Sustainable Management of the Bay of Bengal
Large Marine Ecosystem (BOBLME)

GCP/ RAS/ 179/ WBG

REVIEW OF THE STATUS OF SHARED/ COMMON MARINE LIVING RESOURCE STOCKS AND OF STOCK ASSESSMENT CAPABILITY IN THE BOBLME REGION

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
APFIC	Asia-Pacific Fisheries Commission (formerly IPFC)
ASEAN	Association of South-East Asian Nations
BOB	Bay of Bengal
BOBC	IOFC Committee for the Development and Management of Fisheries in the Bay of Bengal
BOBP-IGO	Bay of Bengal Programme Inter-Governmental Organisation
BOBLME	Bay of Bengal Large Marine Ecosystem
BOBP	FAO Bay of Bengal Programme for Sustainable Fisheries Development
CBM	Community-based management
CCRF	Code of Conduct for Responsible Fisheries
COFI	Committee on Fisheries (of the FAO)
CP	Colombo Plan for Cooperative Economic and Social Development in Asia and the Pacific
EAF	Ecosystem approach to fisheries
EEZ	Exclusive Economic Zone
FAC	Fisheries Advisory Committee
FAO	Food and Agriculture Organization of the United Nations
FSA	Fish Stocks Agreement (Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks)
FSI	Fisheries Survey of India
GDP	Gross domestic product
GEF	Global Environment Facility
HDI	Human Development Index
ICCAT	International Commission for the Conservation of Atlantic Tuna
IFIOR	International Forum for the Indian Ocean
IOFC	Indian Ocean Fisheries Commission
IOMAC	Indian Ocean Marine Affairs Co-operation
IOTC	Indian Ocean Tuna Commission
IPFC	Indo-Pacific Fisheries Commission
IPTP	Indo-Pacific Tuna Development and Management Programme
ISRG	International Scientific Review Group
ISSCAAP	FAO International Standard Statistical Classification of Aquatic Animals and Plants
JWP	Joint Working Party of Experts on Indian Ocean and Western Pacific Fishery Statistics
LME	Large marine ecosystem
mmt	million metric tonnes
MSY	Maximum sustainable yield
NACA	Network of Aquaculture Centres for Asia
NOAA	US National Oceanic and Atmospheric Administration
PDF	Project Development Fund (of the Global Environment Facility)
PPP	Purchasing power parity
RCF	Regional Consultative Forum
RFMO	Regional Fisheries Management Organisation
SACEP	South Asian Co-operative Environment Programme
SAP	Strategic Action Programme
SEAFDEC	South-East Asian Fisheries Development Centre
TAC	Total allowable catch
TDA	Transboundary Diagnostic Analysis
TOR	Terms of reference
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Conference on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WSSD	World Summit on Sustainable Development

EXECUTIVE SUMMARY

1. This report summarises information and issues relating to the utilisation, assessment and management of shared fish stocks in the Bay of Bengal region. The report was carried out as a desk study and is based primarily on published documents and information that is in the public domain, national reports produced under the BOBLME programme, personal communications from specialists in the BOB region and elsewhere, and the author's own personal observations.

2. A number of problem areas are identified, as follows:

- overfishing. There is excess fishing capacity in many of the region's coastal fishery stocks, which is reducing productivity and threatening long-term sustainability;

- destructive fishing of various kinds is commonplace, and may be worsening in some areas. Destructive forms of fishing include use of dynamite and toxins to capture fish, net fishing for prawn larvae which destroys the larvae of other species, live coral mining, and bottom trawling which causes habitat alteration;

- fishery monitoring, control and surveillance arrangements are inadequate, giving rise to problems of unauthorised fishing, user conflict, and a general failure of centralised fishery management arrangements;

- pollution and unmanaged coastal development have widespread and sometimes severe negative impacts on fish stocks;

- processes for ensuring that stock assessment data are integrated into the fisheries management decision-making process are under-developed;

- there is an unrealistic expectation that stock assessment can provide robust, highly reliable measurements, rather than estimates;

- despite most fishery resources being shared among two or more countries, there are few bilateral or multilateral attempts to assess and manage stocks;

- fishery statistics for the region are insufficiently accurate in terms of the main species caught. A large proportion of the region's catch is classified as

miscellaneous categories, generic groupings, or ‘unidentified’. Statistics for the BOB region are difficult to segregate from data on the broader eastern Indian Ocean;

- taxonomic inconsistencies mean that where the catch is identified, the same organism may be reported as different species, or different organisms reported as the same species, among BOB countries;

- the availability of fishery-independent data is declining due to the high costs of running research vessels and carrying out field operations;

- apart from the tuna and allied species, for which management arrangements are progressively being developed through the IOTC, there is little or no attention being given in the region to the management of shared or straddling stocks. Most countries continue to exploit fishery resources within their waters without information on what additional exploitation may be occurring elsewhere on the same stocks;

- stock assessment capability in the region is limited in qualitative terms. There is a need for capacity building, both at the institutional and individual levels;

- there is a need for better communication between fishery scientists and decision-makers, so that the findings of stock assessment work are incorporated into management decisions;

- there is a need for more rigorous and objective fishery management arrangements to reduce the degree of discretion by senior decision-makers, and introduce the consensus views of fishery stakeholders. This should be done through the development of fishery management plans for key fisheries, focussing on shared stocks.

3. A number of specific activities are recommended to address these problems. These include improvements to fishery statistics, improvements to the taxonomic classification of fishery records, collation of historical fishery reports and data, production of synopses on key fisheries and resources, support to national fishery management planning and the collaborative management of shared stocks, and a human resource/ institutional development programme aimed at improving stock assessment

and communication skills in the fisheries community. The establishment of a specialised regional fisheries management support agency is proposed as a means of delivering these activities.

4. It is also proposed to carry out a pilot programme that will trial and demonstrate a coordinated approach to the management of a fishery that straddles an international boundary in the region. Because of the likely high cost and extended time frame of such an exercise, it is recommended to focus on a single pilot activity, rather than multiple smaller projects. The proposed location of the pilot project is in the Gulf of Mannar, between India and Sri Lanka. It is not recommended that this pilot project be managed by the proposed regional fisheries management support agency. Rather, the project should be run by an appropriate combination of national and state governments and NGOs, with the proposed regional fishery support agency providing technical advice and information.

I. INTRODUCTION

A. Background to the present report

5. In September 1997 the Global Environment Facility (GEF) committed financial support from its Project Development Fund (PDF) to a project entitled *Sustainable Environmental Management of the Bay of Bengal Large Marine Ecosystem*[1]. Funding of US$349,000 was provided in the form of a GEF Block B grant, with co-financing of a further $350,000 from the Government of Sweden, and additional in-kind support from the US National Oceanic and Atmospheric Administration (NOAA), as well as from countries of the Bay of Bengal (BOB) region. BOB countries participating in the project are Maldives, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia. The proposal was submitted to GEF on behalf of these countries by the Food and Agriculture Organization of the United Nations (FAO). Government of India endorsement of the proposal was provided in November 1999, after a long delay, and a Memorandum of Agreement between the World Bank and FAO for execution of the project was signed in July 2000. The project is now being implemented by FAO through the BOB Large Marine Ecosystem (BOBLME) Programme.

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1 More information on Large Marine Ecosystems is shown at Appendix 1.

6. The project is regarded as the first phase of a long-term programme for managing the Bay of Bengal large marine ecosystem (LME). The purpose of the project is to prepare a Transboundary Diagnostic Analysis (TDA) of issues affecting the area and to define the scope and process for preparing a Strategic Action Programme (SAP) for the management of the LME. The TDA provides a sound scientific basis for action under the SAP, which must be fully understood by all stakeholders. Conducting a TDA is the first step in building stakeholder ownership at both the national and the regional levels. The TDA identifies and quantifies water-related environmental issues and problems. It is conducted at the national level by scientists, managers and local experts. The output of a TDA should be a scientifically sound public document, but unlike the SAP should not be subject to political approval. (Pernetta 2002).

7. The BOBLME SAP is being prepared by a Regional Task Force which is considering information on the current status of national and international waters in the region, environmental and other threats to them, and options for their future management. The SAP is intended to address not only environmental and management issues which have a clear international dimension, but also national level problems which are replicated in more than one country. The preparation of the SAP began with the First BOBLME Regional Workshop held in Pattaya, Thailand in February 2002.

8. To assist the Task Force in its work, reviews of key issues relating to the use and management of international waters have been commissioned, covering five broad areas: (1) Status of Living Marine Resources, and Stock Assessment Capability; (2) Land-Based Sources of Pollution; (3) Livelihood and Food Security (4) Critical Habitats and Species; and (5) Institutional Mechanisms for Management of the LME. The present report comprises review number (1), and is intended to be considered in conjunction with the other studies.

9. The terms of reference (TOR) for the present review are to describe the current status and level of use of shared and common marine living resource stocks, with a particular focus on fisheries, and to assess the marine living resource stock assessment capability in the BOB region. The review further aims to; identify trans-boundary problems relating to these areas; analyse the root causes of such problems; identify current attempts to address them; describe any knowledge gaps that impede the development of solutions; suggest actions that should be taken to eliminate the knowledge gaps; propose other solutions to the problems identified; and suggest

priorities for action in response to the above issues. The review was conducted as a desk study, without country visits or direct consultations with stakeholders, and is thus based primarily on literature and information that is readily available in the public domain.

10. The definition of fisheries used in the present report is the same as that used in most pieces of fishery legislation in the region. Fisheries involve the harvesting or other extractive use of naturally-occurring living marine resources irrespective of their phylogenetic classification and including, *inter alia*, adults, juveniles, eggs and miscellaneous parts of fish, invertebrates, plants and other organisms that rely on the marine environment for some part of their life cycle. In the present report 'fisheries' are not considered to include aquaculture or non-extractive resource uses such as tourism, although these types of use are discussed where appropriate.

11. Fisheries management in the BOB region encompasses a wide range of situations and issues, from customary systems of marine tenure practised by coastal communities, through national fishery development and governance, to participation in the international management of resources that straddle the Indian Ocean and which are harvested by the fishing vessels of many different nations. Managing the use of these widely differing resources is implicitly linked to aspects of marine resource biology, economic conditions inside and outside the region, pre-existing patterns of fishery exploitation, and the requirements imposed by customary practices and other socio-cultural factors.

12. Finalisation of the present review was considerably aided by the BOBLME Programme International Scientific Review Group (ISRG), whose members provided insightful and valuable commentary on the first draft. Substantial amendments were made in response to the nine reviews received, and in some cases direct quotations or material provided by the reviewers have been incorporated into the report, thereby hopefully improving its quality and relevance. The views expressed are nevertheless those of the author, who takes responsibility for them, and for any errors of fact or interpretation that the report may be found to contain.

13. In the present report expressions in the masculine gender are intended also to include the feminine gender, and vice versa, unless the context clearly implies otherwise.

B. The Bay of Bengal region

14. The Bay of Bengal is an arm of the Indian Ocean, between India on the west and the Malay Peninsula on the east, measuring about 2,090 km long by about 1,600 km wide. For the purposes of this report, The Bay of Bengal region is defined as including selected coastal and EEZ areas of eight countries (Maldives, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia) as well as the international waters between them. The disposition of these countries around the Bay, as well as the extent of their EEZs, is shown below.

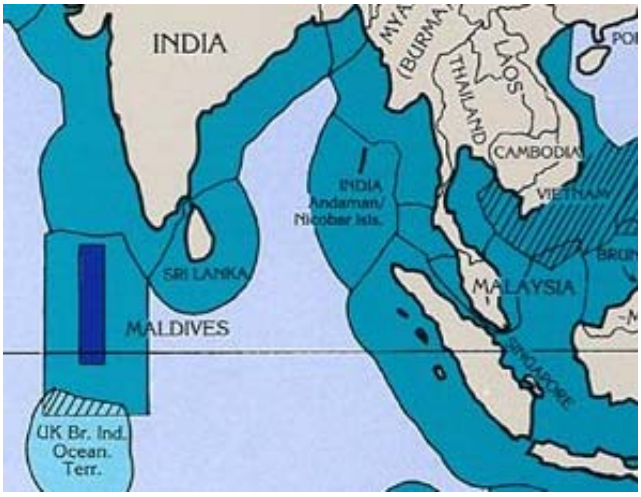

Figure 1: Countries of the Bay of Bengal Region showing estimated EEZ areas (Source: Woods Hole Oceanographic Institution USA)

Figure 2: Extent of the BOBLME (Source: US NOAA)

15. The Bay is generally considered to extend southwards beyond Sri Lanka, and as far as the coastlines of Thailand, Malaysia and the Indonesian island of Sumatra that border on the Andaman Sea and the Straits of Malacca, after which it merges into the waters of the Western Indian Ocean. For purposes of the present project, as well as other projects such as the FAO Bay of Bengal Programme (BOBP), the Bay is also deemed to include Maldives in the west[2]. However most representations of the Bay of Bengal LME, such as that shown in the figure below, indicate the limits of the LME as excluding the Maldives.

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[2] The BOBP was executed in three phases over an approximately 20-year period. Maldives was not included in the first phase as it was not considered to be in the BOB region, but applied to join the BOBP during its second phase.

16. Depending on where the limit of the Bay is taken to be, about 70 – 75% of the BOB LME lies within the EEZs of BOB countries, with the remainder being high seas area outside of any national jurisdiction. The countries with the greatest extent of EEZ area in the Bay are, from largest to smallest: India, Myanmar, Sri Lanka, Indonesia, Thailand, Bangladesh and Malaysia. The position of Maldives is open to interpretation: if it is considered to be in the Bay, then it has the second-largest EEZ area, after India. Sri Lanka, Bangladesh and Myanmar have 100% of their coastlines within the BOB area, while other countries have only parts of their coastline in the Bay, as shown in the table below. Again the position of Maldives is open to interpretation.

Table 1: Maritime area statistics for BOB countries (Source:BOBLME national reports, FAO National Fisheries Profiles)

	Land area (thousand sq.km)	EEZ area (thousand sq.km)	Coastline length (km)	Coastline in BOB
Bangladesh	144	41	480	100%
India	3,287	2,020	8,041	56%
Indonesia	1,905	3,100	81,000	?
Malaysia	330	450	4,810	12%
Maldives	0.3	1,000	?	?
Myanmar	677	486	2,280	100%
Sri Lanka	66	517	1,770	100%
Thailand	513	?	2,624	39%

17. The BOB is located in the tropical monsoon belt and is strongly affected by monsoons[3], storm surges, and cyclones. On the western coast of the bay the harbours are poor, but on the eastern coast are many good ports, such as Sittwe, Moulmein, and Tavoy, all in Myanmar. The islands in the bay include the Andaman and Nicobar groups of India.

18. Several large rivers flow into the bay: the Ganges and the Brahmaputra on the north; the Irrawaddy on the east; and the Mahanadi, the Godavari, the Krishna and the Cauvery on the west. These rivers introduce large quantities of silt into the Bay from July-September during the summer monsoon season. The sediment loading in the

[3] The monsoon is a wind that changes direction with the change of seasons, and prevails mainly in the Indian Ocean. It blows from the south-west, generally from April to October, and from the north-east from October to April. The south-west, or summer, monsoon occurs when warm, moist air from the Indian Ocean flows onto the land, and is usually accompanied by heavy rain in areas of South and South-East Asia, constituting the dominant climatic event of the area. The north-east monsoon occurs when cold, dry winter air flows out of the interior of Asia from the north-east and brings the cool, dry winter season.

Ganga-Brahmaputra watershed caused by accelerated soil erosion in the Himalayas is considered to be one of the main factors contributing to downstream flooding.

19. The surface circulation of the BOB is characterized by a large cyclonic gyre, which reverses during the monsoon period (clockwise from January to July, anti-clockwise from Ausgust to December) (Lamboeuf, 1987: Sherman, 1998). The influx of fresh water from the major rivers impacts the salinity and productivity of the coastal and estuarine waters as well as coastal circulation patterns, especially in the north of the Bay. Conversely, during the season of current reversal, saline water invades the estuaries and lower reaches of coastal rivers. Monsoon rain and flood waters have a strong influence on the dynamics of the Bay, producing a warm, low-salinity, nutrient and oxygen-rich layer to a depth of 100 meters. The BOB LME is considered a moderately productive (150-300 gC/m2-yr) ecosystem. Benthic phytoplankton and zooplankton production is higher in the coastal areas, which receive nutrient-rich waters.

II. LIVING MARINE RESOURCE UTILISATION

A. Fishery statistics

20. Statistics on fishery catch and effort in the BOB region are fragmentary and unreliable. The most comprehensive source of fishery statistics for the region as a whole is FAO, which compiles summary information primarily from national reports submitted by government agencies. According to FAO, financial support for the collection and collation of fishery data has decreased in real terms over the past decade, and data are not fully reliable in terms of timeliness, coverage and quality. Data are often submitted after delays of one, two or more years. The proportion of the catch to be identified at the individual species level has tended to decrease over time, while ‘unidentified fish’ account for an increasing share as fisheries diversify and large stocks are depleted. The general availability of statistics has not improved significantly over the past two decades, and statistics from artisanal and subsistence fisheries – which dominate in the BOB region – are a particular source of concern. As a result, although the available statistics probably do reflect general trends such as growth in production, annual figures and assessments involve considerable uncertainty, and changes from one year to the next may not be statistically meaningful. (FAO 2002)

21. For statistical purposes, FAO divides the world into 29 principal freshwater and marine fishing areas. The BOB previously straddled two of them: Maldives, Sri Lanka and the Indian state of Tamil Nadu fell into area 51 (Western Indian Ocean), with the remainder of the BOB region in area 57 (Eastern Indian Ocean). In 2001 the boundary between the two statistical areas was amended so that the entire BOB region, except for Maldives, now falls into area 57.

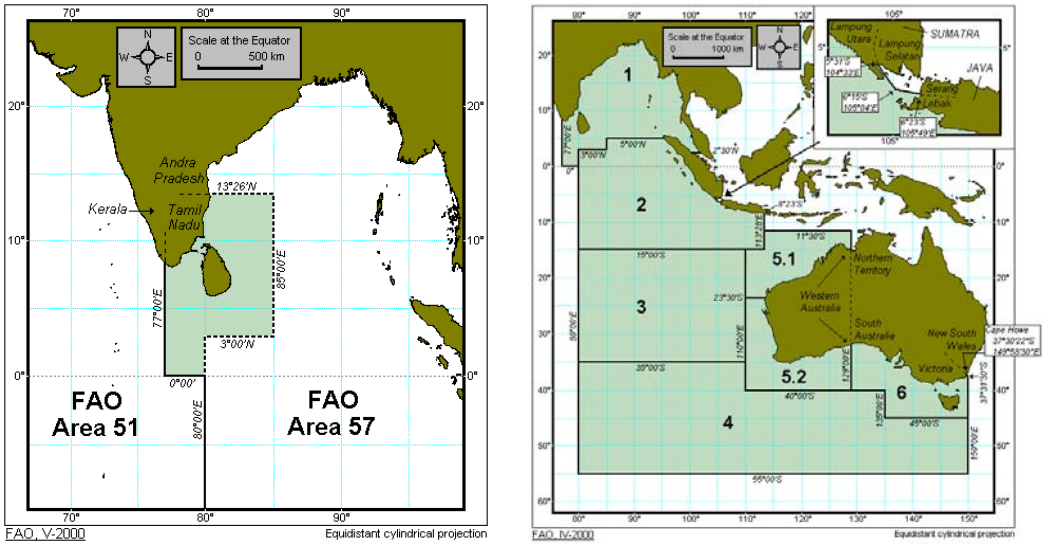

Figure 3: Boundary amendment to FAO statistical areas 51 and 57, approved and operational as of 2001, and proposed subdivision of amended area 57 (Source: FAO Fisheries Department)

22. In 1969 the Joint Working Party of Experts on Indian Ocean and Western Pacific Fishery Statistics (JWP) proposed, through the Indian Ocean Fisheries Commission (IOFC), the establishment of a series of sub-areas for statistical areas 51 and 57. Sub-area 1 of statistical area 57 corresponds roughly to the BOB LME region, (excluding the Maldives), as shown in the figure.

23. Unfortunately statistics have never been routinely broken down by these statistical sub-areas. In the early 1970s FAO developed and distributed a questionnaire for the collection of species and country statistics at the sub-area level. Data received from countries by FAO during the 1970s and 80s were kept in files as paper documents but, apparently due to the lack of interest by the IOFC, were never computerized. The JWP was subsequently dissolved and the last year in which the questionnaire was dispatched was 1989. (A. Crispoldi, FAO FIDI, pers. comm.).

24. Tracking changes and trends in fishery production in the BOB region would be made considerably easier if data summaries were available at this level. FAO has indicated that, if there is renewed interest in the existing historical data records, it may be possible for FAO to devote some resources to making the data accessible (A. Crispoldi, FAO FIDI, pers. comm.). Equally important would be the development of a mechanism to capture current and future data at the scale of the BOB region itself, rather than the broader Eastern Indian Ocean.

B. Marine fishery production

25. World fishery production was estimated to be 128 million metric tonnes (mmt) in 2001, of which about 86.0 mmt was from marine capture fisheries (FAO, 2002)[4]. Three of the world's biggest marine fish producing countries (Indonesia, number 5 with 4.2 million metric tonnes in 2001; India, number 7 with 3.8 mmt; and Thailand, number 9 with 2.9 mmt) are in located in the BOB region[5]. Of course not all the production from these countries comes from the Bay itself, since many of their fishing operations take place in other areas. The table below shows fishery production by BOB countries in FAO statistical area 57, which encompasses the BOB as well as other areas of the Eastern Indian Ocean south of the Bay, and by Maldives in FAO statistical area 51. Also included in the table are estimates of total marine fishery landings presented in the BOBLME national reports, along with the year to which the estimate applies.

