuaries as well as other near shore environments such as seagrass beds and coral reefs. In fact, all of these ecosystems are found to be mutually beneficial to each other. They co-exist in a complex ecological relationship whereby if one is impacted upon, it will affect the others. Therefore, deterioration of mangrove ecosystems of Cambodia will have effects on the coastal system as a whole.

In Cambodia, the main commercial fish species caught in or close to mangrove areas include mullets (*Liza subviridis*), sea bass (*Lates calcarifer*), snappers (*Lutjanus spp.*), tilapia (*Tilapia spp.*), groupers (*Epinephelus spp.*), sea catfish (*Arius spp.*), threadfins (*Eleutheronema spp.*) and snake eel (*Ophichthus microcephalus*) (Christensen, 1982).

The uses and values of the products obtainable from mangroves are many and important. The importance of the resource stems from the many products taken directly from the mangroves, including the non-wood products, as well as amenities provided from within and beyond its boundaries. The economic values from mangrove ecosystem in Cambodia have been figured out in Annex 2 of this document.

Mangroves provide services include:

- Coastal protection against wave, Tsunami, and wind erosion
- Moderating the effects of coastal storms and cyclones
- Shelter and habitat for diverse wildlife, particularly avifauna
- Nutrient sink-effect and reduction in excessive amounts of pollutants
- Entrapment of upland runoff sediments thus protecting near shore reefs and reducing water turbidity

The main mangrove areas had been reduced since 1989 in all provinces along the coastline of Cambodia. Mangrove areas in Koh Kong province have been seriously damaged but now mangroves in those areas have nearly fully re-grown. Mangrove ranges in the area had been cleared by shrimp farmers and timber merchants as demand grew for new fishing grounds and high-quality charcoal following the end of decades of conflict in the early 1990s. Of the province's original 10,000 hectares of mangrove forest, only half

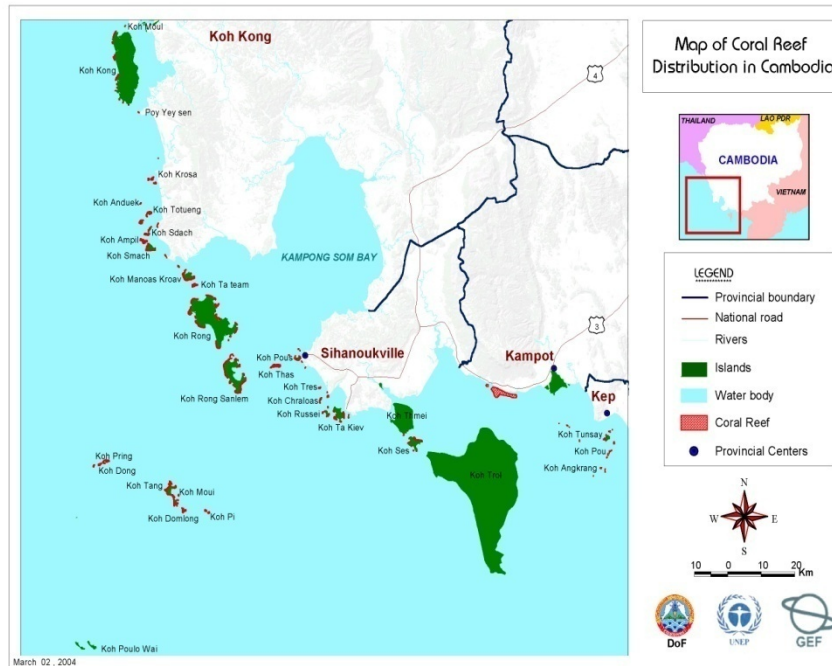
remain, according to the World Rainforest Movement. Today, less than 50 percent remain. Of these, about half are degraded because of:

- i. Extraction for timber and wood chip;
- ii. Exploitive traditional uses;
- iii. Charcoal production;
- iv. Conversions for agriculture (e.g., rice fields, plantations), mariculture (shrimp farming), salt pan, industrial/tourism/residential development, and harbour and canals;
- v. Construction of roads, jetties and small wharfs (urban development);
- vi. Mining/mineral extraction;
- vii. Solid and liquid waste disposals;
- viii. Oil spillage and other chemicals.

## **2.2 CORAL REEFS**

Coral Reefs play an important role in the marine ecosystem, providing critical habitat for many marine species. They also provide a vast array of services including fishing for vital food resources, coastal protection, tourism, biodiversity, and are essential in sustaining the marine fisheries of Cambodia.

Coral reefs of Cambodia are distributed in various localities, generally associated with offshore islands and rocky beds. Coral in Cambodia is mostly distributed as fringing reefs along parts of the mainland, particularly headlands, and around many islands (Figure 2). Corals near to shore are those adapted to living in turbid environments, while further offshore a wider diversity of species is found (Nelson 1999b).



**Figure 2. Map of Coral Reefs in Cambodia (FiA, 2004).**

The total area of reefs has been estimated as 28.065km<sup>2</sup> (FiA, 2004). Diversity studies to date indicate 70 species of coral in 33 genera and 11 families (Nelson, 1999b). While average live coral cover for the whole coastline was estimated to be 23% to 58%, the reefs are generally reported to be in poor health, with low species diversity dominated by massive forms (Annex 3).

The main types of corals collected include table coral (*Acropora spp.*), elephant ear coral (*Turbinaria spp.*), deer horn corals (*Porites spp.*). Previously, large amounts of coral were also collected by high rank military officers for use in the construction of their homes. Diving and snorkeling by foreign tourists in Sihanoukville is also becoming more popular and expected to increase in the future with much potential for further development of ecotourism in the region.

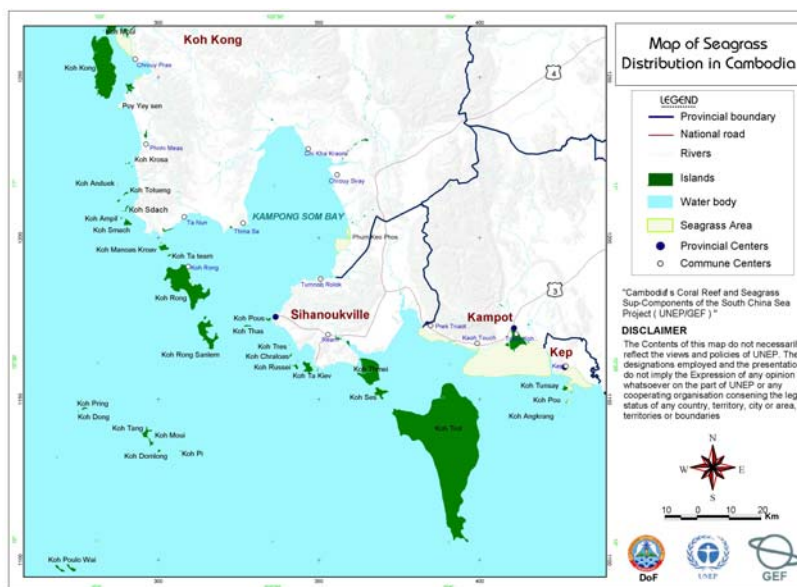
Reef Fish, such as Sweetlips (Haemulidae), Snapper (Lutjanidae), Barramundi Cod (Cromileptes), Grouper, Humphead Wrasse and Parrotfish, are the most valuable and targeted marine species. Though, at present, there are no statistical records of these fish. Traditionally fishers catch these species by using trap, gillnet and hook and lines. However dynamite and cyanide are now also used illegally, much to the detriment of the reefs. These species are collected in all sizes including juveniles. The juveniles and pre-adult fish are collected and re-cultivated in cages along the coast, to be then sold alive to both local restaurants and international markets in Hong Kong, China and Taiwan when they reached commercial sizes

Cambodia's coral reefs are at risk, threatened by an increasing array of anthropogenic impacts from unsustainable and destructive fishing practices; sedimentation and waste dumping; seaweed farming and increasing population and development in coastal areas.

The absence of policies and laws relevant to coral reef management and conservation, coupled with the lack of enforcement, all point to an urgent need to enhance management and research capacity. The existing laws focus on fisheries only with no mention of the protection of coral reefs. There also are some overlaps of responsibilities among concerned government agencies. Currently the Cambodian government has very limited human resources, infrastructure, and finance, to regularly conduct scientific research and monitoring on a permanent basis.

### 2.3 SEAGRASS BEDS

Seagrass habitats in Cambodia can be divided into two main types: extensive seagrass meadows along the mainland, and patches of seagrasses inter-mixed with corals around islands (Ethirmannasingam, 1996 in Nelson, 1999a). Much of the muddy coast of Kampot Province supports seagrass beds, including extensive patchy beds near the river mouth at Kampot town and very large beds east of Koh Tunsay (Figure 3). Inshore seagrass beds are mixed stands of several species, while offshore, *Enhalus acoroides* occurs in extensive beds. Small seagrass beds have been observed in waters adjacent to Koh Rong and Koh Rong Sanleom (Wetland International Asia-Pacific and Lower Mekong Basin Programme, 2001).



**Figure 3. Map of seagrass distribution in Cambodia (Fia, 2004b).**

A survey conducted by Fishery Department officials in 2004 using GPS found that the total area of seagrass in Cambodia's coastal waters is 32,492 ha (FiA, 2004b). The seagrass area at Kampot covers 25,240 ha, and can be divided into three meadows. The first, extending from Prek Trapeang Ampil to Prek Kdat, has an area of 1,795 ha; the

second, extending from Prek Kdat to Prek Koh Torch covers 380 ha; and the third, 23,065 ha, starts at Prek Koh Torch and extends to Kep Town.

Seagrass play an important role for marine animals, including dugongs and green turtles, and provide habitat for many commercially important fish and crustacean species. They also maintain water quality by absorbing nutrients and stabilising sediments (Short *et al.*, 2001). Based on recent taxonomic surveys 10 seagrass species have been identified in the transboundary waters, including *Enhalus acoroides*, *Halophila decipiens*, *Halophila minor*, *Halophila ovalis*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Halophila pinifolia*, *Halodule uninervis*, *Syringodium isoetifolium* (FiA, 2007).

The exact number of seagrass associated species is unknown. Many economically species are associated with seagrass habitat and these areas for spawning, nursing ground as well as feeding. The shallow water seagrass beds occur on soft sediments. In these areas shrimp and demersal fish species, squid and cuttlefish, slipper lobster and mantis shrimps are found in soft bottom.

A review conducted by the Fisheries Component of the South China Sea Project identified 520 marine fish species classified in 202 genera and 97 families, with a standing stock estimate of 50,000 metric tonnes.

Many groups of marine living resources are under threat from human activities and natural phenomena and some species of fish, reptiles, marine mammals and corals are becoming endangered. Based on a review conducted for the Fisheries component of South China Sea Project, there are 12 species of marine mammals and 5 species of sea turtle; in Cambodia marine water (19). According to Tana (1995), there are three species of marine mammals in Cambodia coastline that are accidentally caught by gill nets and shrimp trawlers in the seagrass beds of Sihanoukville and Kampot bay, i.e. Irrawady dolphin (*Orcaella brevirostris*), Spinner dolphin (*Stenella longirostris*) and dugong (*Dugong dugon*).

More species of marine mammals are assumed to be vulnerable, endangered or critically endangered, either locally or globally and therefore conservation of these species is considered to be a high priority by the Department of Fisheries.

Causal chain analyses have been conducted to identify the causes of the five key threats to seagrass in Cambodia. These key threats include:

- sedimentation,
- unsustainable fishing practices,
- seaweed farming on seagrass beds,
- new settlements near seagrass areas, and
- unsustainable development in coastal areas.

## 2.4 COASTAL WETLANDS

These coastal wetlands are located on the coastal plain and are linked to the sea. The water component seasonally changes into brackish during the rainy season and saline during the dry season. The main vegetation types in these wetlands are mangroves and rear mangroves, which support reptiles, small mammals, and aquatic species. There are coastal wetland sites including:

- Stung Metoek Mangrove and Creek System,
- Prek Piphot Creek System and Swamp Mangroves,
- Kampong Trach Marshes and Salt Ponds,
- Prek Kampong Bay, Creek System, Mangrove and Marshes,
- Prek Toek Sap Creek System, Mangrove and Marshes,
- Chhok Veal Rinh,
- Koh Kapik Ramsar Site,
- Prek Kampong Som Mangrove, Swamp and Marshes.

The diverse Cambodian coastline possesses sandy, muddy, and rocky shores associated with seagrass flats and, in place, coral reefs. Inshore reefs appear to be less well developed than those further offshore in the vicinity of islands such as Koh Tang, probably because, inshore, sediment freshwater discharges from rivers inhibits coral development. Dugong and sea turtles, as well as dolphins, are located in the area but there is no information on their status. These species are becoming increasingly rare in other parts of the Gulf.

The major estuarine areas in Cambodia occur in the region around Koh Kong province and near Kampot province. The Stung Koh Pao and Stung Kep estuaries are recognized as wetlands of international significance. Both rivers originate in the Cardamom range and discharge their flow into Koh Kong Bay. The Bay is protected from southwest storms by the large island of Koh Kong.

Mudflats occurs when sediment settles out of the water due to a decrease in current and/or wave action. Mudflats are often associated with estuaries, but also occur in low-energy, coastal environments, such as in large bays or in the lees of islands. They are commonly continuous with mangrove areas. Mudflats can be very productive system as a result of nutrients recycling through the sediments. Typically there are high diversities of invertebrates living in and on the mud, and as a result, the mudflats provide rich feeding grounds for vertebrates such as fish and water birds.

Wetlands provide nutrient-rich and sheltered habitats for fish (breeding, spawning and nursery areas or habitats for adults) and therefore they play a central role in the supply of animal protein in Cambodia. Agriculture is supported by water from wetlands. Wetland water may be stored for use in the dry season or withdrawn for irrigation purposes. Other economic activities utilizing wetland resources include aquaculture, tourism, inland transport, and energy (hydro electricity).

The main threats to coastal wetlands in Cambodia are sedimentation and water pollution arising from industrial and domestic wastes, agricultural run-off, mining activities, over- and illegal fishing practices, mangrove clearance for shrimp farming and charcoal production.

### **3. Coastal Ecosystems Connecting to the Exploited Resources and Uses**

#### **3.1 MPAs/FISHERIES REFUGIA**

The relationship between MPAs or fish sanctuaries and fisheries has been taken into consideration by many scientists. Russ (2000) listed seven expectations from a strictly protected areas (PA), or from strictly protected zones within multiple use MPAs - no fishing mortality, high density and high biodiversity of aquatic species, larger size and higher ages of fish, higher biomass of fish, higher reproductive output per unit area, adult fish fluxing out (the spill over effect), and egg and larval dispersal (recruitment effect).

Where MPAs are under full protection, fishing mortality is eliminated allowing greater density and biomass of fish and allowing the average age and size of fish to increase. In areas that are heavily fished and are adjacent to Fish Sanctuaries or MPAs fish can migrate out (spill over effects and recruitment effect) of MPAs or sanctuaries to support fisheries in neighbouring areas.

Marine conservation through MPAs is a new concept to Cambodia despite the long history of terrestrial protected areas. Totally, Cambodia has 23 Protected Areas, four of which are marine protected areas (MPAs). Most of the 4 MPAs have been designated within the protected areas system under the Royal Decree Creation and Designation of Protected Areas' signed on November 1, 1993 by King Sihanouk in order to conserve natural coastal natural resources including mangroves and marine fisheries (Table 1). These protected areas include the Peam Krasop Wildlife Sanctuary (31,022 ha), and Batum Sakor National Park (171,250 ha). In addition, Koh Kapik (12,000 ha) and associate islets situated within Peam Krasop Wildlife Sanctuary, have been nominated as a wetland of international importance under the Ramsar Convention (AWB 1994). Dong Peng (27,700 ha) is another marine protected area located in Kong Kong Province and designed to be multiple use area, which includes wetland sites of international importance including Prek Chrey, Prek Thnung, and Prek Kampong Som.

**Table 1 Marine Protected Areas in the Coastal Zone of Cambodia.**

Name	Area (ha)	Location
<b>National Parks</b>		
Ream (Preah Sihanouk)	15,000	Sihanoukville
Botum-Sakor	171,250	Koh Kong
<b>Wildlife Sanctuaries</b>		
Peam Krasaop	23,750	Koh Kong
<b>Multiple Use Area</b>		
Dong Peng	27,700	Koh Kong

*Royal Decree, (1993).*

Ream National Park has recently been extended to include marine areas and renamed as Preah Sihanouk National Park in March 1995. The 23,750-ha Peam Krasop Wildlife Sanctuary (declared in 1993) includes a narrow strip of coastal waters, tidal flat, mangrove, Melaleuca forest and watershed areas. Preah Sihanouk (Ream) National Park and Koh Kapik were found to meet the international requirement to be included as regionally Important Bird Areas (IBAs).

