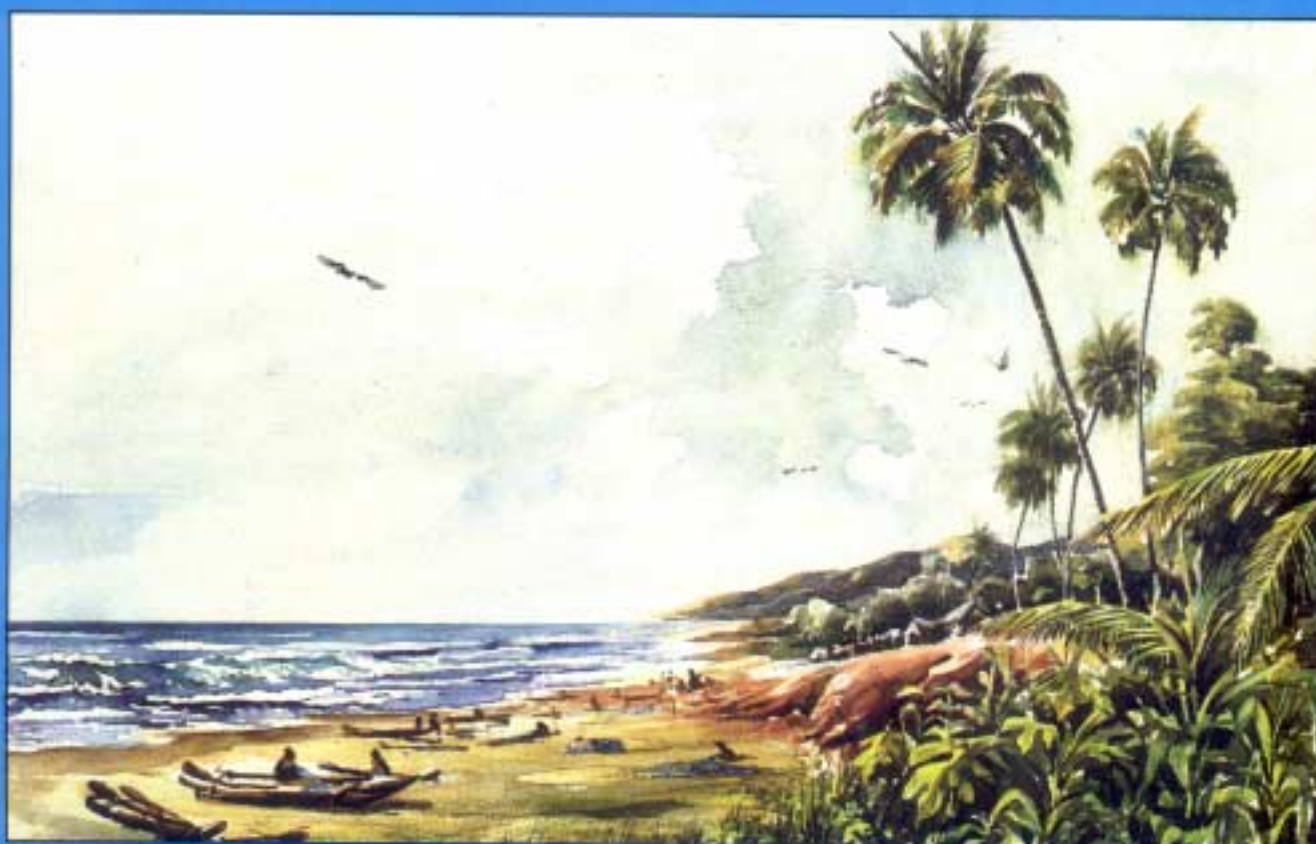


TOWARDS SUSTAINABILITY

Needs and Concerns of Aquatic Resources and Fisheries
in the Bay of Bengal Region
and Project Ideas to Facilitate Their Sustainable Management



INTEGRATED COASTAL FISHERIES MANAGEMENT

TOWARDS SUSTAINABILITY
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and Project Ideas to Facilitate Their Sustainable Management

A report submitted to the JOFC Committee for the Development
and Management of Fisheries in the Bay of Bengal (BOBC)

by

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*A subgroup established by the Bay of Bengal Programme (BOBP)
in cooperation with the IOFC Committee for the Development
and Management of Fisheries in the Bay of Bengal*

At the 8th Session of the IOFC Committee for the Development and Management of Fisheries in the Bay of Bengal (BOBC), held in Dhaka, Bangladesh, in April 1993, the Members, concerned with the inadequacy of the follow-up in the region to UNCED in the fisheries sector, recommended that the Bay of Bengal Programme of the FAO (BOBP), through its Advisory Committee, should be requested to establish a regional BOBC Subgroup to closely investigate the prospects of preparing a consolidated research proposal for donor funding. At the 17th Meeting of the Advisory Committee of the BOBP, held in Dhaka, Bangladesh, in April 1993, it was recommended that, subject to the concurrence of the donors, unspent funds of the main project of the BOBP would be used to support the BOBC Subgroup.

The BOBP organized a consultation in Madras, India, in February 1994, which brought together representatives from India (representing the South Asian Members of BOBP), Malaysia (representing the Southeast Asian Members of BOBP), Maldives, Thailand, and of SEAFDEC, NACA, FAO (HQs and BOBC) to define the terms of reference and the scope of work of the BOBC Subgroup, and to develop a project proposal for the establishment of the BOBC Subgroup for submission to the Advisory Committee of BOBP.

The Advisory Committee of BOBP at its 18th Meeting in Male, Maldives, in April 1994 strongly supported the establishment of the BOBC Subgroup. The Member Countries, to assist the Subgroup, provided it with country papers which gave the country's perceptions of needs and concerns of research related to fisheries development in the context of AGENDA 21. At the request of the BOBC, the Government of India and Malaysia nominated two senior officials each from their fishery agencies to form the BOBC Subgroup: Dr K Radhakrishna, Assistant Director General (Fy), Indian Council of Agricultural Research; Mr B Roy, Deputy Development Commissioner (Fy), Ministry of Agriculture, India; Mr Mohd. I Shaupi bin Derahman, Chief, Resource Management Section, Department of Fisheries, Ministry of Agriculture, Malaysia; and Mr Liang Pit Chong, Chief, National Fry Production and Research Centre, Department of Fisheries, Ministry of Agriculture, Malaysia. BOBP provided the services of its Senior Extension Adviser, Mr R N Roy, to act as the Secretary to the Subgroup. The Subgroup undertook visits to all seven Member Countries of the BOBP and held discussions with officials concerned with fisheries and environmental issues and appraised the needs of the countries in the national and regional contexts. The Subgroup had its final meeting in Penang, Malaysia, in September 1994 to consolidate its findings and to identify project ideas. Ms Yong-Ja Cho, a consultant to the BOBP, assisted the Subgroup in the preparation of its report.

The Report of the Subgroup was discussed at the 9th Session of the BOBC held in Jakarta, Indonesia, in January 1995 and was well endorsed by the Members (Para. 22 of the 9th BOBC Report). In addition, the APFIC Committee on Marine Fisheries (APFIC/COMAF), at its 9th Session held in Yogyakarta, Indonesia, in October 1995, also agreed that it would be advantageous to widen the remit of these BOBC proposals to the east and to the north to become APFIC-wide. It fully endorsed the establishment of a regional cooperative research programme based on the 14 priority areas in coastal capture fisheries, offshore fisheries and aquaculture detailed in the BOBC's report (Para. 59 of the Report of the 9th COMAF). This report is published by the BOBP, under the authority of and in cooperation with the BOBC Secretariat.

The Bay of Bengal Programme (BOBP) is a multi-agency regional fisheries programme which covers seven countries around the Bay of Bengal – Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. The programme is playing a catalytic and consultative role in developing coastal fisheries management in the Bay of Bengal to help improve the conditions of small-scale fisherfolk communities in the Member Countries. The BOBP is sponsored by the governments of Denmark, Japan and the United Kingdom. The main executing agency is the Food and Agriculture Organization of the UN.

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SUMMARY

At the Eighth Session of the Committee for the Development and Management of Fisheries in the Bay of Bengal (BOBC), of the Indian Ocean Fisheries Commission (IOFC), held in Dhaka, Bangladesh, in April 1993, the members, concerned with the inadequacy of the follow-up, in the fisheries sector, in the region, of the United Nations Conference on Environment and Development (UNCED), recommended that the Bay of Bengal Programme (BOBP) of the FAO, through its Advisory Committee, should be requested to establish a regional BOBC Subgroup to closely investigate the prospects of preparing a consolidated research proposal for donor funding. At the 17th meeting of the Advisory Committee of the BOBP, held in Dhaka, Bangladesh, in April 1993, it was recommended that, subject to the concurrence of the donors, unspent funds of the main project of the BOBP would be used to support the BOBC Subgroup in preparing proposals for continued regional cooperation within the framework of Agenda 21 of UNCED.

The BOBP organized a consultation in February 1994 in Madras, India, which brought together representatives from India (representing the interests of South Asian members of BOBP), Malaysia (representing the interests of Southeast Asian members of BOBP), Maldives and Thailand, and representatives of SEAFDEC, NACA, FAO (HQs) and BOBC. This consultation defined the terms of reference and scope of work of the BOBC Subgroup and developed a project proposal for the establishment of a BOBC Subgroup for submission to the Advisory Committee of BOBP. The BOBP Advisory Committee, at its 18th meeting held in the Maldives in April 1994, strongly supported the establishment of the Subgroup and made several recommendations to give direction to the task of the Subgroup. The member countries of the BOBP also provided it with country papers which gave each country's perceptions of the needs and concerns of research related to fisheries development in the context of Agenda 21.

