The Ecosystem-Based Fishery Management in the Bay of Bengal

Executive Summary

1. Introduction

The Ecosystem-Based Fishery Management in the Bay of Bengal is a collaborative fishery research project conducted by members of the Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). The BIMSTEC is an international economic cooperation of a group of countries comprising Bangladesh, India, Sri Lanka, Thailand, Myanmar, Bhutan and Nepal. The economic cooperation initiative was initially formulated Bangladesh, India, Sri Lanka and Thailand in their 6 June 1997 Agreement recognized as the "Bangladesh, India, Sri Lanka and Thailand Economic Cooperation" or BIST-EC. Myanmar attended the inaugural June Meeting as an observer and joined the organization as a full member at a Special Ministerial Meeting held in Bangkok on 22 December 1997, upon which the name of the grouping was changed to BIMST-EC. Nepal was granted observer status by the second Ministerial Meeting in Dhaka in December 1998. Subsequently, full membership has been granted to Nepal and Bhutan in 2004. In the first Summit on 31 July 2004, leaders of the group agreed that the name of the grouping should be known as BIMSTEC or the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation.

BIMSTEC has thirteen priority sectors cover all areas of cooperation. Six priority sectors of cooperation were identified at the 2nd Ministerial Meeting in Dhaka on 19 November 1998. They include the followings:

1. Trade and Investment, led by Bangladesh
2. Transport and Communication, led by India
3. Energy, led by Myanmar
4. Tourism, led by India
5. Technology, led by Sri Lanka
6. Fisheries, led by Thailand

The BIMSTEC member countries recognize the role played by the fisheries sector in food supply and food security for their peoples. The natural resource rents provided by the Bay of Bengal and other inland and coastal bodies of water should be properly managed. In the past decades, the overexploitation of the fishery resources and the overcapacity of fishing fleets are the results of rapid fishing technology development, the ever increasing demands for fish as dictated by population growth and export economic policies, and the open access management of the fisheries. A new and effective management is therefore needed to bail the sub-region out of this economic and technical dilemma.

Around the world, fishery managers are increasingly recognizing ecosystems as natural capital assets. Scientific understanding of ecosystem production functions is improving rapidly but remains a limiting factor in incorporating natural capital into decisions, via systems of national accounting and other mechanisms. It is clear that formal sharing of experience, and defining of priorities for future work, could greatly accelerate the rate of innovation and uptake of new approaches.

The Bay of Bengal is a large marine ecosystem where coastal countries have been fishing. Its geographical and hydrological characteristics support plenitude of a variety of fish and shrimps. Sardines, anchovies, and mackerels are commonly caught whilst yellowfin tuna, bigeye tuna, skipjack tuna and swordfish, other large and precious pelagic fish known in the world market are harvested here. The Bay of Bengal is thus known for the

source of employment in fishing and income enjoyed by a large number of people, as well as their countries in terms of foreign currency earning.

Three projects in the fisheries sectors have been approved by the 6th Ministerial Meeting in 2004. These are: 1) Ecosystem-based fisheries management in the Bay of Bengal (proposed by Thailand); 2) Impact of offshore oil and gas drilling on the marine fishery resources in the Bay of Bengal (proposed by Bangladesh); and 3) marine fish stock assessment, management and development of new fisheries in the Bay of Bengal (proposed by Bangladesh). Further discussion was made on these three projects during the BIMSTEC Technical Meeting in 2005. For the first project, the Technical Meeting suggested that a focus should be made on the straddling and highly migratory fish stocks and the survey of deep sea areas beyond the EEZ.

2. The Overall Objectives

The overall objectives of this project are as follows:

1) To understand the physical and chemical oceanographic and hydrological conditions of the Bay of Bengal.
2) To investigate the biological data of economic fish in terms of species, abundance, distribution, maturity size, feeding etc.
3) To assess the potential of fishery resources in the Bay of Bengal.
4) To strengthen capability in research work and knowledge exchange by training on the job on board the Thai research vessel.
5) To improve understanding and collaboration among researchers of the member countries during on board surveys.

3. The Project Output

It is expected that the obtained scientific data and information from all sub-projects will be highly beneficial for States bordering the Bay of Bengal to eventually draft the policy on sustainable utilization of fishery resources and achieve the effective fisheries management in the Bay of Bengal.