Table 2: Estimated marine capture fishery production by BOB countries in recent years (Source: FAO FISHSTAT/ BOBLME national reports)

	FAO data (tonnes)			BOBLME national reports	
Country	**1999**	**2000**	**2001**	**Tonnes**	**Year**
Bangladesh	137,345	162,037	258,700	367,000	2000-01
India	716,753	781,223	741,656	820,000	1997
Indonesia	782,848	785,530	810,710	-	-
Malaysia	389,960	395,001	377,376	535,188	2000
Myanmar	731,664	849,018	900,492	1,168,000	2000-01
Sri Lanka	241,005	260,010	247,890	274,760	2002
Thailand	685,365	677,894	669,229	750,124	2000
Sub-total area 57	**3,684,940**	**3,910,713**	**4,006,053**		
Maldives	134,423	135,342	125,575	141,000	2002
Grand total	**3,819,363**	**4,046,055**	**4,131,628**		

[4] More information on world fishery production s shown at appendix 2.

[5] India, Bangladesh and Indonesia are also in the top 5 inland fishery producers.

26. As can be seen, there is some discrepancy between the FAO figures and those from the BOBLME national reports, with the latter in all cases reporting higher catches than those estimated by FAO. In this context, it may be worth quoting the words of a knowledgeable expert on the workings of BOB fishery agencies: 'The desire to show increased marine and freshwater fishery landings, for the governments to gain political mileage, has contributed to the weakening of the fisheries statistics programme and the methods of estimating production…' (Sivasubramaniam, 2004).

27. The FAO figures indicate that total production in statistical area 57 by BOB countries, excluding Maldives, has recently topped 4 million tonnes. However it is likely that some countries take a significant portion of their catch outside the BOB (i.e. in proposed sub-areas 2-6 of statistical area 57). For instance Martusubroto (2002) estimates that only 25% of the Indonesian catch from statistical area 57 is taken in the BOB. It is likely that some of the Thai catch is also taken outside the BOB, and some Sri Lankan vessels are known to fish in the Western Indian Ocean even though their catch is included in the statistics from area 57. A more realistic estimate of production from the BOB itself may therefore be closer to 3.25 million tonnes. If the Maldives catch from statistical area 51 is also to be included, the total rises to about 3.38 mmt.

28. If the assumptions above are correct, and assuming the FAO statistics can be relied on, then Myanmar is the region's most important fishing nation in terms of production volume taken from inside the BOBLME, followed by India, Thailand, Malaysia, Bangladesh, Sri Lanka and, lastly, Maldives. Despite having the lowest marine fishery catch of any country of the region, Maldives is the BOB nation that depends most on fishery resources for its economic and dietary well-being.

29. Fisheries in the BOB target a wide range of species that include, among others, sardines, anchovies, scads, shads, mackerels, snappers, emperors, groupers, congers, pike-eels, tunas, sharks, ornamental reef fish, shrimps, crabs, lobsters, octopus, gastropod and bivalve shellfish, sea cucumbers and seaweeds[6]. There has been a generally increasing trend in production, as shown below, such that catches in 2000 were estimated to be about ten times higher than in the 1950s. This equates to an annual rate of increase of about 4.7% per year.

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6 FAO categorises its fishery statistics for the Eastern Indian Ocean into 164 'species items' (individual species or species groups).

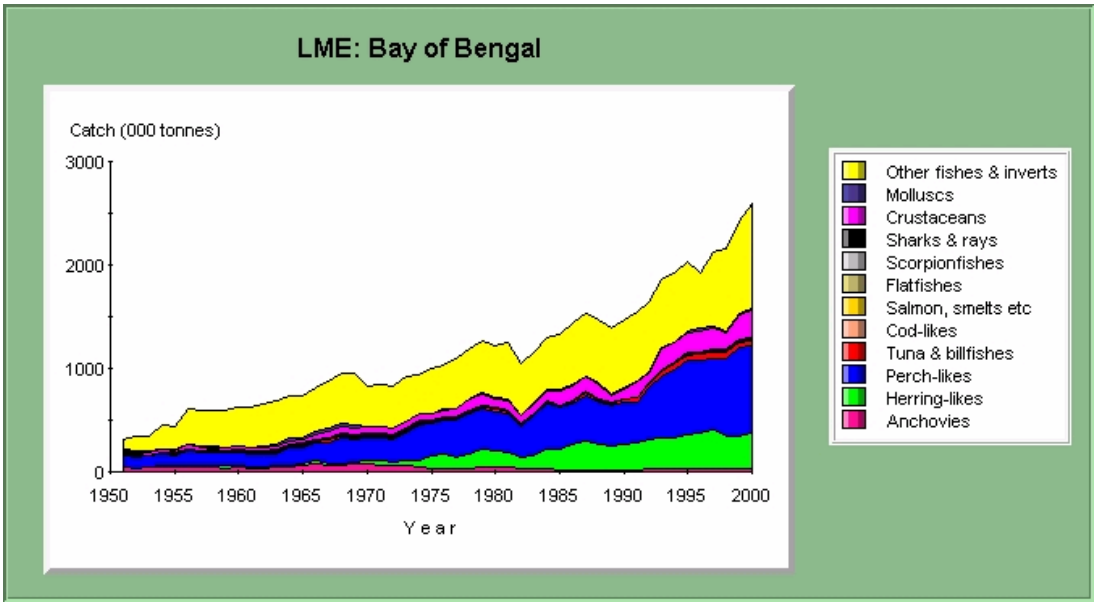

Figure 4: Trends in capture fishery production from the BOB LME by main species group (Source: FAO Fisheries Department)

30. The table below shows estimates of marine fishery capture production by species group in 2002.

Table 3: Major species groups contributing to fishery production in BOB countries, 2002 (Source: FAO FISHSTAT)

	FAO International Standard Statistical Classification of Aquatic Animals and Plants group									
Country	**31: Founders, halibuts, soles**	**32: Cods, hakes, haddocks**	**33: Miscellaneous coastal fishes**	**34: Miscellaneous demersal fishes**	**35: Herrings, sardines, anchovies**	**36: Tunas, bonitos, billfishes**	**37: Miscellaneous pelagic fishes**	**38: Sharks, rays, chimaeras**	**39: Marine fish not identified**	**Total**
Bangladesh	0	0	0	0	0	60	0	0	158,640	158,700
India	2,344	32	218,708	56,777	96,044	25,112	80,103	38,352	224,004	741,656
Indonesia	12,020	0	131,300	18,110	149,400	203,310	208,960	32,850	54,760	810,710
Malaysia	2,036	0	51,045	3,764	13,538	12,302	89,470	6,281	198,940	377,376
Maldives	0	0	0	0	0	110,069	0	11,935	3,571	125,575
Myanmar	0	0	0	0	0	0	0	0	0	900,492
Sri Lanka	0	0	0	12,290	53,230	104,060	28,710	22,860	26,740	247,890
Thailand	9,341		86,953	19,477	92,212	12,835	127,735	8,337	321,339	669,229
Total area 57	**25,741**	**32**	**488,006**	**110,418**	**404,424**	**467,748**	**534,978**	**120,615**	**987,994**	**4,031,628**
Maldives						110,069		11,935	3,571	125,575
Grand total	**25,741**	**32**	**488,006**	**110,418**	**404,424**	**577,817**	**534,978**	**132,550**	**991,565**	**4,157,203**

31. The data indicates that about a quarter of the 2002 catch from the BOB proper, or approximately one million tonnes, is classified as ‘Marine fish not identified’, while a further 28% (1.13 mmt) falls into the three ‘miscellaneous’ categories used by FAO.

The imprecise nature of the statistics introduces considerable unreliability into any conclusions that may be drawn from them.

32. As well as incomplete identification of a large proportion of the catch, there are also problems of misidentification and of comparative taxonomy among BOB countries. Sivasubramaniam (2004) writes: ‘countries have followed their own ways establishing the taxonomic names of marine species that are in the coastal waters of the respective countries. There has been no attempt to compare and establish if there are synonyms, different species or erroneous identifications. Consequently, we are presently facing difficulties, as we expand our horizon in the area of marine environment, identity of stocks and biodiversity.... It is very important to establish some form of standardisation among the countries within the BOBLME, before we start looking into problems of shared resources, different species in different EEZs’.

33. Of the properly defined species categories, group 36 (tunas, bonitos and billfishes) is the most important, making up about 11.6% of the catch from area 57 (13.9% if Maldives is included in the calculation). As noted earlier, however, it is likely that a large part of Indonesia’s tuna catch is taken outside the BOB proper. Correcting for this gives Group 36 a 9.2% share of the catch, or 12% if Maldives is included. Group 35 (herrings, sardines and anchovies) is of equal or greater importance, making up about 12% of the total area 57 catch after correcting for the Indonesian take outside the BOB region. Unlike tunas, members of Group 35 are primarily coastal in nature, and are thus probably all caught inside the BOB region.

C. Economic value of fisheries

34. Despite their generally large populations, BOB countries have relatively small economies. In terms of GDP, none of them ranks among the world’s top ten (India is number 11, Indonesia number 26). Major contributors to GDP include agriculture, mining, manufacturing, utilities, construction, trade, transport and communications, finance, public administration. Other activities, such as tourism, are important to certain countries. In some, especially Maldives, tourism is intimately linked with the quality of the coastal environment.

Table 4: Estimates of gross domestic product for BOB countries, 2002 (Source: World Bank/ ADB/ UNDP)

	GDP (USD millions) (2002)	GDP/ capita (USD) (2002) (crude)[7]	GDP/ capita (USD) (2002) (PPP method)[8]
Bangladesh	47,328	349	1,610
India	515,012	491	2,840
Indonesia	172,911	817	2,940
Malaysia	95,157	3,915	8,750
Maldives	618	2,153	4,798
Myanmar	51,436	1,006	1,027
Sri Lanka	16,373	863	3,180
Thailand	126,407	2,051	6,400

35. Economic statistics generally classify fisheries as part of the broader agriculture sector, making it difficult to obtain accurate statistics on their economic importance. As a result, estimates of the contribution of fisheries to gross domestic product (GDP) vary widely. Despite the discrepancies among estimates, however, it is clear that in general fisheries make only a modest contribution to the GDP of most BOB countries, as shown in the table below. The exception is Maldives, where fisheries contribute over 11% to GDP.

Table 5: Estimated contribution of fisheries to GDP in BOB countries, various years (Source: FAO country fishery profiles)[9]

	Contribution to GDP (%)	Year estimate published
Bangladesh	4.0	1999
India	1.3	2000
Indonesia	2.0	2000
Malaysia	1.57	2001
Maldives	11.1	1998
Myanmar	7.2	2001
Sri Lanka	3.0	1998
Thailand	1.9	2000

7 GDP at purchaser prices is the sum of gross value added by all resident producers in the economy plus any product taxes (less subsidies) not included in the valuation of output. It is calculated without making deductions for depreciation of fabricated capital assets or for depletion and degradation of natural resources. (World Bank, 2003).

8 Crude GDP per capita is calculated by converting a country's GDP into USD using prevailing exchange rates. This takes no account of the differences in prices of traded good in each economy (for instance an item in one country may be much cheaper in another country). Purchasing power parity (PPP) adjustments allow for different product prices and give a more meaningful comparison of the relative purchasing power of income in each country's currency than a simple conversion.

9 The BOBLME national reports provide differing estimates of the contribution of fisheries to GDP. FAO data have been used here because the estimates are all from the same source.

36. Fisheries are nevertheless of major socio-economic importance to BOB countries, and provide direct employment to an estimated 2 million fishermen who operate primarily in coastal and inshore waters. The Indian Ocean in general, and the BOB within it, differs from other oceans of the world in that production from artisanal fisheries equals or exceeds that from industrial fisheries. In Bangladesh, for example, less than 5% of marine landings are estimated to come from industrial fishing activities, with the rest being produced by artisanal fishers (Haossain, 2003).

37. Small-scale fisheries in the region use gill nets, trammel nets, purse-seines, beach seines, push-nets, various kinds of fixed nets and traps, troll lines, pole-and-line gear and longlines (not to mention dynamite and cyanide) to target a wide range of species. These fisheries often involve disadvantaged groups (poorer fishing villagers, women, and migrant families). The importance of the region's small-scale fisheries has continued to increase in recent years and artisanal craft are ranging over progressively larger areas.

38. A characteristic of artisanal fisheries in the BOB region is the low volume of discards, since almost all components of the catch are consumed. Fish constitute a generally affordable source of protein in the BOB, and most of the inshore catch is used for local or domestic consumption, contributing significantly to dietary health and food security, particularly in coastal areas. The table below shows data used by FAO to derive estimates of apparent per capita fish supply in the BOB region.

Table 6: Apparent consumption of fish and fishery products in BOB countries, 1997-1999 average (Source: FAO)

	Production	Non-food uses	Imports	Exports	Food supply	Population (thousands)	Per capita supply (kg)
	All in metric tones						
Bangladesh	1,386,571	7,250	1,495	41,125	1,339,691	131,813	10.2
India	5,325,424	413,811	7,847	376,678	4,542,780	976,346	4.7
Indonesia	4,615,030	52,274	23,783	669,814	3,916,836	206,412	19.0
Malaysia	1,325,052	278,252	347,826	163,400	1,231,576	21,350	57.7
Maldives	126,257	3,000	0	67,842	55,692	274	203.3
Myanmar	940,566	131,905	1,066	190,217	731,724	46,452	15.8
Sri Lanka	263,917	21	125,373	11,628	377,658	18,573	20.3
Thailand	3,422,989	959,366	718,018	1,434,068	1,748,474	61,190	28.6
Total	**17,405,806**	**1,845,879**	**1,225,408**	**2,954,772**	**13,944,431**	**1,462,410**	**9.5**

39. Per capita supply of fish in most countries of the region is well above the world average of about 15.8 kg/ year, and is extremely high in Maldives and, to a lesser degree, Malaysia. The data used to compute these figures include non-coastal

populations, some of which have limited access to fishery products. The per capita supply of fish is undoubtedly considerably higher among those coastal populations of BOB countries that rely more heavily on marine fisheries.

40. Although most fishery production is consumed domestically, there are substantial exports of high-value commodities, as the table indicates. Primary export commodities are shrimp and tuna, which may contribute significantly to national foreign exchange earnings in BOB countries. Overexploitation of shrimp resources in coastal waters has reduced the amount of exports from capture fisheries, and there is now a growing tendency for exports to come from the aquaculture sector. During the last decade some countries have developed offshore fishing for tuna, notably longlining by Indonesia, purse seining by Thailand and gill-netting by Sri Lanka. While the majority of tuna catches continue to come from coastal fisheries, offshore fisheries provide the majority of export-grade tuna. Squid is commercially important, although its production is small, with only Thailand producing relatively high catches. As with the other export fisheries, the proportion of production in value terms far exceeds their share of volume.

D. Shared stocks

41. Most of the living marine resource stocks on which the BOB's fisheries are based traverse the international boundaries of adjacent, and sometimes non-adjacent, countries. Large pelagic species such as tunas and billfishes may move over large ocean ranges and pass through the EEZs of many countries (not just those of the BOB). Smaller pelagic species such as anchovies, herrings and shads are not individually mobile on such a large scale, but may still migrate through the coastal waters of two or more neighbouring countries. Some small pelagic species are distributed along the coastlines of all BOB countries, and their range may extend well beyond the BOB to the east or west, or both. The rainbow sardine, *Dussumeria acuta*, is one example of a species that falls into this category. Resources which appear to be sessile or only locally mobile, such as reef fish, lobsters, sea cucumbers and even corals may have patterns of larval dispersal that give their distribution an international dimension. Tropical lobsters (genus *Panulirus*), for instance, have a pelagic larval lifespan that may last from 4-12 months, during which period the larvae may travel thousands of miles from the place of birth to the place of adult settlement. Fisheries or extractive activities based on these stocks in one country may be replenished by recruitment that originates in another

country. Intensive fisheries in several countries that, knowingly or unknowingly, all target the same stock have the potential to cause overfishing and stock decline or collapse.

42. Unfortunately, accurate identification of specific shared stocks is difficult because of the poor quality of fishery statistical information discussed earlier, and because of taxonomic difficulties or inconsistencies with their identification. Despite this uncertainty, however, there are numerous examples where fisheries of several BOB countries target what are thought to be the same stocks, and where joint research and management action could provide multi-country benefits. The table below lists several important fishery groups which, based on the BOBLME national reports and other sources, appear to fall into this category.

43. Many of these shared stocks are from the group of small pelagics whose abundance usually depicts strong interannual fluctuations and is subject to climatic changes. The high variability in both stock abundance and migratory behaviour poses a particular challenge in their collaborative management. There is nevertheless little doubt from experiences elsewhere that in the absence of joint management, small pelagic species can be fished down to low and possibly unsustainable levels (Martusubroto 2002).

Table 7: Examples of likely shared or straddling stocks in the BOB region

Common name	Scientific name	Countries primarily concerned
Hilsa/ Terubok	*Ilisha/ Hilsa/ Tenualosa spp*	All except Maldives
Small tunas	*Auxis thazard, Euthynnus affinis*	All except Bangladesh
Short mackerel	*Rastrelliger brachysoma*	Indonesia, Malaysia, Thailand, Myanmar
Indian mackerel	*Rastrelliger kanagurta*	Indonesia, Malaysia, Thailand, India, Sri Lanka
Spanish mackerel/ seerfish	*Scomberomorus spp*	India, Bangladesh, Myanmar
Oil sardine	*Sardinella longiceps*	India, Sri Lanka,
Bali sardinella	*Sardinella lemuru*	Thailand, Indonesia, Malaysia
Rainbow sardine	*Dussumeria acuta/ elopsoides*	All, especially southern India/ Sri Lanka
Indian pellona	*Pellona ditchella*	All except Maldives
Goldstripe sardinella	*Sardinella gibbosa/ fimbriata*	All except Maldives
Indian scad	*Decapterus russelli*	All
Indian halibut	*Psettodes erumei*	Indonesia/ Thailand
Bombay duck	*Harpodon nehereus*	India, Bangladesh, Indonesia
Black pomfret	*Parastromateus niger*	Indonesia, Thailand, India, Sri Lanka
Sea catfish	*Arius maculatus, A. thalassinus, others*	All except Maldives

44. Highly migratory tuna and tuna-like species are of particular importance for the fisheries in Sri Lanka and the Maldives, and to a lesser extent in India, Indonesia, Malaysia and Thailand. North of the equator, the main concentrations of these species occur in the Western Indian Ocean. In the Eastern Indian Ocean, the concentrations are more in the southern areas and outside the Bay of Bengal LME. The extent of migration of these species is such that management needs to be approached on an ocean-wide basis.

45. Not all the listed stocks are pelagic species. A neglected but important component of the catch in some countries is made up of sea catfish of the family Ariidae. In recent years this group has comprised 10% of the marine fish catch in Bangladesh, and 4.3% in India, yet little is known about its biology or population dynamics, and in fishery statistics sea catfish are reported by family or order rather than species.

46. Despite the shared nature of most BOB fish stocks, there have been relatively few detailed, multi-country studies on them. One group that has been the focus of recent attention, however, are the tropical shads of the clupeid genus *Tenualosa*[10]. Five species of tropical shads (Clupeidae: *Tenualosa* species) (known locally as Terubuk in Indonesia, Terubok in Malaysia, Hilsa in the Indian sub-continent and Pha Mak Pang in Thailand) live in estuaries and coastal waters throughout the BOB region. The most widespread and well-studied species is *Tenualosa ilisha*, which is found in all BOB countries except Maldives, and is the basis of important fisheries throughout its range. The closely related *T. reevesi* occurs intermittently along the South China coast and far up the Yangtze, Pearl and Qiantang rivers. Once widespread, *Tenualosa toli* is now common only in the estuaries and adjacent coastal areas of Sarawak. *T. Thibaudeaui* only lives in the lower and middle Mekong system and is believed to be close to extinction, and *T. macrura* lives in the coastal waters of Sumatra and Borneo. (Blaber, Brewer et al. 2001).

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[10] Not all authorities have adopted the revised taxonomic nomenclature used here. Older generic names of *Hilsa* and *Ilisha* are still used in various recent publications, including FAO Species Identification Sheets for Fishery Purposes.

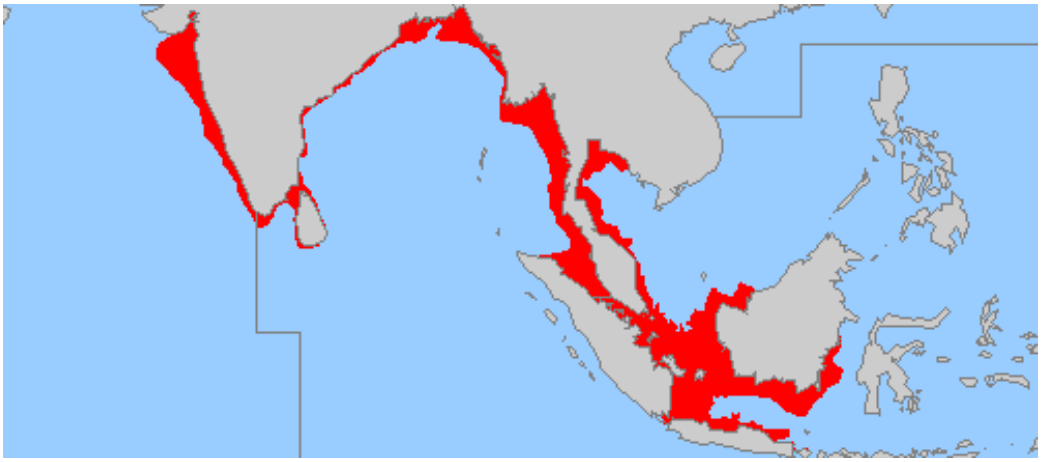

Figure 5: Distrubution map of *Tenualosa toli*
(Source: FAO Fisheries Department)

47. All five species are the subject of important and valuable fisheries, but all have suffered heavy declines in catches as a result of excessive fishing pressure. *Tenualosa toli* and *T. Thibeaudi* are thought to be close to commercial extinction, primarily due to fishers targetting the spawning females for the roe, which command very high prices.