At the request of the BOBC, the Governments of India and Malaysia nominated two senior officials from their fishery agencies to form the BOBC Subgroup, and BOBP provided the secretariat. The members of the Subgroup undertook visits to all seven member countries of the BOBP during June - August 1994. They held discussions with the officials concerned with fisheries development and environmental issues and appraised the needs of the countries in national and regional contexts. The Subgroup met in Penang, Malaysia, in September 1994 to consolidate its findings and identify project ideas. The findings deliberations of the Subgroup and the project ideas recommended are presented in this report. The report was discussed at the 9th Session of the IOFC/BOBC, held in Jakarta, Indonesia, in January 1995.

The BOBC Subgroup's primary responsibility was to identify regional research requirements to facilitate fisheries development in the context of Agenda 21. In order to put research in its proper context and to identify the specific roles research could play, the Subgroup examined the needs and concerns of the fisheries sector as a whole and summarized them broadly under three major fishery domains: Offshore Fisheries (including the high seas); Coastal Capture Fisheries; and Coastal Aquaculture.

While different countries have different concerns and needs, there seems to be some similarities in the problems encountered by the fisheries sector in all Bay of Bengal countries. Common concerns and problems that emerged are:

- Inadequate and uneven exploitation and management of offshore and high seas resources
- Depleting and stressed coastal fishery resources, primarily due to overfishing but also due to environmental degradation of coastal waters caused by land-based and, occasionally, ship-based pollution
- Lack of reliable and timely data, and information, to assess the potential of the resources, and inadequate capability to analyze, interpret, disseminate and utilize the data and information
- Social conflicts due to multiple uses and overexploitation of coastal resources on land and in the water
- Degradation of coastal environments and social conflicts resulting from rapid development, intensification and dependence on a few species in coastal aquaculture

Fishery agencies in the region are confronted with what are essentially old problems, but with 'new' dimensions and parameters. The issues are more complex; they involve a multiplicity of disciplines, deal with multiple agency jurisdictions and involve several stakeholders exploiting the same resources. A serious gap exists in the progression of actions needed to address problems, from research to information to policy decisions based on such knowledge to, finally, the political will to implement and enforce policies. This includes lack of appropriate methodologies to gather and analyze data and information, inadequate and insufficient knowledge upon which to base decisions, and inadequate understanding of complex and interactive situations and problems.

In order to address the key concerns of the sector, the countries need to build up national capacities to undertake a variety of actions, such as

- building their knowledge base
- evolving legal and regulatory frameworks
- developing policy in cooperation with related sectors and agencies
- creating management measures
- strengthening MCS and enforcement
- increasing awareness and participation of stakeholders; and
- generating new technologies and markets

Several actions have already been taken by the countries or are in the pipeline.

The BOBC Subgroup, considering its terms of reference and understanding that many of the above actions can only be undertaken by the countries, given the sociopolitical nature of the problems, decided to focus on the central issue of generating new kinds of knowledge that would facilitate and enable the countries to better understand their problems and take timely and appropriate actions. The Subgroup did not attempt to identify requirements to remedy all the problems of the fisheries sector, but, guided by the needs and the requests of the countries, identified 14 project ideas, classified into the three fishery domains of coastal fisheries, offshore and high seas fisheries, and coastal aquaculture.

The basic expertise and capacity to implement the project ideas exist in the region, but are not equitably distributed. The nature of the project ideas are such that they best lend themselves to national implementation. However, there seem to be several reasons why the countries should consider a regional approach. The idea is not for the countries to abandon their national efforts or to submerge national efforts into a regional activity, but, rather, to derive the benefits from a regional effort without surrendering the benefits of national implementation. Therefore, the Subgroup suggests that the countries consider national implementation within the framework of regional umbrellas which could be provided by some of the regional fishery bodies. Importantly, national expertise and capabilities could be shared and utilized through TCDC and ECDC arrangements. The regional umbrella organization would facilitate regional coordination, sharing of expertise, joint efforts in some cases, sharing of learnings and training, and capacity-building efforts.

What is at stake is the protection of the massive economic benefits derived by the countries in the region from the fisheries sector. Regional research programmes, could stimulate and assist national efforts towards sustainable fisheries development. International funding should not be a prerequisite for regional and subregional action. Countries constrained from participation in regional initiatives due to lack of funds should be encouraged to seek support from bilateral donors.

In view of the seriousness of the problems confronting the fishery sector and, the sector's economic importance, it is suggested that activity be initiated immediately by assessing the interests of the governments in participating in the individual project ideas proposed. Where a high level of interest is indicated, networking should be initiated and detailed project workplans developed.

1. GENESIS

The follow-up to the United Nations Conference on Environment and Development (UNCED) was one of the important items of the agenda of the Eighth Session of the Committee for the Development and Management of Fisheries in the Bay of Bengal (BOBC) of the Indian Ocean Fisheries Commission (IOFC), held in Dhaka, Bangladesh, April 3-5, 1993. The members, concerned with the inadequacy of the follow-up in the region, recommended that the BOBC should request the assistance of the Bay of Bengal Programme (BOBP), through its Advisory Committee, for establishing a regional BOBC Subgroup to closely investigate the prospects of preparing a consolidated regional research proposal for donor funding.

At the 17th Advisory Committee meeting of the BOBP held in Dhaka, Bangladesh, April 6-8, 1993, it was recommended that, subject to the concurrence of the donor agencies, unspent funds of the main project of the BOBP (GCP/RAS/1 | 8/MUL) should be utilized to support the BOBC Subgroup in preparing proposals for continued regional cooperation within the framework of Agenda 21 of UNCED. When undertaking the task, the Subgroup, it was proposed, should take into consideration the activities and experience of the BOBP and other fishery research and development programmes in the region.

In order to implement the recommendations of the Advisory Committee, the BOBP organized a two-day consultation for the establishment of the Subgroup, on February 7-8, 1994, in Madras, India. The consultation brought together two participants from Malaysia (representing the interests of the Southeast Asian members of BOBP), two participants from India (representing the interests of the South Asian members of the BOBP), a participant each from the Maldives and Thailand, and representatives of SEAFDEC, NACA, FAO (HQs) and BOBC. BOBP provided the secretariat. The consultation defined the scope of the work and the terms of reference of the BOBC Subgroup, and provided directions for its establishment. The outcome of the consultation was a project proposal for the establishment of the BOBC Subgroup to identify project ideas for regional fisheries research and development. This was presented to the 18th Advisory Committee meeting of the BOBP, held in the Maldives, April 16-19, 1994, for approval. The members strongly supported the establishment of the BOBC Subgroup, and made several recommendations to give direction to the task of the Subgroup. The terms of reference of the BOBC Subgroup and an extract of the recommendations of the Advisory Committee of the BOBP relating to the Subgroup are in Appendix I of this report. The member countries of the BOBP, in support of the BOBC Subgroup, provided country papers outlining their concerns and needs in fisheries research and development in the context of Agenda 21. (The country papers are available in BOBP files.)

At the request of the BOBC, the Governments of India and Malaysia nominated two senior officials each from their fishery agencies, with experience in research and development aspects of fisheries, to form the BOBC Subgroup and the BOBP provided the services of its Senior Extension Adviser to serve as the Secretary to the Subgroup (see Appendix II: List of the BOBC Subgroup members). The members of the Subgroup, during June-August 1994, undertook visits to all seven member countries of the BOBP, with the Indian members concentrating on the South Asian countries and the Malaysian members on the Southeast Asian countries. These visits gave opportunities for the Subgroup to hold discussions with officials concerned with fisheries development and environment issues and, in the context of the country papers, to appraise the needs of the countries, prioritize them in national and regional terms, and discuss possible project ideas which could address those needs.

The Subgroup met in Penang, Malaysia, during September 13-16, 1994, to consolidate its findings and to identify project ideas for national, subregional and regional implementation. Dr. David James, Principal, Fisheries Research Advisor, FAO, Rome, Ms. Yong-Ja Cho, an international consultant assigned by the FAO to assist in preparation of the Subgroup report, and Mr. R. N. Roy, Sr. Extension Adviser, BOBP-FAO and the Secretary to the Subgroup, also participated in the meeting. The findings and deliberations of the BOBC Subgroup and the project ideas recommended by them were then developed into this report by the Secretariat with the help of the consultant. The report in draft form

was circulated to the Subgroup members and to concerned staff of FAQ (HQs) and FAOIRAPA for their review and comment. The final report, incorporating the inputs received, was submitted to the BOBC Secretariat for circulation to the member countries prior to the Ninth Session of the IOFC Committee for the Development and Management of Fisheries in the Bay of Bengal, to be held in Jakarta, Indonesia, in January 1995.

2. CONCERNS AND NEEDS OF MARINE CAPTURE FISHERIES AND COASTAL AQUACULTURE

In the context of fisheries, the countries around the Bay of Bengal, are quite unique, and, in studying their needs and concerns, the BOBC Subgroup had to keep in mind some features which would affect their perceptions and analysis, and give direction to their recommendations.