All coastal and marine protected areas need to undergo detailed resources and ecological survey to configure their boundaries, and to include fully participatory community involvement in finalising these boundaries.

Apart from functioning as MPAs, Cambodia coastal critical habitats such as mangroves, coral reefs, seagrass and wetlands contributed to sustain fisheries production in the South China Sea and Gulf of Thailand (UNEP, 2007). Their habitats are known to act as refuges for most economically important fish species during critical stages of their life cycles including as larvae, for spawning, and for feeding. Fisheries refugia in the context of the UNEP/GEF South China Sea Project are defined as “spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use” (UNEP, 2007).

The *fisheries refugia* concept as developed by the Regional Working Group on Fisheries (RWG-F) of the UNEP/GEF Project entitled “Reversing environmental degradation trends in the South China Sea and Gulf of Thailand” is based on the use of area-based or zoning approaches to fisheries management aimed at maintaining the habitats upon which fish stocks depend, as well as minimising the effects of fishing on stocks of important species in areas and at times critical to their life cycle. The *fisheries refugia* concept promotes the sustainable use of fish stocks and their habitats, and the use of criteria for



the selection of sites for fisheries and habitat management interventions that focus on fish life-cycle and critical habitat linkages.

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*“Spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use”* (UNEP, 2007)

Fisheries refugia should:

- NOT be “no take zones”,
- Have the objective of sustainable use for the benefit of present and future generations,
- Provide for some areas within refugia to be permanently closed due to their critical importance [essential contribution] to the life cycle of a species or group of species,
- Focus on areas of critical importance in the life cycle of fished species, including spawning, and nursery grounds, or areas of habitat required for the maintenance of brood stock,
- Have different characteristics according to their purposes and the species or species groups for which they are established and within which different management measures will apply,
- Have management plans.

Management measures that may be applied within fisheries refugia may be drawn from the following [non-exhaustive] list:

- Exclusion of a fishing method (e.g. light luring, purse seine fishing),
- Restricted gears (e.g. mesh size),
- Prohibited gears (e.g. push nets, demersal trawls),
- Vessel size/engine capacity,
- Seasonal closures during critical periods,
- Seasonal restrictions (e.g. use of specific gear that may trap larvae),
- Limited access and use of rights-based approaches in small-scale fisheries.

### 3.2 FISHERIES, FISHING, AND MARICULTURE/COMMUNITY FISHERIES

Cambodia's marine capture fisheries are characterised by a multitude of species and the use of a range of fishing gears. With reference to FiA fisheries statistics (Table 2) indicates total marine capture fisheries has increase noticeably since 33,100 tonnes in 1993 to 65,000 tonnes in 2007.

**Table 2. Statistics of total Marine Catches in Cambodia (FiA, 2008).**

Year	Marine Capture Fisheries (tonne)	Shrimp Culture Production (tonne)	Seaweed Culture Production (tonne)
1993	33,100	500	
1994	30,000	560	
1995	30,500	731	
1996	31,200	600	
1997	29,800	266	
1998	32,200	197	
1999	38,100	62	
2000	36,000	20	
2001	42,000	143	3,500
2002	45,850	53	3,650
2003	54,750	90	7,800
2004	55,800	75	16,840
2005	60,000	110	18,000
2006	60,500	40	6,810
2007	63,500	70	

Mariculture has been also occurred along the coastline of Cambodia with seaweed farming and semi-intensive shrimp farming. Shrimp farming has been extensively conducted in Koh Kong province while enormous areas of mangroves have been cleared, then the farming activity has been dropped dramatically due to problem of acid sulphite soil and most shrimp farms were destroyed by such water pollution from the industry. Seaweed farming occurred on the seagrass meadows of Prek Ampil and Prek Kdat in

Kampot Province, however, the activities seemed to be reduced due to the fact that seaweed did not grow well. Both central and local government should clearly identify the impact of seaweed farming on seagrass beds.

The aquaculture of shrimp was introduced to Cambodia in 1993, however, this business collapsed in 1998, when only 197 tonnes of shrimp were produced and the figure has been dropped remarkably to only 70 tonnes in 2007. At present, all shrimp farms are nearly closed. Similarly, the culture of seaweed began in 2001 with the production of 3,500 tonnes. The figure has reached the peak of 18,000 tonnes in 2005; then collapsed in 2007. All farmers stopped seaweed farming in 2007 due to unknown disease that destroyed the whole seaweed industry. Currently, the company is searching a new species of seaweed that can be adopted with such environment.

Marine capture fisheries in Cambodia are divided into two categories, namely middle-scale fisheries and small-scale or artisanal fisheries. Middle-scale fisheries are those utilising highly efficient fishing gear and vessels with capacity to fish both offshore and inshore using a variety of gear types, with the exception of trawling in inshore waters.

Small-scale fisheries are those utilising traditional and/or passive fishing gear, non-power boats, or power boats with a capacity lower than 5 HP. Generally, these fisheries operate in inshore waters up to 3 nautical miles from the shore and small-scale fishers are not required to pay tax. The Coastal Zone Management Project ranked major species by specific fishing gears (Annex 4).

### **Marine Fishes:**

A study identified 435 marine fish species from 202 genera and 97 families in Cambodian waters. It is estimated that approximately 70% of the annual catch is dominated by *Atule mate* (yellowtail scad), *Selar crumennophthalmus* (bigeye scad), *Decapterus maruadsi* (round scad) and other species of Leiognathidae (pony fishes), Scombridae (tunas, mackerels) and Lutjanids (snappers). Elasmobranchiata (rays and sharks) represented 5.6% of the total catch. A small component of the total catch in terms of volume included other unidentified fish species and invertebrates. Large fish including Lutjanidae (snappers), Terapontidae (grunters), *Scomberomorus* spp. (king mackerels), *Thunnus* spp. (tunas), Carangidae (black pomfrets), *Platax pinnatus*, and *Rachycentron canadum* (trevally) were abundant in catches from shallow water areas (20-30 m depth). Mackerels and Clupeidae dominated catches in the northeast part, and Leiognathidae dominated in the southeast part of the Gulf. Stingray occurred throughout the Gulf during the research period (Tana, 1996).

There were 33 fish species that were common in the catches, although only 5 species were very abundant, namely *Megalaspis cordyla* (hardtall scads), *Scomberomorus commersoni* (Spanish mackerel), *Rastrelliger brachysoma* (short-bodied mackerel), *Rastrelliger kanagurta* (Indian mackerel) and *Atule mate* (yellowtail scad). In Khmer, the above species are called *trey kantuy roeung*, *trey sampan*, *trey camong* or *phlathu*, *trey palang* and *trey kalang*, respectively (Tana 1997). According to Tana (1999), another 39

fish species are present in Cambodian waters. Most of these fishes are coral and rocky reef dwelling species, such as groupers, parrot fishes and scorpion fishes. The study of Jensen and Try (2002) identified an additional 17 fish species. A further 80 species have been collected although are yet to have been identified.

### **Crustaceans**

According to Tana (1997) and Jensen and Try (2002), about 50 species of crustaceans are present in Cambodian waters. Of these, 10 species are shrimps, *Penaeus canaliculatus*, *P. semisulcatus*, *P. merguensis*, *P. latisulcatus*, *P. monodon*, *P. japonicus*, *Metapenaeus affinis*, *M. spinulatus*, *Parapenaeopsis sculptilis*, *Parapenaeopsis* sp., 1 stomatopod, *Miyakea neap*, and one slipper lobster, *Thenus orientalis*. Approximately 30 species of crabs are present and annex 2 contains a list of these species. There are 4 species of barnacles, *Lepas* sp., *Tetraclita squamosa*, and 2 unidentified, and several species of hermit crabs.

### **Molluscs**

The “Survey of Coastal Marine Living Resources” and “Tropical Marine Mollusc Programme (TMMP)” identified only 170 species; in which about 100 were gastropods, 50 bivalves, and 8 cephalopods (Jensen and Try, 2002).

### **Marine endangered species**

Four species of marine turtles have been reportedly seen in the country’s waters in the past. These include the Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*), Olive Ridley (*Lepidochelys olivacea*), and Leatherback (*Dermochelys coriacea*) turtles. Fishers have reportedly sighted crocodiles probably Saltwater Crocodiles (*Crocodylus porosus*) in Koh Kong estuaries and Prek Teuk Sap.

The endangered dugong (*Dugong dugon*) was reportedly abundant in parts of the coast especially near Pre Ksach in Koh Kong District, and in Kampot Bay. The more endangered Irrawady Dolphins (*Orcaella brevirostris*) have been reported in many places within the Cambodian coastal zone. Other cetacean species known to occur in the country’s coastal zone are Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Common Dolphin (*Delphinus delphis*), Bottle-nosed Dolphin (*Tursiops truncatus*), Spinner Dolphin (*Stenela logirostris*), and Finless Porpoise (*Neophocaena phocaenoides*). The list of endangered species is attached as in Annex 6.

One estimate is that about 40% of the coastal population are full-time fishers and 30% are part-time fishers. Another estimate is that only 10% of the coastal population is involved in fisheries, including processing and marketing. The majority of fishers are operating on the small-scale or subsistence level. Moreover, the majority of fisher households also have small farming plots.

In recent years, there has been a significant migration of poor people from inland rural areas to the coast. These people mostly engage in fisheries because it requires little

investment and is open access, although they typically have no experience in marine fisheries.

Information regarding the socioeconomic dependence of Cambodians on marine fisheries is scarce. In terms of income, people in the coastal provinces have average per capita incomes slightly below the national average of US\$21 per month and somewhat above the average for the rural population (Ministry of Planning, 1999). Most households obtain income from more than one occupation, and there are no estimates of the number of households with fishing as their main source of income.

Threats to marine fisheries resources in Cambodia include:

- **Stock depletion** - Many indicators are available to identify the problem of overexploitation and threats to marine fisheries resources.
- **Habitat destruction** - Rapid exploitation of mangrove forests for firewood and charcoal took place during the war after 1979. Trawl fishing, push nets, and grouper fishing activities threaten coral reef and seagrass habitats in Cambodia.
- **Increases in fishing effort** -These include increases in fishing effort, decreases in the annual catch, changes in the species composition of catch, and increases in the percentage of low-value fishes in the catch
- **Illegal fishing** - Illegal fishing in Cambodia consists of foreign vessels fishing in Cambodian waters without a licence and/or using illegal fishing gear. In addition, the use of illegal fishing gear by Cambodian fishers is becoming more common.
- **Effects of trawling** - Trawling is a very destructive fishing method in Cambodia. Trawl nets disrupt benthic communities, especially in areas where the intensity of trawling is high.
- **By-catch** -A large proportion of fish caught in Cambodia can be categorised as by-catch or low-value fish.
- **Ghost fishing**-Fishing nets lost at sea often continue to catch fish.

### 3.3 FISHERIES PROCESSING AND TRADING

Informal surveys of market prices for marine fishes, crustaceans and molluscs have provided values in the range of 1,000-28,000 Riels per kg for fish species, and 500-50,000 Riels per kg for invertebrates (3,800 Riels = 1 US\$) (Annex 5). These prices only cover species used for human consumption. Given that up to 60% of the catch is low-value fish, and further assuming an average price for edible species of US\$1 per kg, the total value of the annual marine catch is estimated at US\$15 to 30 million. This value does not include either the returns for fisheries products landed outside the country (illegally) or the value to the subsistence or artisanal sector.

Only a few species of fish, molluscs, and crustaceans have high value in the domestic market. The domestic market for reef fish, especially groupers, is very strong. Reef fish are also an important export commodity. As such, reef fish catches have grown rapidly in Cambodia. Price for reef fish in Cambodia's domestic markets is responsive to market conditions in Hong Kong, Singapore, Thailand, Taiwan, and Japan, as these countries represent the major export markets for Cambodian seafood.

Field studies conducted in Sihanoukville municipality by Jensen & Try (2002) found over 21 fish species, 12 bivalve species, 7 gastropod species, 10 crab species, and 1 horseshoe crab species with high value in the domestic market (Annex 5). Among the molluscs and crustaceans, cephalopods, short-neck clam, shrimp, mantis shrimp, mud crab and swimming crab are the most valuable products domestically, as local price is responsive to price for these products in international markets. International demand and price for these products continues to grow.

### **3.4 COASTAL DEVELOPMENT, PORTS AND INDUSTRIES**

At present time, coastal development, ports and industries are only a high threat to a relatively small percentage of coastal resources and ecosystem in Cambodia. However, as the amount of development along the coastline increases, the percentage of natural resources and ecosystem are at risk from this potential threat will also increase if strict environmental impact assessments and mitigation are not carried out.

### **3.5 TOURISM DEVELOPMENT**

Tourism related to natural resources seems to be poorly developed in terms of infrastructure and activities. Cambodia has very limited resources and infrastructure to encourage this tourism sector. However, compared to the last few years, more and more tourists are coming to coastal areas to see marine nature. For instance, currently more foreign tourists have come to Sihanoukville to see coral reefs in Koh Thas, Koh Rong and Rong Salem, and even Koh Tang. There were four main private SCUBA diving centres in Sihanoukville, namely, ECO-SEA, Chez Claude, SCUBA NATION, and the Dive Shop, which each centre brought about 30-40 divers per month. It is expected the number of divers will increase in the near future when infrastructure and equipment are put in place. In addition, the numbers of tourists visited Kampot have increased dramatically from 92,970 local tourists and 1,261 foreigners in 2001 to 284,228 local tourists and 5,176 foreign tourists in 2005, respectively (Kampot Department of Planning, 2006). Both local and foreign tourists started to visit Koh Kong Province since the road to the province has been renovated.

Apart from fisheries and tourism, coastal resources and ecosystems in Cambodia may play another very important role in scientific research for medical purposes and socio-economic use. However, in Cambodia very limited scientific research has been carried out for medicines or other purposes. In terms of socio-economic use however, most local people who live nearby the reef areas are making their living from the reefs. Most of them

are fishers, but some are fishing gear and boat builders gaining indirect benefits from the reef. Very few people make their living from tourism services such operators and guides.

### **3.6 TRANSBOUNDARY HABITATS, RESOURCES AND MANAGEMENT**

The transboundary waters between the Provinces of Kien Giang (Viet Nam) and Kampot (Cambodia) are located in the eastern portion of the Gulf of Thailand. The coastlines of the two provinces totals 295 km, including 95 km in Kampot Province and 200 km in Kien Giang Province. The transboundary waters cover all Phu Quoc archipelago and Pirate islands of Viet Nam and the coastal waters of Kampot province of Cambodia as defined in the map below (Annex 7).

In the framework of the UNEP GEF project entitled “*Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand*”, the transboundary demonstration site projects in Phu Quoc (Kien Giang, Viet Nam) and Prek Ampil (Kampot, Cambodia) have been under execution since 2005. An outstanding outcome of these demonstration site activities is the establishment of a mechanism for long-term, joint management in the transboundary waters. The management teams of both demonstration sites, through joint meetings with the participation of provincial leaders, have agreed to develop policy and framework for cooperation in the management of coastal ecosystems and natural resources between the two provinces.

The policy and framework are developed on the principles of cooperation, equality and joint development and are intended to reflect the overall goal of the UNEP/GEF project “*Reversing Environmental Degradation Trends in South China Sea and Thailand Gulf*”, namely “*to create an environment at the regional level, in which collaboration and partnership in addressing environmental problems of the South China Sea, between all stakeholders, and at all levels is fostered and encouraged; and to enhance the capacity of the participating governments to integrate environmental considerations into national development planning*”. The Memorandum of Agreement between the People’s Committee of Kien Giang Province (Viet Nam) and Governor of Kampot Province (Cambodia) was signed in order to implement the policy and framework for cooperation in the management of coastal ecosystems and natural resources between two provinces (Memorandum of Agreement, 2008).

Also, Peam Krasop is dominated by small alluvial islands immediately off the mainland of Koh Kong Province many of which have been formed by the deposition of mud and sand eroded from the sandstone catchments of the two main rivers, Peam Krasop estuary called Prek Peam Krasop (in Peam Krasop commune) and Stung Kep estuary (in Koh Kapik commune).

The mangroves in the RAMSAR site and wildlife Sanctuary are bisected by, many creeks. Within the area; 5,235 ha (38.85 %) consists of mangrove forest; 47 ha (0.35 %) is agricultural land; 725 ha (5.40 %) is evergreen disturbed forest; 411 ha (3.1 %) is evergreen mosaic area; 108 ha (1%) is grassland; and the open water surfaces total 6,957 ha (51.60 %) (MoU, 2006). Due to the site’s diverse geomorphology and habitats it is

considered to be a major important spawning and nursery ground for many fish, crustaceans, and molluscs because the area is rich in zooplankton biomass.