48. A joint research project between Malaysian and Australian fishery research agencies established that different *Tenualosa* species exhibit varying life history strategies; for example, that *T. toli* and *T. macrura* change sex (male first year, female second year), while *T. ilisha* and *T. reevesii* do not. Habitat preferences, movement patterns and maximum age also vary between species. In the case of *T. toli*, research findings that the species lives for only two years, that it only spawns in three very specific localities, and that it is possible to culture the species for re-stocking, has led to opportunities to save the species and the fishery. As a result of this work, new collaborative projects on *T. ilisha* in Bangladesh and Indonesia, and *T. macrura* in Indonesia and Sarawak, are being developed (Blaber, Brewer et al. 2001).

49. Not all shared stocks are of major importance to fisheries, but there may be other reasons why they should receive research and management attention. In some cases excess fishing pressure, environmental degradation or other factors may be leading to serious depletion and possible localised extinction of species which may have only formed a minor part of the commercial catch. For example Sampath (2003) notes that, in India, ‘certain commercially threatened marine finfish due to indiscriminate fishing are the whale shark *Rhiniodon typus*, marine catfish of the genera *Tachysurus* and *Osteogrneousus*, the white fish *Lactarius lactarius*, the flat head

Platycephalus maculipinna, the threadfins *Polynemus indicus* and *P. heptadactylus*, the sciaenids *Pseudoscianena diaqcanthus* and *Otolithoides brunneus*, the perch *Pomadasys hasta*, and the eel *Muraenosox*.' There may thus be arguments for joint research and stock assessment on fishery species because they are threatened or endangered, rather than because they are of great commercial importance.

E. Effect of traditional ownership and customary use rights

50. The BOBLME national report for Maldives states that open access to fishery resources is the historical norm. In other countries of the BOB region, however, many coastal living marine resources are, or were, subject to customary rights of use or ownership. These remain particularly strong in, for example, the coastal lagoons of India and Sri Lanka, where ownership rights are well-demarcated, resembling those that apply to inland lakes and tanks. In these areas strict rules exist in regard to fishing areas, seasons and gears, with the rights to fish often being passed down from one generation to the next. In such locations the physical nature of a semi-enclosed lagoon lends itself to monitoring and control by the customary rights owners. In open or non-enclosed waters where 'enforcement' by customary owners is more difficult, coastal dwellers have seen their traditional user rights progressively eroded in the face of commercial fisheries development, coupled with central government fishery management policies that, overtly or tacitly, give recognition to the principles of open access and the right of 'outsiders' to fish in areas that were previously the domain of local residents.

51. There are some areas within the BOB where the traditional rights of coastal resource users remain in place, or are being re-established through community-based management arrangements. Phang Nga Bay in Thailand is one such area where local communities have increasingly reasserted their will over the way 'their' marine resources are used. However in many more areas traditional use rights have been replaced by essentially open access fisheries where local dwellers have no more rights than those from elsewhere. This has led to many examples of user conflict, especially where commercial fishermen from afar (often bottom trawlers) come to exploit the same resources that local artisanal fishermen traditionally used.

52. In most BOB countries, declining resources and user conflicts are coupled with the failure of centrally-based fishery management arrangements to cope with a wide

range of problems, from destructive fishing to illegal entry by foreign fishing vessels. This has led to a renewed interest in locally-based fisheries management, sometimes referred to as community-based management (CBM) or co-management, in which the government advises and assists stakeholders to develop acceptable management arrangements which they will themselves enforce. To be effective, co-management requires the devolution of power and authority from higher levels of government down to locally-constituted bodies, which may range from local authorities or communities, to committees made up of a representative selection of stakeholders in the fishery. This in turn requires enabling legislation at the national or state level, coupled with appropriate local by-laws that give effect to the co-management arrangements in question.

53. Co-management is not yet widespread in the BOB at present, but is likely to become increasingly common in the future. This will represent a reversal of the trend towards open access fisheries, in favour of placing control of fishery resources back in the hands of those who have the most to gain from using them sustainably over the longer term.

III. STOCK ASSESSMENT

A. Methodology

54. A preoccupation of the fishery scientific community in BOB countries is its capacity to undertake stock assessment. The TOR for the present study emphasised this aspect, and most of the national reports produced under the BOBLME programme identify a lack of stock assessment capacity as a major constraint to effective fishery management in the region.

55. The definition of stock assessment used by the International Commission for the Conservation of Atlantic Tuna (ICCAT) is ‘The application of statistical and mathematical tools to relevant data in order to obtain a quantitative understanding of the status of the stock as needed to make quantitative predictions of the stocks reactions to alternative future regimes’ (Lleonart, 2002).

56. Stock assessment in its simplest form involves measuring the abundance and distribution of fishery resources in an attempt to estimate the standing stock or biomass of the resource. Traditionally this has been done to provide a guide to what is

potentially available for capture – often taken to be some arbitrary proportion (say half) of the estimated biomass. More comprehensive forms of stock assessment take into account the size, age and sex distribution of the target population, as well as its dietary, reproductive, migratory and other behavioural characteristics, the location of its feeding and spawning grounds, the current impacts of fishing activities, and the effect of environmental variables. These variously allow the determinationof a stock's productive potential and its resilience in the face of exploitation, and permit the establishment of ways to maximise biological or economic productivity in a sustained manner.

57. Various approaches, methods and tools that may be integrated into the stock assessment process include:

- **Indirect methods,** based on fishery-dependent information, such as catch and effort data and age structure of the catch. Fishery-dependent data is considered to be only indirectly representative of the fished population as a whole because it is filtered by selective processes that result from the use of particular fishing gears, areas, seasons and other aspects of fishing behaviour. The 'classical' mathematical models of population dynamics, including production models (also known as global, surplus production or catch-effort models), virtual population analysis, length cohort analysis, yield-per-recruit models and stock-recruitment relationships are usually included in this category. Indirect methods are said to be analytic if the population structure is modelled by age or length, and global when a model is used to simulate the whole stock without any internal structure being assumed.

- **Direct methods,** which aim to avoid the biases of commercial catch data by carrying out research surveys and other direct sampling of the target stock. These are typically used for estimating abundance, determining population demographic structures, and assessing biological characteristics. Direct assessment methods include trial fishing carried out according to statistically-designed sampling regimes, aerial or underwater visual surveys, transects and quadrats, eggs and larval surveys, ichthyoplankton surveys, size-frequency sampling, and measuring the biological condition of the target population. Proxy direct methods include hydroacoustic surveys, habitat area estimation using mapping or remote sensing, estimation of primary productivity,

measurement of zooplankton abundance, and examination of stomach contents of higher trophic forms;

- **Statistical methods** refer to analytical procedures based on descriptive statistical techniques such as generalised linear models or time series analysis. They share with the direct methods the absence of any underlying biological, conceptual, or mathematical model of the stock's demographic structure, but do not fall into either of the two other categories since they can be based on fishery or survey data.

58. These stock assessment techniques are based on relatively simple mathematical procedures (non-parametric statistics, calculus, regression, approximate solutions, etc.). With improvements in computing power, more sophisticated approaches (numerical simulations, non-linear modelling, Bayesian statistics and other methods requiring medium-to-high computing performance) are becoming increasingly used. These have led to the development of more complex modelling techniques that depart from the 'classical' single-species and purely population/ biological-oriented methods in two major ways:

- the **bio-economic approach**, which examines not only the biological aspects of the fishery, but also the impacts of changing exploitation or management regimes on the economic yields it produces, as well as the feedback effects on the fished population of economic changes in the fishery;

- the **ecological approach**, which simulates the population dynamics of multiple species, their ecological roles, and the analysis of environmental effects. Under the ecosystem approach to fisheries, stock assessment attempts to evaluate the impact of fishing not only on the target resource, but also on predator, prey, by-catch and other associated species. This is intended to permit the establishment of responsible use goals that go beyond optimising returns from the resource, and into the realm of maximising the broader ecosystem level benefits derived from it.[11]

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[11] Additional commentary on the ecosystem approach to fisheries management is shown in Appendix 3.

59. Lleonart (2002) states: ‘a fishery is a complex system and it cannot be completely described in a simple form. A stock assessment method is a way to see a piece of the system from a very particular point of view, hence a perfect image cannot be obtained from only one method. Different methods are complementary and it is recommended to use several of them if possible’.

B. National and regional stock assessments

60. Stock assessment exercises commenced in the BOB in the 1950s, when surveys and evaluations were carried out in several BOB countries (notably India) and in the Indian Ocean generally (see for example Shomura et al (1967), Prasad et al (1970), and Cushing (1971)). Various national and multi-country stock assessment exercises were undertaken in the years that followed, usually using government research vessels (India alone had a fleet of 20 fishery and oceanographic research vessels to explore the Indian EEZ) which prospected new resources using a variety of industrial fishing gears, as well as carrying out hydro-acoustic surveys to quantify fish biomass.

61. Stock assessment initiatives in the BOB were given a boost in the late 1970s and early 80s through a joint FAO/ Norway fishery research programme, under which the Norwegian Fishery Research Vessel *Dr. Fridtjof Nansen* visited all BOB countries except India. The vessel made assessments of mainly demersal and small pelagic fin-fish resources, based primarily on echo-sounder surveys, fishing trials using pelagic and demersal trawls, and occasional sampling using other fishing gears such as bottom longlines and lobster traps.

62. Since that time, various other assessments have been carried out by national and international agencies working in BOB countries. A brief synopsis, based primarily on information presented in the BOBLME national reports, is presented in the following paragraphs.

63. **Bangladesh**: At least seven comprehensive surveys of Bangladesh marine resources have been carried out, as shown in the table below. Pelagic fish have received relatively little attention compared to demersal species, which have been viewed as potential targets for increased trawl fishery production.

Table 8: Fishery resource surveys carried out in Bangladesh (Based on Haossain, 2003)

Year	Estimated potential (thousand tonnes)			Reference/ Notes
	Demersal fish	Pelagic fish	Shrimps	
1972	264-373	-	9	West (1973)
1979/ 80	160	90-160	-	Saetre (1981). RV *Dr Fridtjof Nansen*. The survey noted potential yield of 100,000 t for each group, and that seasonal variability is very great.
1981	200-250	160-200	4-6	Penn (1982)
1981	152	-	-	Khan (1983)
1984	-	-	3.3	West & Khan (1985)
1986	188	25.6	-	Lamboeuf (1987)
1984-1986	176.2		0.857	Khan (2000). Re-assessment of data collected in 1984-1986 by *RV Anusandhani*.

64. There are wide discrepancies among the survey results, possibly due to differing methodologies, different area coverage and seasonal variation. Haossain (2003) states: 'The current consensus based on the reassessment of the previous and related studies showed a trawlable standing stock of 150,000-160,000 t in the coastal water of Bangladesh of which about 53% consists of commercially important demersal and about 16% consists of commercially important pelagic fishes. Due to lack of information on the standing stock of pelagic resources and sustainable harvest development of biological resources, a proper management policy has become impossible'.

65. **India:** Attempts to explore new stocks and fishing grounds have been made since independence, but became more systematic with the establishment at Bombay in 1947 of the Deepsea Fishing Station, which later became the Fisheries Survey of India (FSI). Diversified gears including shrimp trawls, mid-water trawls, pelagic trawls, bull trawls, high opening bottom trawls, purse seines, longlines, squid jiggers, etc. were deployed for the exploration of new resources. Considerable areas of the Indian EEZ were surveyed at different times by a fleet of 20 vessels of the FSI, as well as by research/ survey vessels of the Central Marine Fisheries Research Institute, the Integrated Fisheries Project, the Central Institute of Fisheries, Nautical and Engineering Training, and the Department of Ocean Development's research vessel *Sagar Sampada*. The surveys aimed to estimate fish abundance in various bathymetric zones, geographic areas and seasons. Acoustic surveys for quantification of pelagic fish biomass have also been conducted in recent times along the southwest coast of India by FAO/UNDP Pelagic Fisheries Project, and some experiments in remote sensing based on satellite

and aircraft support have also been made during the last few years. Sampath (2003) states: 'The results of exploratory surveys by the research vessels have indicated abundance of perches, nemipterids, tunas (yellowfin, bigeye, skipjack) bill fishes, sharks, demersal resources such as pomfrets, bull's eye, deep sea lobsters, deep sea shrimps, cephalopods (squids and cuttlefishes), etc. The bottom trawling conducted by RV *Sagar Sampada* during 1985 to 1989 in the offshore and deep sea areas of Indian EEZ located fishable concentrations of finfishes and shellfishes, such as threadfin breams, bull's eye, drift fish, lizard fish, barracudas, ribbonfish, catfish, mackerel and deep sea prawns and lobsters'.

66. As a result of these surveys, India's annual potential yield is estimated to be around 3.934 million tonnes, as shown in the table below.

Table 9. Summary of marine fishery resources potential in the Indian EEZ (Source: Ministry of Agriculture, 2000, cited in Sampath (2003))

Depth Zone/ Resources	1991-92 estimates					2000 estimates
	0-50 m	50-200 m	200-500 m	Oceanic	Total	
Demersal	1.280	0.625	0.028	--	1.933	2.017
Pelagic	1.000	0.742	--	--	1.742	1.673
Oceanic	--	--	--	0.246	0.246	0.244
Total	**2.280**	**1.367**	**0.028**	**0.246**	**3.921**	**3.934**

67. The estimated yield comprises about 2.017 million tonnes of demersal, 1.673 million tonnes of pelagic and 0.244 million tonnes of oceanic resources. Of this, 58% of the potential lies within the 0-50m depth zone, 35% in the 50-200m depth zone, and the remaining 7% beyond 200m. Sampath (2003) states: 'about 65% of the total estimated marine fishery potential is presently being tapped, with 35% left for future exploitation. While the resources within the 0-50m depth are almost exploited to the maximum sustainable yield levels, the resources available beyond 50m depth still offer scope for exploitation. About 80% of the present level of marine fish production is accounted for from within the 50m zone and about 20% from depths up to 200m'.

68. **Indonesia:** the *Dr. Fridtjof Nansen* undertook a visit to the west coast of Sumatra in 1980, and estimated standing stocks to be 65,000 t of demersal fish and 250,000 t of pelagic fish, excluding tuna-like species (Aglen et al, 1981c). No potential yield estimates were made due to insufficient time, and the survey report notes that 'more research is needed'.

69. In the Indonesian BOBLME national report, Purnomohadi (2003) presents various estimates of fishery potential within the Indonesian area of the BOB. Citing a range of sources, this author estimates the potential yield in the Indonesian portion of the Malacca Strait to be 25,560 t of large pelagic fish, 124,840 t of small pelagics and 116,900 t of demersal fish. Corresponding estimates provided for the west coast of North Sumatra are 323,000 of large pelagics, 429,000 t of small pelagics and 135,000 t of demersals. The author states that the 'situation in the Indian Ocean West of Sumatra was rather complicated due to the estimation of the small and large pelagic groups of species were combined to all Indian Ocean'.

70. **Malaysia:** the 1980 visit to the west coast of Peninsular Malaysia by the *Dr. Fridtjof Nansen* estimated the standing stock of demersal fish to be 30,000 t, and that of pelagic fish to be 300,000 t. The survey further noted that the limit of potential fishery yield for the area had already been reached (Aglen et. al., 1981b). In regard to the west coast fishery, the BOBLME national report for Malaysia states that 'the ranking in terms of contribution by species group to total landing has been consistent over three decades indicating that the fishery, though over exploited, has been relatively stable.' (Omar et al., 2003).

71. **Maldives:** Little survey work appears to have been carried out in this coral atoll nation. The RV *Dr. Fridtjof Nansen* visited the country in August 1983 and carried out hydroacoustic surveys and trial fishing. Based on this work, demersal resources in the inter-island channels were estimated to comprise 3,000 tonnes of shrimp and 60,000 tonnes of fish of low commercial value. Deep-sea lobsters were estimated at 80 tonnnes, while stock of small pelagic species were considered to be insufficient for commercial fishing. (Stromme, 1983). Subsequently, Shakheel (1994) estimated the maximum sustainable yield of groupers to lie between 1,100 – 2,500 t/ year.

72. **Myanmar:** The RV *Dr Fritdjof Nansen* visited Myanmar in 1979 and 1980, and estimated that the standing stock of demersal fish in the country's EEZ was 540,000-960,000 tonnes, with a potential yield of 200,000-290,000 tonnes. For pelagic fish, standing stocks were estimated at 620,000-1,330,000 tonnes, with a potential yield of 500,000-670,000 tonnes (Stromme et all, 1980).

73. Myint (2003) refers to four additional surveys of demersal fish resources carried out off the Myanmar coast between 1981 and 1983, which estimated demersal stocks to

be 784,850 tonnes and potential yields to be 550,000 tonnes. The same author also refers to an undated survey of pelagic resources which estimated biomass to be about 1 million tonnes, and potential yield as 0.5 million tonnes. This author concludes that the total fish stocks of Myanmar are about 1.75 million tonnes, of which 1.05 million tones can be harvested annually.

74. **Sri Lanka:** Sivasubramaniam (1995) compiled summary results of resource survey work within the Sri Lankan EEZ. Joseph (1993) produced preliminary estimates of resources in offshore waters (tunas, billfish, sharks) adjacent to Sri Lanka, based on the commercial fishery, surveys, school sightings, etc. These various estimates are summarized in the table below.

Table 10: Fishery resource surveys carried out in Sri Lanka ((Sivasubramaniam (1995) and Joseph (1993))

Resource type	Estimated potential (tonnes)	Methodology	Reference
Demersal	60,000	Exploratory trawl survey	Tiews (1966)
Demersal	52,000	Organic productivity	Jones and Bannerji (1973)
Pelagic	90,000		
Offshore	29,000	Using information on existing fisheries	Sivasubramaniam (1978)
Demersal	80,000	Acoustic survey	Blindheim and Foeyn (1980)[12]
Pelagic	170,000		
Demersal	74,000	Acoustic and swept area	Sivasubramaniam (1985)
Offshore		Based on exploratory fishing, resource surveys, school counting, etc	BOBP/ WP/ 31 (1985)
	98,874	Yield/ unit area	
	56,600	School count	
	44,188	Mean catch rate	
Offshore	40,000	Based on a variety of approaches	FAO/ ADB (1988)

75. Joseph (1993) acknowledged that the 'offshore' estimates are 'of little relevance in view of the fact that the resources supporting offshore fisheries are the highly migratory tunas, billfish and sharks that are shared by coastal states as well as some distant water nations fishing in Indian Ocean'. The same author further noted: 'There are some offshore areas, in the northwest, discovered during a survey by the Soviet

[12] This reference actually describes three separate surveys carried out by the *Dr. Fritdjof Nansen* between September 1978 and February 1980. Standing stock estimates of demersal fish ranged from 250,000 – 350,000 t, while the standing stock estimate of 450,000 t for small pelagic species was noted as being highly variable between seasons. As well as the potential yield estimates shown for demersal and pelagic species, the survey also estimated a further potential yield of 100,000 tonnes of fish of 'low commercial value', and did not cover the 'substantial resource' of large pelagic fish.

vessel *Optimist* in 1972, (and in the south) which may be capable of sustaining trawling operations for deep-sea lobsters, shrimp and a few commercially important species of fish. Most of the fish stocks discovered were only suitable for conversion into fishmeal, and since the declaration of EEZ's, some of these stocks now lie within Indian territorial waters. Whether the deep-water lobsters and shrimp can support a commercial fishery remains a question that needs further investigation. Many of the deeper water demersal and mesopelagic fin-fishes, deep sea crabs, lobsters, prawns, octopus, squids and cuttlefish varieties have no established market, and the economics of exploiting even those for which markets exist remain doubtful (Nishida and Sivasubramaniam, 1986). The consensus of opinion is that demersal fisheries beyond the continental shelf do not present any substantial potential for expansion.'

76. **Thailand**: The BOBLME national report for Thailand states: 'There were many attempts to assess the state of demersal resources stock. It was found that the maximum sustainable yield in the coastal areas of a depth ranging from 10 to 90 m was 154,000-230,000 t. The pelagic resources stock was estimated to be 136,602 MT and it seems that most of the pelagic resources in this area are still not fully exploited. Thus an increase in pelagic resources production is viable but an increase in fishing effort should be done carefully' (Juntarashote, 2003). However the 1980 visit to Thailand by the *Dr. Fridtoj Nansen* estimated demersal resources to be only 27,00 tonnes, and attributed the decline since the earlier assessments to overfishing (Aglen et al, 1981a).

77. Juntarashote (2003) also notes: 'In order to understand the changes of catch rates of trawlers in this area, the Department of Fisheries conducted surveys by means of her research vessel. The surveys found that the catch per unit of effort of demersal resources caught by the research vessel that conducted the monitoring survey in Phangnga bay and adjacent areas in 1966 was 238.9 kg/hr. It decreased to 105.3, 64.6 and 37.5 kg/hr in 1971, 1978 and 1987-1988, respectively. Thus, it may be concluded that the demersal resources in this area had been fully exploited since 1971 when the catch rate dropped to half of the original abundance'.