In terms of fish production, from both marine capture fisheries and coastal aquaculture, the contributions of South and Southeast Asian countries are considerable and any ranking of countries, by production, would put some of the Bay of Bengal countries in the first ten. The other side of the coin is that the region, with its vast coastline and approximately 20 per cent of its population living within 20 km of the coast, has a population of fisherfolk running into millions and still growing. About 60-70% of these fisherfolk can be described as artisanal fisherfolk who fish in the nearshore with traditional, small motorized and nonmotorized craft, and contribute a disproportionate 50-60% of the fish production. These fisherfolk are often poor and do not have access to social services which their agrarian counterparts take for granted. They are also increasingly confronted with decreasing catch rates and stressed (and, sometimes, depleted) fish stocks.

The coastal aquaculture sector in the region, spurred on partly by the need to increase production to overcome declining catch rates in nearshore fisheries, but mostly due to very lucrative markets and foreign exchange earnings, has expanded dramatically over the last decade with overwhelming focus on one species: *Penaeus monodon*. The growth of coastal aquaculture has not been without problems, with destruction of mangroves, salinization of soils and groundwater, inequitable land holdings, resulting in social and political pressures and unrest which governments cannot ignore.

Fish not only is big business, earning valuable foreign exchange, but also is food. Fishery products contribute in excess of 50 per cent to the animal protein intake of the majority of the population in the region. What is alarming is that the contribution of fish to diet is declining. Partly due to increasing fish prices (fuelled by urban and export demands) and population growth and partly due to decreasing purchasing power, people, particularly the poor, who traditionally and culturally have depended on fish, find it difficult to retain fish as a part of their diet.

In the post-GATT world, with possibilities of trade and non-trade barriers looming over the horizon, the countries in the Bay of Bengal region cannot afford not to worry about better managing their marine fisheries and coastal aquaculture. Given the economic, social and environmental implications, particularly the growing concerns amongst stakeholders and consumers, it is not surprising that governments in the region are giving priorities to fisheries and aquaculture management at levels far higher than what would be expected for a sector that involves a relatively small portion of the population and contributes a small portion of national GDPs.

2.1 National Needs and Concerns

In order to identify the needs and concerns in marine fisheries and coastal aquaculture, each member country was requested to prepare a country paper, stating national policy, problems and constraints in development and management of fisheries, research requirements and priorities. The BOBC Subgroup then visited fishery agencies, research organizations, other agencies concerned with environmental protection and development, and held discussions with senior policy and technical personnel in the member countries that border the Bay of Bengal: Bangladesh, India, Indonesia, Malaysia, Maldives,

Sri Lanka and Thailand (see Appendix III for list of agencies and institutions visited and officials met). The issues raised in the country papers and the findings of the Subgroup are briefly described below. Appendix IV summarizes the needs and constraints, specifying the countries where they are felt, and also lists examples of the regional and international agencies that are in one way or the other addressing some of these needs.

BANGLADESH

In the offshore region of the EEZ, which is largely unexploited, there are three concerns:

- Wastage of by-catch from the as-yet-small mechanized shrimp trawl fishery
- The fishery agency does not have an adequate understanding of the resource situation, which is needed to guide and regulate development and for which there is entrepreneurial interest
- The fishery agency lacks the means to monitor and control the poaching of its resources by foreign vessels

The inshore, coastal waters of Bangladesh are overfished although the data is insufficient to substantiate this except in the case of a few species. Some extremely destructive fishing gear are in use, primarily to harvest *Penaeus monodon* fingerlings which are in great demand in the coastal aquaculture sector. A very large population depends on fishing in coastal and estuarine waters for their livelihood, as fish provide over 50 per cent of the animal protein intake of the population. The most urgent need is to establish a resource database, which would then address the other major needs of evolving management mechanisms.

The coastal aquaculture sector is growing rapidly and moving from extensive to semi-intensive modes of farming. This sector still depends on wild seed, which are collected using extremely destructive gear. Public concern about the environmental effects of aquaculture and of the impacts of degraded environments on it are growing, thus bringing considerable political pressure on the government. There is an urgent need to develop

- siting protocols and standards, environmental damage mitigation measures, and
- policy and management mechanisms for this sector

What is lacking is expertise, knowledge and information to do so.

Two **other** concerns are:

- Ship-based pollution of coastal areas, particularly around harbours
- Land-based pollution of coastal waters, including the impacts of upstream modifications to riverine systems

INDIA

In the offshore region of the EEZ the primary concern is incomplete or outdated resource information. The area is largely unexploited, and industry is reluctant to enter the sector because there is not enough information of the resources or of the techno-economic viability of tapping them. India is also interested in developing a better understanding of straddling and highly migratory fish stocks in the high seas to facilitate efforts at management and exploitation.

The coastal waters are fast reaching their resource limits, with some species already showing signs of overfishing. Shrimp trawling is a concern not only because it is believed to be a destructive mode of fishing but also because it discards a lot of by-catch, and has been the main source of social conflicts due to its interaction with artisanal fisheries. There is need for reliable and timely information

about the status of the resources and fishing efforts. Additionally, mechanisms of management and enforcement are still in the early stages of development.

The coastal aquaculture sector is growing rapidly and is already facing considerable opposition from agrarian and coastal communities for a variety of environmental and socioeconomic reasons. With hatcheries unable to meet demand for fingerlings and quality seed, destructive catching practices of wild seed are prevalent. A tendency to intensify farm operations to earn bigger profits and the clustering of farms has led to environmental problems, and the increased possibility of disease outbreaks. The sector is focused basically on *Penaeus monodon*. The fishery agency is very interested in

- developing policy and regulations to manage and guide the sector
- evolving siting protocols and standards
- developing environmental impact assessment (EIA) methodologies, norms and guidelines
- developing culture practices to reduce environmental impact and prevent diseases
- diversifying into other species, particularly finfish, which would require development of hatchery and culture technologies;
- developing environmental damage mitigation measures to make coastal aquaculture more sustainable
- developing sea-ranching, cage and pen culture; and
- improving the capacity in fish location and forecasting by using remote-sensing technology

In addition, the country would like to

- reduce post-harvest losses
- add value to the fish to increase fisherfolk incomes, and
- monitor the coastal water quality in order to ensure the future of coastal fisheries which are increasingly being affected by land-based pollution

INDONESIA

The offshore regions within the EEZ of the country are regarded as underexploited, and are mostly fished by small craft of less than 5 GT. While the country believes that there is room for development, particularly for tuna, little is known of the stock situation, the estimates varying widely. The situation is complicated by the fact that the offshore region is exploited by fleets of some neighbouring countries and their catch is not reflected in the existing national data. The primary need is to improve the understanding of the resource situation through timely assessment based on existing and rapidly-collected information, so that management decisions can be supported. The fishery agency feels that there is need for the development of a purpose-built craft to promote offshore fisheries, which, in particular, would give smallscale fisherfolk access to the offshore, while possibly reducing the load on the inshore, coastal waters.

The coastal fisheries of Western Indonesia, particularly around Java and Sumatera, are heavily-exploited and there are signs of some stocks being stressed. However, the coastal waters in Eastern Indonesia are relatively underexploited and there is room for expansion. Given the demand for fish to meet local and external requirements and the experience in Western Indonesia, the major concern in the coastal fisheries is to evolve mechanisms of management to ensure sustainability and to rehabilitate stressed stocks.

This would require development of

- rapid, low-cost, low-data-demanding resource assessment systems
- effective monitoring and enforcement systems, and
- management methods

Indonesia feels strongly that some form of participatory community-based management may prove the most viable for its conditions.

Coastal aquaculture is unevenly distributed, with 60 per cent of the production coming from Java, Sumatera and South Sulawesi. The sector is dominated by three species: *Penaeus monodon* leads, with milkfish trailing behind and a small amount of tilapia making up the rest. The fishery agency is very concerned about the environmental effects of aquaculture which has had visible and highly publicized environmental impacts such as mangrove destruction, pollution of coastal waters, salinization of soil and groundwater not to mention the social conflicts that have emerged out of indiscriminate expansion. Intensive culture has proved to be unsustainable and several farms have been abandoned. High-intensity in culture and clustering of ponds has resulted in disease problems. The fishery agency is interested in diversifying species to reduce dependence on a few. There is need to develop EIA methodologies and standards. There are few mechanisms to regulate and control coastal aquaculture, and where they do exist there are no means to monitor and enforce the regulations. The country sees the need to build up its capacity to manage the sector sustainably.

MALAYSIA

With its coastal waters heavily fished, the country has actively promoted offshore fisheries, and close to 600 licences have been issued in the last six years. While the offshore fisheries have contributed to a considerable increase in total marine fish landing, there has been no systematic assessment of the offshore region of the EEZ. It is generally believed that there is room for further expansion of the offshore pelagic fisheries, but inadequate understanding of the current status of the resources is coming in the way of managing the shared resource optimally and sustainably.