Peam Krasop Demonstration Site involves joint management of wetland and mangrove habitats and direct cooperation with the Mangrove Demonstration site in Trat Province Thailand through the joint declaration Cambodia-Thailand; exchange of knowledge and skills, data and information; and assistance to each other in addressing illegal activities (MoU, 2006). The provinces of Koh Kong (Cambodia) and Trat (Thailand) managed to discuss and signed the similar cooperative policy framework to Kampot and Kien Giang Provinces in order to joint manage and conserve transboundary coastal ecosystems and resources. The map of the Peam Krasop transboundary demonstration site with Trat is attached with as in Annex 8.

#### **4. Policy and Management Legislations**

##### **4.1 GOVERNMENT POLICY**

Broad guidelines for environmental management were outlined in the First 5-Year Socio-Economic Development Plan (1996 to 2000), indicates that coastal zone planning and local zoning and development plans should be developed for the coastal region.

National policies with respect to CZM include the fisheries policy, or more specifically, the management of the marine fisheries in the country. The main points in this policy include:

- The creation of job opportunities and improved livelihoods for local communities.
- Equity in access to, and distribution of benefits within the fisheries sector.
- The encouragement of integration of fisheries management within overall rural development in fishing communities.
- The extension of institutional responsibilities of fisheries management to the communities.
- The enhancement of protection and sustainable use of the fisheries resources of Cambodia.

The goals of the government with respect to coastal zone management include:

- The development of a preliminary coastal zone master plan with delineation and zoning of critical sections of the coast.
- The development of local area management plans for areas of intensified activity.
- Definition of the institutional mechanisms for implementation of the plans.



- Provision of local infrastructure and services. Regulatory surveillance by MoE, development of local institutions for the provision and maintenance of infrastructure, and compliance with environmental criteria and surveillance.

Of critical importance to CZM on environmental policy:

- The implementation of all national policy and programmes relating to the environment.
- The protection of the environment from all economic development.
- Conservation through the creation of protected areas.
- The development of laws and sub-decrees with respect to environmental management, conservation and protection.
- The strengthening of existing laws and sub decrees with respect to environmental management, conservation and protection.
- The preparation and implementation of national and regional environmental action plans through co-coordinating functions.
- Ensuring sustainable development.

#### **4.2 MANAGEMENT LEGISLATIONS**

In order to manage and control the use of Cambodia's natural resources, specifically aquatic resources, the FiA instituted Cambodia's Fisheries Law (in Khmer called Kret Chhbab Lek 33 Kra Chor) for the Management and Administration of Fisheries Resources in Cambodia. The FiA administered this law, which aimed to conserve and regulate the exploitation of Cambodia's fishery resources. It represents a modified and upgraded version of Cambodia's fisheries law of 1965. The new Fisheries Policy and Fisheries Law have been formally adopted by the government of Cambodia on 30<sup>th</sup> March 2006.

With regarding to marine resource management and conservation, several sub-decrees, proclamations, and other regulations have been adopted and drafted, which were:

- Fisheries Law adopted on 30th March 2006;
- The Royal Decree on the Establishment of Community Fisheries adopted on May 29<sup>th</sup> 2005;
- The Sub-decree on Management of Community Fisheries adopted on 20<sup>th</sup> March 2007;
- Prakas on Guideline for Community Fisheries 13<sup>th</sup> July 2007.

Apart from fisheries resources management and conservation, major environmental legislations:

- Law on Environmental Protection and Natural Resource Management (1996)
- Law on Protection of Cultural and National Heritage
- Prakas No. 1033 on the Protection of Natural Areas (3 June 1994).

There are overlaps of functions and responsibilities among institutions since the fact that legislations in each institution were not clearly defined. During developing legislation, each institution tries to cover as many areas and resources as possible for the sake of its own benefits.

## **5. Institutional Framework**

There are a number of government bodies in Cambodia with the responsibility for coastal habitats and resources management. The main ministries include the Ministry of Agriculture, Fisheries and Forestry (MAFF), the Ministry of Industry, Mines and Energy (MIME), the Ministry of Tourism (MT), the Ministry of Public Works and Transport (MPWT), the Ministry of Rural Development (MRD), the Ministry of Women's Affairs, the Ministry of Planning, and the Ministry of Environment. Additionally, there are a number of existing ministerial committees with responsibility for certain key issues. The two of significance in the coastal zone are the National Committee for Land Management, Urbanisation and Construction and the Committee on Land Tenure. Also of relevance to the coastal zone is the Cambodian Development Council, which is the body responsible for the management of foreign investments, including both private business and donor investments.

A National Steering Committee chaired by the Minister of Environment, with representatives from other institutions and ministries with a stake in the coastal zone, oversees Coastal Zone Management in Cambodia.

National Steering Committee is included from relevant concerning institutions:

Minister	Ministry of Environment (Chair)
Under-Secretary of State	Ministry of Agriculture, Fisheries and Forestry
Under-Secretary of State	Ministry of Tourism
Under-Secretary of State	Ministry of Industry, Mines and Energy
Governor	Kampot Province
Governor	Kep Municipality
Governor	Sihanoukville Municipality

Governor	Koh Kong Province
Representative	Cambodian Development Council
Representative	Ministry of Public Works and Transport
Representative	Ministry of Rural Development
Chief	Coastal Co-ordination Unit
Representatives	NGO and other donor projects in the Coastal Zone

Day-to-day management of coastal resource and their use is the responsibility of the Ministry of Agriculture, Forestry and Fisheries, particularly the Fisheries Administration (Nelson, 1999). There are fisheries personnel at district and provincial levels responsible for patrolling and managing commercial and medium scale fisheries. They also monitor and protect critical fisheries habitats such as mangroves, seagrasses, and coral reefs.

The mandate of the Ministry of Environment overlaps with that of the Ministry of Agriculture, Forestry and Fisheries to a certain extent. The Ministry of Environment is responsible for the management of protected areas and for overseeing environmental protection. This includes protection of coral reefs, seagrasses, and mangroves, particularly when they occur in a protected area. This overlap does not seem to be problematic for managers on the ground, but requires legal clarification.

The provincial governors are highly influential in provincial areas. They control the budgets of provincial sectoral departments. It is very unclear how decision-making powers are divided between provincial and national decision-makers. It may depend on the personal power of the provincial governor compared with officials at the central government level. A draft Environmental Impact Assessment (EIA) Sub-decree is currently before the National Assembly (Nelson, 1999). This law will require all coastal developments to pass an EIA administered by the Ministry of Environment.

There is currently no mechanism for coordinating the operational activities of the different ministries in the coastal zone. In the future, coastal management may be managed through the National Steering Committee or through the Coastal Coordinating Unit of the Ministry of Environment, which is now trying to build its capacity through improvements to its facilities and equipment.

## **6. Collaboration of National and Provincial Institutions**

Natural resources, including marine living resources and ecosystems belong to the state; and the Fisheries Administration (FiA); under the Ministry of Agriculture, Forestry and Fisheries (MAFF); is the designated government institution responsible for managing and conserving these marine resources in the marine and coastal water of the Kingdom of Cambodia. Marine resources are managed under the new fisheries law. Furthermore, an important legal document related to the activities of natural resource management and

conservation is the Declaration No. 1470 on the Organisation and Functioning of the FiA (MAFF, 1990).

Provincial Fisheries Cantonments, with full time staff, are day to day operating under the Fisheries Administration. There are also fisheries staff at district level under the Fisheries Administration, whose direct responsibility is to monitor and control commercial and subsistence fisheries, and protect marine resources and habitats (mangroves, seagrass and coral reefs) from illegal and destructive practices.

Apart from fisheries, the government has established environmental institutions to protect environment and natural resources and reverse environmental degradation. These include the Ministry of Environment (MoE) at national level, and the Provincial Department of Environments (DoEs) at provincial level. The DoEs operate under direct supervision of the MoE and the Provincial Governors. The responsibilities of the DoEs include the conservation of natural resources; oversight of environmental protection measures; and the management and conservation of marine natural resources in Marine Protected Areas and National Parks.

A National Coastal Steering Committee has been established to oversee management and development of the natural resources and environment for the whole coastline of the Kingdom of Cambodia involving these two Key Ministries together with the Provincial Department of Tourism, the Royal Navy and Provincial level institutions from the three coastal municipalities/provinces.

Local fishers, local villagers, schoolchildren, seaweed farmers, and Buddhist monks; are very important partners in resource management and conservation, particular in relation to public awareness and education. Following the introduction of decentralisation of government management, and the initiation of community-based natural resource management, the government has recognised and supported local community organisations, including some coastal fisheries community organisations that are officially recognised and have responsibility for management and protection of the natural resources within their own defined areas.

Commercial fisheries owners, processors and fish transporters may also be considered stakeholders, even though they represent a small group in the population they are the influential people as they are comparatively wealthy. These people could potentially contribute to the conservation and management of the resources if they were aware, and understand the significant value of marine habitats and resources.

Currently, there are few large business and tourism activities in the area. However, the government proposes to develop tourist resorts along the coastline of Cambodia. There are more and more tourists visiting National Parks and beaches in all provinces. Therefore, in the near future, tourist operators and resource-related private sector should play very important role in the contribution to the sustainable use and management of coastal habitats and resources in Cambodia.

There are Non-Governmental organisations (NGOs) working with communities in Coastal provinces, including as DANIDA, APHEDA, JICA, and WCS. The role of NGOs is very important in supporting activities, and they will be encouraged to participate in meetings and workshops for planning and developing strategy for management and conservation of resources at community level. These NGOs work closely with local communities in remote coastal areas. As they have experience in working with local communities, these NGOs could be able to provide information and or even expertise to the management authorities. They can contribute mostly on alternatively livelihood development (aquaculture, livestock cultivation, and vegetable farming) and participatory approach for managing resources.

## **7. Conclusion and Recommendations**

Coastal resources and ecosystems are very important by providing enormous goods and services to Cambodian people and national economy. There are various coastal resources and ecosystems in the Cambodian coastal waters and they are completely inter-connected with each other. Each of which depends on one another in order to balance in the marine ecosystems. When one component of either resource or ecosystem has been destroyed or removed, the whole ecosystem will be collapsed.

Until present time, some components of resources and ecosystems have been under threats from over-exploitation, illegal fishing, cutting mangrove forests, unsustainable farming practices, pollution, and coastal development. It is required a clear understanding of the problems and taking appropriately collective actions, then these coastal habitats and resources can be preserved.

The government managed to establish policy, institutional framework and legislations for management and conservation coastal resources and ecosystems into sustainable manner and improving livelihoods of local people. However, there were outdated and conflicted implications among institutions and their legislations.

The implications are needed to be concisely and precisely identified and resolved in a coherent and synergetic way. Personal commitment and willingness of individuals, who are both responsible for management of these resources and ecosystems and using them, are indispensable for ensuring long term sustainability of resources for next generation.

## References

- Christensen, B., (1982).** Mangrove Resources: Their management and utilization for forestry fisheries and aquaculture near Khlung Chanthaburi Province Thailand. FAO Regional Office for Asia and the Far East, Bangkok. 62 p.
- CZM, (1999).** Environment Coastal Zone Management in Cambodia. Ministry of Environment, #48, PO Box 1504, Preah Sihanouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.
- DNCP, (2007).** National Report on Mangroves in Cambodia. Department of Nature Conservation and Protection. Ministry of Environment, #48, PO Box 1504, Preah Sihanouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.
- Ethirmanasingam, S. (1996).** Preliminary survey for Cambodian seagrass resources. Unpublished report to Wetlands International, Cambodia-Mekong Programme. 5pp.
- FiA, (2003).** Map of Coastal Zone in the Kingdom of Cambodia. Fisheries Administration, No. 186, Preah Norodom Blvd., Phnom Penh, Cambodia.
- FiA, (2004).** *National Report of Coral Reefs in Cambodia.* Fisheries Administration, No. 186, Preah Norodom Blvd., Phnom Penh, Cambodia.
- FiA, (2004b).** *National Report of Seagrass in Cambodia.* Fisheries Administration, No. 186, Preah Norodom Blvd., Phnom Penh, Cambodia.
- FiA, (2007).** Socio-economic, Resource Use and Value of Seagrass Bed in Kampot. Fisheries Administration, PO Box 582, Norodom Blvd., Phnom Penh.
- FiA, (2008).** Statistics of Cambodian Fisheries in 2007. . Fisheries Administration, No. 186, Preah Norodom Blvd., Phnom Penh, Cambodia.
- IUCN, (2003).** IUCN Red List of Threatened Species in 2003. [www.redlist.org/](http://www.redlist.org/) accessed on 29 January 2004).
- Jensen, K. R. and Try. I. (2002).** Report on Marine Living Resources of Cambodia. Preah Norodom Blvd., Phnom Penh, Cambodia.
- Kampot Department of Planning (2006).** *Five-Year Provincial Strategic Development Plan: 2006-2010.* Kampot Department of Planning, Kampot Province.
- MAFF (1990).** The Declaration N. 1470 on the Organization and Implementation of the Fisheries Administration. Fisheries Administration. No. 186, PO Box 582, Preah Norodom Blvd., Phnom Penh, Cambodia
- Memorandum of Agreement (2008).** Memorandum of Agreement between the Provincial People's Committee of Kien Giang Province (S.R. Viet Nam) and the Governor of Kampot Province (Kingdom of Cambodia). Kampot Province.

**Ministry of Planning, (1999).** Report on the Cambodia Socio-Economic Survey 1999. Phnom Penh: Preah Monivong Blvd., Sangkat Boeung Keng Kang 1, Phnom Penh, Cambodia.

**MoE, (1995).** Environment Coastal Zone Management in Cambodia. Ministry of Environment, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**MoE, (1996).** Coastal Zone Management in Cambodia. In: Book 1: Current Conditions, Part 1b: Review of the Oceanography, Natural Resources and Fisheries of the Coastal Zone of Cambodia. Ministry of Environment, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**MoU, (2006).** Second Amendment to the original Memorandum of Understanding, signed on 30th November 2004, between the United Nations Environment Programme (UNEP) and the Department of Nature Conservation and Protection (DNCP). Department of Nature Conservation, Ministry of Environment, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**National Institute of Statistics, (1998).** General Population Census of Cambodia in 1998. Ministry of Planning, Preah Monivong Blvd., Sangkat Boeung Keng Kang 1, Phnom Penh, Cambodia.

**Nelson, V., (1999a).** Draft Coastal Profile: Volume I & II: The Coastal Zone of Cambodia-Current status and Threats. MoE/DANIDA Coastal Zone Management Project. Ministry of Environment, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**Nelson, V., (1999b).** State of Coral Reefs in Cambodia. MoE/DANIDA Coastal Zone Management Project, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**Royal Decree (1993).** Royal Decree on the Creation and Designation of Protected Areas. Ministry of Environment, #48, PO Box 1504, Preah Siahnouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.

**Russ, G.R. (2000).** MB5310: Tropical Fisheries Biology. School of Marine Biology and Aquaculture. James Cook University. Townsville.

**Short, F. T., McKenzie, L.S., Coles, R. G. and Vidler, K. P. (2001).** Seagrass Net Manual for Scientific Monitoring of Seagrass Habitat (QDPI, QFS, Cairns). 56Pp.

**Tana, T.S. (1996).** Result from the scientific research on commercial fishery biology of the Cambodia Sea (1982-86). Report. Cambodia. Phnom Penh. 20pp.

**Tana, T.S. (1997).** Status of marine biodiversity of Cambodia. Phuket Marine Biological Centre Special Publication 17(1): 175-180.

**Tana, T.S. (1999).** Review on previous and present ichthyology works on marine fish of Cambodia. 29 pp.

**UNEP, (2007).** Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand. Report of the Second Joint Meeting between the Management Teams of Phu Quoc and Kampot Demonstration Sites. UNEP/GEF/SCS/PQ-KP.2/3.

**Wetland International Asia-Pacific and Lower Mekong Basin Programme, (2001).** Final Report on Coral Reef and Seagrass Surveys in Cambodia. Ministry of Environment, #48, PO Box 1504, Preah Sihanouk Blvd., Tonle Bassac, Chamkarmon, Phnom Penh, Cambodia.