78. As well as the larger-scale stock assessment exercises described above, fishery research agencies in BOB countries have carried out literally thousands of smaller-scale assessments relating to local fisheries and resources. These are generally reported or published in internal reports, mimeographed papers, local conferences or journals, etc. that do not reach the broader fishery research community. As an example, an FAO-

sponsored project in Sri Lanka aimed to produce ‘resource profiles’ of six key species groups (demersal fish, large pelagic fish, medium pelagic fish, small pelagic fish, prawns and lobsters) (Preston, 1998). The process, which took about 4 months, turned up 239 locally published documents and references on these subjects, about 80% of which were extremely restricted in their distribution, in some cases being limited to single copies in the filing cabinet of an individual researcher. In some cases the earlier discovery or broader distribution of this information might have avoided the need to carry out more recent research projects on the same topics.

79. Judging from the bibliographies of most of the BOBLME national reports, it seems likely that a similar scenario exists in all the countries of the BOB region. Enumerating and documenting this vast body of information for all BOB countries is far beyond the scope of the present report, and in any case would be impossible as a desk study. To do so would nevertheless be an extremely worthwhile task, as this would make stock assessment results more widely known among fishery researchers and managers who can make practical use of the information, and, importantly, help avoid the repetition of key and sometimes costly research. With the electronic technology available today, it is a simple matter to convert historical information to a digital format and make it widely available to any researcher who has access to a computer, either on CD or over the internet/ worldwide web.

80. As noted earlier, reliable stock assessment requires both data obtained from fishery monitoring and fishery-independent data. The types and extent of data required are largely dependent on the goals and complexity of the stock assessment programme in question. As further noted earlier, however, the collection of fishery statistics – which is fundamental to stock assessment – has declined in the last two decades, partly due to a general reduction in available funding.

81. The preceding paragraphs indicate that the amount of fishery resource survey work carried out by BOB countries through research cruises or expeditions has also tailed off in recent years, with lack of funding again being frequently cited as a problem. Haossain (2003), for example, states in relation to a recent FAO-sponsored alternative livelihoods project in Cox’s Bazaar in Bangladesh: ‘the survey for the estimation of standing stock and identification of new fishing grounds has been totally stopped due to lack of research vessel and skilled manpower’. Many BOB countries can

no longer afford the luxury of running full-time research vessels to gather fishery-independent data and carry out direct assessments of stocks.

C. Stock assessment capacity

82. BOB governments have dedicated considerable effort to establishing fisheries research and stock assessment capacity and infrastructure in the region. All the BOB countries have at least one government fisheries research agency, and some have several, as shown in the table below. Some are extremely large – the Thai Department of Fisheries, for example, has over 3,000 professional employees, most of whom are researchers – and, in principle at least, concern themselves with activities such as identification of new resources and gathering of statistical data for use in stock assessment work. Most countries also have universities which undertake fisheries research and provide graduate and post-graduate training in fisheries science-related disciplines. Several international technical assistance agencies – including FAO, SEAFDEC, the WorldFish Centre (formerly ICLARM) and others – also regularly run training workshops and provide specific technical assistance to government fishery agencies in aspects of stock assessment and its application to management. For example between 1999 and 2001 FISHCODE, which is just one FAO project, ran three workshops on stock assessment, bio-economic modelling and fishery management planning for small pelagic fisheries on the west coast of Peninsular Malaysia.

83. If these agencies and programmes are doing their jobs properly, then it seems counter-intuitive that lack of stock assessment capacity should be a constraint to effective fishery management in BOB countries. However lack of stock assessment capacity is regular cited as an issue for the region. Sivasubramaniam (2004) states: ‘Reports available in the respective countries will reveal numerous estimates of potentials and Maximum Sustainable Yield levels of demersal and pelagic resources for their countries. The inadequacy of data used, in terms of quantity and quality, tend to provide highly varied values of estimates for the potentials of the resources and reduce the reliability of the estimates. The high degree of variability makes it difficult to use even an average of the various values available or consider any one particular value to be close the true situation.’

Table 11: Partial listing of fisheries research and training facilities in BOB countries (Source: various documents)

Country, Institution	Function
Bangladesh	
National Fisheries Research Institute (FRI)	Various fisheries research and investigations, training in fisheries management
Cox's Bazaar Marine Fisheries and Technological Station	Oceanographic and biological research
Fisheries Faculty, Agriculture University at Mymensingh	Graduate and post-graduate training
Institute of Marine Science, Chittagong University	Graduate and post-graduate training
India	
Indian Council of Agricultural Research (ICAR)	Coordination of fisheries research in India
Central Marine Fisheries Research Institute (CMFRI), Kochi, Kerala	Capture fisheries database; assessment and management of marine fishery resources; fishery forecasting; monitoring of fishery environmental characteristics
Central Institute of Fisheries Education (CIFE), Mumbai, Maharashtra	Education and research programmes leading to post graduate (MFSc and PhD) degrees in specialized disciplines of fisheries science and technology
National Bureau of Fish Genetic Resources (NBFGR), Lucknow, Uttar Pradesh.	Management and conservation of genetic resources
Fishery Survey of India (FSI), Mumbai, Maharashtra	Marine fisheries resources survey in the Indian EEZ
Indonesia	
Central Research Institute for Capture Fisheries, Agency for Agricultural Research and Development, Jakarta	Coordinates activities of four fishery research agencies (marine fisheries, fish technology, freshwater fisheries, and coastal aquaculture),
Research Institute for Marine Fisheries, Jakarta	Resource survey, stock assessment, fisheries management-oriented research
Institute for Fishing Development	Applied research and training on fishing methods and techniques
University of Agriculture in Bogor University of Diponegoro in Semarang University of Hasanuddin in Makassar University of Sam Ratulanggi in Manado University of Pattimura in Ambon University of Brawijaya in Malang University of Riau in Pakan Baru University of Gadjah Mada in Yogyakarta University of Bung Hatta in Padang University of Fisheries in Jakarta	Research and tertiary education programmes in fisheries resource assessment, fish biology, aquaculture, mangroves, corals, habitat development and rehabilitation, pollution monitoring and assessment, virology, toxicology and others
Malaysia	
Fisheries Research Institute (FRI), Department of Fisheries. Headquarters (Batu Maung, Penang) and Peninsular East Coast Marine Branch, Chendering, Kuala Terengganu	Research on marine capture fisheries, marine ecology and aquaculture
Science University in Penang/ University of Malaya in Kuala Lumpur/ Agriculture University in Selangor/ University Malaysia Sarawak in Kuching/ University Malaysia Sabah/ National University Malaysia in Bangi, Selangor/ University Technology Malaysia in Johore.	Research and tertiary education programmes in fisheries resource assessment, fish biology, aquaculture, mangroves, corals, habitat development and rehabilitation, pollution monitoring and assessment, virology, toxicology and others
Maldives	
Ministry of Fisheries and Agriculture	Assessment of tuna stocks, investigation of reef fish and other marine resources, analysis of statistics and socio-economic surveys, resource management
Myanmar	
Department of Fisheries Marine Resources Survey and Research Unit	Fisheries research and monitoring, plus aquaculture research
University of Mawlamyine Marine Science Department	Research on meso-plankton distribution in benthos communities of coastal region
The University of Yangon, Mandalay and Mawlamyaine	Research on freshwater species
Sri Lanka	
Natural Aquatic Resources Research and Development Agency (NARA)	Research on marine biology, oceanography, hydrography, environmental studies, socio-economic research and other areas
Thailand	
Department of Fisheries	Research on marine fisheries conservation and management as well as a wide rage of other areas

84. A possible explanation for this situation may be related to issues of quality rather than quantity. While there seems to be a considerable stock assessment capability in the region when measured in numbers of organisations or personnel, the quality of the output may be inadequate. This in turn may be due to insufficient funding being available to stock assessment programmes for them to be effective (for instance, if the quality or quantity of input data is insufficient), or because the individuals responsible for stock assessment work are insufficiently skilled, and require additional training or experience. It seems likely that both these issues come into play, although it is impossible to accurately determine their relative importance to each country or to the region as a whole through a review such as this one. A more detailed regional planning exercise may be required to determine in more detail the stock assessment capabilities and shortcomings of the various fishery research and management institutions in the region, and undertake one or more coordinated human resource development and institutional strengthening exercises aimed at assisting them upgrade their functions where this is shown to be necessary.

85. A further issue that may affect the region's stock assessment capacity is the 'more research is needed' factor. The individuals involved in stock assessment, who are primarily the ones articulating the supposed lack of capacity, are fisheries scientists themselves. Scientists tend to be unwilling to make recommendations to decision-makers unless they themselves are firmly convinced that their results and conclusions are robust and can be properly defended. Consequently even costly, in-depth scientific studies often conclude that 'more research is needed' before a recommendation can be made on the matter that the study was intended to address. Fish stock assessment is at best a very inexact discipline, with a high level of inherent variability and consequently a high level of risk that the conclusions might be inaccurate. It may be that those responsible for stock assessment work in the BOB region have unrealistically high expectations of what their science is able to achieve. Developing stock assessment capability to a level of infallibility is an unattainable goal, in the BOB and elsewhere. Rather than interpret this as a lack of stock assessment capacity, it may be necessary for fishery scientists to accept that their discipline carries a high level of risk, and that they may sometimes be wrong. This in itself is not really a major issue if fishery management systems can be developed that are adaptive and flexible enough for corrective action to be taken when stock assessment conclusions have to be revised, as they inevitably will.

D. Improving the effectiveness of stock assessment

86. Historically, stock assessment in the BOB region has primarily involved the quantification of fishery resources as a basis on which to determine the potential for increased fishery production. Up until the mid-1990s, this was the main reason for carrying out fishery stock assessment in most BOB countries, and still remains a key argument for fisheries research in the region. A more recent aim of stock assessment in some countries has been to try to understand the reasons for observed declines in fishery production, and mitigate them – in other words, to inform the process of management, rather than development. This is becoming a more common reason for countries wishing to undertake stock assessment work, although the identification of new resources and development opportunities continues to be a common corollary justification.

87. This being the case, the question has to be asked: if the capacity of BOB countries to undertake stock assessment was improved to the point that stock assessment results were 100% reliable (an impossible target, of course, but the question is a hypothetical one), would the quality of fisheries management and the sustainability of living marine resource use improve in parallel? Based on the BOBLME national reports, a wide body of other documentation, and the author's own observations, the answer would have to be an emphatic 'No'. Stock assessment information is often a minor factor in the fishery management decision-making process in the region, and may be ignored completely. Other factors that usually overshadow stock assessment considerations are many and varied, and may include short-term needs taking priority over longer-term perspectives, political trade-offs, the power exercised by particularly influential, self-interested stakeholders (whether these be individuals or groups), the personal ambitions of fishery decision-makers, corruption, or plain lack of understanding. These factors are not confined to the BOB region of course, but as regards the BOB, it would seem that there may be little point in focussing on improving stock assessment capacity unless stock assessment results can be more effectively used to inform and steer the fishery management process.

88. One possible way to do this is to replace the discretionary decision-making powers of influential individuals with formalised, legally binding fishery management plans which establish pre-determined rules for responses to stock assessment results (before those results are known), and whose implementation is monitored by a

representative group of stakeholders. An example, used purely for illustrative purposes here, is the rolling total allowable catch (TAC) system that has been applied in some developed-country prawn-trawl fisheries. Under the rolling TAC system, next year's TAC may be set at, say, the average of the three best years catches from the previous five. Thus, if catches show an up-trend, the TAC progressively increases according to a pre-determined set of rules: if catches show a down-trend, the TAC responds in like manner. As long as the system is codified into law, and the plan is monitored by an appropriately-constituted group of fishery stakeholders, then there is much less room for discretionary or political decision-making, and stock assessment results are actually translated into management action.

89. Another relevant issue is that of communication. There are some fisheries in the BOB region for which stock assessment information is quite comprehensive, and management recommendations have been developed that would, if implemented, protect both the resource and the economic well-being of the fishers harvesting it. In some of these cases the management recommendations have nevertheless been ignored and alternative measures adopted that threaten resource sustainability or the economic performance of the fishery. Management decisions are ultimately made or approved by political decision-makers, whether these be elected national or state politicians, or appointed senior officials. The scientists who undertake stock assessment work are usually civil servants who are not expected to – and dare not – challenge those in authority. The decision-makers, who are often motivated by an entirely different set of factors than those which influence the scientists, may not act on stock assessment findings for the simple reason that the results have not been communicated to them, at least not in a form or language that they can understand. Poor communication by scientists is a major reason worldwide why stock assessment results are often not translated into management action. In addition to undertaking stock assessment, therefore, scientists need to be able to communicate the findings, by appropriate mechanisms and in appropriate language, to the individuals who are responsible for fishery management decisions.

90. A final issue relating to stock assessment and more generalised fishery research capacity in the BOB region is that of access to historical data and information. Many good quality data collection and biological investigations have been carried out in the past, many at times when fishery research was given a higher priority in government

budgets than it is now. Much of this information is buried in the archives and filing cabinets of fishery research and management agencies, and is forgotten or difficult to access. Some research that has been carried out in one country is highly relevant to issues in another, but may be unknown there. New research is relatively costly, whereas the compilation of pre-existing information is cheap, and can be done electronically, permitting virtually unlimited access to the materials produced. There would therefore be considerable value in a programme to actively search out and computerise historical research information, not only as a means of possibly avoiding to repeat research that has already been carried out, but also as a way of obtaining historical data that no amount of new research can replicate.

91. It is almost certainly correct to say that there is a need to improve fish stock assessment capacity in the BOB region, both through skill development and through development of funding mechanisms to ensure that stock assessment and data collection programmes are effective. This would best be addressed through a broad regional capacity-building programme which supports the functioning of key institutions and promotes human resource development. As part of such a programme, however, there is also a strong need to improve the uptake of stock assessment results into the management process. Improved communications between scientists and decision-makers, and the development of formal fishery management plans have been identified as two possible approaches. There is also a need to ensure that the results of earlier research are fully utilised and not progressively lost to the scientific knowledge base as time goes by. There may of course be other needs and mechanisms, and the way these are combined will undoubtedly differ among different fisheries and resources, each of which has its own particular biological, social, economic and political dimensions.

IV. COMMON AND TRANSBOUNDARY ISSUES

A. Prioritisation of issues

92. Based on the BOBLME national reports and a wide range of other literature, the following sections identify the region’s most important trans-boundary and multi-country problem areas from a fisheries perspective. All of the issues presented are common to two or more countries in the region, and the majority also have a multi-country or regional dimension which makes them truly trans-boundary.

93. The issues discussed are presented in order of decreasing priority (i.e. the highest priority issues are described first) under the two sections of ‘resource utilisation’ and ‘stock assessment’.

B. Resource utilisation

1. Overfishing

94. Unsustainable resource use may be signalled by a number of indicators, including declining catch rates, declining average size and weight of individual members of the catch, fewer individuals in the catch, failure of migrations or aggregations, and fishermen having to range beyond their usual fishing grounds in order to achieve a good catch. All of these indicators were described in the BOBLME national reports in relation to a wide range of resources that included finfish, sharks, crustaceans, molluscs and echinoderms.

95. Falling catch rates and a decline in the average size of fish in the catch are normal responses of a fish population to fishing, and do not in themselves indicate overfishing. As long as the total fishing effort in the fishery is below the level that will produce the theoretical maximum sustainable yield (MSY), then further increases in effort will produce increases in catch. The rate of such increases will progressively decline as MSY is approached. In addition, since increases in effort usually mean increasing numbers of fishing units in the fishery, the average catch per unit of fishing effort, or per fishing unit, will also generally decline. Even so, a stock that is still in this condition will continue to give greater total yields if fishing effort increases.

96. Once the fishing effort has increased beyond that required to produce MSY, however, then the fishery is said to be overfished. There are two generalised types of overfishing:

- **Growth overfishing**, in which the level of fishing effort has gone beyond that needed to produce MSY, but the resource still contains enough reproductive capacity to ensure there will be a surplus of juveniles to replenish the stock in future years. In such a case the consequences of overfishing are primarily economic, since the fishery is not producing the biological maximum sustainable yield. Further increases in fishing effort will reduce both the average catch per unit of effort or per fishing unit, and the total yield from the fishery.

Many of the BOB region's fisheries, including most of the shads, sardines, anchovies and other small pelagic species, are probably in this condition. These fisheries may be sustained in this sub-optimal but essentially stable state, or they may be pushed by increased fishing pressure, extreme fluctuations in climatic or other conditions, or environmental degradation, into the second category:

- **Recruitment overfishing,** in which the level of fishing effort is so great that the resource no longer has the reproductive capacity it needs to replenish future generations. In this condition the fishery is likely to collapse, either as a direct result of overfishing, or due to a combination of fishing and an extreme variation in some environmental variable, such as sea surface temperature or rainfall, which adds a further stress to an already strained reproductive capacity, and pushes the stock over the edge. Once reproductive failure occurs the stock crashes, and catches can be reduced to a tiny fraction of their previous levels. Massive fisheries, such as those for the Peruvian anchoveta and Atlantic cod, have experienced recruitment overfishing, and whole industries have collapsed as a result. Recovery of such damaged stocks may take decades, or may never happen.

97. In the western BOB, much overfishing occurs as a result of increasing fishing pressure exerted by highly populated coastal communities of artisanal or small-scale fishermen targeting inshore demersal and small pelagic resources. Unsustainable exploitation of reef-associated fish and invertebrates, which are particularly vulnerable to overfishing, is also reported from Maldives, Sri Lanka, India and Malaysia. In the absence of actions to prevent further increases in fishing effort, many fisheries that are currently in the growth overfishing stage may enter recruitment overfishing and collapse.

98. In some cases (beche-de-mer and groupers in Maldives, for instance) the issue of overfishing may be confined to a single country, in which case it may be possible for that country to resolve the issue without recourse to collaborative action. Given the transboundary nature of most BOB fish stocks, however, bilateral or multilateral collaboration will probably be required to solve most of the region's overfishing problems.

2. Destructive fishing

99. Dynamite fishing, often for small pelagic species, and the use of cyanide and other toxins for capturing ornamental and live food fish, are both on the increase in the region, and cause long-term damage not only to the target resources but to the environments they inhabit. A less conspicuous but equally pervasive form of destructive fishing relates to long-term seafloor habitat change caused by fishing techniques such as bottom-trawling. The BOBLME national report for Malaysia noted the large volumes of 'trash fish' indiscriminately taken as by catch in the trawl fishery there.

100. A type of destructive fishing that is a particular problem for Bangladesh and the northern BOB states of India is the use of various kinds of estuarine set-nets and push nets to collect prawn post-larvae, which are then sold for ongrowing in the prawn farming industry. This type of fishing results in the capture of vast numbers of larvae and juveniles of other fish and invertebrates, some of which are commercially important. These other larvae, which typically make up more than 99% of the catch, are generally killed as a result of the fishing activity, or dumped on the shore during the sorting of the catch. Attempts to prevent this destruction through awareness and alternative livelihood campaigns, or the promotion of closed-cycle prawn hatcheries, have not yet resolved the problem.

101. Technically, coral mining is a fishing activity as it involves the extractive use of a living marine resource. Coral mining for lime production used in the construction and other industries is a further type of destructive fishing recorded as a problem in several BOB countries, including Sri Lanka, India and, to a lesser extent, Bangladesh. The BOBLME national report for Maldives states that coral mining used to be a problem there until it was successfully banned by the Government.

3. Inadequate monitoring, control and surveillance

102. All the BOBLME national reports bemoaned unauthorised incursions into their country's EEZs by foreign fishing vessels. In many cases these are commercial or industrial vessels from distant-water fishing nations. In others, the problem is that of encroachment by artisanal or commercial fishermen from one BOB country into the waters of another. These problems are attributed to inadequate systems of monitoring,

control and surveillance, and a general inability by national and local governments to enforce fishery laws and regulations.

103. Also included in this category of trans-boundary issue is conflict between different prospective users of the same resource, in particular where trawlers operate in inshore waters in competition with artisanal fishers. This is a particular problem in Bangladesh and the BOB states of India, where sometimes bloody conflicts and deaths have resulted. In Thailand, coastal communities have taken the step of constructing 'artificial reefs' as a deliberate obstacle to the operation of trawlers in shallow inshore zones. Again these user conflicts are generally seen to represent a failure of regulatory approaches to fisheries management.

4. Pollution

104. A wide range of environmental issues impact the BOB and its living marine resources. The Bay receives pollutants from land-based sources, including agricultural fertilisers, pesticides and industrial waste, via the major rivers and from seasonal flooding. These tend to accumulate in the near-shore environment which contains fish spawning and nursery areas, coral reefs and mangroves. Discharge of sewage, often untreated, can be beyond the capacity of the environment to absorb, especially close to urban centres. Sea-based pollution also occurs from ballast discharge by merchant shipping and fishing vessels operating in the region. Heavy oil tanker traffic south of Sri Lanka and through the Straits of Malacca presents the threat of more serious oil spills. Prawn farms and other aquaculture facilities are being increasingly blamed for pollution of inshore waters with antibiotics, chemicals, pathogens and untreated feed and water waste as a result of 'dirty' farming practices. Mass mortalities of fish have been attributed to chronic or acute pollution events in India and Bangladesh, and possibly other countries of the region.

105. There is limited information on pollution and sedimentation loads entering BOB waters and coastal habitats, the fate and effect of pollutants have not been studied extensively, and the assimilative capacity of the Bay of Bengal is largely unknown. Much of the pollution that enters the Bay is thought to be ultimately become bound up in seafloor sediments or dispersed across the southern part of the LME into the broader waters of the Indian Ocean, but these hypotheses remain largely untested.