The coastal waters of Malaysia have long been heavily exploited by a combination of traditional fishing gear, trawlers and purse-seiners. Though further entry into the sector is restricted through licensing, the fishing effort has increased through modernization and use of fishing aids. Several efforts at managing the coastal resources have been initiated. Examples are a clear zoning of the waters which restrict different types of craft-gear combinations to different zones and give exclusive rights to traditional fisherfolk to the first five nautical miles, construction of artificial reefs to both enhance and aggregate the stocks and also to prevent the use of certain gear such as trawls, and declaring certain critical areas as marine parks where fishing is not allowed, to conserve fisheries and protect habitats such as coral. The concern is that the success and impacts of such measures have not been systematically evaluated and such justification would be very necessary to expand and extend what is essentially an expensive investment. The key needs are to develop

- methodologies to
- ensure cost-effectiveness and impact assessments, and
- selective gear that reduce the catch of juveniles and by-catch

In the coastal aquaculture sector there has been considerable expansion in the last decade. Except in the case of marine shrimp, the inadequate supply of seed, especially those for marine finfish, is a major concern. The fishery agency is also interested in diversifying and increasing the number of cultured species, which would require development of hatchery and culture technologies. Acid sulphate soils in some areas have resulted in lowered production. Pollution from industry and hatcheries have in some cases resulted in occasional culture failures. Besides, effluents from shrimp ponds have

resulted in environmental pollution and conflicts with other users of coastal resources. Clustering of farms has given rise to cross-contamination and reduced water quality, leading to disease outbreaks. Overall, there is a need to

- better manage and regulate the sector, and
- develop hatchery and culture technologies to make it more sustainable

MALDIVES

From the fisheries, aspect the Maldives is unique. The country being comprised of archipelagic coral islands, the fisheries are essentially of two types: those restricted to the reef structures around the islands and deep sea fisheries, which in most other countries with continental shelves would be often beyond the access of artisanal fisherfolk but in the case of the Maldives is just beyond the reef. The fishing is almost entirely restricted to small motorized craft using pole-and-line for skipjack and other tuna, with some longlining for shark.

Reef resources are mainly fished for the use of tourists and for export. There is considerable concern about the sustainable use of reef resources, as the nation is dependent on them not just for fish products but also for coral for building and as a barrier against the sea and the weather.

The **EEZ** is underexploited, except by craft from neighbouring countries. The country sees a need to better understand and assess the tuna and shark resources in its EEZ to enable it to undertake their management. There is also a need to develop processing technologies to add value to the fish to increase fisherfolk and national earnings.

Some reef and lagoon fisheries are stressed; in fact, the government had to step in and ban the beche de mer and giant clam fisheries as they were in danger. There is particular interest in developing a management plan for ornamental fish, capture of which is an activity growing rapidly and already causing concern. The country has taken some steps in evolving participatory reef management but feels that the efforts should be strengthened. The need reduces to generating a better understanding of the resources and evolving sustainable management methodologies. While there are some initial efforts at mariculture, the concept of coastal aquaculture is non-existent. A unique and major concern in the Maldives is the acute shortage of trained manpower in the fishery sector.

SRI LANKA

The offshore fisheries in the EEZ, targeting tuna, billfish and shark with small multiday boats, is the fastest growing sector. The fishery is also exploited by fisherfolk of other countries. While there is no immediate crisis, there are enough indications that all may not be well. The country needs to assess and better understand the resources in order to sustainably manage it.

The coastal fisheries are heavily exploited and some species have shown signs of stress and depletion. Some species may still have potential and there is a trend of fisherfolk moving into them. However, these conclusions are based on poor and incomplete information. There is also no real data for the entire Northeast of the country due to political disturbances. There is considerable concern about managing the coastal fisheries and the major need is for the development of rapid, economical data-collection and assessment systems to enable fishery managers and policy-makers to make timely decisions. In particular, the ornamental fishery is mentioned as one that needs immediate management. There are several environmental concerns regarding coastal fisheries, including dumping of sewage, industrial pollution, destruction of mangroves and coral reefs, and destructive forms of fishing. There is a lack of sufficient expertise and information to manage the resources. The key concerns that need addressing include lack of

- adequate guidelines for development
- EIA procedures

- environmental standards
- methodologies to mitigate against environmental degradation
- coordination amongst concerned agencies, and
- monitoring and enforcement mechanisms

In the coastal aquaculture sector, which is fast developing and almost totally focussed on *Penaeus monodon*, development is already causing social concerns and actions due to environmental and social disruptions, such as soil and groundwater salinization, mangrove destruction, pollution of coastal and riverine systems, conversion of land use and displacement of communities. Some mechanisms exist to regulate the development, but

- development guidelines
- EIA methods
- pollution avoidance and mitigation measures, and
- mechanisms to monitor the activity and enforce regulations

are weak and need strengthening.

THAILAND

With the coastal waters heavily fished, the fishing fleet has long ventured into the offshore waters of the EEZs of neighbouring countries. However, as the degree of exploitation of the offshore fisheries of other countries in the region varies considerably, the Government is keen on bilateral agreements to enable joint fishing ventures. The deepwater fishery resources are believed to be relatively underfished as a result of inadequate resource information and doubts about the marketability of such species. The country is keen on

- developing resource assessment capacity
- developing sustainable fishing gear to tap these species, and
- processing and product development to meet the huge demand of fish and fish products in the country and the region

The coastal waters of Thailand have been heavily exploited since the introduction of trawling in the '60s. Several signs of overfishing are visible and there is considerable concern, particularly because of the demand for fish for local consumption and because the vast majority of fisherfolk are artisanal fisherfolk dependent on coastal waters for their livelihood. The trawl and pushnet fisheries are considered the most destructive. Environmental degradation, especially in the estuarine regions, is also a concern. The need for managing the coastal fisheries has been recognized and several efforts have been undertaken. Licensing of vessels and banning trawl fishing within 3 km have not been very successful due to inadequate monitoring and enforcement and this needs to be addressed. The fishery agency has invested heavily in large artificial reef programmes, partly to enhance and conserve stocks and partly to discourage trawling. The concern is that the cost-effectiveness of these measures has not been clearly established and this would effect the continuance and expansion of such efforts. The country needs the development and testing of methodologies to undertake such evaluations or assessments. The fishery agency is convinced that community-based fishery management may be the only viable option to manage the coastal waters and stresses to develop and test methodologies and build up its capacity to enable such efforts.

The coastal aquaculture sector, particularly shrimp farming, has shown tremendous development over the last decade. The country leads the region in technological development and leads the world in production. The environmental and social problems encountered by the sector are quite similar to those of the other countries in the region. However, what is different is that Thailand is confident of

overcoming the problems and managing the sector sustainably. The one need that the fishery agency did raise was that of developing technologies to move and use seawater for culture without effecting the soil and groundwater regimes.

2.2 Analysis of Needs and their Prioritization

The Subgroup's primary responsibility was to identify regional research and development requirements to facilitate fisheries development in the context of Agenda 21. In order to put research in its proper context and to determine the specific roles research could play, the Subgroup had to examine the fisheries sector as a whole and understand its needs and concerns. The national needs and concerns emerged from three main sources:

- The country papers which were presented at the BOBP Advisory Committee Meeting in the Maldives
- The country appraisals undertaken by the Subgroup members
- The observations of the Subgroup members

The national needs and concerns, as summarized in Section 2. and Appendix IV, could be broadly classified into three major fishery domains, namely:

- Offshore Fisheries (including the high seas)
- Coastal Capture Fisheries
- Coastal Aquaculture

Tables 1,2, and 3 (on the following pages), in the opinion of the Subgroup, highlight the key symptoms, the causes of the underlying problems, and specify the countries in which they are considered as high priority concerns.

In trying to analyze and better understand the needs, concerns and constraints summarized above, it is necessary to situate them in the context of ground-level reality.

Fisheries in the Bay of Bengal region is an important sector. It provides affordable animal protein to a large population who are culturally and traditional dependent on fish; it generates considerable foreign exchange earnings; it provides livelihoods to millions, a large portion of whom are poor; and it is a source of significant employment and business. Inadequate planning and regulation on the one hand, and increasing population, the open access of marine capture fisheries and the dramatic growth of coastal aquaculture fuelled by lucrative export markets on the other, have resulted in stressed and depleted fish stocks, fish habitat destruction, environmental damage to coastal areas and social conflicts. All this puts a sector of considerable socioeconomic significance at risk. The need to address the problems of the sector and the urgency of doing so cannot be over emphasized.

The fisheries sector, given its relatively low contribution to national GDPs and its low entitlement to political attention because fisherfolk populations are small and scattered, has often been affected by policies that are primarily established by sectors outside the 'fisheries'. National policies, particularly food policy, food security and environmental policies, which aim at sustainable development of both natural resources and fisherfolk communities, would be necessary to enable the sector to grow.