## Annexes

### Annex 1. List of Mangrove Species along the Coast of Cambodia (CZM, 1999).

Scientific Name	Family	Khmer Name
<i>Acanthus ebracteatus</i>	Acanthaceae	Tracheak Kranh
<i>Acanthus illicifolius</i>	Acanthaceae	Tracheak Kranh Sleuk Veng
<i>Acrostichum aureum</i>	Pteridaceae	Proang
<i>Acrostichum speciosum</i>	Pteridaceae	Proang/Khmanh
<i>Aegialites rotundifolia</i>	Plumbaginaceae	Smair
<i>Aegialites corniculatum</i>	Myrsinaceae	Krachok Day Neang
<i>Amoora cucullata</i>	Meliaceae	Kbanh/ Mouy Roy Sratop
<i>Avicennia alba</i>	Verbenaceae	Kbanh Sor/Smarn
<i>Avicennia marina</i>	Avicenniaceae	Sporng
<i>Avicennia officinalis</i>	Avicenniaceae	Kbang Khmao/ sporng
<i>Barringtonia racemosa</i>	Lecythidaceae	Doeum Tracheak Preush
<i>Bruguiera cylindrical</i>	Rhizophoraceae	Basak/Amlann
<i>Bruguiera gymnorrhiza</i>	Rhizophoraceae	Basak Kraham
<i>Bruguiera sexangula</i>	Rhizophoraceae	Basak Sor
<i>Caesalpinia crista</i>	Leguminosae	
<i>Calotropis sp.?</i>	Asclepiaceae	
<i>Cerbera odollam</i>	Apocynaceae	Deum Chheung Tea/Pich Pil/Chhum Pou Prey
<i>Ceriops decandra</i>	Rhizophoraceae	Smair Sor
<i>Ceriops tagal</i>	Rhizophoraceae	Smair Kraham
<i>Clerodendrum inerme</i>	Verbenaceae	Deum Chheong Poush
<i>Dernis trifoliata</i>	Leguminosae	
<i>Excoecaria agallocha</i>	Euphorbiaceae	Ta Thmar/ Ka Toum
<i>Finlaysonia maritime</i>	Aslepiaceae	

<i>Heritiera littoralis</i>	Sterculiaceae	Kan Kay/ Doeum Khlay
<i>Hibiscus tiliaceus</i>	Malvaceae	Doeum Bash, Bash Prey
<i>Intsia bijuga</i>	Leguminosae	KoKoh Tuk Pray/Kranhoung Tuk Pray
<i>Ipomoea pre-caprae</i>	Convolvulaceae	
<i>Kandelia candel</i>	Rhizophoraceae	Lam Ka Chea
<i>Lumnitzera littorea</i>	Combretaceae	Kranheub Phka Kraham
<i>Lumnitzera racemosa</i>	Combretaceae	Kranheub Phka Sor
<i>Nypa fruticans</i>	Palmae	Doeum Chark
<i>Pemphis acidulate</i>	Lythraceae	
<i>Phoenix paludosa</i>	Palmae	Masao Pueng
<i>Rhizophora apiculata</i>	Rhizophoraceae	Kong Kang slek toch
<i>Rhizophora lamarckii</i>	Rhizophoraceae	
<i>Rhizophora mucronata</i>	Rhizophoraceae	Kong Kang slek thom
<i>Rhizophora stylosa</i>	Rhizophoraceae	
<i>Scaevola toccata</i>	Goodeniaceae	
<i>Sonneratia caseolaris</i>	Sonneratiaceae	Ampou Kraham
<i>Sonneratia ovata</i>	Sonneratiaceae	Am Pea
<i>Terminalia catappa</i>	Combretaceae	
<i>Thespesia populnea</i>	Malvaceae	Por Tuk Pray
<i>Xylocarpus granatum</i>	Meliaceae	Tabun Sor
<i>Xylocarpus moluccensis</i>	Meliaceae	Tabun Khmao
<i>Xylocarpus rumphii</i>	Meliaceae	Ta Pann

**Annex 2 Different Types of Mangrove Values in Cambodia (DNCP, 2007)**

<b>Description</b>	<b>Gross value (US\$/year)</b>	<b>Net value (US\$/year)</b>	<b>Average value per user household (US\$/year)</b>
Firewood	125,133	112,062	25
Construction wood	23,659	23,659	18
Medicinal plants	10,788	10,788	11
Food	17,695	17,695	18
Roofing materials	13,397	13,397	84
<b>Sub-total, forest products</b>	<b>190,672</b>	<b>177,601</b>	
Crops	316,594	316,594	119
Livestock	203,750	227,702	143
<b>Sub-total, farming</b>	<b>520,344</b>	<b>544,296</b>	
<b>Total, forest products and farming</b>	<b>711,015</b>	<b>721,897</b>	



**Annex 3. Summary of Coral Reef Status in Cambodia (FiA, 2004)**

Location	Koh Kong	Koh Sdach	Koh Rong	Koh Takiev	Koh Tang	Prek Ampil	Koh Pouh
Net CR Area (ha)	72.5	529.0	468.0	292.5	439.0	953.0	52.5
Live Coral (%)	47.4	29.3	23.1	58.1	38.3	53.8	41.0
Dead Coral (%)	29.6	35.6	44.9	0.6	13.1	0.0	19.2
Other Fauna (%)	4.2	2.2	5.1	3.1	4.2	5.6	2.4
Algae (%)	1.6	17.5	0.6	0.0	0.6	0.6	10.1
Abiotic (%)	17.2	15.4	26.4	38.1	43.8	40.0	27.4
Butterfly Fish/100 m <sup>2</sup>	1.6	0.5	1.8	0.8	1.3	7.0	0.0
Sweetlips (Haemulidae) /100 m <sup>2</sup>	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanidae) /100 m <sup>2</sup>	0.13	0.10	6.50	1.75	0.42	0.00	0.00
Barramundi Cod ( <i>Cromileptes</i> ) /100 m <sup>2</sup>	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Grouper /100 m <sup>2</sup>	2.63	0.23	2.25	0.25	1.67	0.00	0.00
Humphead Wrasse/100 m <sup>2</sup>	0.00	0.47	0.00	0.00	0.33	0.00	0.00
Bumphead Parrotfish/100 m <sup>2</sup>	0.13	0.07	0.00	1.25	0.00	0.00	0.00
Other Parrotfish/100 m <sup>2</sup>	4.38	2.37	0.75	2.00	15.33	0.00	0.00
Moray Eel/100 m <sup>2</sup>	0.00	0.00	0.00	0.00	0.08	0.00	0.00
Banded coral shrimp ( <i>Stenopus hispidus</i> ) /100 m <sup>2</sup>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Diadema</i> urchins/100 m <sup>2</sup>	5.0	17.0	213.0	17.0	129.8	7.0	4.3
Pencil urchin ( <i>Heterocentrotus mammilatus</i> ) /100 m <sup>2</sup>	0.0	0.4	0.0	0.0	0.1	0.0	0.0
Sea cucumber (edible	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Location	Koh Kong	Koh Sdach	Koh Rong	Koh Takiev	Koh Tang	Prek Ampil	Koh Pouh
only) /100 m <sup>2</sup>							
Crown-of-thorns star ( <i>Acanthaster</i> )	0.0	0.1	0.8	0.0	0.0	0.0	0.0
Giant clam ( <i>Tridacna</i> ) /100 m <sup>2</sup>	2.0	1.2	0.3	0.0	0.3	0.0	0.0
Triton shell ( <i>Charonia tritonis</i> ) /100 m <sup>2</sup>	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Lobster/100 m <sup>2</sup>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coral damage Anchor*	0.9	0.2	0.0	0.0	1.4	0.0	0.3
Coral damage: Dynamite	1.8	0.7	0.0	0.0	2.4	0.0	1.3
Coral damage: Others	0.5	0.7	0.0	0.3	1.2	0.0	0.3
Trash: Fish nets	0.4	0.3	0.0	0.0	0.7	0.0	0.8
Trash: Others	0.0	0.3	0.0	0.0	0.2	0.0	0.3

\* From this row to the end explains about general reef condition: None=0, Low=1, Medium=2, High=3.

**Annex 4. Species targeted by different fishing gears in Cambodia**

Fishing gear		Target group	Secondary group
English Name	Khmer Name		
Mackerel gill net	Mong Trey Kamong	<i>Rastrelliger brachysoma</i>	<i>Rastrelliger kanagurta</i> , <i>Megalaspis cordyla</i> , <i>Thunnus tonggol</i>
Anchovy encircling seine	Uon Ka Koeum	<i>Stolephorus indicus</i>	
Shrimp gill net	Mong Bang Kear	<i>Penaeus merguensis</i>	
Fish gill net	Mong Trey	<i>Scomberomorus guttatus</i> , <i>Thannus thannus</i> , <i>Ariidae</i> <i>thalassinus</i> , <i>Eleuteronema</i> <i>tetradactylum</i> , <i>Liza</i> <i>argentea</i> , <i>Valamugil ceheli</i> , <i>Rastrelliger brachysoma</i> , <i>Rastrelliger kanagurta</i> , <i>Megalaspis cordyla</i> , <i>Formio</i> <i>niger</i> , <i>Lates calcarifer</i> , <i>Dasyatidae</i>	Serranidae, Lutjanidae, Nemipteridae, Sciaenidae, Drepanidae, Siganidae, Trichiuridae, Stromatoidae, Chirocentridae and Synodontidae.
Crab gill net	Mong Kdam	<i>Portunus</i> spp., <i>Scylla</i> <i>serrata</i>	
Crab trap	LopKdam	<i>Portunus</i> spp., <i>Scylla</i> <i>serrata</i>	
Squid trap	Lop Meuk	<i>Sepioteuthis lessoniana</i> , <i>Loligo</i> spp.	
Fish stake trap		Mixed fish species	
Horizontal longline	Santouch Ro Noug	Orectolobidae, Carcharinidae, <i>Dasyatidae</i> , Serranidae, Lutjanidae	
Push net	Chhep Yun	Mixed fish, <i>Metapenaeus</i> spp. <i>Sepiolidae</i> , <i>Octopus</i>	

Fishing gear		Target group	Secondary group
		spp.	
Shellfish dredge	Chhneang os khchorng	Arcidae, Veneridae	
Beach seine net	Uon Khow	Mixed fish, Sepiolidae, <i>Loligo</i> spp.	

(Source: MoE, 1996)



**Annex 5. Marine Fishery Resources of high value in the Psar Loeur Market, Sihanoukville, Cambodia in 2002 (Exchange Rate: 3850 Riel/USD) (Jensen and Try, 2002)**

**A. Fishes**

No.	Scientific name	Common name	Khmer name	Price (Riel/Kg)
1	<i>Cromileptes altivelis</i> (Valenciennes, 1828)	Humphack grouper	Trey Tok Ke Chrouk	24,000-28,000
2	<i>Pomacanthus annularis</i> (Bloch, 1787)	Bluering angelfish	Trey Me Ham Boa	23,000-25,000
3	<i>Epinephelus coioides</i> (Hamilton, 1822)	Orangespotted grouper	Trey Tok Ke Koa	22,000-28,000
4	<i>Pampus argenteus</i> (Euphrasen, 1788)	Silver pomfret	Trey Chab Sor	20,000-26,000
5	<i>Epinephelus faciatus</i> (Forsskål, 1775)	Blacktip grouper	Trey Tok Ke Kra horm	18,000-20,000
6	<i>Plectropomus oligocanthus</i> (Bleeker, 1854)	Highfin grouper	Trey Tok Ke Uch Kiev	18,000-25,000
7	<i>Epinephelus quoyanus</i> (Valenciennes, 1830)	Longfin grouper	Trey Tok Ke Para	11,000-16,000
8	<i>Diagramma pictum</i> (Thunberg, 1792)	Yellowdot sweetlips	Trey Ka chii	10,000-15,000
9	<i>Pampus chinensis</i> (Euphrasen, 1788)	Chinese silver pomfret	Trey Chab Khmao	4,000-6,000
10	<i>Atelomycterus marmoratus</i> (Bennett, 1830)	Coral catshark	Trey Chhlam Khla	2,000-3,000
11	<i>Chiloscyllium punctatum</i> Müller & Henle, 1838	Brown-banded catshark	Trey Chham Chhmar	2,000-3,000
12	<i>Scarus quoyi</i> Valenciennes, 1840	Quoy's parrotfish	Trey Sek Khiev	2,000-2,500
13	<i>Himantura imbricata</i> (Bloch & Schneider, 1801)	Scaly whipray	Trey Bor Bel	1,500-2,000

14	<i>Sargocentron rubrum</i> (Forsskål, 1775)	Redcoat	Trey Kror horm sraka tom	1,500- 2,000
15	<i>Strabozebrians cancellata</i> (McCulloch, 1916)	Harrowed Sole	Trey An Dat Chhek	1,500- 2,500
16	<i>Siganus virgatus</i> (Valenciennes,)	Doublebarred spinefoot	Trey Korn Taing Tmor	1,500- 2,200
17	<i>Cephalopholis formosa</i> (Shaw & Nodder, 1812)	Bluefined grouper	Trey Tok Ke Kroeum	1,300- 1,800
18	<i>Diploprion bifaciatum</i> Kuhl & Van Hasselt, 1828	Yellow emperor	Trey Sek Loeung	1,100- 1,500
19	<i>Siganus argenteus</i> (Quoy & Gaimard, 1825)	Silver spinefoot	Trey Korn Tang Pe	1,100- 1,500
20	<i>Siganus canaliculatus</i> (Park, 1797)	Whitespotted spinefoot	Trey Korn Tang Kro Ub	1,100- 1,500
21	<i>Siganus guttatus</i> (Bloch, 1727)	Goldenspotted spinefoot	Trey Korn Tang Phoeung	1,100- 1,500

## B. Bivalves

No.	Scientific name	Common name	Khmer name	Price (Riel/Kg)
1	<i>Anadara nodifera</i> (Martens, 1860)	Nodular ark	Kreng Chhiem	1,800- 3,000
2	<i>Amusium pleuronectes</i> (Linnaeus, 1758)	Asian moon scallop	Khchorng plate	1,800- 2,500
3	<i>Meretrix lyrata</i> (Sowerby, 1851)	Lyrate hard clam	Kreng Sor	1,500- 2,500
4	<i>Paphia undulata</i> (Born, 1778)	Undulate venus	Krum Kror Lar Hol	1,500- 2,500
5	<i>Scapharca inaequivalvis</i> (Bruquière, 1789)	Inequivalve ark	Kreng Chheim Meat Viech	1,500- 2,500
6	<i>Anadara binakayanensis</i>	Globose ark	Kreng Chheim Mor	1,500-

	(Faustino, 1932)		Mis	2,500
7	<i>Pteria penguin</i> (Röding, 1798)	Penguin wing oyster	Krum se	1,500-2,000
8	<i>Pinna bicolor</i> Gmelin, 1791	Bicolor pen shell	Krum Chorb Chik	1,500-2,000
9	<i>Meretrix lusoria</i> (Röding, 1798)	Poker-chip venus	Ngeiv Hol	1,000-2,000
10	<i>Perna viridis</i> (Linnaeus, 1758)	Green mussel	Krum Cham Puch Tea	500-1,000
11	<i>Donax cuneatus</i> Linnaeus, 1758	Cradle or cuneate donax	Ngeav Sor	500-1,500
12	<i>Polymesoda erosa</i> (Solander, 1786)	Common geloina	Ngeav Puok	500-1,500

### C. Gastropods

No.	Scientific name	Common name	Khmer name	Price (Riel/individual)
1	<i>Turbo marmoratus</i> Linnaeus, 1758	Green Turbo or Green snail	Khcho rng Prak	15,000-30,000
2	<i>Haliotis asinina</i> Linnaeus, 1758	Donkey's ear abalone	Khchorng Pav Hoeur Vieng	7,000-10,000
3	<i>Haliotis ovina</i> Gmelin, 1791	Oval abalone	Khchorng Pav Joeur Khey	7,000-10,000
4	<i>Turbo petholatus</i> Linnaeus, 1758	Tapestry turban	Khchorng Krour La Proum	3,000-6,000
5	<i>Strombus canarium</i> Linnaeus, 1758	Dog conch	Khchorng Choeung Muoy	2,000-4,000
6	<i>Babylonia areolata</i> (Link, 1807)	Maculated ivory whelk	Khchorng Pong Krouch	1,500-3,000

7	<i>Melo melo</i> (Lightfoot, 1786)	Indian volute	Khchorng Dong	1,500-3,000
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#### D. Marine and Horseshoe Crabs