4. The Findings

The project spent a total of 58 days (from 25 October to 21 December 2007) in the survey, using a SEAFDEC research vessel, in the following maritime areas:

Area A (latitude 16°N -19°N, longitude 88°E -91°E)
Area B (latitude 09°N -14°N, longitude 82°E -85°E)
Area C (latitude 09°N -13°N, longitude 95°E -97°E)

Three types of fishing methods were used during the whole period of the surveys: pelagic long line, drift gill net and automatic squid jigging.

The results of the studies are summarized as follow:

4.1 The Oceanographic and Hydrobiological Conditions

a) The Oceanographic Condition

The oceanographic survey found the western side (area B) of the Bay with higher salinity than the north (area A) and the eastern (area C) boundaries. The water circulation in the Bay, as exhibited by the surface salinity in three spatial areas, was density-driven. Two core cold eddies were observed in the north area of the Bay. The large volume of

freshwater discharge by the major rivers plays an important role in inducing lower salinity and higher temperature of the mixed layer (between 14 and 49 m) in the western and eastern areas of the Bay. Hypoxia (where dissolved oxygen was <0.5 ml/l) was found 200 m and deeper in the northern side of the Bay. Surface water shallower than 400 m was occupied by three water masses: Bay of Bengal water (salinity 32-34 psu), Andaman Sea water (salinity 31-33 psu), and Indian Central water (salinity more than 35 psu). The Indian central water occupied all deepest layers of all survey areas.

Distribution of nutrients: nitrite + nitrate, silicate and phosphate were found to correlate positively with depth at all sampling stations. The concentrations of nutrients in the mixed layer depth were low and undetectable in several sampling stations but distinctly high at western station (station 23) of the north of the Bay where chlorophyll-a concentration was also high. In the thermocline layer, a strong nutricline concentration was noticed to be rapidly increasing with depth. Until about 200-250 m the nutrient values were nearly constant or slightly changed. The differentiated pattern of depth profiles of both total phosphorus and total alkalinity together with the relationship between total alkalinity and total phosphorus indicate that sea water characteristic in the enclosed Andaman Sea is different from the entire Bay of Bengal.

Spatial distribution of chlorophyll-a displayed a pattern similar to that of salinity. Most of the low latitude stations exhibited somewhat higher chlorophyll-a concentrations than in those of high latitude stations.

b) Hydrobiological Conditions

A total of 135 phytoplankton species identified belong to the groups of cyanobacteria, diatom, dinoflagellates and silicoflagellates. The northern side of the Bay was inhabited by the highest phytoplankton densities due to the blooms of *Pseudo-nitzschia pseudodelicatissima* in the western part (station 23) of this area.

Similar to phytoplankton, a high concentration of zooplankton was found in the northern area of the Bay. The zooplankton community consisted of 205 species. Copepod was the most prevalent group both in terms of the number of species and biomass. Thirteen families of cephalopod paralarvae were found during the survey period. Family Ommastrephidae was widely distributed in the Bay.

Of the fifty-two families of fish larvae identified, those belong to Family Photichthyidae were the most abundant. The majority of these fishes belong to the inshore reef-fish and oceanic fish groups. In overall, the east of the Bay or the Andaman Sea harbours the richest ichthyodiversity and the highest biomass of fish larvae compared to other study areas.

4.2 The Fishery Resources

From the fishery surveys with 3 types of fishing gear; drift gill net (DGN), pelagic longline (PLL) and automatic squid jigging machine (ASJ), DGN and PLL were satisfactorily effective in catching pelagic fishes and were ideally appropriate tools for sustainable exploitation of the pelagic fishery resources in the Bay of Bengal. It was low catch per unit of effort (CPUE) from ASJ. The overall CPUEs from each type of fishing gear operated in the entire survey areas were DGN 0.84 no/hr (1.27 kg/hr), PLL 1.23 no/100 hooks (27.96 kg/100 hooks) and ASJ 0.19 no/line/hr (0.03 kg/line/hr)

In all fishing areas and with all types of fishing gear, the sum total of five most abundant species captured by number were in the following order: skipjack tuna (*Katsuwonus pelamis*, 22.94%), swordfish (*Xiphias gladius*, 12.94%), silky shark (*Carcharhinus falsiformis*, 8.82%), frigate tuna (*Auxis thazard*, 8.24%) and bigeye thresher shark (*Alopias supersiliosus*, 6.47%).