(Continued on page 13)

Table 1 : Coastal Capture Fisheries

<i>Symptoms</i>	<i>Causes</i>	<i>Countries</i>
Declining rate of catch	Overfishing, including ornamental fish, over-capitalization; inadequate and ineffective management methods; destructive fishing methods, wild seeds collection for culture; degradation of coastal environment	All BOB, less priority in Maldives
Conflicts among fisherfolk and others	Interactive fishing; inadequate management measures; lack of policies relating to access to resources	All BOB, less priority in Maldives
Changing catch composition	Changes in fishing methods and patterns; overfishing; use of more selective gears	All BOB, except Maldives
Reduction of unit value, <i>i.e.</i> reduced real earnings	Removal of predators of higher value; increased catch of juveniles; increased fishing efforts	All BOB
Wastage of bycatch	Catch juveniles, discards; inappropriate gear; post-harvest wastage; inadequate infrastructure and marketing channels	All BOB
Uneven exploitation by location and species	Uneven population and fishermen distribution; inadequate access to market; inadequate marketing; lack of infrastructure	<i>Location</i> : India and Indonesia ; <i>Species</i> : All BOB
Declining employment capacity	Increasing efficiency of craft and gear; Note: In some countries, declining employment is a solution for declining catch, but in other countries declining employment opportunities is a serious social problem	All BOB
Fish mortality and public health	Harmful algal blooms; marine pollution	India, Malaysia
Relating to all symptoms identified above	Inadequate data; lack of political will; inability to enforce regulations; paucity of skills and methods in analysis and interpretation, extension and dissemination; ineffective MCS; communication gap between research and users; inadequate law and regulations; lack of participatory and community-based management approaches; lack of methodology to evaluate impacts of conservation and management measures	All BOB

Table 2 Offshore Fisheries

<i>Symptoms</i>	<i>Causes</i>	<i>Countries</i>
Underexploitation	Lack of fishing capacity; inadequate infrastructure; lack of assessment; high investment requirement; lack of technology; lack of product development; <u>lack of knowledge on economic feasibility</u>	All BOB
Conflicts	Ineffective monitoring, control and surveillance; Overlapping claims and disputed boundaries; destructive fishing; lack of resource data and information	All BOB
Lack of technology	Underutilized and untapped species; economic utilization of mesopelagic species	All BOB
Related to all symptoms noted above	Lack of data and resources; inadequate management methods, laws, regulations, and monitoring, control and surveillance	All BOB

Table 3 : Coastal Aquaculture

<i>Symptoms</i>	<i>Causes</i>	<i>Countries</i>
Environmental degradation (<i>in situ</i> and ambient) of coastal land and water	Poor management, inadequate laws and regulations; lack of standards; lack of awareness; lack of coordination among concerned agencies; inadequate mechanisms for MCS; inadequate planning and zoning; over-intensification of culture; nutrient loading; improper feeding; wild seed collection; removal of mangroves; waste disposal; impacts of farm escapees on wild stock in foreseeable future.	All BOB, except Maldives
Environmental and coastal conflicts	Multiusers; displacement of traditional users; impacts of landbased activities, salinization of soil and groundwater; wild seed collectors; introduction and production of exotic species	All BOB
Monoculture or limited culture species	Lack of technology; unavailable and lack of culture and hatchery technology; inadequate market; lack of promotion of consumption	All BOB
Inadequate seed supply	Shortage of hatchery; lack of hatchery technology; shortage of brooders and spawners	All BOB
Cost and <u>availability of feed</u>	Lack of technology; competing use of raw materials	All BOB
Diseases; drugs; residues; fish and public health	Lack of technology; poor culture management; overintensification; lack of trained specialists in fish diseases; lack of research on vaccine; <u>inadequate quarantine procedures and fish transfer facilities</u>	All BOB
Non-availability of, and competition for, water and land resources	Competing use; salinization; property rights; right allocation; enclosures; lack of survey to identify suitable sites	All BOB

The countries concerned about fisheries have made efforts to manage and develop the sector. Unfortunately, most of these have not been very successful. There could be several reasons for this, some of them being the following:

- Most of the current problems in fisheries management are political and socioeconomic in nature and the traditional technological approach in solving problems has not been effective
- The policies and management measures are sometimes inadequate because they have not considered the social and human aspects of the problems
- Participation of the stakeholders in formulating and implementing policies has often been ignored
- The emphasis of fishery information and statistics programmes has been on data-collection, not on analysis and utilization for planning and management
- Extension services, which have the tasks of communicating the thinking of agencies and mobilizing actions, are underdeveloped and often understaffed
- Monitoring, control and surveillance and enforcement are costly, time-consuming and often the weakest link in fisheries management
- Importantly, management responsibilities for coastal resources are divided and scattered among various government agencies and at different levels

Managing complex tasks in the fisheries requires cooperation and coordination amongst related agencies that will have to be catalyzed and nurtured. It would be difficult to expect changes unless these fundamental aspects are addressed.

Fisheries research capacity has been strengthened considerably in the past few decades and is well-established in the region. However, the focus has been primarily on the technical aspects. The new challenges facing fisheries development and management would require strengthening of capacity in diverse areas, such as social sciences, legal and political sciences, economics, data and information management and communication. Furthermore, multidisciplinary and cross-disciplinary efforts will have to be promoted. Scientific capability in some technical fishery areas, such as better understanding of multispecies and multigear tropical fisheries, will have to be developed.

All these prerequisites to enable the strengthening of the fisheries sector would, obviously, take time and effort. The question is, can the countries afford to wait for certain knowledge before they act. Given the nature of ecosystems and the urgency of the tasks, the countries will need to begin with 'precautionary measures', and this requires information and skills of specialists who can rapidly respond to needs and generate information to enable formulation of timely and appropriate decisions.

These issues relating to the needs and concerns are basic and far-reaching, and can only be addressed by the member countries. Any efforts at sustainable development and management of fisheries and aquatic resources that ignore these critical aspects would jeopardize particular actions, such as the project ideas in this report, and, in turn, put the future of an important economic sector at risk.

3. PROJECT IDEAS

While different countries have different concerns and needs, some of which are rather specific to their particular situations, there seems to be some similarities in the problems encountered by the fisheries sector in all Bay of Bengal countries. Key common concerns and problems that emerged are:

- Inadequate exploitation and management of offshore and high seas resources
- Depleting and stressed coastal fishery resources, primarily due to overfishing but also due to environmental degradation of coastal waters caused from land-based and, occasionally, ship-based pollution

- Lack of reliable and timely data and information, and inability to effectively apply and utilize existing data and information
- Social conflicts due to multiple uses and overexploitation of coastal resources (on land and in the water)
- Degradation of coastal environments and social conflicts resulting from rapid development, intensification and dependence on a few species in coastal aquaculture.

An international basis for the protection and sustainable use of seas is provided by the UN Convention on the Law of the Sea (UNCLOS). The implementation of the objectives of Agenda 21 and the principle of UNCLOS call for new levels of international and regional cooperation. Additionally, the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks and the Code of Conduct for Responsible Fishing will provide a framework for international management of resources offshore and in the high seas.

Fishery agencies in the region are confronted with what are essentially old problems, but with ‘new’ dimensions and parameters. The issues are more complex. They involve multiplicity of disciplines, such as law, social sciences, ecology, area management, and community development, deal with multiple agency jurisdictions, and encompass several sectors interacting and exploiting the same resources.

Even in fisheries, the challenges are new – the need to better understand brackishwater systems, environmental impacts, multispecies, multigear tropical fisheries, and, most importantly, the role of people in ecosystems.

A serious gap exists in the progression of actions needed to address problems, from research, to information, to policy decisions based on such knowledge, to, finally, the political will to implement and enforce policies. This includes

- lack of appropriate methodologies to gather and analyze data and information
- inadequate and insufficient knowledge upon which to base decisions, and
- inadequate understanding of complex and interactive situations and problems.

In order to address the key concerns of the sector, the countries need to build up their capacities to undertake a variety of actions, such as:

- Building their knowledge base
- Evolving legal and regulatory frameworks
- Developing policies in collaboration with other concerned agencies and sectors
- Introducing management measures
- Strengthening monitoring, control and surveillance systems
- Increasing public awareness
- Developing and promoting new, appropriate technologies and markets

The Subgroup noted that the countries bordering the Bay of Bengal have initiated a number of activities that aim to strengthen the capacities of the fisheries sector. Also, the Subgroup recognized that the national programmes are able and more appropriate to undertake necessary initiatives in such areas as developing new products and technologies and public awareness-building.

Therefore, in identifying ideas for regional actions, the Subgroup did not attempt to identify research and development requirements to address all the problems in the fisheries sector; that would have not only been beyond the Subgroup’s terms of reference, but would also have been too large a task. Rather, the Subgroup, guided by its terms of reference, decided to focus on the central issue of

generating the new kinds of knowledge that would facilitate and enable the countries to better understand the problems confronting them and to provide a knowledge base to formulate timely and appropriate decisions for sustainable development and management of the fisheries sector.

Within such a context, and guided by the requests and suggestions of the member countries, the following fourteen project ideas have been identified for consideration. The project ideas are listed under three major classifications, dictated by the thrusts of action. (See Appendix V for more details on the project ideas.)

A. MANAGEMENT OF COASTAL FISHERIES RESOURCES

1. Analysis and Interpretation of Resources Data

OBJECTIVES

To improve and strengthen national capabilities in fisheries resource assessment and fisherfolk community appraisals through development of methodologies for both rapid appraisal and long-term evaluation. Specifically:

- To develop methodologies for rapid resource assessment and community appraisals
- To identify critical parameters for resource assessments and community appraisals and develop guidelines for data collection
- To strengthen the capacity of national fishery agencies in data collection, analysis and interpretation, and in rapid appraisal methods

2. Monitoring and Assessment of Impact on Fisheries of Pollution in Coastal Waters

OBJECTIVES

- To develop appropriate methodologies and guidelines to monitor coastal pollution and assess its impact on aquatic resources and their habitats

3. Methods and Capacity for Community-Based Management

OBJECTIVES

To strengthen capacities of national fishery agencies and NGOs to enable and facilitate community-based coastal fisheries management. Specifically:

- To develop and test methodologies of, and approaches for, community-based coastal fisheries management
- To strengthen skills of the national fishery agencies in undertaking such efforts

4. Assessment of Fisheries Conservation and Management Measures

OBJECTIVES

- To develop appropriate methodologies for assessing the biological impacts and cost-effectiveness of fisheries conservation and management measures, such as artificial reefs, marine parks, closed areas and closed seasons

5. Development of Selective, Ecofriendly Fishing Gear

OBJECTIVES

- To modify existing fishing gear and, where necessary, design new types of fishing gear to reduce by-catch, avoid incidental catch of endangered species, harvest under and untapped species, and enable cost-effective fishing operations.