No.	Scientific name	Common name	Khmer name	Price (Riel/Kg)
1	<i>Scylla serrata</i> (Forsskål, 1775)	Giant mud crab	Kdam Thor	45,000-50,000
2	<i>Charybdis feriatus</i> (Linnaeus, 1758)	Crucifix crab	Kdam Khlar	25,000-40,000
3	<i>Thalamita crenata</i> (Latreille, 1829)	Crenate swimming crab	Kdam Thor Kiev	25,000-40,000
4	<i>Charybdis anisodon</i> (de Haan, 1850)	Two spined arm swimming crab	Kdam Dornng Kiev Sor	7,000-20,000
5	<i>Portunus pelagicus</i> (Linnaeus, 1758)	Flower crab or swimming crab	Kdam Se	7,000-20,000
6	<i>Tachypleus gigas</i> (Müller, 1785)	Traingular-tail horseshoe crab	Balang Kak	7,000-15,000
7	<i>Charybdis natator</i> (Herbst, 1789)	Hairy swimming crab	Kdam Neak	4,000-6,000
8	<i>Episesarma singaporenes</i> (Tweedie, 1936)	Singapore vinegar crab	Kdam Chorr	4,000-6,000
9	<i>Episesarma versicolor</i> (Tweedie, 1940)	Violet vinegar crab	Kdam Chorr	4,000-6,000
10	<i>Podophthalmus vigil</i> (Fabricius, 1798)	Sentinel crab	Kdam Phneak Vieng	3,000-6,000
11	<i>Ozium guttatus</i> Milne Edward, 1834	Spottedbelly rock crab	Kdam Pkor lienn	1,500-2,500

**Annex 6. Marine Endangered species found in Cambodian coastal waters**

<b>Species</b>	<b>Common name</b>	<b>Occurrence in Cambodia (Jensen &amp; Try, 2002)</b>	<b>IUCN category</b>
<i>Chelonia mydas</i>	Green turtle	common, nesting	En
<i>Eretmochelys imbricata</i>	Hawksbill turtle	present, nesting	Cr
<i>Caretta caretta</i>	Loggerhead turtle	present? (unconfirmed)	En
<i>Lepidochelys olivacea</i>	Olive ridley	present? (unconfirmed)	En
<i>Dermochelys coriacea</i>	Leatherback turtle	present, rare	Cr
<i>Batagur baska</i>	Mangrove terrapin or Royal terrapin	present, rare	Cr
<i>Feresa attenuata</i>	Pygmy killer whale	present	DD
<i>Grampus griseus</i>	Grey dolphin	present	DD
<i>Lagenodelphis hosei</i>	Fraser's dolphin	present	DD
<i>Neophocaena phocaenoides</i>	Black finless porpoise	present	DD
<i>Orcaella brevirostris</i>	Irrawadi dolphin	present	DD
<i>Sousa chinensis</i>	Indo-Pacific Humpback Dolphin	present	DD
<i>Stenella longirostris</i>	Spinner dolphin	present	LR/cd
<i>Tursiops aduncus</i>	Indian Ocean bottlenose dolphin	(as <i>T. truncatus</i> )	DD
<i>Dugong dugon</i>	Dugong	present	Vu
<i>Atelomycterus marmoratus</i>	Coral catshark	?	NT
<i>Carcharhinus amblyrhynchoides</i>	Graceful shark	?	LR/nt

<i>Carcharhinus amblyrhynchos</i>	Grey reef shark	?	LR/nt
<i>Carcharhinus dussumieri</i>	Whitecheek shark	?	NT
<i>Carcharhinus leucas</i>	Bull shark	?	LR/nt
<i>Carcharhinus limbatus</i>	Blacktip shark	present	NT
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark	?	LR/nt
<i>Carcharhinus melanopterus</i>	Blacktip reef shark	?	LR/nt
<i>Chiloscyllium indicum</i>	Slender bamboo shark	present	NT
<i>Chiloscyllium punctatum</i>	Brownbanded bamboo shark	present	NT
<i>Galeocerdo cuvier</i>	Tiger shark	present, rare?	LR/nt
<i>Isurus oxyrinchus</i>	Shortfin mako	present, rare?	LR/nt
<i>Prionace glauca</i>	Blue shark	?	LR/nt
<i>Pristis zijsron</i>	Green sawfish	?	En
<i>Rhincodon typus</i>	Whale shark	present, rare	Vu
<i>Scoliodon laticaudus</i>	Spadenose shark	present	LR/nt
<i>Sphyrna lewini</i>	Scalloped hammerhead	present	LR/nt
<i>Stegostoma fasciatum</i>	Leopard shark	present	Vu
<i>Triaenodon obesus</i>	Whitetipped reef shark	?	LR/nt
<i>Aetomylaeus nichofii</i>	Banded eagle ray	present	Vu
<i>Mobula japonica</i>	Japanese devilray	(as <i>Manta birostris</i> )	NT
<i>Taeniura lymma</i>	Bluespotted fantail stingray	present, by-catch	NT
<i>Hippocampus kuda</i>	Seahorses	present (+2 other)	Vu

		species)	
<i>Cephalopholis boenack</i>	Chocolate hind	present	DD
<i>Cromileptes altivelis</i>	Humpback seabass	present	DD

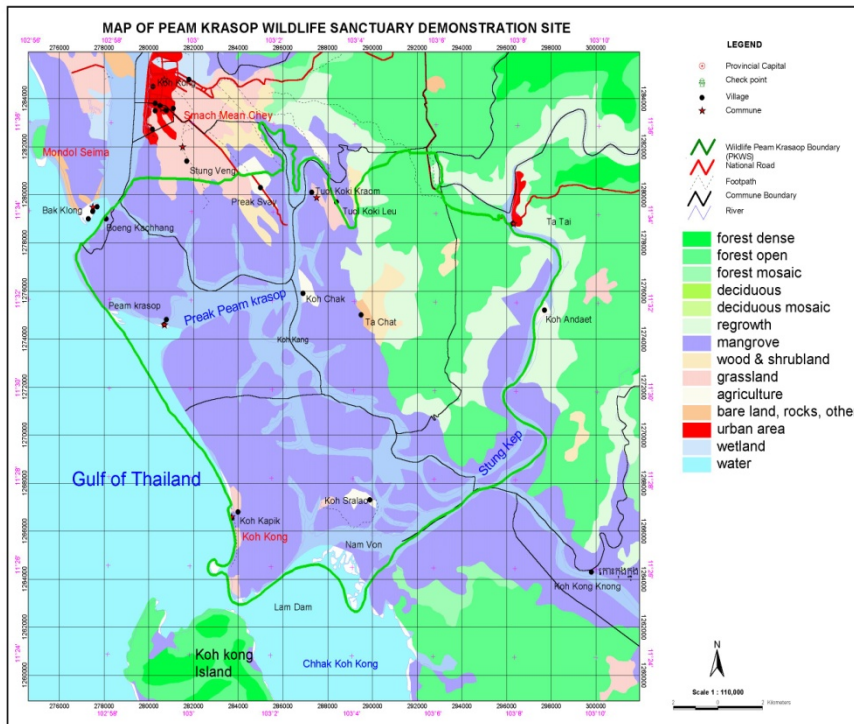
Source: Jensen and Try, 2002; and IUCN, 2003.

**Annex 7. Map of Transboundary Waters between the Provinces of Kien Giang (Viet Nam) and Kampot (Cambodia) (Memorandum of Agreement, 2008)**





**Annex 8. Map of Peam Krasop Wildlife Sanctuary Demonstration Site which is a transboundary mangrove management project with Trat Province of Thailand (MoU, 2006)**





## Indication on Important life-cycle stage of Indo-Pacific mackerel in the Gulf of Thailand

Pirochana Saikliang

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### Indications on important life-cycle stage of Indo-Pacific mackerel in the Gulf of Thailand

#### 1<sup>st</sup> International Conference

Subject: To Attain Security of Fisheries and Aquatic Resources

8 December 2008

Pirochana Saikliang

Marine Fisheries Research and Development Bureau,  
**Department of Fisheries, Thailand**

1



### Scope of my presentation

- Development of fishing gears and practice
- Study on Life-cycle of Indo-Pacific mackerel
- Management of fisheries *refugia*/fishing ground

2



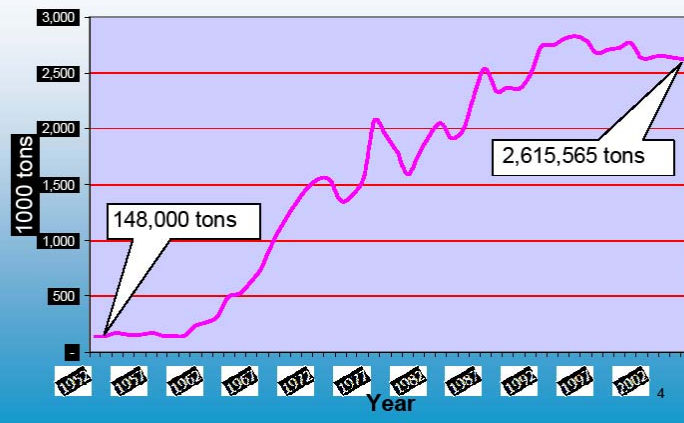
## Development of Marine Fisheries

### Thai's Marine Fisheries:-

- Marine fishery was the tradition career of Thai people for long time ago and operated near shore waters.
- Since 1925, Chinese purse-seine was introduced for catching the pelagic fish and after that it was modified to Thai purse-seine.
- In 1960, the otter-board trawl net (German type) was introduced to Thailand for catching the demersal fish.



### Total Marine Catches of Thailand, 1952-2002



### Marine Fishing Gears Registration

Fishing vessels registered **13,627**

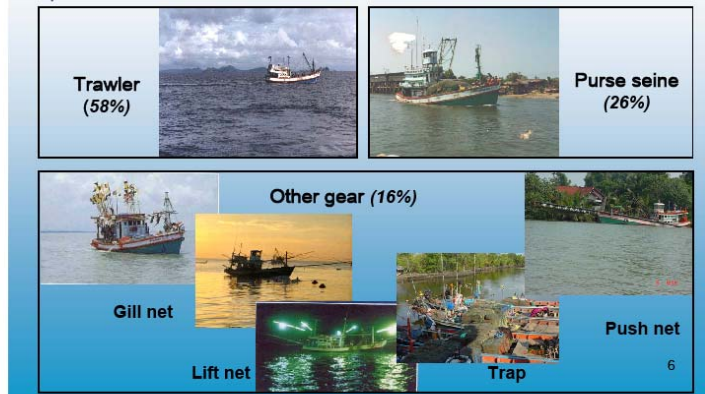
- Trawlers 42 %
- Falling nets 24 %
- Gill nets 15 %
- Purse seiners 12 %
- Push net 4 %
- Others 3 %

DOF, 2007

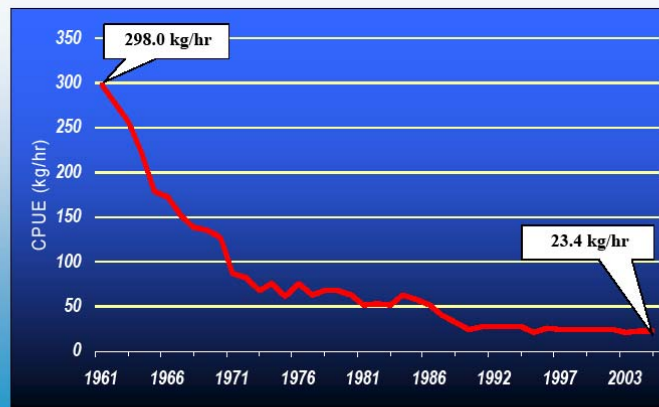




## The Catches of marine Fishes by Main Fishing Gear



## Catch per Unit of Effort in the Gulf of Thailand



The development of area in the Gulf of Thailand for closing in some season and prohibited some kind of fishing gears

### Pre-1953

- Identification of the importance of Indo-Pacific mackerel (*Rastrelliger brachysoma/neglectus*)



### 1953

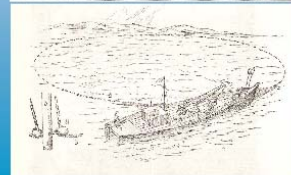
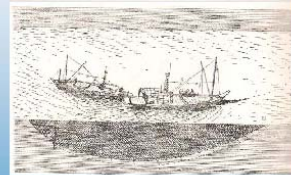
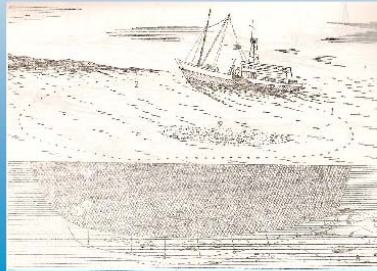
- Establishment of a spawning season closure for Indo-Pacific mackerel (1<sup>st</sup> April - 31<sup>st</sup> May) :- prohibition of purse seine fishing





### Gears prohibited:-

- Large Chinese purse seine
- Chinese purse seine type 1
- Siamese purse seine type 2
- Thai purse seine



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### Development of the Prachuab Khiri Khan – Surat Thani Fisheries *Refugia* Site in the Gulf of Thailand

#### 1953-1959

- Realizations that the 1953 spawning closure was ineffective (site was too large, insufficient enforcement capabilities, and based on limited information)
- Establishment of the Indo-Pacific mackerel research team (1957)
  - Collection of fishery biological information (mainly fish larvae)
- Led to change in 1959 of spawning closure area and duration from 1<sup>st</sup> April to 31<sup>st</sup> May to 1<sup>st</sup> January – 30<sup>th</sup> April



10



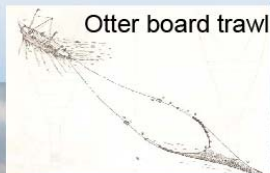
### Gears prohibited:-

- All type of trawler
- Thai purse seine
- Mackerel encircling gill net

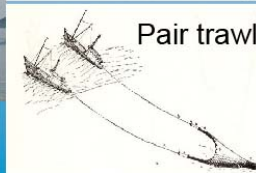


MCS system

11



Otter board trawl



Pair trawl





## Development of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site in the Gulf of Thailand

### 1953-1959 (cont.)

- Purse seine and gill net fishing was prohibited during the January - April closure
- Department of Fisheries included a provision in the regulation that enabled fishers to operate these gears during closes season if they were licensed and maintained log books.
- Follow up the study on the status of Indo-Pacific mackerel



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## Development of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site in the Gulf of Thailand

### 1960-1963

- On-going fishery research, focus on larval fish
- Establishment of specific spawning (1<sup>st</sup> January-31<sup>st</sup> March) and nursery closures (15<sup>th</sup> April-14<sup>th</sup> June) in 1962
- Purse seine and gill nets prohibited during spawning closure
- Encircling gill nets could be used during nursery closure if mesh size >4.7cm . Purse seine fishing was prohibited.



13



## Development of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site in the Gulf of Thailand

### 1964-1972

- Over-fishing of demersal resources led trawl fishers to modify their gears and practices to target pelagic species
- List of fishing gear prohibited was extended to include trawling during the periods 1<sup>st</sup> February - 31<sup>st</sup> March 1972

### 1973-1975

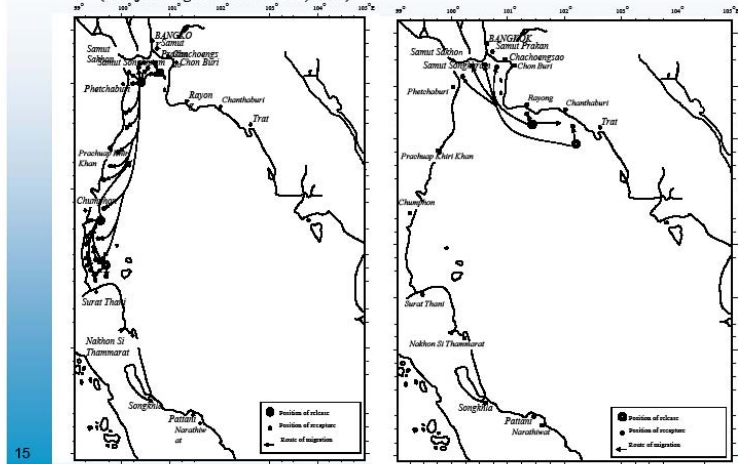
- Rapid increase in the use of light luring purse seines – led to ban of this practice and extension of nursery closure to 14<sup>th</sup> July



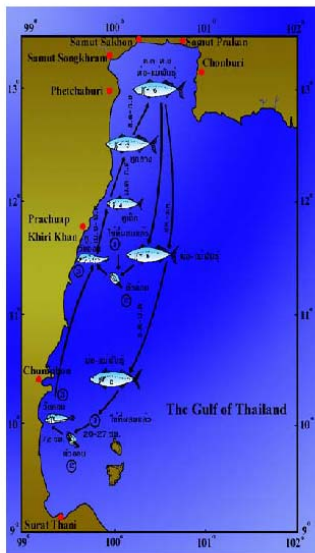
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**The migratory route of tagged Indo-Pacific mackerel (*Rastrelliger neglectus/brachysoma*) in the Gulf of Thailand (Somjaiwong and Chullasorn, 1974)**



15



**Chub mackerel's spawning grounds  
Closed areas in some seasons**



**Development of the Prachuap Khiri Khan – Surat Thani Fisheries Refugia Site in the Gulf of Thailand**

**1985-1994**

- Anchovy purse seine fishing permitted in area for 6 years.
- Conflicts between fishers using anchovy purse seines and other gears.