106. To date, anthropogenic effects on the quality of coastal waters of the countries are thought to be still mainly local, and confined to coastal areas. However, increasing evidence suggests that more serious local and cumulative environmental degradation is occurring. High levels of pesticides can be found in coastal areas, especially near cities and ports. Localised heavy metal contamination of fish has occurred, and in some regions of the Bay a change in composition of plankton species has been noted.

107. In other areas and regions of the world various pollutants are known to cause fish kills, damage fish spawning and nursery areas, reduce the ability of marine organisms to reproduce, and lead to changes in trophic structure. The excess nutrients in sewage cause eutrophication and oxygen depletion which results in massive death of marine life. Bacterial loads in sewage present public health risks and threaten post-harvest contamination of fish products caught or handled in polluted coastal waters. All of these issues may already be occurring in various areas of the BOB, and certainly present threats in the foreseeable future.

5. Coastal development

108. Unmanaged or irresponsible development of the coastal zone is also an issue in most BOB countries. High-density residential or commercial developments along the littoral fringe, clearing of mangrove areas for aquaculture, intensive prawn and fish farming, extraction of coral and sand for construction purposes, and a host of other activities damage critical habitats, increase the coastal contamination load and reduce the ability of the environment to assimilate pollutants. This is a particular issue in the coastal lagoons of India and Sri Lanka, as well as semi-enclosed coastal seas in Thailand.

109. Further inland, logging and clearing of forests, development of monocultures or plantation agriculture, and other changing land-use practices are causing permanent modification of watersheds and catchment basins, altering the spatial and temporal patterns of water and sediment discharge. The result is increased soil erosion, reduced cycling of pollutants on land, and deposition of increased amounts of sediment and associated contaminants into the coastal waters of the Bay.

C. Stock assessment

1. Management

110. Stock assessment is not sufficiently integrated into the fishery management process. Management decisions are often made without sufficient consideration of stock assessment results. This is a feedback loop: the less heed is paid to stock assessment results in the management process, the less they are seen to be important, and the less importance (and budget) is assigned to research and stock assessment.

2. ‘More research is needed’

111. Fishery scientists are reluctant to accept the fact that fish stock assessment is an inexact science. There may be an unrealistic expectation that stock assessment can always provide precise, dependable answers, when in fact this is rarely the case, because of both the approximative nature of the discipline, and the fact that fish populations are not static. The inexactitudes of stock assessment can be accommodated through the use of flexible, adaptive fishery management arrangements that respond to changes in the assessed status of the resource.

3. Insufficient inter-country collaboration

112. A focus on local or national fishery issues, coupled with an absence of international institutional arrangements to promote collaborative work, means that there are few instances of bilateral or multilateral fishery research, assessment and management initiatives, even where stocks obviously straddle country borders.

4. Inadequate data

113. Fishery statistics programmes have undergone a progressive decline in both quantitative and qualitative terms, while at the same time fishery activities have expanded, resulting in a wider range of species being exploited. Fishery statistics programmes may have been compromised by politically-driven desires to show increases in fishery production, rather than to paint an objective picture of fishery evolution. Shortage of funds and other operational factors have led to a parallel decline in the capacity of BOB fisheries research agencies to carry out field surveys and gather fishery-independent data to complement fishery statistics.

5. Taxonomic inconsistencies

114. The same species may be identified differently in different countries, resulting in data inconsistencies that could affect the interpretation of statistics and stock assessment results.

6. Human resource development

115. Although there has been extensive training of BOB fishery scientists in fisheries science and stock assessment, it may be that additional training, particularly in specialised fields, is required. There is a suggestion that in some countries the best-trained scientists tend to leave the marine fisheries sector to work in inland fisheries or other disciplines, driven by government policies which give lower priority to marine fisheries development and management.

D. Root causes

1. Population and poverty

116. The eight countries surrounding the BOB include some of the most populous on earth, with India, Indonesia and Bangladesh being among the world's top ten. Collectively BOB countries are home to some 1.55 billion people, or a little less than a quarter of the world's population. Of these about 400 million are estimated to live in the Bay's catchment area.

Table 12: Population statistics for BOB countries (Source: World Bank/ UNDP)

	Land area (thousands of sq.km)	Population (thousands) (2002)	Population density (pers/sq. km) (2001)	Predicted population (thousands) (2015)	Predicted population density (pers/ sq. km) (2015)
Bangladesh	144	135,684	1,024	181,400	1,260
India	3,287	1,048,279	347	1,246,400	379
Indonesia	1,905	211,716	115	250,400	131
Malaysia	330	24,305	72	29,600	90
Maldives	0.3	287	935	400	1,333
Myanmar	677	48,895	73	55,800	82
Sri Lanka	66	18,968	290	20,600	312
Thailand	513	61,613	120	69,600	136
Total/ *average*	**6,922.3**	**1,549,747**	***224***	**1,854,200**	***268***

117. All BOB countries are expected to see significant future population growth, averaging about 20% across the eight countries by 2015. This will lead to a

corresponding increase in population density from a current average of 224 persons/ sq. km to 268 persons/ sq. km. in 2015.

118. Population pressure is much higher in the four western BOB countries than in those four to the east. Despite having similar total land areas (3,497,300 sq. km. in the west, 3,425,000 sq. km. in the east) the total population of the western countries is 1,203 million, as opposed to 347 million in the east, or a ratio of about 3.5 to 1.

119. The figures are expected to increase to 1,448 million and 405 million respectively by 2015, or a ratio of 3.6:1. In consequence population densities are also higher in the west, at 344 persons per sq. km (rising to 530 by 2015), compared to 101 persons/ sq. km (rising to 118 in 2015) in the east. Some 65% of the region's urban population lives in large coastal cities, and migration towards the coastal regions is increasing.

Table 13: Human development index of BOB countries, 2001 (Source: UNDP)

	HDI (2001)[13] (global range: 0.944 to 0.275)	HDI Rank (2001)[14] (out of 175)
Bangladesh	0.502	139
India	0.590	127
Indonesia	0.682	112
Malaysia	0.790	58
Maldives	0.751	86
Myanmar	0.549	131
Sri Lanka	0.730	99
Thailand	0.768	74

120. BOB countries are all ranked by the UN Human Development Index (HDI) as being of Medium Human Development (see above table). Nevertheless the eight countries of the region are home to the world's largest concentration of the income-poor. Many of the 400 million people living in the Bay's catchment area are among the

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13 The Human Development Index (HDI) is calculated by the UNDP Human Development Report Office for as many of the world's countries as possible (i.e. where data is available). The HDI is based on a composite of four development indicators: life expectancy at birth, adult literacy rate, educational enrolment rates, and GDP per capita. The range is 2002 was from 0.944 (Norway) to 0.275 (Sierra Leone). Countries with an index value greater than 0.8 are classified as High Human Development, those between 0.5 and 0.8 as Medium Huma Development, and below 0.5 as Low Human Development.

14 HDI rank is a simple ranking of the 175 countries for which HDI estimates are available, with 1 bein the highest and 175 being the lowest.

world's poorest, subsisting at or below the poverty level. This is especially true in Bangladesh and India, where some 35% of the population has an income less than the equivalent of one US dollar per day (UNDP, 2003 Human Development Report). Many of these people are dependent primarily or entirely on marine resources, and have few if any alternatives to fishing, even when overfishing is clearly occurring.

121. Many of the marine and coastal environmental problems faced by the BOB are inextricably linked with the large populations of the region's coastal areas, and their impoverished status. Continued population growth, and the increasing concentration of people in coastal cities, will exacerbate these problems in the future. Unless checked, environmental degradation and unsustainable resource use practices will cause fisheries to become less and less able to provide sustenance and income for coastal people, thus leading to increased poverty in a spiralling effect. There is thus a growing need to address coastal management, pollution, fishery management and alternative livelihood issues in parallel.

2. Preoccupation with development vs conservation

122. BOB countries are governed through a range of different systems, including parliamentary democracies, hereditary rulers, religious leaders and military junta. Despite their differences, all the governments of the region are eager to promote economic growth and development, including through increased exploitation of living resources. As a result, all the region's governments have been keen to see increased marine and freshwater fishery landings, as well as aquaculture production, and have expended considerable funding to make this happen. Public funding assistance to the fisheries sector has taken the form of subsidies and grants, construction of infrastructure (ports, ice machines, etc.), establishment of government-owned fishing companies, and concessions to foreign fishing vessels. Much of this funding has come from aid sources, or in the form of concessionary loan finance from multilateral banks.

123. In line with their desire to see economic growth, all BOB governments have multi-year development plans, all of which imply or assume increased capture fisheries production. In many cases this is expressed as a simple annual percentage increase in landings, projected indefinitely into the future. Although some development plans recognise that fish stocks have been assessed at a certain level or abundance, they do

not acknowledge that there will be a point at which the growth of capture fisheries will eventually hit a ceiling.

3. Neglect of the marine fisheries sector

124. Despite the emphasis on growth in fishery production in most of the regions' development plans, the marine fisheries sector of some countries may not have received sufficient support or attention from government. Writing about Bangladesh, Haossain (2003) states: 'Recent report by different authors reveals that the coastal and marine fisheries are a neglected area and have not received major interest or investment since the early 80's and received less than 4% of all the development project funded by national and donor agency for the development of fishery sector. As a result, the developments of coastal and marine fisheries resources have greatly suffered due to lack of investment and development initiatives. This clearly indicates that proper attention was not given in the past for the development of the marine fisheries sector though there is enough scope for increased investment in the context of vastness of our marine resources and involvement of a large number of fisherfolk for employment and livelihood'.

125. In similar vein, Sivasubramaniam (2004) states: '…there are specific scenarios of Governments failing to show eagerness to promote balanced development of their freshwater and marine fisheries sub-sectors. Sri Lanka has had relatively negligible inputs in terms of the number of international technical aid and assistance programmes into the development of freshwater fisheries, so far, in comparison to the enormous inputs that have gone into the marine sub-sector. This is reflected by the facilities and funds allocated for development and research into the freshwater fisheries. On the other hand the scenario in Bangladesh illustrates the failure of the Government, since it became an independent country, to have not made any significant contribution to the development of marine fisheries in the coastal waters, except to permit the private sector to undertake industrial shrimp and finfish trawling. Historical events have resulted in very few or very negligible number of government officials experienced and competent to deal with planning, development and management of marine fisheries. Few that received training also have been diverted into freshwater fisheries. Attempts are being made to rectify this situation in both countries right now'.

4. Ineffective management arrangements

126. Fisheries management in BOB countries is given legal effect through a wide range of laws and regulations enacted at national or, in some countries, state level. The table below provides a summary of key legislative instruments or approaches in the countries of the region.

127. Although most countries have a comprehensive legal basis for fisheries management, the effective enforcement of rules and regulations remains an elusive goal. In the case of commercial or larger-scale fishing activities, enforcement capacity in the form of seagoing vessels and trained personnel may be lacking. In addition, many commercial fishing operations are owned or operated by persons of influence who, even if apprehended for an offence, may be able to circumvent the due process of law. There does not appear to be any mechanism within the region through which countries can coordinate joint surveillance patrols by military, police or coastguard vessels, or overflights by military or commercial aircraft. Coordination of this kind of activity has proven a very effective disincentive to illegal fishing within the EEZs of Pacific Island countries, and has also opened up another channel for assistance by developed nations, who have incorporated surveillance overflights into their military training or maintenance programmes.

128. As regards artisanal fisheries, small-scale fishing operations involve thousands of fishermen and vessels dispersed over large areas of coastline, which makes the physical logistics of surveillance and enforcement difficult. In addition, enforcement activities create conflict with local fishermen which government officials are averse to for a variety of reasons which may include fear of violence and physical harm (riots have occurred among fishing communities on the BOB coast of India on numerous occasions), creation of adversarial relationships which impinge on the official’s other functions (such as extension services), loss of political support, or just plain sympathy with the situation of the artisanal fishing community, many of whom are poor or have no alternative sources of livelihood.

Table 14: Partial listing of fishery management laws and regulations in BOB countries (Source: various documents)

Fishery laws & regulations of BOB countries (excludes legislation that applies only to inland waters, or areas outside the BOB)
Bangladesh • The Protection and Conservation of Fish Act, 1950 (amended 1982); • The Fish and Fish Products Ordinance, 1983; • The Marine Fisheries Ordinance, 1983
India • Maritime Zones of India (Regulation of fishing foreign vessels Act, 1981, No. 42 of 1981 dated 28th September 1981.) (India's EEZ is closed to foreign vessels) • All maritime States in India have laws for fishing and other related fisheries activities, for enforcement of closed seasons, mesh regulation, welfare of fishermen, aquaculture, etc. • A typical example is The Andhra Pradesh Gazette notification Part IV-A, extraordinary No. 27 dt. December 27, 1993, Hyderabad. Sub.: Regulation of fishing by fishing vessels in the territorial waters in the coastline of Andhra Pradesh.
Indonesia • Act No. 9/1985: Fisheries Act; • Government Decree No. 15/1984 or Regulation No. 15 on Fisheries Resources Management in the Indonesian Exclusive Economic Zone; • Ministerial Decree No. 144/1993: on appointing a Port as a Fishing Base for Chartered Foreign Flag Fishing Vessels for Fishing in the Indonesian EEZ; • Ministerial Decree No. 473/1985 on the Amount of Allowable Catch in the Indonesian EEZ; • Ministerial Decree No. 475/1985 on Permit for Private and Foreign Companies to Fish in the Indonesian EEZ; • Ministerial Decree No. 476/1985 on Reporting Requirements for Fishing Vessels Permitted to Fish in the Indonesian EEZ; • Ministerial Decree No. 477/1985 on the Fishing Fees Imposed on Foreign Persons or Legal Entities • Ministerial Decree No. 277/1986 on Fishing Permits in Indonesian Waters and EEZ; • Ministerial Decree No. 417/1988 on Control of the Utilization of Fishery Resources in the Indonesian EEZ; • Ministerial Decree No. 900/1988 on the Requirements for Foreign Fishing Vessels to Export Their Harvests from Indonesian Ports or to Sell Them in Domestic Markets; • Letter of Instruction from Minister of Research and Technology 557/1985 on the Development of Fishing Fleet; • Ministerial Decree No. 815/1990: on Fishing Business Licensing; • Ministerial Decree No. 816/1990: on the Use of Chartered Foreign Flag Fishing Vessels for Fishing in the Indonesian EEZ; • Ministerial Decree No144/1993: on Appointment of Ports as a Fishing Base for Foreign Vessels Chartered by Indonesian Companies for Fishing in Indonesian EEZ • Ministerial Decree No. 375/1995 on the Prohibition of Catching Napoleon Wrasse (Cheilinus undulatus Ruppel); • Ministerial Decree No. 805/1995 on the Use of Fish Carrier Vessels.
Malaysia • Fisheries Act 1985 • Fisheries (Marine Culture System) Regulations 1990 • Fisheries (Maritime) Regulations 1967 • Establishment of Marine Parks & Marine Reserves Order 1994 • Fisheries (Conservation & Culture of Cockles) Regulations 1964 • Fisheries (Prohibition of Methods of Fishing) Regulations 1980 • Fisheries (Licensing of Local Fishing Vessels) Regulations 1985 • Fisheries (Close Season for the Catching of Grouper Fries) Regulations 1996 • Fisheries (Prohibited Fishing Methods for the Catching of Grouper Fries) Regulations 1996 • Fisheries (Prohibited Areas) Rantau Abang Regulations 1991 • Fisheries (Prohibited Areas) Regulations 1994 • Fisheries (Prohibition of Import etc. of Fish) Regulations 1990 • Fisheries (Control of Endangered Species of Fish) Regulations 1999

Fishery laws & regulations of BOB countries
(excludes legislation that applies only to inland waters, or areas outside the BOB)

Maldives

- No person may be engaged in fishing in lagoons of inhabited island or tourist Resort Island without permission from respective administration office.
- It is generally permitted to do fishing from any lagoons without any island or sand bar.
- Prohibition on net fishing in Male's lagoon.
- Fixed fish traps or weirs must be registered at the atoll office. No person may remove fish from traps or weirs or their immediate vicinity during their periods of operation.
- Prior permission from the Ministry of Fisheries and Agriculture (MOFA) required before installing fish holding cages or pens.
- Prohibition on interfering with pole and line fishing in the vicinity of tuna trolling, long line or drop line fishing.
- Prohibition on removal of any drifting objects on fishing grounds.
- Prohibition on use of any dynamite or explosives in fishing is prohibited.
- Prohibition on use of any poison to catch fish is prohibited.
- Prohibition on use of any spear guns for fishing is prohibited.
- Prohibition on fishing for lobster and beche-de-mer by diving with deep diving equipment.
- Prohibition on fishing so as not to be able to attend Friday prayer.
- Protected Marine Life: Dolphin, Turtle, Whale, Whales Shark, Napoleon Wrasse, Giant Clam, Triton Shell, Black Coral, Lobster less than 25 cm in length or berried female lobster.
- Any new type of fisheries or use of non-traditional gears requires permission from MOFA.
- Any fisheries research carried out in EEZ of Maldives require permission.
- The Ministry of Trade and Industries gives EEZ fishing licence.
- Statistics and other information must be submitted in the form required by MOFA.
- MOFA is empowered to make regulations for management and development of fisheries resources within the EEZ.
- MOFA may ban fishing for different species, or declare season or area closures.

Myanmar

- Law relating to the Fishing Rights of Foreign Fishing Vessels of 1989
- Myanmar Marine Fisheries Law of 1990
- Fisheries (Prohibition of Import of Fish) Notifications
- Notifications 8/94 and 9/94 (crab size limits)
- Notification 2/95 and 3/95 (prawn closed season)
- Fisheries (Control of Endangered Species of Fish) Notifications

Sri Lanka

- Fisheries and Aquatic Resources Act, 1996
- Fishing operations regulations
  - Push net fishing, harpooning for marine mammals, moxi net fishing, and gill net or trammels net fishing on coral reefs or rocks are prohibited.
  - Catching, landing, transporting, selling, buying, receiving or possessing of any marine mammal or turtle is prohibited.
  - Only specified fishing operations are allowed on licences.
- Foreign fishing regulations
  - No permits are issued for foreign fishing vessels to operate within the Exclusive Economic Zone of Sri Lanka;
  - Landing permits are issued to foreign fishing vessels to use local fishing ports and other shore facilities for the fish caught outside Sri Lanka's EEZ.

Thailand

- Fisheries Act, B.E. 2490
- Fisheries Act (No. 2), B.E. 2496
- Fisheries Act (No. 3), B.E. 2528
- Act Governing the Right to Fish in Thai Waters, B.E. 2482
- Act Organizing the Activities of the Fish Market, B.E. 2496
- Thai vessels Act, B.E. 2481
- Wildlife Reservation and Protection Act, B.E. 2535
- Animal Feed Control Act, B.E. 2535
- Act Governing the Right to Fish in Thai Waters (No. 2), B.E. 2539

129. Lack of enforcement capability is one of the reasons why community-based management approaches for artisanal fisheries have become increasingly favoured in the BOB and other regions. CBM involves bringing together the various stakeholders in the fishery and, through a participatory process of dialogue and consultation, determining mutually agreeable arrangements to support sustainable resource use that all parties are willing to adhere to. In some cases, where the fundamental problem is overpopulation or excess fishing capacity, CBM may need to be backed up by related programmes to buy back fishing gear or find alternative livelihoods for existing participants in the fishery.

130. In order to function, CBM requires that stakeholders have the power to develop and enforce their own management decisions at the local level, and to exclude 'outsiders' who are not party to the management system. This in turn may require the legislative empowerment of local communities to control fishery resources, and the attribution of user or ownership rights in fisheries that are currently open to all. Depending on the circumstances these can both be difficult processes that require considerable time and sometimes money to put into practice.

131. CBM has been promoted in particular by phase 3 of the FAO Bay of Bengal Programme, which undertook several demonstration projects in its member countries during the 1990s. Further promotion of CBM is also proposed by a number of bilateral or multilateral donor-funded projects, as well as by the BOBP's successor organisation, the Bay of Bengal Programme Inter-Government Organisation, (although BOBP-IGO appears to be having difficulty attracting the necessary funds to give effect to its proposals). A review of lessons learned during the implementation of the BOBP phase 3 found that while many of the CBM demonstration projects it initiated were conceptually sound and strongly supported by stakeholders, they had often stalled due to lack of follow-up and funding, and an insufficiently long time horizon for implementation (Preston and Yadava, 1999).

132. One of the problems of community-based management is that the scale of social organisation most appropriate for CBM to function may not correspond to the scale of the resource. For example, if twenty villages or communities all fish for sardines from the same stock, then conservation actions taken by one community will not have much impact on the stock if the other 19 start fishing more heavily or use destructive fishing methods. The introduction of CBM may thus create a new level of 'straddling stocks'

which traverse community boundaries and require collaboration between management units, in much the same way that international collaboration is required to effectively manage ecosystem-scale straddling stocks. Fortunately national systems of government generally provide the opportunity to establish umbrella management frameworks and protocols within which CBM should be able to function, and which are based on participatory rather than regulatory principles.

133. Despite the apparent obstacles, there are increasing numbers of countries around the world where CBM is being seen as probably the only way to achieve sustainable resource use over the long term. In the BOB region, the over-riding problem facing the region's coastal fishing communities will be the unsustainable harvesting of inshore resources resulting from a tradition of open access, exacerbated by increasing coastal populations and a generalised failure of central regulatory-based management arrangements. In this context it seems that persistence with attempts to promote community-based fisheries management, carried out in parallel with effort reduction and alternative livelihood schemes, may provide a way to improve the sustainability of coastal resource use.