6. Utilization of Trawler By-Catch

OBJECTIVES

- To develop methods of collecting, transporting, processing and utilizing trawler by-catches for human consumption and livestock feed and to determine their techno-economic feasibility

B. MANAGEMENT OF OFFSHORE AND HIGH SEAS FISHERIES RESOURCES

1. Assessment of Offshore and High Seas Fisheries Resources

OBJECTIVES

Improved understanding of fisheries resources and potential in the offshore regions of the EEZs and in the high seas to facilitate policy decisions and management measures. Specifically:

- To develop and establish common survey and assessment methodologies for fisheries resource assessments in offshore regions of EEZs and in the high seas
- To undertake national and joint-regional assessments and surveys
- To strengthen the skills of national personnel in data analysis and interpretation
- To develop regional mechanisms to share relevant data and information

C. MANAGEMENT OF COASTAL AQUACULTURE

1. Methodologies for Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) in Coastal Aquaculture

OBJECTIVES

- To develop EIA and SIA methodologies to guide the sustainable development of coastal aquaculture.

2. Environmental Standards for Effluents of Coastal Aquaculture

OBJECTIVES

Within the overall objective of sustainable coastal development and reduction of social conflicts. Specifically:

- To recommend environmental standards for effluents of coastal aquaculture

3. Establishment of Protocols and Guidelines for Siting and Clustering Density of Coastal Aquaculture

OBJECTIVES

- To develop methodologies and guidelines for identifying suitable sites for aquaculture development in the context of sustainable coastal zone development
- To develop methodologies and guidelines for determining clustering density levels for aquaculture farms in particular sites identified for aquaculture

4. Prevention and Control of Disease in Coastal Aquaculture

OBJECTIVES

In the context of producing wholesome fish and reducing economic loss due to disease. Specifically:

- To develop sustainable culture practices
- To develop methods to prevent and control diseases

5. Seed Supply and Hatchery Development

OBJECTIVES

- To ensure greater availability of seed, in terms of quantity, quality and variety
- To diversify the aquaculture base and accelerate the pace of aquaculture development
- To reduce the need for wild fry collection, and contribute to the conservation of fisheries resources

6. Development of Feeds for Culture of Marine Finfish

OBJECTIVES

- To ensure availability of commercially formulated feeds for marine finfish
- To reduce demand for trash fish

7. Reclamation of Sites Abandoned Due to Culture Failure

OBJECTIVES

- To return to productive use aquaculture sites abandoned due to culture failures.

Some of the project ideas that were considered were specific to certain countries and are more appropriate for national implementation. They were, therefore, not elaborated upon by the report, which focussed on the following regional needs:

- Establishment of a data base for coastal fisheries management
- Establishment of monitoring, control and surveillance and enforcement systems.

Further, considering the economic value of activities resulting from value-added processing of fishery products, the Subgroup felt that the private sector had an important role to play in research related to post-harvest handling and product development, and the project idea which could best be considered by the private sector was Value-Added Processing of Fishery Products.

4. STRATEGIC ISSUES IN IMPLEMENTATION

4.1 Implementation Approaches

The basic expertise and research capacity to implement the project ideas identified exists in the Bay of Bengal region. It is perhaps not equally distributed and in certain subject areas may need strengthening. The nature of the project ideas, deriving out of national needs, suggests that the activities be nationally implemented. This is particularly necessary since, while the problems are reasonably similar in the region, the national conditions and causes are sufficiently different and will require locale-specific actions.

There are several reasons, however, why the member countries should consider regional approaches in implementation.

First, different countries have varying levels of capacity and manpower availability in different subject areas, and the countries may wish to share expertise and capacity within the region rather than seek assistance from outside the region.

Secondly, given the similarity of the problems and concerns in the region and, parallelly, the distribution of ecosystem types and other factors, a regional coming-together would be beneficial from the point of view of getting a more complete understanding of the problems at hand.

Thirdly, a regional effort would enable the countries to learn from each other's efforts and experiences, and share learnings, which would also be very cost-effective. The idea here is not for the countries to abandon their national efforts or to submerge national efforts into a regional activity, but, rather, to derive the benefits from a regional effort without surrendering the benefits of national execution.

Therefore, the Subgroup suggests that the member countries consider a framework of a regional or subregional umbrella, with the regional level facilitating regional coordination, sharing of expertise, sharing of learnings, joint efforts in some cases, and shared training efforts. They could then draw on the larger critical mass of regional expertise and capacity to supplement their on-going national programmes. Further, the countries in the region could benefit a lot by sharing national expertise and capacities through TCDC and ECDC mechanisms.

As indicated in Appendix IV, there are a considerable number of regional activities in fisheries and related fields in the Bay of Bengal region. The regional fisheries bodies visited by the Subgroup members indicated their eagerness to support and cooperate with the initiatives of the BOBP member countries. It would be beneficial for the member countries to make appropriate linkages to share experiences and supplement existing efforts.

4.2 *Funding*

Protection of the massive economic benefits derived from the fisheries sector, which is already threatened, requires, among other things, research. It has been shown that a regional research programme could stimulate and supplement national efforts. It is suggested that the availability of international funding should not be a prerequisite for regional and subregional cooperation in fisheries research. A true regional programme requires national commitments, and it is only right that the region, which is a world leader in fisheries, should own its research programmes. Countries that are constrained from participation in the regional initiatives due to lack of funds should be encouraged to seek support from bilateral donors.

4.3 *Action by the BOBC*

Should the above approach be acceptable to the IOFC Committee for the Development and Management of Fisheries in the Bay of Bengal, it would be necessary to consider regional umbrella mechanisms for coordination. These mechanisms can best be provided by existing regional fishery bodies. The FAO would be prepared to provide support, bearing in mind the existing constraints in funding.

In view of the importance of the problems facing the fisheries sector and of the urgency for action, it is suggested that activity be initiated immediately by assessing the interests of the governments in participating in the individual project ideas. Where a high level of interest is indicated, networking arrangements should be initiated and detailed formulation of project workplans be developed.

APPENDIX I

Terms of Reference of the BOBC Subgroup for Preparation of Proposal for Regional Fisheries and Fisherfolk-Related Research and Development Programmes

I. TERMS OF REFERENCE FOR THE SUBGROUP

Within the framework of the BOBC, the Subgroup consisting of four members shall, in close consultation with BOBC member countries, regional and international agencies dealing with fisheries research in the region, the SIFR, and such other agencies as necessary, formulate research and development proposals in the broad context of Chapter 17 of Agenda 21 to address the important, high-priority fishery-related concerns of the region.

The Subgroup shall be made up of high-level staff responsible for planning and research efforts of the national fisheries agencies, two each from India and Malaysia, who will represent the interests of their respective subregions.

The Subgroup *inter alia* shall:

- a. Review the research and development requirements in the areas of
 - Sustainable management of coastal and high seas fisheries
 - Planning of coastal aquaculture, post-harvest technology, and information gathering
 - Sharing of initiatives in the BOB region of national, subregional and regional significance
- b. Identify areas of research and development needs with the following:
 - Commonalities of interest problems
 - Regional relevance of outcomes
 - High priority with national governments
 - Possibility of regional approach in handling
 - Interest and commitment in participation in regional research efforts by member governments
- c. Review and consider human resource development and national research capacity-building aspects.
- d. Identify national/regional UNCED follow-up of fishery-related activities, online and projected, to ensure that the areas identified above are supplementary and complementary to the effort.
- e. In consultation with research and government agencies, evolve project concepts to address the needs identified.
- f. In consultation with, and on the basis of priorities assigned by member governments, elaborate the concepts into project briefs in forms appropriate for submission to donor agencies.
- g. Submit the concepts and project briefs to the BOBC.

The Subgroup shall be assisted by a Secretariat provided by BOBP.

In order to undertake their task the Subgroup shall:

- Undertake such travel as necessary, in the region and within countries, to consult with institutions and individuals and undertake field appraisals
- Call meetings of regional and subregional country representatives as necessary
- Request member governments to nominate and depute staff to the BOBC Subgroup, to assist them in their task
- Where necessary, hire consultants to assist them, through the BOBP Secretariat

II. RELEVANT EXTRACTS FROM THE REPORT OF THE 18TH MEETING OF THE ADVISORY COMMITTEE OF THE BAY OF BENGAL PROGRAMME FOR FISHERIES DEVELOPMENT

1. The formation and the terms of reference of the Subgroup were endorsed.
2. The Subgroup should carefully take into consideration past and ongoing efforts of other organizations and initiatives related to fisheries and fisherfolk research and development, including those of the Strategy for International Fisheries Research.
3. The Subgroup should communicate their efforts to the donor gathering organized by SWR in Paris, making particular reference to the fisheries research priorities of the region, in order to support the consensus already developing out of other initiatives and, in turn, seek information about the procedures.
4. The Subgroup should not restrict itself to considering research but should also consider development-oriented efforts.
5. The Subgroup in addressing fishery research and development issues should clearly lay emphasis on the sustainable human development aspects.
6. The Subgroup, in considering short-term applied research and development proposals versus long-term basic efforts of strategic nature, should keep in mind the institution-building aspects.
7. The Subgroup should give consideration to proposals which address both national and regional concerns.
8. The Subgroup should not restrict itself to proposals dealing with small-scale fisheries but consider all fishery related issues of the region.
9. The Subgroup, in evolving proposals, should use the context of Agenda 21 in its entirety as its guiding principle.
10. The Subgroup, in formulating the proposals, should consider them in a programme framework.