**1995-1999**

- Rapid increase in the use of new fishing gears and practices – 1999 Notification of permitted fishing gears and practices (Mackerel encircling gill net).



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### Recent Challenges in the Management of the Prachuab Khiri Khan – Surat Thani Fisheries Refugia Site

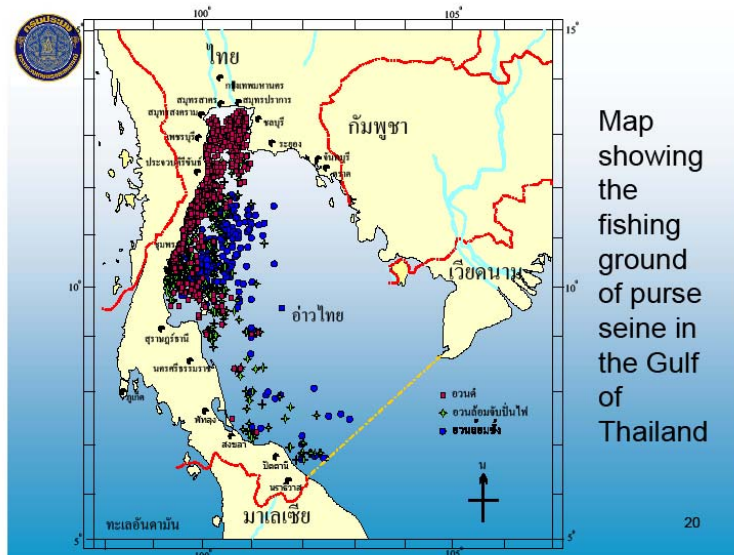
#### 2000-2008

- Pressure from fishers to reduce the area of the site by 3,000 sq.km in the Chumphon area.
- Inappropriate use of mackerel gill net by both large and small scale sectors.

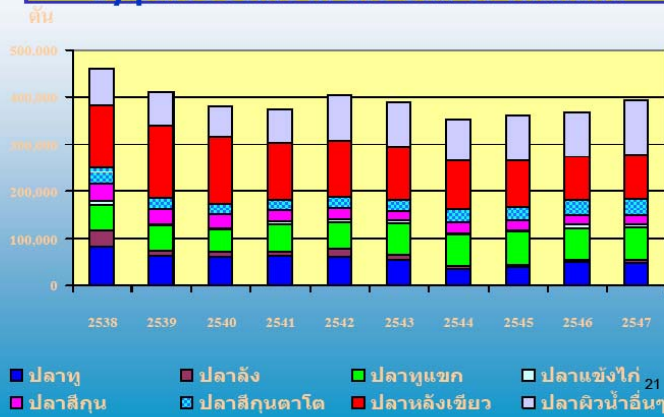


**Mackerel gill net:** Mesh size=4.7cm  
Length=>14km

- Schools detected using echo-sounders
- Net set in zig-zag manner
- Hauled by power-block
- Fishers target Indo-Pacific mackerel
- Practice highly species/size selective
- Species targeted during spawning aggregations
- ≈100% of mackerel landed at maturity stage (stage 4 & 5)



### Species composition of pelagic fish caught by purse seine in the Gulf of Thailand





Recent Challenges in the Management of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site



Stakeholder Consultations



Recent Challenges in the Management of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site

Immerging issue:-  
Gill net fisheries



Long-tail fishing boats – adapted for use of long gill net

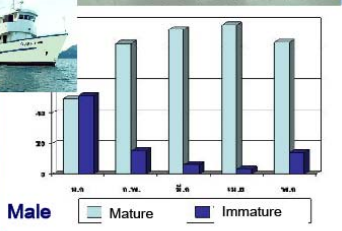
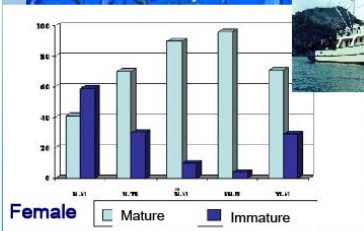
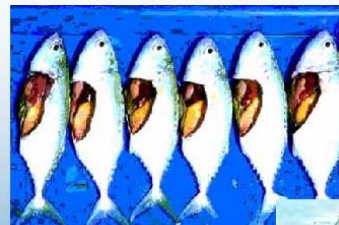
Large-size fishing boats – adapted for use of long gill net

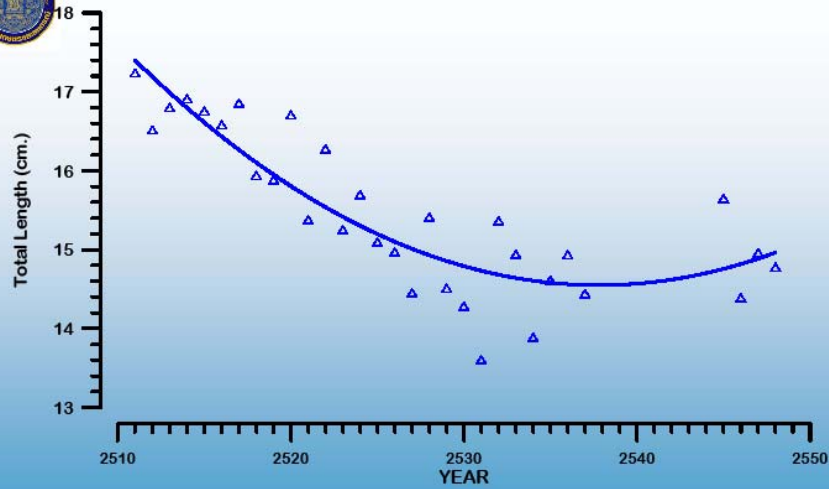


Medium-size fishing boats – adapted for use of long gill net



Recent Challenges in the Management of the Prachuap Khiri Khan – Surat Thani Fisheries *Refugia* Site





Annual relationship between average total length of Indo-Pacific mackerel (*Rastrelliger brachysoma* (Breker, 1851)) during 1968-2005



## Conclusion and Recommendation

- There are many challenge for closure area in the Gulf of Thailand
  - Changing a fishing gear and practice
  - Reduce a area and period of time
  - Should have enough scientific information to supporting before establish fisheries *refugia*
- The scientific information should be significant to supporting
- Stakeholder consultation are needs before *refugia* establishment
- The area should be the critical area of the life cycle of the important economic fish or rare species
- Monitoring Control and Surveillance (MCS) should be improved

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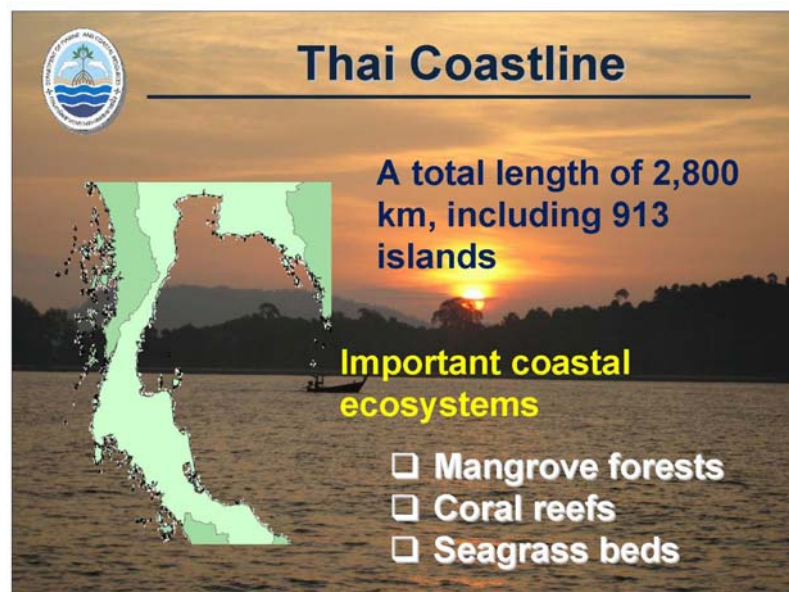
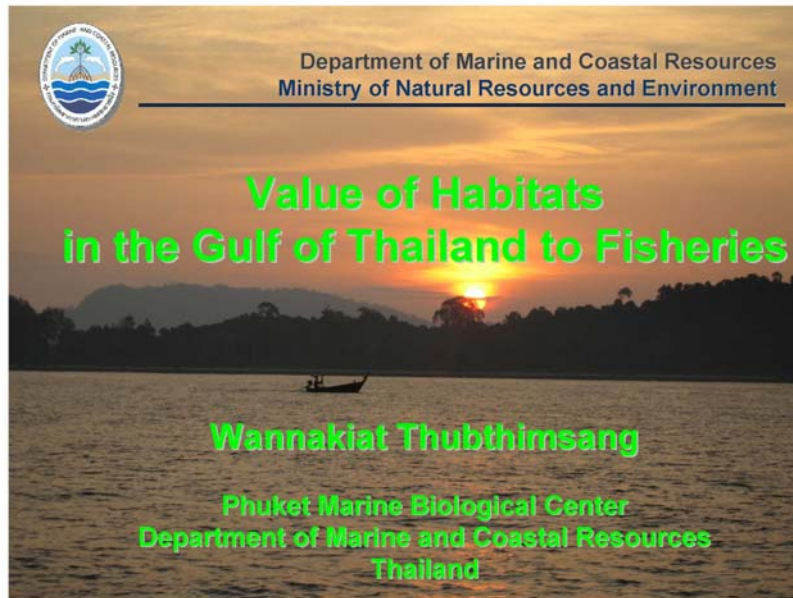


## Value of Habitats in the Gulf of Thailand to Fisheries





Wannakiat Thubthimsang

Phuket Marine Biological Center, Department of Marine and Coastal Resources, Thailand  
e-mail:wannakiat@yahoo.com

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## Mangrove Ecosystem

**Total area of Mangrove forest: 2,330 km<sup>2</sup>**

- High biological diversity
- High productions, plants and animals
- Support food and habitat for all stages of marine lives
- Source of foods for coastal community
- Prevent coastal erosion
- Filter of pollutants



## Mangrove Ecosystem (3)

### Problems and threats

Over utilization of mangrove area and resources

- Trespassing
  - Agriculture: shrimp farming, mariculture
  - Urbanization and Industrial estate
- Woods harvesting
  - Firewood
  - Charcoal
  - Furniture & construction
- Land conversion for tourism purposes






**Mangrove Ecosystem (4)**

**Management and Conservation**

**1. Restoration and Conservation**




**2. Replantation**



**Coral Reef Ecosystem**

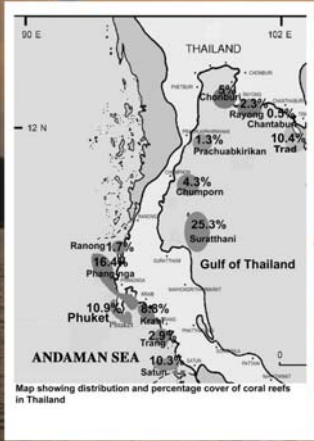
- Characteristic ecosystem generally found in the coastal area
- High biological diversity
- High production, supply food and shelter for various marine organisms
- Natural coastal barrier, also help prevent coastal erosion
- Popular tourist destinations, esp. for diving



**Coral Reef Ecosystem (2)**

**Coral reef area in Thailand**  
**154 km<sup>2</sup>**

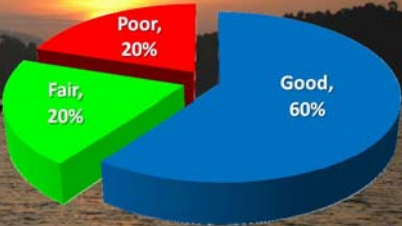
- Gulf of Thailand = 72.8 km<sup>2</sup>
- Andaman Sea = 81.2 km<sup>2</sup>



Map showing distribution and percentage cover of coral reefs in Thailand

**Overall coral reef conditions in Thailand**

- Good, 60%
- Fair, 20%
- Poor, 20%





### Coral Reef Ecosystem (3)

#### Impact of external factors on coral reef ecosystem

##### Natural Causes:

- Storms
- Higher sea surface temperatures
- Lower sea levels
- Crown-of-thorn starfish outbreaks



### Coral Reef Ecosystem (4)

##### Human activities:

- Eutrophication
- Sedimentation
- Fishing activities
- Destructive fishing methods
- In-experienced divers



### Coral Reef Ecosystem (5)

##### Management and Conservation

1. Status assessment for up-to-date database
2. Coral reef rehabilitation





 **Coral Reef Ecosystem (6)**

**Management and Conservation**

3. Conduct innovative researches to improve rehabilitation techniques



Mid-water coral nursery

 **Coral Reef Ecosystem (7)**

**Management and Conservation**

4. Install artificial reefs: provide artificial habitats and create new diving spots



 **Coral Reef Ecosystem (8)**

**Management and Conservation**

5. Cooperation with other organizations both local and international in conservation



With Green Fins, UNEP, and private sectors in the conservative diving campaign

With UNDP, conducting underwater guide project

With UNDP, in various activities after Tsunami 2004

With local volunteer group in cleaning activities and setting buoys for diving boats

**Seagrass Ecosystem**

Conceptual model  
Seagrass Ecosystem

- phytoplankton
- zooplankton
- epiphytic greenish
- Benthos

- Productive coastal ecosystem
- High biological diversity
- Serving food and habitats for marine lives, ranging from single-cell algae to large marine vertebrate such as sea turtles and dugongs

**Seagrass Ecosystem (2)**

Total area of seagrass beds:  
150 km<sup>2</sup>

- Gulf of Thailand = 55 km<sup>2</sup>
- Andaman Sea = 95 km<sup>2</sup>

Overall seagrass conditions

- Good, 70%
- Fair, 15%
- Poor, 15%

● Dugong sites

**Seagrass Ecosystem (3)**

**External factors effecting seagrass ecosystem**

1. Sedimentation from coastal activities
2. Sewage dumping: Seaweed blooms
3. Illegal fisheries: push net

Seagrasses covered with massive amount of green seaweed (*Ulva*)

Push-net operation


### Biodiversity of coastal habitats in the Andaman Sea

	Mangroves	Seagrass beds	Coral reefs
Mangrove plants	74	-	-
Seagrasses	-	12	-
Algae	5	30	115
Corals	-	-	350
Octocorals	-	1	60
Sea anemones	-	3	10
Crustaceans	124	76	380
Molluscs	87	75	620
Echinoderms	5	16	110
Fishes	268	240	960
<b>Total</b>	<b>563</b>	<b>453</b>	<b>2,605</b>





**Note:** Excluding several other groups e.g. Sponge, Bryozoan, Zoanthid, Polychaete, Flat worm, Ribbon worm, Sipunculid, Ascidian, etc.