V. CURRENT ATTEMPTS TO ADDRESS TRANSBOUNDARY ISSUES

134. The BOBLME national reports document a number of ongoing projects and activities which try to address some of the transboundary concerns noted above. A summary of these activities is show at Appendix 6.

VI. IMPEDIMENTS TO THE DEVELOPMENT OF SOLUTIONS TO TRANSBOUNDARY ISSUES

A. Knowledge gaps

135. Several important technocratic knowledge gaps have been identified earlier in the report, and are briefly recapitulated here:

- Fishery statistics, already fragmentary and unreliable, continue to decline in quantity and quality, even as fisheries become more diverse and more complex;
- Fishery-independent data, gathered through field surveys and other means, is collected less frequently due to the high costs of maintaining research vessels and carry out other data-gathering operations;

- The relative taxonomy of resources in different countries is uncertain due to inconsistency of identification.

- More specialised training of fishery scientists in aspects of fishery research and stock assessment may be needed.

136. As a result of these deficiencies, there is a lack of understanding about the capacity of key fishery resources accommodate current or future levels of fishing pressure. Assuming that such knowledge would influence the fishery management decision-making process – which is not always certain – it may be argued that absence of this knowledge and information increases the risk of overfishing and stock collapse in the region.

137. Other knowledge gaps exist at the level of the fishing community, and the general public, who often do not have a good understanding of responsible or sustainable use practices, or the interconnectedness of different elements of the marine environment (importance of corals and mangroves as fishery habitat: consequences of pollution, destructive fishing or inappropriate coastal development for fisheries; connection between larval and adult fish populations; reasons for size limits and other regulations; etc.). These knowledge gaps encourage perpetuation of destructive, irresponsible or other bad practices within the region's fisheries.

B. Policy distortions

138. As noted earlier, the continued increase of fishery production is a goal of the national development plans of all BOB countries. At the same time, all BOB countries have also stated their commitment to the sustainable management and use of their marine resources, sometimes through formal fishery policy statements or directives. In some cases it is recognised that future production increases will come primarily from aquaculture (which is generally categorised along with capture fisheries), or from offshore fishing. In others, it is not clear how the two apparently conflicting goals of increased production and sustainable management will be reconciled. Many reports on LME management in the region which talk of 'policy distortions' and 'weak fisheries management strategies' in BOB countries are referring to this inherent inconsistency.

139. As regards fisheries management *per se*, one of the most striking features of 'fisheries development' in some BOB countries (particularly Sri Lanka and India) is the

extent to which the government subsidises fishers, especially artisanal fishers. Cheap gear and equipment, artificially high product prices, credit facilities and cash subsidies are incorporated into welfare schemes aimed at fishermen and fishing communities. While there is no doubt that these schemes provide needed relief to members of the poorest communities, subsidies are likely to make resource management problems worse in the long run. Subsidising fishers or fishing operations allow them to keep on fishing even when catches have declined to very low levels, thus increasing the chances of serious overfishing and consequent stock collapse. In the context of fisheries management, subsidies are a good example of short-term priorities taking precedence over longer-term, sustainable-use goals.

C. Institutional weaknesses

140. From the regional fisheries perspective, the main institutional weakness affecting the BOB is the absence of any regional agency which encompasses all the BOB countries, and which could provide a conduit for information gathering and dissemination, joint fishery research and management, technical assistance and other mutually beneficial activities. There is a long history of fisheries collaboration in the BOB region[15], but various agencies that have been established from time to time in the past have become defunct, and there is no presently operating body that seems to fit the strong need for a regional technical fisheries agency. An issue in the past has been the reluctance of BOB countries to participate significantly in the financing of regional fishery initiatives, which have consequently all depended mainly on donor funding for their existence.

141. At the national level, other institutional problems exist. In most BOB countries there is a plethora of fishery-related agencies with overlapping or ill-defined mandates (As an example, Sri Lanka’s Ministry of Fisheries and Ocean Resources encompasses ten different agencies, all of which operate autonomously, and most of which have some sort of marine fisheries responsibility). This can result in agencies passing responsibilities around among themselves instead of tackling problems. Alternatively, given that government departments often compete with each other for status or resources, it can lead to one agency deliberately undermining the activities of another.

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15 More information on the history of fisheries collaboration in the BOB region is shown in Appendix 5.

Poor coordination among government bodies is a particular issue in regard to coastal zone management, where many different sectors and areas of responsibility come into play.

142. In the larger countries, state or provincial governments may have technical or administrative bodies, research departments, universities or other organisations which replicate at a provincial level the roles and functions of their national counterparts. There may therefore be a large number of agencies to be consulted that make even national cooperation and coordination a complex matter, and which is further magnified when international collaboration is involved. This problem applies both to fisheries and environmental issues in the BOB region.

143. Further institutional weaknesses arise in regard to the promotion of community-based management or co-management arrangements. Governments are often ill-equipped to mediate in the development of such arrangements: government officers, especially in rural areas, are often under-resourced and may function according to public service procedures and working hours; the dual role of government officers in regard to enforcement as well as extension may lead to their being distrusted by community members; and many government officer adopt a high-handed or superior attitude to fishers and members of fishing communities, many of whom may be very low on the social ladder. For these reasons NGOs, which tend to have better contact at the community level, have increasingly come to the fore in regard to local fisheries management and conservation. Governments and NGOs will need to shed their mutual distrust of each other and form partnerships in order to give effect to successful fishery co-management arrangements.

VII. PRIORITY ACTIONS NEEDED TO ADDRESS TRANSBOUNDARY ISSUES

A. General

144. The following paragraphs suggest priority actions which may help address the trans-boundary issues described in earlier sections. Many of these actions would be best executed through a dedicated agency which provides various forms of support to improved fisheries management in the region, as proposed in the next section.

B. Establish a regional fisheries support agency

145. The primary recommendation is the creation of a regional fisheries agency through which many of the programmes proposed later in this section would be carried out. Such an organisation would be entitled the Bay of Bengal Fisheries Management Cooperation Organisation (BOBFMCO), or similar name which clearly indicates the mandate of the agency without implying that it has any kind of final decision-making authority in regard to international fishery management issues. Over time, if participating countries wished, it may be possible for the organisation to graduate to a fully fledged regional fisheries management organisation. Alternatively, or in addition, the organisation may be mandated to promote broader cooperation in relation to pollution and other environmental issues, rather than just fisheries.

146. It may be possible for such an organisation to be established under the aegis of an existing international cooperation association operating in the BOB region. However given the east-west polarisation that tends to divide the BOB, it may be difficult to identify a suitable organisation acceptable to all BOB countries. In addition, there is a danger that working within an existing organisation with a broader mandate or constituency might cause BOB-specific issues to be subsumed by larger concerns relating to economic, trade and development issues, or the larger geographical regions of South and South-East Asia.

147. The preferred option would thus be to establish a small, focussed agency with a relatively narrow fisheries management (or perhaps overall LME management) mandate, and based in one of the BOB countries. The BOBFMCO should be owned directly by BOB countries, meaning that it should be established through inter-country agreement and have a core budget comprised of member country contributions, which could then be supplemented by additional revenue from other sources. It may be possible to envisage a transition period during which the agency is initially financed using external funds, until it becomes fully operational. In the long run, however, member countries will only take the organisation seriously, and develop a full commitment to its goals and work, if they are paying for it from their own pockets.

148. In making this recommendation it is recognised that BOB countries have in the past shown reluctance to take over financial responsibility for regional fisheries programmes that have been established in the region.This is likely to be a sticking point

that may take some time and negotiation to overcome. However the establishment of such an agency would almost certainly provide a channel for substantial external financial and technical assistance to the management of the region's fisheries, and possibly the broader LME, that countries are currently unable to access. An attempt to quantify such potential benefits as part of the present TDA/ SAP process may help convince BOB governments that participation in the BOBFMCO would be a worthwhile investment for them to make.

149. It is proposed at this stage that BOBFMCO focus primarily on the promoting joint management of shared stocks of small pelagic fish, demersal fish and prawns, but not focus for the time being on tuna and tuna-like species. These species fall under the mandate of IOTC, and in most cases need to be managed at a larger scale than just the BOB. It is nevertheless recommended that the proposed BOBFMCO establish strong collaborative links with the IOTC, as this would provide benefits for both organisations. BOBFMCO would be able to draw on an existing pool of information and expertise on stock assessment, statistics and other technical fishery issues, while IOTC could take advantage of BOBFMCO to improve communications with the BOB region and obtain additional data from it. At a later stage, depending on the evolution of the two organisations, it may be possible for BOBFMCO to provide a sub-regional platform for IOTC, or assist countries develop sub-regional positions or arrangements regarding the management of tunas and related species.

C. Improve fishery statistics

150. The generalised inadequacy of fishery statistics is one of the main multi-country issues that need to be addressed if the management of the BOB's fisheries is to be improved. As well as providing a basis for stock assessment work, statistics are needed to monitor the ongoing condition of fisheries and their responses to management initiatives. There is a strong requirement for BOB countries to improve the quality of their fishery statistics, particularly in regard to the correct identification of those key fishery species that are most heavily exploited and make up large parts of the catch.

151. Improvement of fishery statistics is something that needs to take place on a national basis in each country. There will be a requirement for fisheries agencies in some countries to re-prioritise this area of their operations, and increase the funds or manpower they dedicate to it. However there are also many ways through which a

regional or international programme could support national fishery statistics efforts, or encourage collaboration between them. These include standardisation and harmonisation of data collection methods, forms and terminology, training of enumerators and data analysts, data verification and quality control, and production of regional-level data summaries or interpretations. This is a clear area where GEF incremental funding could be applied to add value on a regional or trans-boundary basis to the outputs of national fishery statistics programmes.

152. A regional initiative to improve fishery statistics from the BOB region would best be run through the umbrella fisheries agency proposed in the preceding section. However there are other organisations whose involved in such an initiative should be sought. For many years FAO has promoted the improvement of fishery statistics programmes worldwide. As mentioned earlier, FAO has a historical paper-based collection of fishery statistics from the BOB region which may prove to be useful historical baseline data for future stock assessment projects on the region's fishery resources. IOTC also has a lead role in improving statistics relating to tuna and tuna-like species in the broader Indian Ocean. As well as having potentially useful historical data, both agencies embody significant skills and resources relevant to any future BOB-based fishery statistics initiative, and both would stand to benefit from improved data from the region. It would thus be logical for any BOB-based agency with a fishery research and management mandate to forge strong collaborative links with both these organisations

D. Improve taxonomic classification of fish catches

153. It has been noted that there are problems in correctly identifying even important constituent species of the fish catch in BOB member countries. This problem could be addressed through the production of a comprehensive taxonomic guide to exploited fishery resources, coupled with a training programme to introduce the guide to fishery officers and researchers in BOB countries, which would aim to ensure that statistical enumerators were able to correctly identify the key components of the catch in their own areas.

154. Excellent work in this field has already been carried out by FAO, which has produced extremely practical fish identification guides for several regions and countries of the world, one of which is Sri Lanka (De Bruin, Russell and Bogusch, 1994). *The*

Marine Fishery Resources of Sri Lanka could serve as a model for a similar, expanded publication that would cover the resources of the BOB region as a whole, and this could then serve as a basis for the training/ upskilling programme referred to above. FAO would be the obvious agency to be asked to prepare the taxonomic guide.

E. Establish a digital collection of historical documents

155. Fishery research agency libraries, archives and document collections should be scoured for past publications, reports, and data relevant to fisheries research and stock assessment. These should be scanned or otherwise converted to a compact digital format, professionally catalogued and keyword-indexed, and placed on a website for downloading by fishery researchers and managers in the region. Provision should be made for providing document collections on CD to those individuals who have computers but no internet access, and in hard copy for users with no computer access. The assembly of such a regional document collection should be coordinated and managed by the BOBFMCO proposed earlier, but should involve the active collaboration of fisheries agencies throughout the region. To promote information-sharing and avoid duplication of effort, close links should be developed with the fisheries information services of other international fishery bodies, in particular the WorldFish Centre (formerly ICLARM).

F. Produce fishery or resource synopses

156. As an adjunct to the process of establishing a digital fisheries document collection described above, synopses should be produced which document all existing knowledge and information on selected species, fisheries or resources in the region. These should be based on existing published and unpublished research and data, and should attempt to provide the regions fishery managers and researchers with the maximum possible amount of information relevant to the management of the species, fishery or resource in question. Initial priority should be given to preparing synoptic documents on the shared resources or stocks listed in table 7. As well as documenting information already available, the production of synopses would allow detailed evaluation of information gaps on key resources, and the development of research programmes to fill these gaps.

157. Resource synopses should be prepared through the agency of the BOBFMCO referred to above, wherever possible using expertise from BOB countries as a means both of securing regional knowledge, and of promoting skill development in the region's fishery researchers.

G. Promote fishery management planning

158. The development of management plans for specific fisheries or resources is not yet very common in the BOB region, but is becoming increasingly practised in some parts of the world. Fishery management plans (FMPs) provide opportunities to involve stakeholders more closely in the management process, increasing buy-in by fishery while simultaneously reducing opportunities for discretionary decisions by powerful individuals. As noted earlier, FMPs may also help ensure that the results of fish stock assessment or applied research work are taken proper account of in the decision-making process, which is not always the case at present.

159. The growing interest in community-based fisheries management in BOB countries adds a further dimension to higher-level fishery management planning. Because the scale of CBM is almost always smaller than the scale of the resource being exploited, there is a need for FMPs to provide an overall framework within which CBM can operate. For instance, if stock assessment work indicates that a resource can support an annual yield of 10,000 tonnes, and there are ten communities exploiting it, those communities need to work together to ensure that their aggregate take does not exceed what is sustainable. Where CBM is being promoted, therefore, FMPs need to provide for a higher level of consultation and collaboration between management units that will permit larger-scale management targets to be met.

160. This approach is somewhat novel in the BOB region, with only one example being uncovered by research carried out for the present study[16]. There would be ample justification for a regional initiative to assist BOB countries to FMPs for key fisheries, and to incorporate appropriate participatory frameworks into these plans in situations

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16 An ADB loan-funded Coastal Resource Management Project is supporting the establishing of multi-level participatory management arrangements for selected key fisheries in Sri Lanka, including the south coast lobster fishery, and the 'offshore multi-day boat' fishery that carries out gill-netting and long-lining for sharks and tuna..

where CBM exists or is expected to develop. Once again, fishery management planning support could best be provided via the proposed umbrella regional fisheries agency.

161. It should be emphasised that no recommendation is being made for the proposed umbrella regional fisheries agency to become directly involved in the CBM process. As noted earlier, prior experience with the BOBP has illustrated that this is an area where significant funding support and a long time horizon may be needed to achieve success. Specific CBM projects are probably best supported by local or international NGOs who may be able to access bilateral or multilateral donor support. The role suggested for the proposed umbrella regional fisheries agency is to assist national or state governments develop the fishery management framework within which CBM can operate.

H. Promote collaborative management of shared stocks

162. A primary concern for the region's fisheries is that many shared resources are being fished by two or more countries with little or no knowledge of the ability of the stock to support such fisheries. In other parts of the world fisheries that have been exploited in this way have collapsed, and there is strong evidence that some BOB resources, such as hilsa, have undergone serious declines, or are likely to do so in future. There is thus a strong argument for the establishment of joint management arrangements for a number of stocks, resources or fisheries. Candidate fisheries would include (but not necessarily be limited to) those listed earlier in table 7.

163. An appropriate approach to initiating joint management would be to establish a Fisheries Advisory Committee (FAC) for each stock or fishery, which would include representatives of those nations in whose waters the resource occurs, or whose fishers exploit it. The Committee would review exploitation patterns in the fishery concerned, commission appropriate research and investigations to assess the status of the resource and its management requirements, and make recommendations for consideration by participating countries. Investigations would be carried out by the concerned countries through joint research projects, possibly supported by donor or developed-country funding and technical assistance. In some cases research and management collaboration with neighbouring regions might be needed. Representatives on the Committee would need to be sufficiently senior to be able to effectively present their country's views on the way the fishery or resource should be managed, and to convey the Committee's

recommendations back to their government at a high enough level for some kind of action or response to be expected.

164. There are two possible approaches to implementing the proposed FAC arrangements. The first, which is not recommended, would be for each FAC to operate as a separate entity, completely independent of any others. In this case there would probably be insufficient justification for the establishment of a full-time secretariat for each FAC, so one of the participating countries would probably need to act as convenor and secretariat, and funding for research, meetings, etc. would have to be raised on an ad hoc basis. There would be a strong risk that the FAC would not function effectively due to non-availability of funding. The agency or individual selected as convenor/ secretariat would probably have numerous other commitments, some of which may take higher priority than the FAC.

165. The alternative approach, which is strongly preferred, would be to establish an umbrella fisheries agency covering the BOB region, and which would coordinate the activities of all the FACs as well as acting as a shared secretariat for them. This would lead to economies of scale, promote information sharing, enable coordination of activities, and allow centralised fund-raising initiatives. Such an agency could also be pro-active, assisting countries to identify common fishery management issues and encouraging the development of solutions to them.

I. Upgrade stock assessment capabilities

166. It has been noted earlier that there is a need to strengthen capacity for stock assessment and appropriate fisheries research in the BOB region, preferably through a capacity building programme that addresses both institutional strengthening and individual skill development.

167. The establishment of such a programme would logically be run in conjunction with the process of constituting FACs, as described above. As part of the work of the FACs, national fishery research institutions would be commissioned to undertake or participate in well-defined collaborative research programmes on the fisheries or stocks within the FAC’s purview. These collaborative research projects would also involve universities and other research institutes both from within and outside the BOB region, where such bodies possessed recognised skills and expertise relevant to the subject in

question. The aim of the collaborative investigations would not only be to provide the research information needed by the FACs: where appropriate they would also provide project management support to participating fishery institutions in BOB countries, as well as offering mentoring and training opportunities to BOB country nationals. Through these two primary mechanisms the programme would progressively strengthen stock assessment and fishery research skills and capacity within the region while also contributing to the body of information available to support improved fishery management.

168. It would be logical for such a capacity-building programme to be run through the umbrella fisheries agency referred to earlier. This is in itself another strong reason for proposing the establishment of such an agency.

J. Improve communication of stock assessment results

169. An issue noted earlier was that of stock assessment information not necessarily reaching, or being appreciated by, the senior-level individuals in BOB countries who are ultimately responsible for fishery management decisions. In many cases the focus of decision-makers is on increasing fishery production, or on short-term measures that may have negative long-term consequences. This issue may not be confined to the fisheries sector: senior officials in government departments responsible for economic planning, business development, foreign investment and various other agencies, at national and sometimes state or local levels, often make decisions that have significant implications for the fisheries sector.

170. The development of national- and regional-level information products to improve understanding of fishery management issues at a senior level would help combat this situation. An approach that has worked in some countries has been the production of ‘resource profiles’ or similar documents that summarise, very briefly and in plain language, the basic characteristics of key fishery resources, and the expected limits to which they can be exploited. If produced properly, such resource profiles can have wide application: they can be used not only to inform senior officials, but as resource materials for community meetings, press releases and formal seminars or presentations. The preparation of resource profiles and other public information materials would be a simple matter if synoptic documents, as described earlier, had already been produced for the resources in question.

171. It is recommended that communication skills and the production of information materials appropriate to senior officials and the lay public be emphasised as a key part of the stock assessment capacity-building project described above. The programme should be designed to train fishery scientists in the production of public information materials, in public speaking and in basic negotiation skills. The programme should also provide direct support to and coordinate the production of appropriate information materials, as the nature of the subject matter means that it will almost always have multi-country application.

K. Engage lower levels of government

172. The vastly different sizes of the region's countries, from Maldives with only 287,000 people to India with over a billion, as well as each country's individual history, means that there are quite different levels of national, state and local governments. The table below describes some of the systems of sub-national government that apply in different BOB countries. It should be noted that the table is only intended to illustrate the range of different systems in place, and does not pretend to be a detailed guide to the region's governments.

173. Four BOB countries – India, Malaysia, Thailand and Indonesia – only have part of their land area, coastline or EEZ in or adjacent to the BOB (in the latter two cases only a relatively small part). In these countries it might be expected that those states or provinces that are actually adjacent to the Bay may have a greater interest in BOB-related issues than the national government, and certainly greater than those local governments are located away from the BOB. Lower levels of government in BOB countries generally have at least partial and sometimes primary responsibility for fisheries and other natural resource development and management at the local level, as well as for local-scale economic planning and development[17]. For any fisheries or environmental management issues that concern the BOB, therefore – including the proposed BOBFMCO – it seems logical that a priority should be to engage the active participation of those state, provincial and local governments that are actually adjacent to the Bay, and whose interests will be most affected. Positive engagement may result

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[17] For example Article 246, Fisheries, of the constitution of India makes it a subject for State List no. 21. This means that all laws and regulations related to fishing, fish marketing, fishers' welfare, etc., are framed by the state legislatures

in direct action by coastal provinces and administrations within their sphere of responsibility, or in active lobbying of national government to take concurrent action, or both.

L. Implement a fisheries management pilot project

174. As part of the suite of activities being developed here, it is recommended that a pilot fisheries management project be designed and implemented, which would allow adoption and demonstration of the principles described earlier in relation to one or more straddling stocks in the region. The proposed project would address a group of identified local fisheries problems and fulfil a demonstration function, and would also allow testing and refinement of some of the other more regionally-oriented activities already described above. The ultimate goal would be to put in place appropriate management arrangements that ensure the long-term sustainable use of fishery resources in the area.

175. Characteristics of the proposed pilot project would be as follows:

- it presents a genuine opportunity to develop sustainable use regimes for marine fisheries (i.e. the fisheries are not so over-fished as to be beyond rescue);
- it involves two or more countries;
- it involves multiple species which are widespread in the BOB region;
- there is a strong participatory or community management component.