APPENDIX II

List of BOBC Sub-group Members

MEMBERS

Mohd Shaupi Derabman,
Head, Resource Management Section, DOF,
Malaysia.

Liong Pit **Chong**,
Chief, National Prawn Fry Production and Research Centre,
DOF, Kedah, Malaysia

Dr. K. Radhakrishna,
ADO, Fisheries, ICAR,
Delhi, India.

B. Roy,
Deputy Commissioner (Fisheries), Ministry of Agriculture,
Delhi, India.

SECRETARY TO THE BOBC SUB-GROUP

R. N. Roy,
Sr. Extension Advisor, BOBP

ADVISOR

Dr. David James,
Principal Fisheries Research Advisor, FAO, Rome

CONSULTANT

Yong-Ja Cho (Ms.)

APPENDIX III

List of Agencies and Institutions Visited and Officials Met

BANGLADESH

Ministry of Fisheries and Livestock: Secretary; Joint Secretary Fisheries; Joint Chief, (Planning). **Department of Fisheries:** Director-General; Deputy Director-in-Charge of Marine Wing; Project Director, Marine Fisheries Research Management and Development Project. **Fisheries Research Institute:** Director; Chief Scientific Officer. **Ministry of Environment and Forests:** Joint Secretary (Environment). **Department of Environment:** Deputy Director (Research). **Bangladesh Agricultural Research Council:** Member-Director (Fisheries). **FAO Representation:** FAO Representative; Asst. FAO Representative; Programme Officer. **UNDP:** Programme Officer (Environment); Programme Officer (Fisheries). **International Centre for Living Aquatic Resource Management: Bangladesh Aquaculture and Fisheries Resource Unit: (ODA-UK).** **Bangladesh Centre for Advance Studies, Department of Geography, Dhaka University (Environmental Survey and Research Unit):** Project Managers and senior staff.

INDIA

Ministry of Agriculture and Cooperation: Joint Secretary (Fisheries); Commissioner (Fisheries); Assistant Commissioner (Fisheries). **Indian Council of Agricultural Research:** Deputy Director-General (Fisheries). **Central Marine Fisheries Research Institute:** Director and senior scientists. **Central Institute of Fisheries Technology:** Senior scientists. **Fisheries Survey of India:** Zonal Director. **Seafood Association of India:** Vice-President and Secretary. **Central Institute of Brackishwater Aquaculture:** Director and senior scientists. **Central Institute of Fisheries Nautical Engineering Technology:** Senior scientist. **Association of Industrial Fisheries of India:** Senior staff and members. **Department of Zoology, Marine Living Resources and Environmental Sciences, Andhra University:** Senior faculty members.

INDONESIA

Directorate-General of Fisheries: Secretary; Director (Planning); Senior staff from Production and Planning Sections. **Centre for Brackishwater Aquaculture, Japery:** Director and senior staff. **Central Research Institute of Fisheries:** Senior staff. **Agency for Agricultural Research and Development, Ministry of Agriculture:** Project Team Leader. **Bogor Agricultural University, Faculty of Fisheries:** Senior faculty. **Provincial Fisheries Office, Central Java:** Chief and senior staff. **University of Deponegoro, Marine Science Faculty:** Senior faculty. **Ministry of Environmental Affairs:** Secretary to Asst. Minister. **FAO Representation:** Asst. FAO Representative. **Japanese International Cooperative Agency:** Fisheries expert.

MALAYSIA

Economic Planning Unit, Prime Minister's Department: Senior officials and technical staff. **Ministry of Science, Technology and Environment:** Senior officials and technical staff. **University Malaya:** Senior staff. **University Sains Malaysia:** Senior staff. **University Kebangsaan Malaysia:** Senior staff. **University Pertanian Malaysia:** Senior staff. **Fisheries Research Institute:** Senior officials and technical staff. **Marine Fisheries Development and Management Department:** Senior staff. **ASEAN-Canada Cooperative Program on Marine Science:** Senior staff. **Fisheries Department:** Senior officials and technical staff.

MALDIYES

Ministry of Fisheries and Agriculture: Minister; Director of Fisheries; Director, Fisheries Research and Planning. **Marine Research Section:** Director and senior scientists. **UNDP:** Resident Representative. **Ministry of Planning and Environment:** Deputy Director (HRD).

SRI LANKA

Ministry of Fisheries and Aquatic Resources: Secretary; Director (Planning). **Department of Fisheries and Aquatic Resource:** Director; Head (Fisheries Management Unit). **National Aquatic Resources Agency:** Chairman; Director-General; Director (Marine); Director (Environment); Director (Brackishwater Culture). **Coast Conservation Department:** Director and Manager (Planning). **Department of Wildlife Conservation:** Director. **Asian Development Bank, Fisheries Sector Development Project:** Director; Marine Biologist. **FAO-UNDP Marine Fisheries Management Project:** CTA and senior staff. **Central Environmental Authority:** Chairman; Deputy Director-General; Chief of Wetland Conservation Project. **Ministry of Environment and Parliamentary Affairs:** Secretary; Additional Secretary. **Coastal Resource Management Project:** Project Manager. **Sri Jayawardenapura University, Department of Zoology:** Senior faculty. **Wildlife and Nature Protection Society of Sri Lanka, Environmental Foundation Ltd.:** Heads and senior staff. **FAO Representation:** FAO Representative; Programme Officer.

THAILAND

Directorate of Fisheries: Director-General; Deputy Director-General; Marine Fisheries Adviser; Director, Fisheries Environment Division; Director, Foreign Fisheries Division; Director, Oceanic Fisheries Division; Director, Marine Fisheries Division. **Marine Biology and Fisheries Research Institute, Phuket:** Director and senior scientists. **Andaman Sea Fisheries Development Centre:** Director. **National Institute of Coastal Aquaculture:** Director and senior scientists. **Phuket Coastal Aquaculture Development Centre:** Director and senior scientists. **Provincial Fisheries Office, Phuket:** Chief and senior staff. **SEAFDEC:** Secretary-General; Deputy Secretary-General; Head and staff of Training Division. **NACA:** Coordinator; Senior Aquaculturist; Environment specialist; Information specialist, **FAO Representation:** FAO Representative. **RAPA:** Regional Fisheries Officer; Regional Aquaculture Officer.

APPENDIX IV

Constraints and Needs of the BOBC Countries

<i>Constraints, Problems, Needs</i>	<i>Countries</i>	<i>Examples of Agencies involved</i>
<p>Management of Coastal Fisheries Resources</p> <ul style="list-style-type: none"> • Resource inventory, monitoring and assessment, and relevance to local fishing communities • Impacts of changing fishing patterns and operations • Guidelines for development of EIA procedures, environmental standards, methodologies to mitigate activities, including destructive and illegal fishing, on coastal resources such as coral reefs, estuaries, lagoons, mangroves etc. • EIA of ornamental fishing and tourism • Water quality criteria and marine pollution monitoring, <i>e.g.</i> discharge of agricultural, industrial and domestic wastes, oil spills, harmful algal bloom, etc. • Overfishing, including ornamental fish. • Improved knowledge of the carrying capacity of coastal ecosystems • Fishery oceanography 	<p>Bangladesh India</p> <p>Indonesia</p> <p>Malaysia</p> <p>Maldives Sri Lanka</p> <p>Thailand</p>	<p>SEAFDEC/MFRDMD (ASEAN)</p> <p>GESAMP, IOC, USAID/CRM (Sri Lanka and Thailand)</p> <p>FAO1; UNEP, UNESCO; IOC; ESCAP SACEP</p> <p>IOC's HAB Project; CPMS (ASEAN Canada Coop. Prog. on Marine Science); ICLA.RM; GEF/UNDP/IMO Project (Eastern Asia Seas)</p>
<p>Development and Management of Offshore Fisheries</p> <ul style="list-style-type: none"> • Collaborative efforts in stock assessment and management (offshore migratory pelagic stocks, shared stocks) • Assessment of the potential for deep water fishery • Identification of underexploited areas and species • Policy agreement and joint ventures 	<p>Bangladesh India</p> <p>Indonesia</p> <p>Malaysia</p> <p>Sri Lanka Thailand</p>	<p>UNCLOS</p> <p>UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks</p> <p>SEAFDECIMFRDMD; FAO</p>
<p>Management of Coastal Aquaculture</p> <ul style="list-style-type: none"> • Impact on coastal ecosystems • EIA methods and guidelines, including legal framework, policies and guidelines; and minimum standards to protect the environment 		