### Exemplification for the economic important component of coastal fishes

	Mangroves	Seagrass beds	Coral reefs
<b>Fish species</b>	<b>268</b>	<b>240</b>	<b>960</b>
-Edible	~100 (37%)	~70 (30%)	~190 (20%)
-Ornamental	-	-	~570 (60%)








Economic importance – edible species

	Grouper: <i>Epinephelus coioides</i>
	Grunt: <i>Pomadasys kaakan</i>
	Snapper: <i>Lutjanus argentimaculatus</i>
	Terapon: <i>Terapon jarbua</i>








**Economic importance – edible species**

	Mullet: <i>Liza subviridis</i>
	Emperor: <i>Lethrinus lentjan</i>
	Rabbitfish: <i>Siganus javus</i>
	Eel-catfish: <i>Plotosus lineatus</i>











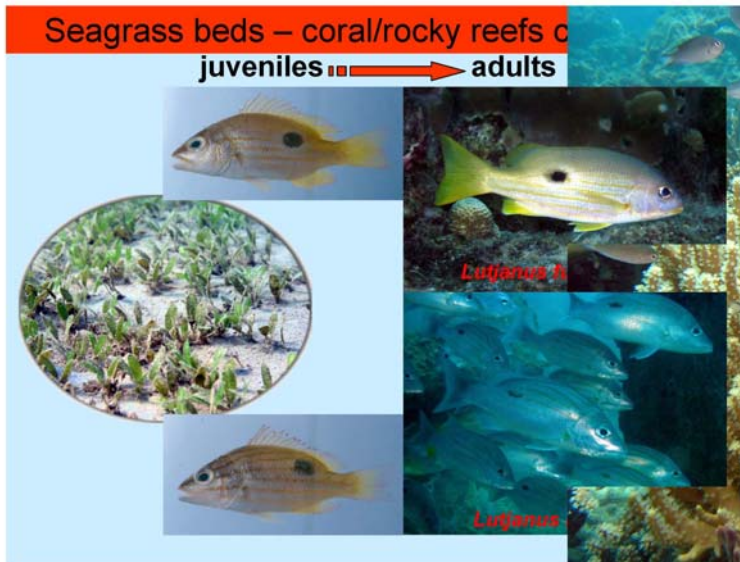
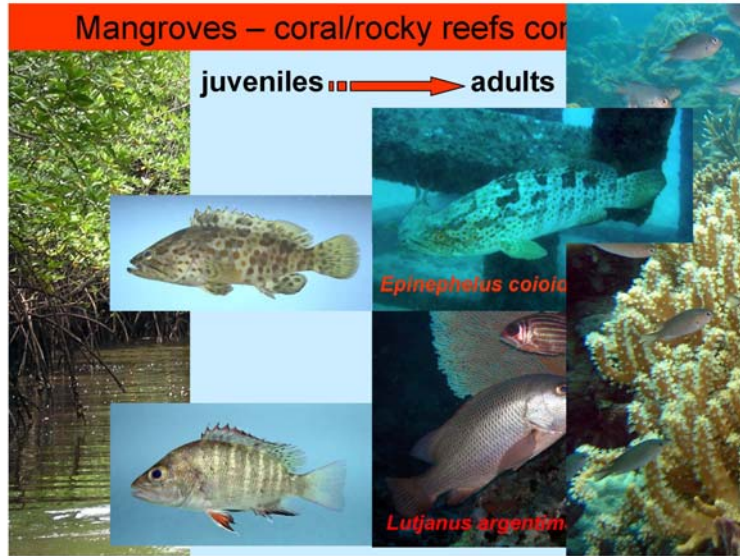
**Economic importance – edible species**

	Trevally: <i>Caranx melampygus</i>
	Fusilier: <i>Caesio cuning</i>
	Snapper: <i>Lutjanus argentimaculatus</i>
	Groupers: <i>Cephalopholis polyspila</i>



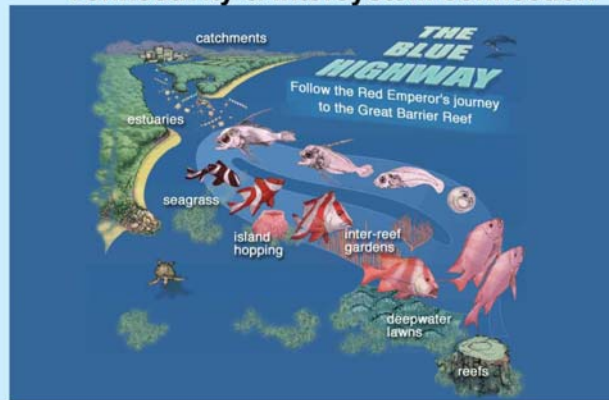
**Economic importance – ornamental species**



**Coastal habitats are critical areas** for conservation of biodiversity and fisheries management

**Connectivity & intersystem connection**



**Marine Endangered Species**

**Sea Turtles**

Reduction of natural population:

- Reduction of brood stock and nesting grounds
- By-catch from fishing gears

**Marine Endangered Species (2)**

**Marine mammals**

- Whale
- Dolphin
- Dugong

A project on dolphin conservation for eco-tourism

Whale and Dolphin watch

 **Marine Endangered Species (3)**

สัตว์ทะเลเสี่ยงสูญพันธุ์ในน่านน้ำไทย  
**Marine Mammals of Thailand**




**23 species of whales and dolphins found in Thai waters**

 **Marine Endangered Species (4)**



**Microlite: flying object for Dugong sighting**


**Aerial photo of Dugong herd at Talibong Island, Trang Province, with an estimated number of 126 dugongs in this area**

 **Coastal Environment**

**Coastal Erosion**

- Andaman Sea coast: 43 areas with a total length of 110 kilometer
- Gulf of Thailand: 112 areas with a total length of 490 kilometer

Department of Marine and Coastal Resources established a strategic management plan in 2007 to cope with coastal erosion problem



Low  
 Medium  
 Serious



## Coastal Environment (2)

### Coastal monitoring program

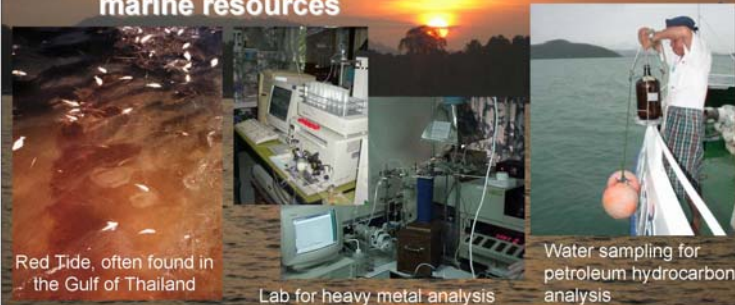
1. Environmental quality: measurement of physical, chemical, and biological parameters in seawater and sediment



## Coastal Environment (3)

### Coastal monitoring program

2. Red Tide watch
3. Contamination and impact of pollutant on marine resources



## Coastal Environment (4)

### Coastal monitoring program

4. Changing in oceanographic process and its impact on coastal resources





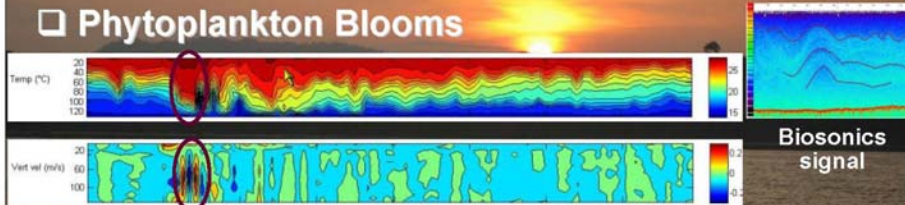


## Coastal Environment (5)

### Internal Wave

Andaman Sea in 2007

- Mass mortality of fish and benthic animals
- Phytoplankton Blooms



Data from ADCP, temperature logger, and BIOSONICS revealed a clear signal of internal wave moving inshore with amplitude of 100 meter.

The offshore water brought in cold and high salinity water mass, rich with dissolved nutrients but low dissolved oxygen to the shore, especially close to the bottom.

# THANK YOU


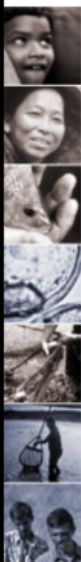


# Connection between Large Rivers and Fish Resources in Indochina

Eric Baran

WorldFish Center

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## CONNECTION BETWEEN LARGE RIVERS AND FISH RESOURCES IN INDOCHINA

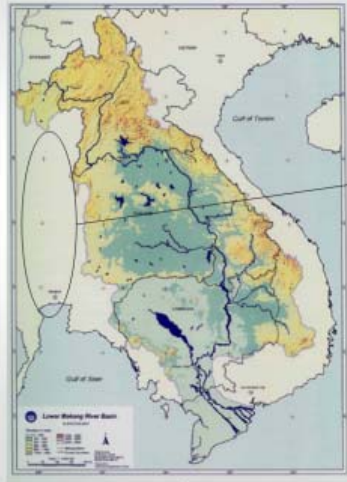
Eric BARAN

### Outline

- Big rivers of Indochina
- Big rivers and freshwater fish production
- Big rivers and coastal fish production
  - Big rivers of the world
  - Mekong
  - Chao Phraya
- Conclusions



## BIG RIVERS OF INDOCHINA



	Mean discharge (m <sup>3</sup> /s)	Drainage area (km <sup>2</sup> )	Length	Deltaic area (km <sup>2</sup> )	Dams
<b>Mekong</b>	11,000	793,000,000	4000	94,000	Largely unregulated river (2 mainstream dams out of 32 in operation, 26 planned + possibly 72)
<b>Chao Phraya</b>	196	160,000	375	11,000	Strongly regulated since 1924 (9 irrigation dams+ 3 hydropower dams)

## BIG RIVERS AND FRESHWATER FISH PRODUCTION

The total yield from river fisheries worldwide amounts to about 10 million tonnes/year.

*FAO statistics*

The Mekong River produces around 2.6 million tonnes of fish per year (MRC and scientific estimates). This represents:

- 7 times the inland fisheries production in Northern America
- 4 times the whole fisheries sector in France
- 13 times the marine fisheries sector in Australia

The value of Mekong fish amounts to about USD 2,000 million/year at landing sites (and increases more than fivefold along the trade chain)

*MRC 2005*

## BIG RIVERS AND COASTAL FISH PRODUCTION



### SOUTHAMERICA

The most critical factor governing the occurrence and degree of enhanced seasonal production and standing crop at Barbados is the total annual volume outflow of Amazon River water into the western tropical Atlantic.

*Kidd & Sander 1979 Influence of Amazon river discharge on the marine production system of Barbados, West Indies*

### SOUTHAFRICA

River discharge affects the geomorphology, salinity and turbidity of estuaries, which in turn influence the distribution and abundance of fish and crustaceans in the coastal zone

*Whitfield 1996 Fishes and the environmental status of South African estuaries*

### NORTHAMERICA

Strong correlation between river discharge and commercial fish landings in the

- Gulf of Mexico, USA and Mexico (Day *et al.*, 1985)
- San Francisco Bay, USA (Rozengurt and Herz, 1985)
- St Lawrence River, Canada (Sutcliffe 1972, 1973)

### AUSTRALIA

High discharge events are clearly the most important component of the flow regime for many species of commercial importance. The reduction or elimination of large flow events is likely to eliminate the associated high catches of fish and crustaceans.

*Loneragan & Bunn 1999 River flows and estuarine ecosystems*

The nitrogen and phosphorus seasonally exported from river systems have a significant influence on estuaries and nearshore marine environments by stimulating phytoplankton and benthic microalgal production

*Loneragan & Bunn 1999 River flows and estuarine ecosystems*

### NORTH SEA

When the river load is reduced by 50%, the net primary production is reduced by 15%

*Lenhart *et al.* 1997 Effects of river input on the coastal zone of the North Sea*

## NILE

Following the building of the Aswan Dam (1965) the concentration of nitrates, phosphates and silicates in coastal waters declined a lot, phytoplankton blooms in coastal waters were greatly reduced, catches of prawns were halved (from 8000 to 4000 t) and catches of plankton feeding fishes (*Sardinella* spp.) declined from 15 000 tonnes to 550 tonnes

*Aleem 1972 Effect of river outflow management on marine life*



## WESTAFRICA

The impact of the Zaire's waters on production is not obvious: the turbulent and opaque waters do not permit planktonic growth near the coast. The outflow of the Niger into the sea also does not perceptibly enrich the coastal waters. In Ivory Coast, the flood periods coincide with the main upwelling season at sea, which long blurred the importance of continental inputs.

*Binet et al. in FAO 1995 Effects of riverine inputs on coastal ecosystems and fisheries resources.*

## BIG RIVERS OF INDOCHINA AND COASTAL FISH PRODUCTION

### MEKONG

Around 1000 fish species (between 768 and 1200)

The fish fauna of the plume, which is the area of the South China sea that is influenced by discharge from the Mekong River, up to 500 km beyond the mouth of the river, rely heavily on the nutrient input from the river.

*MRC 2003 Fish Migrations in the Mekong River Basin*

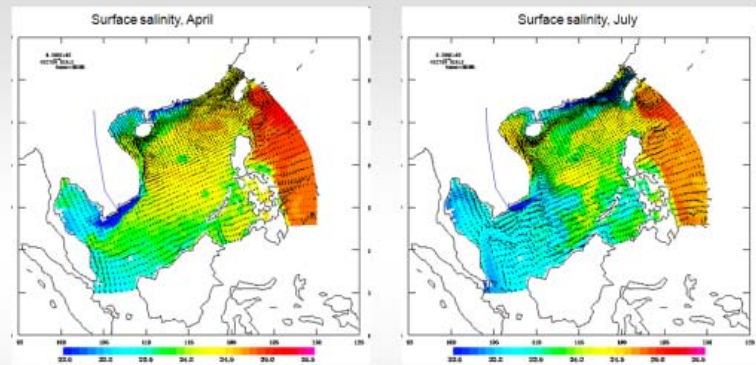
Mekong capture fish production:

- 66% from freshwater capture fisheries
- 31% from the brackish water and coastal zone
- 3% from reservoir fisheries

*Lagler 1976 Fisheries and integrated Mekong River Basin development*

A remarkable concentration of fish can be noticed at the mouths of the Bassac and Mekong Rivers. at the beginning of the dry season. The fish are attracted by the enormous concentration of nitrogenous material coming from the Mekong and their scales register the sharp acceleration of growth that results. The Great Lake of Cambodia thus imposes its rule and its rhythm to a distant population at sea

*Chevey 1933 The Great Lake of Cambodia*



*A 3D Circulation Model of the South China Sea*  
Huijie Xue, Fei Chai, Neal Pettigrew, Danya Xu, Maochong Shi

The loss of nutrients, either dissolved or in organic silt, from the plume of the Mekong/Bassac will certainly diminish productivity in the near-shore areas and to a lesser extent in the off-shore areas.

The fishery of the Mekong plume in the South China Sea also will be subject to impacts of the controlled and augmented low-flow regime. While the characteristics of the fishery are anticipated to change, little is known scientifically of the migratory patterns of fish to and from the plume.

*Lagler 1976 Fisheries and integrated Mekong River Basin development*

## CHAO PHRAYA

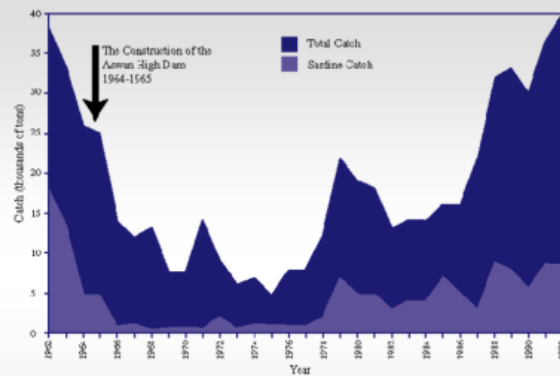
250 fish species

*Nuanmanee Pongthana*  
*Current status of aquatic genetic resources conservation in Thailand*

Four major rivers, i.e. the Chao Phraya, the Tha Chin, the Mae Klong and the Bang Pakong drain a large amount of water into the Gulf of Thailand annually. This has greatly influenced the biodiversity and the richness of the resources in the Gulf.

The seawater quality along the entire coast east of the Chao Phraya River is degraded and highly variable. Coliform bacteria levels are extremely high during the wet season. Pollution plumes are generally carried eastward toward Khlong Dan. Heavy metal accumulation in the sediments is moderate to high. There is considerable seasonal variation in the abundance of plankton and benthic animals off the coast of Khlong Dan.

*ADB 2002 Samut Prakarn wastewater management project*



*El-Sayed and van Dijken 1995  
The southeastern Mediterranean ecosystem revisited*

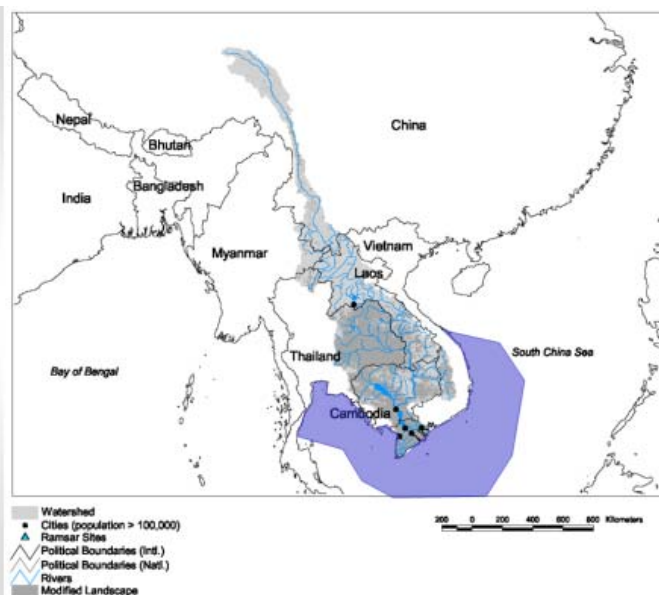
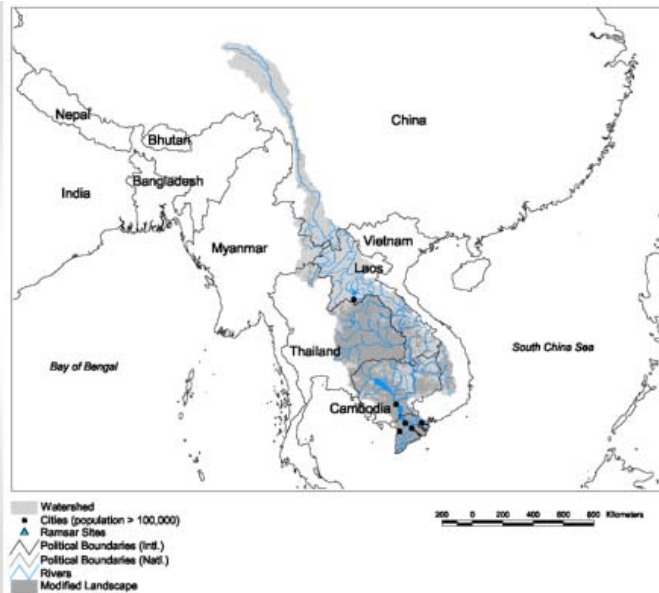
Dam + pollution = same coastal fish production as a pristine river?