176. As noted earlier, experience in the region to date suggests that participatory or community-based management projects require a significant commitment in both time and money if they are to be successful. It is for this reason that one single, substantial, long-term demonstration project is being recommended, rather than multiple smaller projects which would have a lesser chance of success.

177. It is not proposed that such a pilot project be managed or run through the BOBFMCO. Given the nature of the activity, the project would be best organised as a joint activity between the relevant governments, with the formal involvement of one or more NGOs able to mediate and promote participatory management arrangements. However it is proposed that the BOBFMCO should be a partner or technical

collaborator in the project, and be responsible for providing technical advice and assistance to it.

M. Improving understanding and collaboration on transboundary issues

178. The terms of reference for the present study stipulate that the report should discuss ‘ways to assist the countries in the BOBLME region to better understand the transboundary issues related to biologically or ecologically unsustainable exploitation and use of shared/ common marine living resource stocks, and to the regional marine living resource stock assessment capability, and to work collaboratively to address them.’ Many of the actions described above are expressly intended to promote increased understanding and collaboration on transboundary issues, hence this aspect of the TOR is deemed to have been addressed under the preceding sections.

VIII. SUGGESTED LOCATION OF PROPOSED ACTIVITIES

179. The primary recommendation is for the establishment of a Bay of Bengal Fisheries Management Cooperation Organisation. If this comes to pass, objective criteria that should also be considered the process of selecting a base and headquarters for the BOBFMCO should include the following:

- host country should have a representative range of fishery resources and issues;
- good communication, service and operational facilities;
- possibility of interaction with other specialised fishery agencies;
- able to attract international-calibre specialists.

180. Based on these criteria, prospective locations for the BOBFMCO would be Phuket in Thailand, Penang in Malaysia, Colombo in Sri Lanka, and Chennai in India. In reality, of course, the process of selecting a base and headquarters for such an agency would be a matter of political negotiation.

181. The various activities to be carried out by the BOBFMCO will be regional or multi-country in nature.

182. The recommended location for the proposed pilot fishery project is the Gulf of Mannar, between Sri Lanka and India. Reasons for this recommendation are as follows:

- on the Sri Lankan side, civil war has prevented fishing for a decade, so resources are currently in a reasonably healthy state;

- on the Indian side lies the Gulf of Mannar Marine Biosphere Reserve, where existing local conservation arrangements provide a management impetus;

- development of a joint research and action plan could lead to sustainable management of this area, conserving resources and providing long-term benefits to communities on both sides of the Gulf;

- if not addressed, competition between resource users on both sides of the Gulf has the potential to escalate into a management problem over the longer term;

- the site meets all the other criteria proposed earlier.

183. Although this is the recommended choice of location, there are no doubt other sites that could be considered, and where the selection criteria may be met in full or in part.

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APPENDIX 1: LARGE MARINE ECOSYSTEMS

184. An ecosystem is a functional unit comprising all the organisms in a particular place interacting with one another and with their environment, and interconnected by an ongoing flow of energy and a cycling of materials. There are many different ways of delimiting ecosystems, for example by size: the whole earth may be regarded as one giant ecosystem, while smaller ecosystems may correspond to vegetation units, species assemblages or habitat types. Ecosystems may be defined according to the main primary producer, with the boundaries of the ecosystem being taken as the extent of the vegetation type. Ecosystems may also be defined by geographical boundaries such as wet coastal, intertidal and littoral, estuaries and enclosed seas, coral reefs, continental shelves and deep ocean.

185. In recent years the concept of large marine ecosystems has been developed and adopted as a useful tool for approaching the management of international waters and the transboundary problems that they present. LMEs are characterised as relatively large regions of ocean space, typically 200,000 square km or greater in size, and having distinct bathymetry, hydrography, productivity and trophically dependent populations. They encompass river basins and estuaries and extend out to the seaward boundary of continental shelves and the seaward margins of coastal current systems. The LME as an organizational unit facilitates management and governance strategies that recognize the ecosystem's numerous biological and physical elements and the complex dynamics that exist amongst and between them. Sixty-four LMEs have now been defined, as shown in the figure below. Between them these areas are responsible for about 95 per cent of the fish and shellfish yield of the world.

186. Presently, the health of many LMEs is at risk as a result of pollution, over-fishing, habitat modification and habitat destruction. The consequences of these threats to ecosystem function and health, as well as the corresponding impacts on human populations, is not known in empirical terms (ecosystem dynamics are non-linear, often with causes and effects separated by a variable time lag). However, the importance of marine and coastal area resources is undeniably substantial. Mitigating the negative impacts of these threats and adopting management practices that sustain ecosystem function and health has therefore become a major concern to the international community.

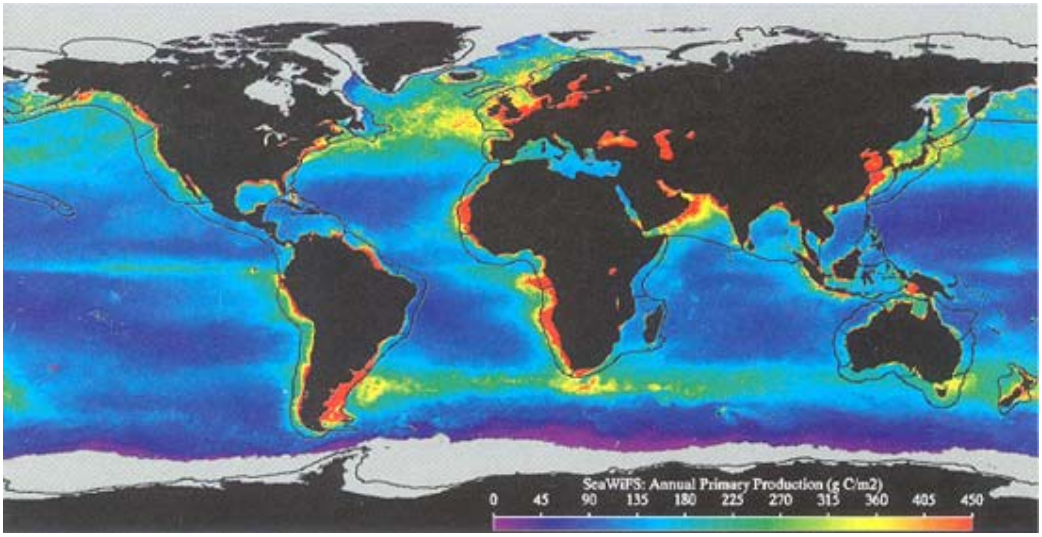

Figure A1.1: Boundaries of the 64 large marine ecosystems of the world (Source: US National Oceanic and Atmospheric Administration)

187. As a result of follow-up actions to the 1992 UNCED declarations on the declining state of global coastal ocean areas, many governments have now made ministerial-level commitments to ecosystem-based marine area assessment and management practices in support of the global objectives of Chapter 17 of Agenda 21. Ecosystem-scale management projects are now in place for the Benguela Current, Yellow Sea, Baltic Sea and Guinea Current LMEs, with additional projects being planned for the Canary Current, Somali Current, Aghulas Current, Caribbean, Gulf of Mexico and of course Bay of Bengal LMEs. Among the specific objectives of these various projects are:

- the recovery of depleted fish biomass and fisheries to promote greater food security, sustainable productivity and socioeconomic benefits;
- reduction in pollution and eutrophication levels of coastal waters; and
- restoration of degraded habitats including corals, mangroves, and wetlands.

188. The biomass recovery and restoration activities involved in these projects encompass whole LMEs, and engage institutions across traditionally separate sectors such as Environment, Fisheries, Energy, Tourism, and Finance. The approach to project implementation is generally based on a 5-module assessment and management methodology. The modules are science-based and relate to considerations of ecosystem (1) productivity, (2) fish and fisheries, (3) pollution and ecosystem health, (4) socioeconomics, and (5) governance. This modular approach will not be described in detail here, but can be found in various publications, including (Sherman 2002).

APPENDIX 2: WORLD FISHERIES PRODUCTION

189. World fisheries production, including marine and inland fisheries and aquaculture, was estimated in 2001 to be about 128.8 million metric tonnes (mmt), or 86.0 mmt excluding China[18]. As can be seen from the figure below, production has been steadily increasing from the approximately 20 mmt recorded in 1950, when the first attempts to compile comprehensive statistics were made (FAO 2002). Fish is now the largest single source of animal protein in the world, providing more than 15% of animal protein supplies and making a significant contribution to food security. Over one billion people rely on fish and shellfish as their main protein source. Of the top forty countries ranked by the share of animal protein derived from fish, 39 are developing countries. Most of the 50 mmt of wild-caught marine fish used for human consumption is produced by artisanal fishermen. Seafood is also the fastest-growing food commodity in international trade, providing direct and indirect employment to over 100 million people globally (FAO, 1995a).

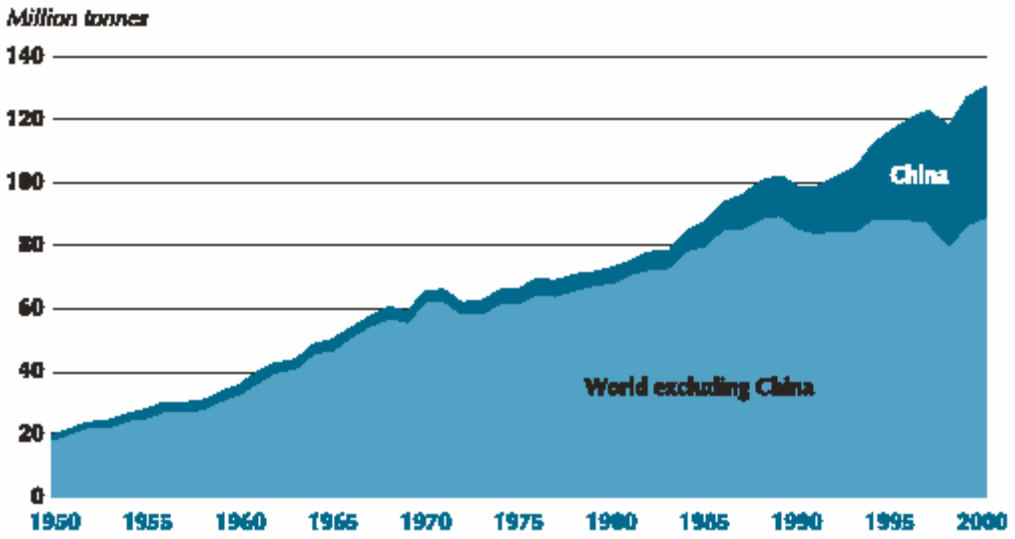

Figure A2.1: World capture fisheries and aquaculture production, 1950 – 2000 (FAO 2002)

190. Following a decline to 79.2 mmt in 1998, total production of marine capture fisheries increased to 84.7 mmt in 1999 and 86.0 mmt in 2000, thus recovering to levels

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[18] China remains by far the largest producer, with reported fishery production of 41.6 mmt in 2000 (17 mmt from capture fisheries and 24.6 mmt from aquaculture). However several recent academic studies show that production statistics from China have been grossly overstated, especially since the 1990s. Because of its importance and the uncertainty over its production statistics, China is now often discussed separately from the rest of the world in documents on fishery performance.

close to the historical maximum recorded for 1996 and 1997. If China is excluded, world production in 2000 was 71.3 mmt, about 5% less than the historical peak of 75.5 mmt in 1995. The global situation of the main marine fish stocks for which assessment information is available follows the general trend observed in recent years. Overall, as fishing pressure continues to increase, the number of underexploited and moderately exploited fisheries resources continues to decline slightly, the number of fully exploited stocks remains relatively stable, and the number of overexploited, depleted and recovering stocks is increasing slightly (FAO 2002).

191. Although the level of catch from marine capture fisheries appears to have stabilized, the statistics mask the fact that many fisheries have undergone serious declines. All but two of the world's fifteen major fishing areas have shown decreasing productivity and, in the most extreme cases, entire fisheries have disappeared. World marine capture fishery production is being maintained by the increased exploitation of those resources that are not yet overfished, and by the harvesting of newly discovered or previously unexploited stocks. Both these processes are subject to finite limits which will be reached in the near future, if they have not already.

192. Underlying the rapid growth in fisheries production since the 1950s has been a large increase in global fishing effort, both in numbers of vessels and in technological capacity. The global fishing fleet, which now numbers about 4.1 million vessels (2.28 million of which are mechanized) is excessively large and heavily subsidized. A generalised absence of property rights in fisheries, coupled with continued heavy government subsidies to fishing operators, are considered to be the major contributors to over-investment and over-exploitation. Excess fishing capacity and other forms of overcapitalisation are often perpetuated in cases where fleets or processing facilities continue to benefit from Government subsidies. In the context of marine capture fisheries, FAO (1995a) notes that "the policy measures most likely to bring about effective resource management are those which embrace removal of free and open access to resources and introduce, wherever appropriate, measures to allocate resources and establish use rights. Where it is possible to introduce such measures they will, *inter alia*, provide greater incentives to reduce excess fishing capacity which has been one of the factors most responsible for overfishing".

193. In addition to large international fisheries, many local or coastal fisheries of vital significance to domestic economies and food security are being threatened

worldwide, not only directly by overexploitation or other aspects of poorly regulated harvesting, but also indirectly through the deleterious effects of pollution, habitat destruction through coastal development, and poor watershed management. The Bay of Bengal is no stranger to these phenomena, and the declining, sometimes overfished and frequently degraded coastal fisheries of the region are as much in need of protection and management as their counterparts in other regions of the world.

APPENDIX 3: ECOSYSTEM-BASED FISHERIES MANAGEMENT

194. Various international conventions and agreements, including UNCED, CCRF and, most recently, WSSD have called for the implementation of ecosystem-based management (EBM) of marine resources. EBM implies a broader view than simply maximising or optimising returns from given resources: it requires that the various goods and services delivered by the ecosystem be optimised, rather than just a portion of them. For instance, if an ecosystem is simultaneously supporting fisheries and acting as a sink for land-based pollution, EBM would aim to strike the best balance between those two functions, instead of maximising one at the expense of the other.

195. The ecosystem approach to fisheries (EAF) is an extension to EBM, which is intended to improve on 'traditional' approaches to fisheries management. EAF specifically recognises that fisheries are not distinct from an ecosystem, but are an integral part of it: extraction of target and non-target species may result in changed biological interactions, use of certain gear types may cause habitat change, discharge of wastes and contaminants may cause pollution-induced changes, etc., all of which may have long-term environmental consequences. Conversely, climate change, pollution from land-based sources, or changing land-use practices may have environmental consequences that impact on fisheries. EAF thus attempts to take a broader view than 'traditional' fisheries management approaches, in which fisheries have generally been viewed independently from wider environmental or ecosystem-scale developments. EAF recognises the broader economic and social interests of stakeholders, and involves the setting of economic and social objectives based on a comprehensive consideration of ecological values and constraints. This in turn requires a greater stakeholder base, increased participation, and improved linkages of fisheries management with coastal ocean planning and management activities.

196. EAF is not inconsistent with, or a replacement for, the current fisheries management approaches. Current fisheries management best practice of: planning; setting objectives; implementing strategies and measures to meet the objectives; and performance monitoring and assessment, if conducted to a satisfactory standard, would still provide a sound basis for implementing EAF. Indeed, rigorously applying 'traditional' fisheries management approaches (with appropriate emphasis on the precautionary approach and rights-based allocation) would go a long way towards

solving current fisheries problems. If such action had been taken in the it past would have prevented some of the ecosystem problems currently being faced.

197. In substance, there is little difference between the LME management approach and an ecosystem approach to fisheries management (EAF), except for the focus of EAF being clearly on fisheries and fish habitats. The risk of both approaches is that an inordinate amount of effort is spent on describing and analyzing the scientific dimensions of the management problems but fails to bring about a lasting improvement in institutional and human capacities and performances that are needed for effective management (Martusubroto, 2002)

198. A further issue is that, if ‘traditional’ fisheries management practices have largely failed to achieve the goal of sustainable resource use, then the EAF, which is technically and scientifically more demanding, may suffer similar failures. In order to move from ‘traditional’ fisheries management to EAF, a step-wise approach is likely to be needed in order to ensure the development of human capacity and sound technical approaches. In practice, therefore, if EAF is to develop at all, it is likely to be as an incremental progression of current fisheries management practices and approaches.

APPENDIX 4: INTERNATIONAL FISHERY AGREEMENTS AND CONVENTIONS

199. A number of international agreements and conventions now govern the way that national governments should approach the management of their fisheries. Some of these relate specifically to the establishment of regional fishery bodies (RFBs) which may variously have advisory, scientific or management roles in relation to particular stocks or areas. A large number of RFBs have now been established, as shown below.

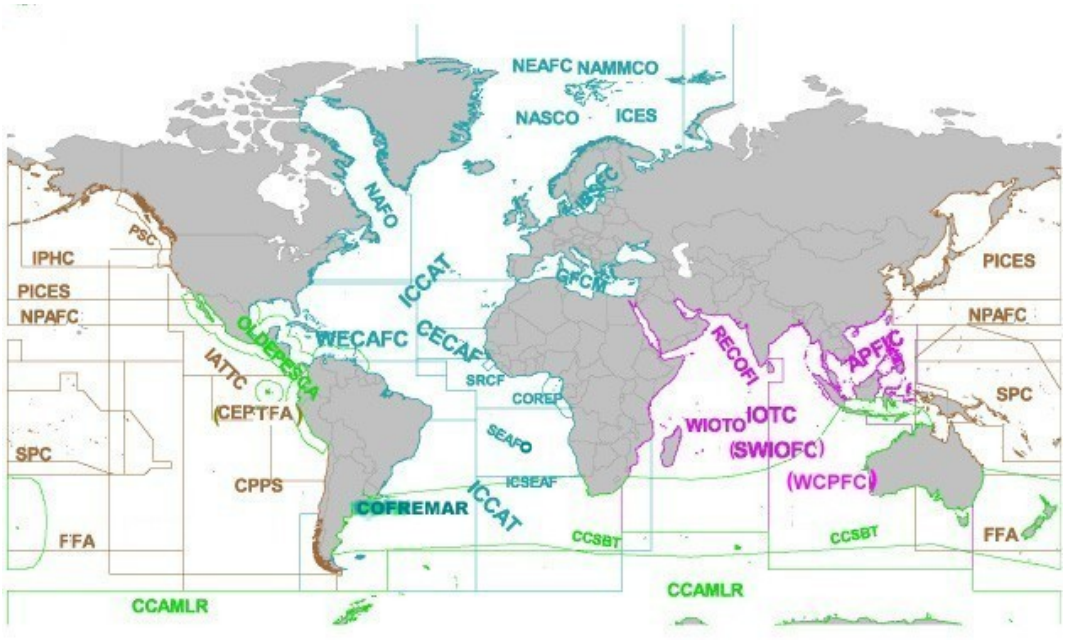

Figure A4.1: Regional fishery bodies of the world
(Source: Food and Agriculture Organisation of the United Nations)

200. Considerable impetus was given to the establishment of management-oriented RFBs (also called Regional Fishery Management Organisations, RFMOs) by the *United Nations Convention on the Law of the Sea* (UNCLOS), which was adopted in December 1982 following the widespread declaration in the late 1970s of exclusive economic zones (EEZs). UNCLOS provides the international legal basis for coastal states to pursue the protection and sustainable development of the marine and coastal environment and its resources. The Convention confers rights and responsibilities onto coastal states to exploit and manage both living and non-living resources within their EEZs. There are now 145 full parties to UNCLOS, including both developed and developing states. The only major non-party among developed countries is the USA

201. The new legal regime of the ocean created by UNCLOS gave recognition to coastal States' jurisdiction over the fishery resources within their EEZs, which collectively cover only about 10% of the ocean's surface but embrace some 90% of the world's marine fisheries (Weber, 1994). However, although it constituted a necessary first step towards better fisheries management, extended national jurisdiction on its own was insufficient to assure fisheries development on a sustainable basis. The first priority of many coastal states was simply to extract greater benefits from fisheries within their EEZs (FAO, 1995b).

202. In order to progress those aspects of UNCLOS pertaining to fisheries management in the face of delays over seabed mining and other issues, the UN convened the Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, which ran from 1993 to 1995. At its 6th and final session in August 1995 the Conference approved the *Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.* Commonly referred to as the *Fish Stocks Agreement*, or FSA, this instrument 'gives teeth' to the provisions of UNCLOS in regard to management of fisheries which straddle several EEZs and/ or high seas areas. Countries may accede to the provisions of the FSA even though they have not ratified UNCLOS, thus de-linking the development of living marine resource management regimes from the protracted deadlock over other issues. In addition, the FSA defines more clearly a number of issues relating to living marine resources that are addressed in UNCLOS only in general terms (Van Dyke, Nakano and Gardner, 1996).

203. The FSA entered into force on 11 December 2001. As at 1 May 2003, 34 States had ratified or acceded to the Agreement, including some BOB countries, as shown below.

204. The FSA is an important step forward in the development of international fisheries management regimes because, for those countries which accede to it, participation in management arrangements is mandatory, not optional or discretionary. Further, management is to be based on the "precautionary approach" under which the absence of scientific certainty may not be used as a reason for failing to take conservation and management measures. In addition, under the precautionary approach the burden of proving whether or not a fishery is capable of withstanding increased

exploitation may be shifted from those responsible for regulating the fishery to those wishing to benefit from increased exploitation (Garcia, 1994). This is particularly significant for those states which have limited means to gather or interpret the scientific data necessary for meaningful fishery stock assessment or monitoring in their EEZ (as opposed to coastal) areas.