In terms of weight, the swordfish (34.82%) ranked first of the top-five species followed by bigeye thresher shark (33.88%), silky shark (8.21%) black marlin (*Makaira indica* 4.23%) and yellowfin tuna (*Thunnus albacares*, 3.98%), respectively.

Considering the fishing areas where fish were found in great abundance, the top-five pelagic species were mostly found in area A and C. It can be said that area A is a fertile fishing ground for DGN fishery targeting at tunas particularly skipjack tuna whereas area C is a good fishing ground for billfish fishing with PLL. Although DGN and PLL were operated successfully, their lower CPUEs were achieved when comparing to that of commercial fishing vessels. This could attribute to seasonal variation as the survey period may not fall into a high fishing season. Moreover, the fishing operations were not as intensive as those exerted by commercial fishing vessels.

It was found that the sizes of the fishes captured by these types of fishing gear were mostly sexually mature. The mean total lengths of skipjack tuna, frigate tuna, dolphinfish, swordfish, bigeye thresher shark and silky shark were 41.46, 35.14, 72.94, 211.00, 271.00 and 111.33 cm, respectively. Sex ratios of these species, except that of skipjack tuna, were approximately 1:1. The schools of skipjack tuna were male dominant. Although there were high percentages of sexually mature individuals of both sexes during the survey period, it still insufficient to determine the spawning ground and spawning season. It was considered that the survey duration was rather short, approximately 2 months, and so the acquired biological data concerned with reproductive cycle were insufficient to clarify such items.

Regarding the squids caught by automatic squid jigging machine, the total catches were represented by only one species of Ommastrephidae, purpleback flying squid (*Sthenoteuthis oualaniensis*) which was noticeable more concentrated in area C than in areas A and B. The mean length of the cephalopod was 104 mm for males and 169 mm for females. Sex ratio was 1 male to 4.57 females. At present purpleback flying squid is not regarded as a target species in commercial fishery because of its gristle and low quality for human consumption.

5. Heavy Metal Contamination

The Bay of Bengal's purpleback squid (*Sthenoteuthis oualaniensis*) contained mercury (Hg), lead (Pb) and Zinc (Zn) concentrations in both edible parts and visceral mass were within the safety limits. The mean copper (Cu) concentration in visceral (but not edible) tissues of the squid from every station was higher than the safety limit. The mean cadmium (Cd) concentrations in both edible part and visceral mass of the squid from every station are higher than those of the proposed safety limit. This concluded that Hg, Pb, Zn and Cu concentration in the edible body part of the purpleback squid from the Bay of Bengal are lower than safety limit except Cd. At the same time the study of Hg concentration in fish tissues caught from the same area were also carried out. Most fish analyzed still had Hg concentration in the tissue within the EU and CODEX limit of 0.5µg/g, particularly when fish size not exceeding approximately 15 kg in weight or 150 cm in length. The Hg burden in the tissue of both bigeye thresher shark and swordfish reported in this study were the highest. Swordfish which weighed more than 40 kg accumulated very high Hg content in their flesh exceeding 1 µg./g wet weight which was over the upper limit of the CODEX and EU guideline levels.

6. Acknowledgements

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Figure 1 Fisheries Research Vessel M.V. SEAFDEC.

Specification

Length over all	65.02 m
Length between perpendiculars	57.00 m
Breadth, molded	12.00 m
Depth to super structure deck, molded	7.10 m
Draft, molded	4.658 m
Service speed at 4.50m draft	14.3 knots
Maximum sea trial speed	16.64 knots
Deadweight	744.42 t
Classification	NK, NS, MNS, Fisheries Training and Research Vessel
Official sign	HSHE
Flag	Kingdom of Thailand
Port of registry	Bangkok, Thailand
Gross tonnage	1178 t
Net tonnage	354 t
Fish hold capacity	145.38 m^3
Tank capacity fuel oil	428.96 m^3
Delivery	10th Feb. 1993
Builder	Miho Shipyard Co., Ltd.