## CONCLUSIONS

Despite links between flow and the secondary production of estuaries and coastal waters, there is **still a common perception that "water going to sea is wasted"** and a continuing trend to regulate the flow of rivers.



- River discharge has a strong positive effect on the production of coastal fisheries.
- Seasonal patterns of flow are as important as their magnitude
- However the connection between rivers and coastal productivity can be blurred by:
  - i) flow dynamics and coastal hydromorphology;
  - ii) the chemical element studied (carbon, nitrogen or phosphorus);
  - iii) the resource studied (plankton dependent on turbidity and local upwellings, fish dependent on coastal nurseries, etc)
- River regulation is likely to have a dramatic effect on the production of coastal fisheries (plus other factors such as costal geomorphology)



Specific research questions in this area include:

- To what extent will individual coastal ecosystems be modified physically by a reduction of different levels of river flow in the estuarine zone? Does the seasonal distribution of flow significantly affect this process?
- What will be the consequences of greater salinization of the coastal zone for the livelihoods of people dependent upon coastal ecosystems and their resources?
- What will be the impact of a reduced freshwater input on the productivity and catch composition of coastal fisheries? How does this translate into economic terms?

*Dugan et al. 2002 The contribution of aquatic ecosystems and fisheries to food security and livelihoods: a research agenda*



# Anthropogenic contribution to the security of fisheries and aquatic resources

Sanchai Tandavanitj<sup>1</sup> and Damrong Silpachai<sup>2</sup>

<sup>1</sup> Senior Advisor on Senior Advisor on International Fisheries Affairs, Department of Fisheries, Thailand, e-mail: sanchaitan@gmail.com

<sup>2</sup> Advisor to the Director-General, Department of Fisheries, Thailand

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## Anthropogenic contribution to the security of fisheries and aquatic resources

Sanchai Tandavanitj<sup>[1]</sup> and Damrong Silpachai<sup>[2]</sup>

<sup>[1]</sup> Senior Advisor on International Fisheries Affairs,  
Department of Fisheries

<sup>[2]</sup> Advisor to the Director-General,  
Department of Fisheries, Thailand

1

- Small-Scale Fisheries (Traditional Fisheries)
- Common Property
- Open Access

2

**Bottom Trawl were Introduce since 1960**

Over Fishing  
(CPUE in 1966=132kg/hr  
in 2006=29kg/hr)

3

- **Small-Scale Fisheries = 85 %**
- **only 12.4% of Total Landing from Small-scale**
- **2,500 Fishing Villages**
- **57,801 Households**
- **158,166 Fisherfolk(2000)**  
**Men 82.2%,Female 17.8%**

## **Shrimp farms**



5



6



**In year 2000**  
**Total Fishing Vessels = 58,119**  
**Small-scale 77.2%**  
**(out board 72.7%, without engine 4.5%)**

**-3 km. from the shore line**  
**(Prohibit for Trawler**  
**and Push-net)**  
**-Close Season**  
**-MPA**  
**-Type of Fishing Gears**  
**and Mesh Size**

## Experiences in Small-Scale Fishery Development

- Small-scale fisheries development project in Makham Pom Bay(1982-3)
- Small-scale fisheries development project, Bay of Bengal Programme, FAO.(start in 1979)
- Small-scale marine fisheries development project(1985-6)
- Artificial Reefs project(start 1988)
- Children of the Sea(2003-6)
- Coastal Habitats and Resources Management (CHARM) Project(2002-7)

# CHARM

Coastal Habitat And Resource Management

Project Overview  
2002 - 2007

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# CHARM Key Activities-Results



- Increase participation in CRM activities through Networks at provincial level and baywide
- Set up CRM arrangements in Tambon
- Provide livelihood opportunities in villages
- Build human capacity of implementation partners

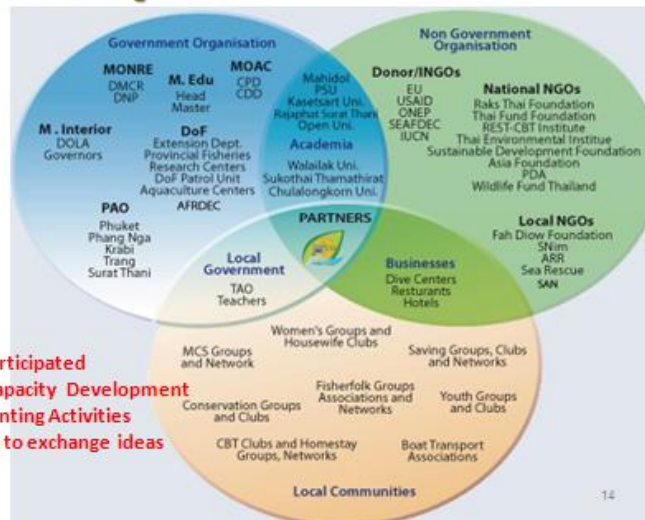


- Encourage policy development
- Participate in National dialogue on coastal zoning to encourage a wider CRM uptake
- Develop tools, manuals and kits to support others in comanagement
- Encourage learning by partners
- Improve the human capacity of partners



13

## Who Participated



14

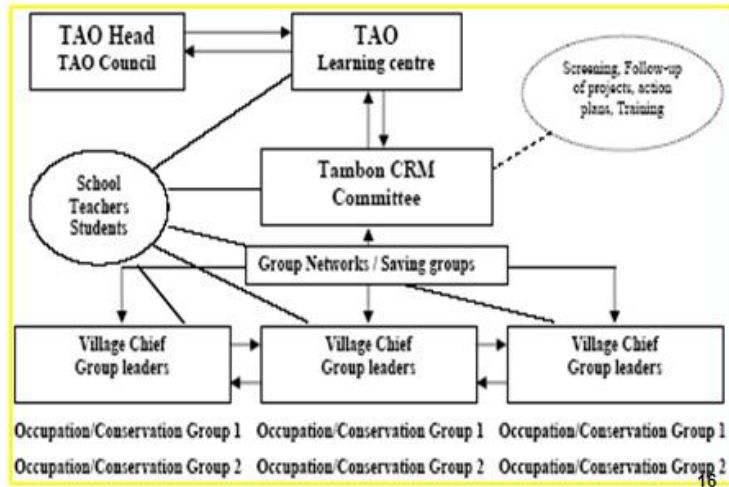
## Who Benefited

- Women implemented most income Generating projects – 9% of total participants
- Women implemented all seafood processing projects - 3.4% of total participants
- Fishing families through Sea-based livelihoods – 45% of total participants
- 149 projects supported families affected by Tsunami
- Fishers stopped using destructive gear by providing another legal gear or providing an alternative livelihood – 12% of total participants

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## What was Learned

### Tambon co-management arrangements



**the Administrative Decentralization  
of the country that start since 1991  
under  
the National Administrative Act of  
1991.**

17

## Coastal Zone Management

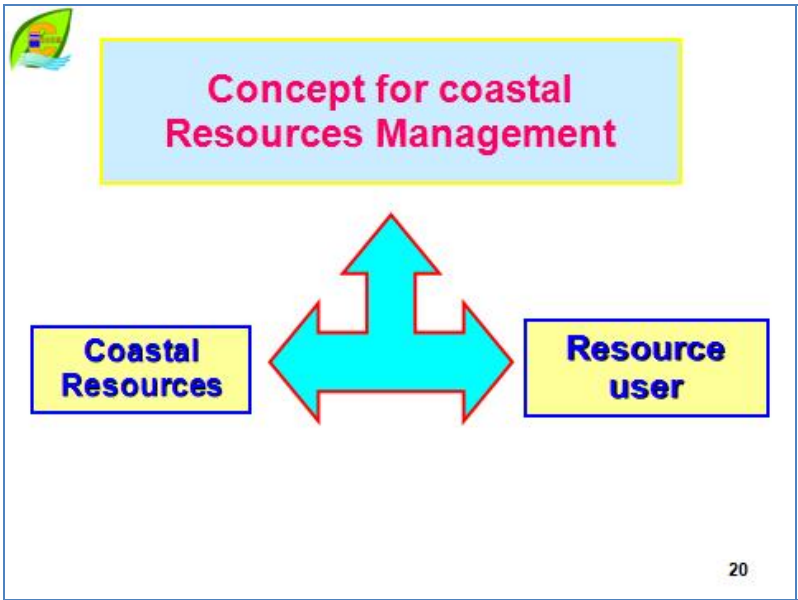
- Participation
- Co-management
- Lesson learn

18





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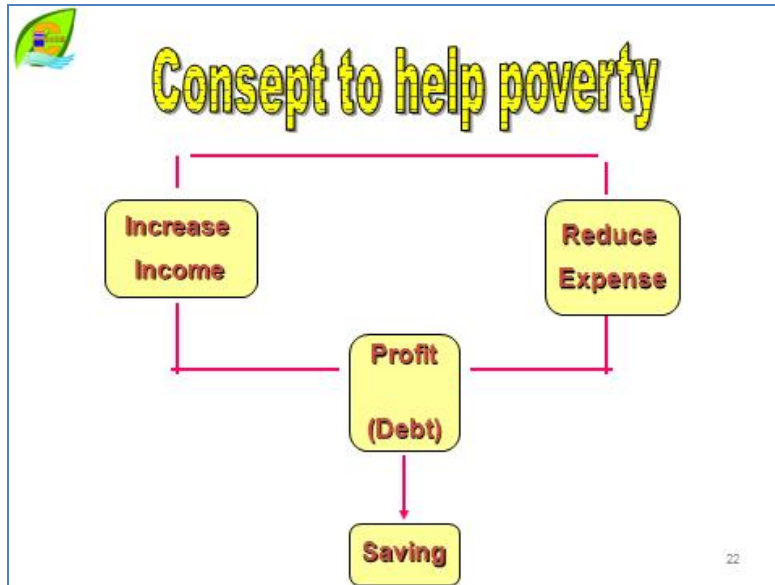


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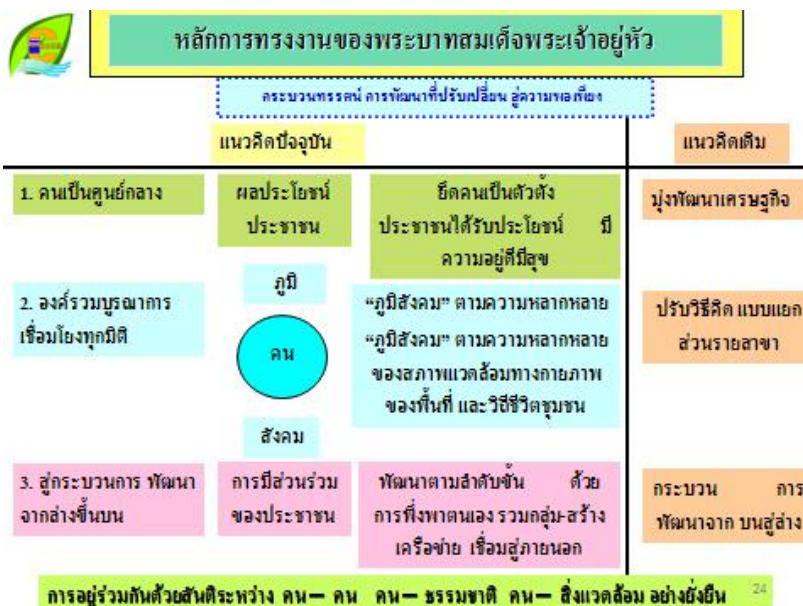
**Community & Local Government**

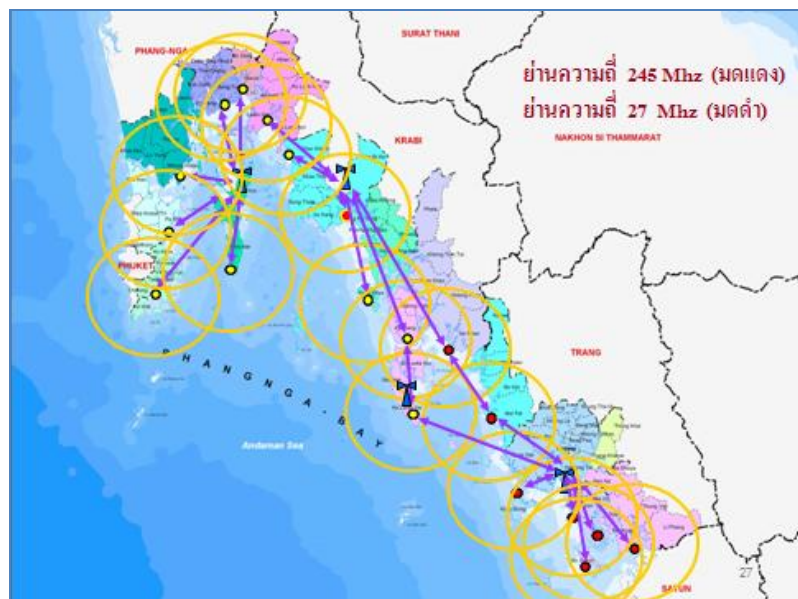
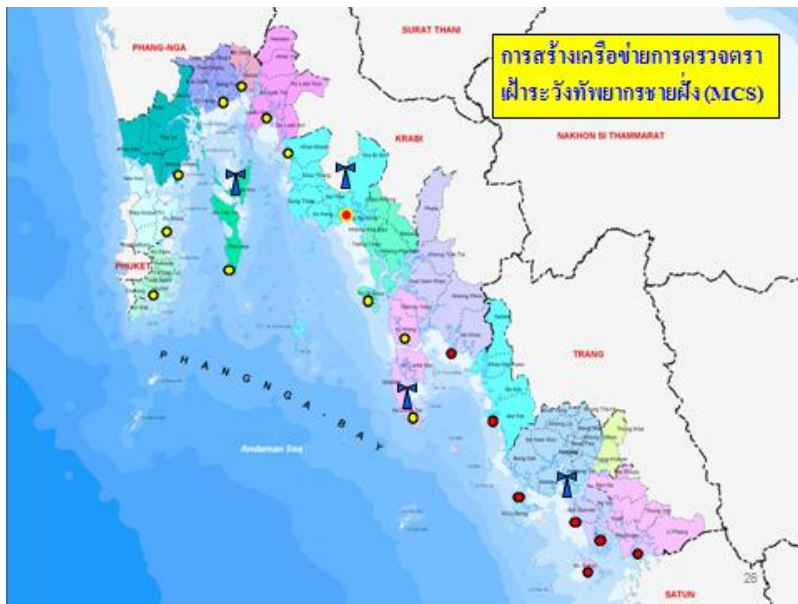
**(communities Base Management,  
Responsible Fisheries)**

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- ## Implementation
- Integrated Approach
  - Participatory Management
  - Better Living Condition
  - Capacity Building, Awareness Building
  - Communities Strengthening
  - Building Network
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## Lesson Learn

- 1) **social, economic, human rights**, including construction of infrastructures, e.g., fish piers, fishing gear mending shops, artificial reef installation, establishment of occupational groups, promotion of cooperatives, financing revolving funds, promotion of women's rights—this last contribution enable DOF to win a national prize in 2008;
- 2) **sustainable resource use and access rights** by encouragement of community participation in abstention from using destructive fishing gear, synthesis of community bylaws;
- 3) **post-harvest promotion**, e.g., promotion of fish processing groups, networking, and upgrade production to the required FDA or to OTOP standards.

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## 10 years Master Plan for Marine Fisheries (2008-2017)

- Strategy 1:** Improved the marine fisheries management system efficiently through active participation of all stakeholders.
- Strategy 2:** Improved fisheries infrastructures and organizational potentials.
- Strategy 3:** Promotion of responsible and sustainable marine fisheries resource exploitation.
- Strategy 4:** Ecological system rehabilitation and development of marine fishing grounds to maintain biodiversity, and marine environment.
- Strategy 5:** Promotion and development of distant fishing.

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**CORMAT**  
**(Coastal Resources Management**  
**Alliance of Thailand)**

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