Table A4.1: Status of BOB countries in regard to UNCLOS and the FSA (Source: United Nations Office for Ocean Affairs)

State	UNCLOS		FSA	
	Signed	Ratified	Signed	Ratified
Bangladesh	Yes	27 July 2001	Yes	No
India	Yes	29 June 1995	Yes	19 August 2003
Indonesia	Yes	3 February 1986	Yes	No
Malaysia	Yes	14 October1996	No	No
Maldives	Yes	7 September 2000	Yes	30 December 1998
Myanmar	Yes	21 May 1996	No	No
Sri Lanka	Yes	19 July 1994	Yes	24 October 1996
Thailand	Yes	No	No	No

205. The capabilities of developing nations to implement the FSA are also addressed in another of its important provisions. Article 24 of the FSA requires that "States shall give full recognition to the special requirements of developing States in relation to conservation and management of straddling fish stocks and highly migratory fish stocks. To this end, States shall, either directly or through the United Nations Development Programme, the Food and Agriculture Organisation of the United Nations and other specialised agencies, the Global Environment Facility, the Commission on Sustainable Development and other appropriate international and regional organisations and bodies, provide assistance to developing states". In other words, developed countries are expected to provide financial and other assistance to help developing countries meet their obligations under the FSA.

206. Since the adoption of the FSA in 1995, the UN General Assembly has called for its implementation in successive resolutions. In paragraphs 13 and 14 of its resolution 57/143, the General Assembly proposed the establishment of a voluntary trust fund to assist developing States Parties to the FSA, as provided for by article 26.1 of the Agreement. In paragraph 15 of the same resolution, the Assembly urged the development of detailed terms of reference for such a trust fund and suggested that the following should be considered for early implementation through the fund:

- Facilitating the participation of developing States parties in relevant regional and sub-regional fisheries management organizations and arrangements;
- Assisting with travel costs associated with the participation of developing States parties in meetings of relevant global organizations;
- Supporting ongoing and future negotiations to establish new regional or subregional fisheries management organizations and arrangements in areas where such bodies were not currently in place, and to strengthen existing subregional and regional fisheries management organizations and arrangements;
- Building capacity for activities in key areas such as monitoring, control and surveillance, data collection and scientific research;
- Exchanging information and experience on the implementation of the Agreement;
- Assisting with human resources development and technical assistance.

207. The FAO Committee on Fisheries (COFI) has approved FAO participation in the development and management of the fund. There thus appears to be a strong likelihood in the coming years of increased financial and technical assistance to help developing states, including BOB countries, put in place improved management arrangements, in particular where these address international or transboundary issues through RFMOs.

208. The living marine resource responsibilities of coastal states were further reinforced by *Agenda 21*, which was adopted by the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992. Chapter 17 of Agenda 21 deals with “protection of the oceans, all kinds of seas, including enclosed and semi-enclosed areas, and coastal areas and the protection, rational use and development of their living resources”. This component of Agenda 21 has promoted widespread recognition of the fact that critical environmental problems are shared globally and that oceans and coastal areas are key components of most of those global problems. The key difference between UNCLOS and Agenda 21 is that UNCLOS is legally binding, whereas Agenda 21 is not.

209. The results of UNCED were intended to give much-needed impetus to the establishment, at all levels, of more comprehensive and multi-disciplinary approaches

to sustainable marine and coastal development, especially the management of marine living resources, conservation of biodiversity, and scientific cooperation for these purposes. Agenda 21 focusses particular attention on the development and implementation of concepts of integrated management of marine and coastal areas, and ecosystem-based management. Programme area A of chapter 17 of Agenda 21 deals with integrated marine and coastal area planning and management, and represents the first time that this topic has been elevated to the level of a global issue. The relationship of integrated marine and coastal area planning and management to the control of land-based sources of marine pollution, the conservation of biodiversity and adaptation to global climate change are all recognised, as also are the potential benefits of adopting ecosystem-based approaches to marine management. Programme area C of Chapter 17 of Agenda 21 makes specific reference to the fact that "*management of high seas fisheries is inadequate in many areas and some resources are over-utilised*". This situation is attributed to a range of causes, including unregulated fishing, over-capitalisation, excessive fleet size, vessel re-flagging to escape controls, insufficiently selective gear, unreliable databases and lack of sufficient cooperation between states.

210. Just prior to UNCED, FAO organised an International Conference on Responsible Fishing in Cancún, Mexico, in early 1992. The *Declaration of Cancún* endorsed at that Conference gave impetus to the concept of responsible fishing and was an important contribution to UNCED, which subsequently supported the development by FAO of a *Code of Conduct for Responsible Fisheries* (CCRF). After considerable debate and many revisions in various FAO and other fisheries meetings, the CCRF was adopted in October 1995 by the 28th Session of the FAO Conference. It provides principles and standards for the conservation, management and development of all fisheries, and covers the capture, processing and trade of fish and fishery products, as well as fishing operations, aquaculture, fisheries research and the integration of fisheries into coastal area management. Although voluntary, the Code is largely based on relevant rules of international law, including UNCLOS, and the number of coastal states that have formally adopted it is growing.

211. The FAO Technical Consultation on High Seas Fishing, held in September 1992, further recommended the elaboration of a mechanism to address problem areas relating to the management of high seas fisheries. This consultation ultimately led to the adoption by the 27th Session of the FAO Conference, in November 1993, of the

Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas. The Compliance Agreement, as it is usually called, was the first concrete output made under the CCRF. In broad terms, the Agreement places a general obligation on flag States to take such measures as may be necessary to ensure that vessels flying their flags do not engage in any activity that undermines the effectiveness of international conservation and management measures, and seeks to limit the freedom of vessels that have a bad compliance record to 'shop around' for new flags. Article VI of the Agreement requires Parties to exchange information on vessels authorised by them to fish on the high seas, and obliges FAO to facilitate this information exchange. The Compliance Agreement was adopted on 24 November 1993 but has not yet entered into force as only 18 of the required 25 acceptances have been received.

212. Several other recent agreements also have indirect relevance to living marine resource management. The *Kyoto Declaration on the Contribution of Fisheries to Sustainable Food Security* recognises the need for responsible management of fisheries if they are to maintain or increase their contribution to world food security. Several conventions and agreements relating to pollution, environmental management and biodiversity conservation have fisheries or living marine resource provisions, including the *International Convention for the Prevention of Pollution from Ships* (MARPOL), the *Programme of Action for Small Island Developing States* (relevant to Maldives, the only BOB country to be so classified), the *Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities,* and the *International Coral Reef Initiative* (ICRI).

213. Ten years after UNCED, the *World Summit on Sustainable Development* (WSSD), held in Johannesburg in 2002, reviewed progress since the Rio conference. The conference noted that "*The global environment continues to suffer. Loss of biodiversity continues, fish stocks continue to be depleted, desertification claims more and more fertile land, the adverse effects of climate change are already evident, natural disasters are more frequent and more devastating, and developing countries more vulnerable, and air, water and marine pollution continue to rob millions of a decent life*". Countries participating in the WSSD reaffirmed their commitment to the principles of Agenda 21, and through the adoption of its Plan of Implementation set a number of specific goals, some of which applied to the management of fisheries and

oceans. In particular, the Plan notes the need to '*maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015*', urges States to ratify or accede to UNCLOS and the FSA, and recommends the implementation of the ecosystem approach to fisheries (EAF) and ocean management by the year 2010. The EAF is discussed in more detail in Appendix 3.

APPENDIX 5: FISHERY COLLABORATION IN THE BOB REGION

214. A number of international, regional and sub-regional organisations and programmes operate in the Bay of Bengal, sometimes with overlapping mandates. Regional co-operation traditionally revolves around two poles: the western BOB countries of South Asia (Bangladesh, India, Sri Lanka and Maldives), and the eastern BOB countries of South East Asia (Indonesia, Malaysia, Thailand). Myanmar, which falls into the eastern group, has only recently begun to participate more broadly in international programmes.

215. All eight BOB region countries are members of the Colombo Plan for Cooperative Economic and Social Development in Asia and the Pacific (usually abbreviated to the Colombo Plan, or CP) which became effective in July 1951. The CP was conceived at a meeting of Commonwealth nations in 1950 as a means of coordinating technical and financial assistance from developed members of the group (primarily Australia, Japan, New Zealand and the USA) to its developing country members. Under the plan, aid is provided in the form of loans, grants, or commodities such as fertilizers, equipment, and consumer goods. Assistance programmes are arranged bilaterally between the donor and the recipient nation. Although assistance has primarily been given by participating developed nations, less developed members are increasingly using the plan as a means of cooperating with one another. Training programmes are also part of the plan, and efforts are being made to use training facilities within the recipient nations and to build up exchange and technical cooperation programmes.

216. The major economic development organizations of the area are the Association of South East Asian Nations (ASEAN), established in 1967, and the South Asian Association for Regional Co-operation (SAARC), established in 1985. BOB region members of ASEAN are Indonesia, Malaysia, Myanmar and Thailand, while SAARC members are Bangladesh, India, Maldives and Sri Lanka, reflecting the east-west divide. SAARC undertakes limited activities in the fisheries sphere, although its agriculture programme has promoted increased contacts among fisheries scientists. ASEAN undertakes a broader range of fisheries activities, primarily related to aspects of economic development. ASEAN implements its fisheries programme through the Sectoral Working Group on Fisheries, and focuses on: the standardization of quality control measures and processing techniques for fish and fishery products; the

standardization of aquaculture practices, particularly for shrimps; the harmonization of fisheries sanitary measures; and the harmonization of regulations for fishery products.

217. In 1994, ASEAN started to collaborate with the Southeast Asian Fisheries Development Centre (SEAFDEC) in '*promoting the sustainable management and utilization of marine fisheries resources in the Southeast Asia region*'. This cooperation has strengthened further in recent years, especially since the ASEAN-SEAFDEC Fisheries Consultative Group was established in 1999. The Special Meeting of Senior Officers of the ASEAN Ministers of Agriculture and Forestry, held in April 2000, agreed on seven ASEAN-SEAFDEC collaborative programmes, all of which have now commenced. The programmes cover: the upgrading of the traditional fish processing industry; promotion of mangrove-friendly aquaculture; conservation and management of the sea turtle; regionalization of the Code of Conduct for Responsible Fisheries; development of a fish disease diagnostic inspection mechanism; improvement of fisheries statistics; and fish trade and environment. The Special Meeting also decided to organize an ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium ('*Fish for the People*'), which took place in November 2001. This Conference approved the Resolution on Sustainable Fisheries for Food Security for the ASEAN Region and a related Plan of Action.

218. Various other economic groupings have also been established at various times, and it is noteworthy that they sometimes involve sub-national levels of government. The Indonesia-Malaysia-Thailand Growth Triangle was set up in 1993 and encompasses two Indonesian provinces (North Sumatra and Daerah Istimewa Aceh), four north Malaysian states (Kedah, Penang, Perah and Perlis) and five provinces of southern Thailand (Narathiwat, Pattani, Satun, Songkhla and Yala). The SIJORI Growth Triangle, situated at the other end of the Malacca Straits, links Singapore, the Malaysian state of Johore and Indonesia's Riau Province. The East Asia Growth Area was formed in 1994 by the governments of Brunei, Indonesia, Malaysia and the Philippines and similarly involves participation by various provinces in those countries. The South Asia Sub-Regional Economic Cooperation, established in 1997 brings together Bangladesh, Bhutan, Nepal and the eastern states of India. Most of these economic cooperation arrangements were promoted by the Asian Development Bank (ADB) as a means of creating synergies between neighbouring local economies. In the SIJORI growth triangle, for instance, the more technologically advanced economies of

Singapore and Johore are complemented by the cheaper labour, ample land area and abundant natural resources of Riau. In this way the economies are encouraged to support each other's growth for common benefit, rather than competing with each other.

219. The main relevance of these various sub-national economic cooperation projects to the present study is that they demonstrate the possibility of lower levels of government – state or provincial –becoming involved in international programmes. Because some BOB countries are only partially situated in the BOB, and because state governments often have jurisdiction over inshore fisheries and coastal management issues, state-level participation may enhance the prospects of success for international approaches to managing the BOB LME.

220. The only regional fisheries management organisation whose jurisdiction extends into the Bay of Bengal is the Indian Ocean Tuna Commission (IOTC). This Commission was established in the Seychelles in 1993 to '*promote cooperation in the conservation of tuna and tuna like species and also promote their optimum utilization, and the sustainable development of the fisheries*'. Only four of the eight BOB countries (Sri Lanka, India, Thailand, Malaysia) are Contracting Parties to IOTC, reflecting the relatively low importance of tuna-related species for some countries. In December 2002 Indonesia's application to become a Cooperating Non-Contracting Party was accepted by the Commission. Maldives is not a member of IOTC despite tuna being the mainstay of its artisanal fishery.

221. Although the research, statistics collecting, advisory and management functions of IOTC cover both the western and eastern Indian Oceans, a good deal of its effort goes into managing large-scale industrial purse-seine and longline tuna fisheries. Most purse-seining occurs in the western Indian Ocean, and the majority of industrial fishing is carried out by non-BOB countries (although some of it takes place in their waters). Although the situation is slowly changing, industrial-scale tuna fishing has not historically been a high priority for BOB countries.

222. A number of other technical or advisory regional fishery bodies have operated in the BOB region at various times in the past, but there is a history of these organisations petering out, or being subsumed into other bodies.

223. The Indo-Pacific Tuna Development and Management Programme (IPTP), essentially the predecessor of the IOTC, was set up in 1982 with funding from UNDP and execution by FAO (after 1986, IPTP was funded totally by member country contributions). IPTP did not have management responsibilities, but gathered statistics and advised member countries on tuna fisheries development and management. The IPTP programme initially covered the Indian Ocean and an area extending over the western Pacific. In later phases, the area of competence was trimmed to cover only the Indian Ocean. Although not exclusively a BOB organisation the fact that IPTP was based in Colombo, Sri Lanka resulted in relatively close contacts being maintained with countries of the BOB region. Over the fifteen years of its activity notable IPTP achievements included the constitution of a database covering tuna fisheries and extending back to the very beginning of industrialised tuna fishing in the Indian Ocean. In the process, many countries bordering the ocean were assisted in setting up statistical sampling schemes. Numerous studies were conducted on tuna biology and fisheries, including a number of tagging experiments. Six Expert Consultations on Indian Ocean tunas and five on western Pacific tunas were organised, as well as a number of workshops which provided information on the status of tuna stocks in the area. Subsequently, however, the IOTC was established in 1993 as a fully-fledged RFMO, with the intention of transferring the functions of the IPTP to it. This took place in 1997 once the IOTC Secretariat was established and functional in Seychelles, and the IPTP was closed down at that time.

224. Another defunct RFB is the Indian Ocean Fishery Commission (IOFC), which was established in 1967 as an FAO body to '*promote programmes for fishery development and conservation; to promote research and development activities; to examine management problems with particular reference to offshore resources*'. The Commission did not have a permanent regional presence but was supported by a Secretariat based at FAO headquarters in Rome. Operating under the Commission was a Committee for the Development and Management of Fisheries in the Bay of Bengal (BOBC), which met ten times between 1981 and 1998, in every BOB country except Myanmar. At the 11th IOFC Session in February 1999, however, IOFC members recommended that the Commission be dissolved, and this was subsequently done later in the same year through FAO Resolution 1/116. Reasons for the dissolution included IOFC's diminishing relevance in the face of other RFMOs developing in and adjacent

to the region, and the difficulties faced by both FAO and member countries in financing the operations of the Commission.

225. At its tenth session in September 1997, the BOBC recommended that its functions be absorbed by the Asia-Pacific Fisheries Commission (APFIC), a RFB established in 1948 (as the Indo-Pacific Fisheries Commission, IPFC) '*to keep fishery resources under review; to formulate and recommend conservation and management measures; to keep under review the economic and social aspects of fishing; to encourage training and research*' in both marine and inland waters of the Asia-Pacific region. Like IOFC, APFIC is established under the aegis of the FAO Convention. APFIC members include seven of the eight BOB countries (Maldives is the only one that does not participate) as well as another 13 countries including Australia, China, Japan, UK and USA.

Figure A5.1: Area of the Asia-Pacific Fisheries Commission (Source: FAO Fisheries Department)

226. The proposal to absorb the BOBC function was accepted by APFIC at its 26th session in September 1998, and subsequently approved in the same FAO Resolution 1/116 that abolished the IOFC. Earlier, at its last session in February 1999, the IOFC had noted that with the merging of BOBC with APFIC, the responsibility of the APFIC Secretariat would increase, and requested FAO to strengthen the APFIC Secretariat in order to carry out its expanded functions more effectively. In reality, however, the

opposite seems to have happened: the 27th APFIC Session in September 2001 was primarily concerned with the future of the organization itself, in the face of limited financial and other resources, and uncertainty about the Commission's future role and responsibilities. Essentially, FAO is obligated to ask APFIC members to assume a greater share of the financial burden in maintaining the organization, something which they appear unable or unwilling to do.

227. The session considered several options for the future of APFIC, including maintaining the status quo, emphasizing collaborative research or development functions, assuming the role of a regional consultative body, or transition to a fully-fledged RFMO. No firm decision was reached on these issues, but the Session did agree that:

- APFIC should continue to function;
- APFIC should have more focussed and well defined programmes of action that are responsive to the needs of its Members;
- APFIC could implement cooperative research and development initiatives;
- APFIC could assume the role of a consultative forum; and
- There is a need for continued support for capacity building and transfer of technology in sustainable fisheries management and development for both marine and inland fisheries

228. At the present time the future of APFIC appears somewhat uncertain. Shortage of finance is likely to be a problem for the Commission in the foreseeable future, and this situation is unlikely to change until its mandate is refined. Given the inherited mandate of APFIC to advise on fisheries in the BOB region, the fact that seven of the eight BOB countries already members of the Commission, and the ongoing review of APFIC functions and responsibilities, there may be an opportunity to re-engineer the organisation to cater more fully for the needs of the BOB region. This sentiment was articulated during the 27th APFIC session by Bangladesh, which noted that the Commission should assume the role of a Regional Consultative Forum (RCF) for the Bay of Bengal.

229. Another RFB which has waxed and waned is the FAO Bay of Bengal Programme (BOBP), which was established in 1979 in Chennai, India. The programme

has undergone three distinct operational and funding phases spanning some twenty years, with the first phases focussing ore on fisheries development, and the last on fisheries management. During its existence BOBP provided technical assistance in various fisheries fields to its member countries, which included all the BOB countries except Myanmar (Maldives joined at the beginning of the second phase).

230. During its two decades of existence BOBP progressively shifted its emphasis from helping countries increase their fish catches to helping them introduce fishery and environmental management measures. BOBP's focus throughout was on small-scale fisheries and on local rather than large-scale management actions. The Programme correctly recognised that sustainable use of fishery resources in the BOB region would require the adoption of responsible fishing practices and attitudes by the region's hundreds of thousands of small-scale fishers. In its latter years, therefore, BOBP focussed primarily on the promotion of community-based or participatory management arrangements in local fisheries.

231. In 1999 BOBP essentially ran out of steam, after a long period during which the Programme increasingly became starved of funds. As with other bodies established by or through FAO, participating countries were unwilling or unable to move towards greater financial participation, and shortage of funds from FAO coupled with 'donor fatigue' by traditional bilateral funding agencies ultimately led to the Programme's winding down.

232. The BOBP has been succeeded, in a reduced form, by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO), membership of which is restricted to the four western BOB countries of Maldives, Sri Lanka, India and Bangladesh. BOBP-IGO continues to promote responsible management of small-scale fisheries, and related activities such as awareness-raising and information dissemination, but at a considerably diminished scale. BOBP-IGO is another potential candidate for promoting increased cooperation in fisheries and LME management in the BOB. For this to happen however its membership would need to be expanded to encompass the full complement of BOB countries, and the structure of the organisation would need to be radically altered to that of a management agency rather than a technical assistance programme.

233. Other international programmes relevant to the marine sector in the Bay include the South Asian Co-operative Environment Programme (SACEP), the UNEP Regional Co-ordinating Unit for East Asian Seas, and the Indian Ocean Marine Affairs Co-operation (IOMAC) the International Forum for the Indian Ocean (IFIOR), the Indian Ocean Rim Initiative, and the Network of Aquaculture Centres for Asia (NACA).

APPENDIX 6: CURRENT ATTEMPTS TO ADDRESS TRNSBOUNDARY ISSUES

(Pending)

Stock assessments that estimate fishing mortality and biomass can be based on a variety of population dynamics models. The assessment methods most commonly used (seeDichmont et al.Â Using a statistical model based on time-to-event analysis and 569 coastal marine fish and invertebrate stocks landed in commercial fisheries, we quantify the impact of region, habitat, life-history, and economic factors on the annual probability of being assessed. Although the majority of landings come from assessed stocks in all regions, less than half of the regionally-landed species currently have been assessed.Â The recent stock assessment for this region used an assumed fixed rate of natural mortality (M), obtained from a general life-history relationship based on weight. Mustafa MG (2003) Trophic model of the coastal ecosystem in the waters of Bangladesh, Bay of Bengal. In: Silvestre G, Garces L, Stobutzki I, Ahmed M, Valmonte-Santos RA, Luna C, Lachica-AliÃ±o L, Munro P, Christensen V, Pauly D (eds) Assessment, management and future directions of coastal fisheries in Asian countries. WorldFish Center conference Proceedings, vol 67, pp 263â€“280, 1120 pGoogle Scholar. 11.Â Preston GL (2004) Review of the status of shared/common marine living resources stocks and of stock assessment capability in the BoBLME region. Bay of Bengal Large Marine Ecosystem (BoBLME) Theme report, FAO-BOBLME ProgrammeGoogle Scholar. 26.