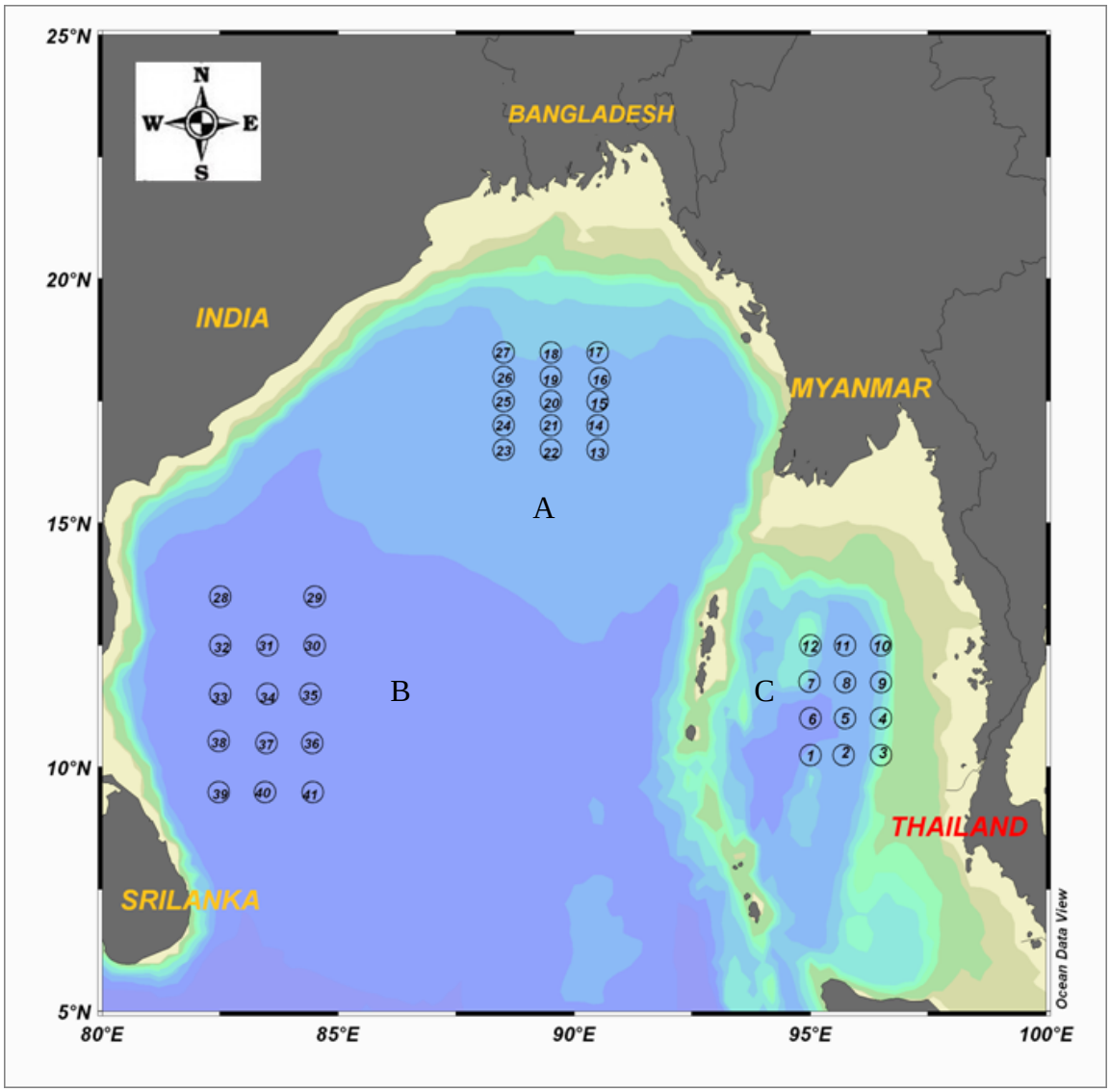

Figure 2 Map showing the survey stations.

Survey Areas

The survey area A, B and C

Area A (latitude 16°N -19°N, longitude 88°E -91°E)
Area B (latitude 09°N -14°N, longitude 82°E -85°E)
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