1FAO refers to both FAO, Rome, and FAO/RAPA

<i>Constraints, Problems, Needs</i>	<i>Countries</i>	<i>Examples of Agencies involved</i>
<ul style="list-style-type: none"> Guidelines and procedures to identify suitable sites, determining clustering densities, culture practices and environmental protection measures Supply of seed, breeding and hatchery technologies Diversification Water quality control, waste management and effluent treatment Reclaiming abandoned ponds Disease control methods and use of chemicals and drugs Lack of awareness among farmers that intensive farming is environmentally damaging and unsustainable 	Bangladesh India Indonesia Malaysia Sri Lanka Thailand	FAO; NACA; AADCP; SEAFDEC/AQD
<p>Conflict Resolution Between Artisanal and Industrial Sectors and Agriculture, Industry and Fisheries</p> <ul style="list-style-type: none"> Access to resources, property rights and competing water use Availability and consistency of land-use planning for brackishwater aquaculture Impacts of flood control, drainage irrigation, cross dams, river close, etc. on fisheries and aquatic resources. 	Bangladesh India Indonesia Sri Lanka Thailand	SEAPOL; UNCLOS; FAO (?)
<p>Community-based Coastal Fisheries Management</p> <ul style="list-style-type: none"> Unsatisfactory implementation of policies and management measures due to the lack of cooperation from the fisherfolk Community-based management measures and methodologies 	Bangladesh Indonesia Sri Lanka Thailand	SEAFDEC/AQD; BOBP FAO
<p>Monitoring, Control and Surveillance</p> <ul style="list-style-type: none"> Prevention against overexploitation of inshore resources and cost-effective enforcement methods Encroachment into mangrove areas Monitoring and surveillance of coastal pollution, e.g. discharge and dumping wastes, and ship-based oil pollution and oil spills Guidelines for licensing, conservation of species, fishing methods and areas, etc. Lack of management-oriented planning Lack of community participation 	Bangladesh India Indonesia Malaysia Sri Lanka Thailand	IMO/UNDP; FAO; SEAPOL

<i>Constraints, Problems, Needs</i>	<i>Countries</i>	<i>Examples of Agencies Involved</i>
<p>Data and Information</p> <ul style="list-style-type: none"> • Lack of reliable and timely information to assess the situation, and facilitate and support management decisions and efforts, particularly in inshore and estuarine fisheries • Need for low-cost, less data-demanding information system and economical data collection and assessment system to feed information that allows policymakers and fishery managers to take decisions • Rapid studies to provide managers with information to assist decision-making • Accurate assessment for offshore and high seas fisheries resources • Language barrier, information in non-national languages • Lack of data to assess potential of EEZ • Lack of fishery socioeconomic data • Gaps in or lack of reliable and timely data, <i>e.g.</i> for stock assessment, aquaculture development and forecasting • Inadequate capability to analyze and interpret data and information 	<p>Bangladesh India Indonesia Malaysia Maldives Sri Lanka Thailand</p>	<p>FAO; SEAFDEC; INFOFISH; IOTC; NACA; BOBP; ICLARM</p>
<p>Training and Human Resources Development</p> <ul style="list-style-type: none"> • Short-term, practical training in various areas, particularly for regulation and enforcement, to build the capacity of institutions (Indonesia) • All aspects of fisheries, from survey, policy formulation, implementation, monitoring and management (Bangladesh) • Manpower at operational and managerial level to support the envisaged investment from private sector (India) • Research capability (Malaysia) • Scientist, technicians, managers, economists, statisticians, operators, extension workers (Maldives, Sri Lanka) • Well-trained crew for fishing vessels (Thailand) 	<p>Bangladesh India Indonesia Malaysia Maldives Sri Lanka Thailand</p>	<p>BOBP; SEAFDEC; AADCP; NACA; ICLARM; FAO</p>

<i>Constraints, Problems, Needs</i>	<i>Countries</i>	<i>Examples of Agencies Involved</i>
<p>Public Awareness and Extension</p> <ul style="list-style-type: none"> • Lack of awareness amongst concerned stakeholders, from political decision-makers to ground-level participants, of the problems and needs for management actions • Improved communication and extension methods for successful community-based management efforts • Inadequacy in suitable extension network • Slow technology transfer 	<p>Bangladesh India Indonesia Malaysia Thailand</p>	<p>BOBP; NACA; SEAFDEC/MFRD</p>
<p>Post-harvest Handling</p> <ul style="list-style-type: none"> • Reduction of trawler discards • Reduction of wastage and utilization of underutilized species • Reduction of mortality • Increased awareness of hygiene and sanitation criteria 	<p>Bangladesh India Indonesia Malaysia Maldives Sri Lanka</p>	<p>SEAFDEC/MFRD (ASEAN); AFHB INFOFISH; FAO</p>
<p>Marketing Ability</p> <ul style="list-style-type: none"> • Lack of assured markets and distribution systems • Restricted market destination • Inadequate market information • Landing of Maldivian fish in neighbouring countries, price difference between cooperatives and private industries 	<p>India Indonesia Maldives Sri Lanka Thailand</p>	<p>FAO/GLOBFISH; INFOFISH</p>
<p>Effectiveness of Conservation and Management Measures</p> <ul style="list-style-type: none"> • Understanding the reasons for failure of the past efforts, such as fisheries stock assessment systems. • Development of evaluation methodologies for conservation measures, <i>e.g.</i> artificial reefs, closed seasons and areas, and marine park 	<p>Bangladesh Malaysia Thailand</p>	<p>ICLARM, SEAFDEC</p>
<p>Fishing Gear and Vessels</p> <ul style="list-style-type: none"> • Development of inexpensive, cost-effective fishing gear • Environmentally friendly fishing gear to reduce by-catches of endangered species and juveniles 	<p>India Indonesia Malaysia Thailand</p>	<p>SEAFDEC/TD and MFRDMD</p>

<i>Constraints, Problems, Needs</i>	<i>Countries</i>	<i>Examples of Agencies involved</i>
Coordination mechanisms among the Related Agencies	Bangladesh Sn Lanka Thailand	
Infrastructure <i>e.g.</i> harbour, vessels, landing sites etc. suitable for only inshore fishing vessels	India Indonesia Malaysia	
Research and Training Institutions <ul style="list-style-type: none"> • Inadequate educational and training facilities • Regional cooperation in use of research vessels • Under-funding of fisheries research institutions 	Bangladesh India Malaysia Thailand	
Lack of long-term financial credit	India	

APPENDIX V

List of Project Ideas

Fourteen project ideas emerged from the country reports and Subgroup missions, and are listed under the headings:

- a) Management of Coastal Fisheries Resources
- b) Management of Offshore Fisheries;
- c) Management of Coastal Aquaculture

MANAGEMENT OF COASTAL FISHERIES RESOURCES

1. Analysis and Interpretation of Resources Data

JUSTIFICATION

Rational and sustainable use of the coastal aquatic resources, including ornamental fish, and an understanding of island ecosystems requires a continuous assessment of the resource base through appropriate methodologies and judicious identification of the required parameters. This is a long-term programme which produces the information to enable the management of fisheries. At the same time, policymakers also need timely and appropriate information based on existing data and rapid appraisals in order to take policy decisions. Although the countries of the region have collected data on coastal aquatic resources, these are often underutilized because the information is not complete and, often, time series data is not available for long enough periods. The problem is further compounded by the fact that appropriate analytical methods and assessment methodologies are not available, particularly for the complex, multigear, multispecies, interactive tropical fisheries of the region. Methodologies and guidelines for data collection are necessary, particularly to enable rapid resource assessments, and rapid community appraisals need to be developed to provide timely information. This is important because, given the complexity of environmental systems, it is often not possible to wait while information of a more complete nature is generated and 'precautionary measures' have to be taken. Finally, not only is there need to develop methodologies but there is also the need to build and strengthen the capacities of fishery agencies to undertake such tasks.

OBJECTIVES

To improve and strengthen national capabilities in fisheries resource assessment and fisherfolk community appraisals through development of methodologies for both rapid appraisal and long-term evaluation. Specifically:

- To develop improved methodologies for coastal aquatic resource assessment
- To develop methodologies for rapid resource assessment and community appraisals
- To identify critical parameters for resource assessments and community appraisals and develop guidelines for data collection
- To strengthen the capacity of national fishery agencies in data-collection, analysis and interpretation, and in rapid appraisal methods

EXPECFED OUTPUTS

- Improved methodologies for coastal aquatic resource assessment and fisherfolk appraisals
- Manuals for resource assessment and fisherfolk appraisals
- Methodologies for rapid resource assessment and rapid community appraisals
- Staff of national fishery agencies trained in collection, analysis and interpretation of resources data and in rapid appraisal methods

MAJOR ACTIVITIES

Information/Data needs analysis

Ecosystems analysis

Fisherfolk community analysis

Identification of critical parameters

Development of methodologies

Testing of methodologies in pilot cases

Development of manuals

Training of staff

Dissemination of results

IMPLEMENTATION

Most of the activities would be undertaken by the national fisheries agencies. Appropriate facilitation and coordination through regional fishery bodies would be beneficial. External inputs may be required for development of analysis and interpretation methods and for regional training. National agencies in the region: CMFRI, DAC and FSI in India; DFAR & NARA in Sri Lanka; DOF and FRI in Malaysia; DOF in Thailand; DGF and CRIFI in Indonesia; DOF and FRI in Bangladesh; and, MOFA and MRS in the Maldives.

2. Monitoring and Assessment of Impact of Fisheries on Pollution in Coastal Waters

JUSTIFICATION

Coastal waters and the environment of the Bay of Bengal are subjected to pollution from a variety of sources, such as industrial effluents, agricultural residues, domestic sewage, and oil. It is general knowledge that such pollution damages aquatic resources and the environment that nurtures them, occasionally kills fish, and sometimes results in toxic substances entering the human food chain. However, the impact of the pollution on the aquatic resources has not been assessed and monitored systematically. Furthermore, there is a lack of appropriate methodologies to monitor and assess the impact of pollution on aquatic resources and habitats. Development of methodologies for such assessments are required for conservation of aquatic resources in the region, for the protection of public health as well as for the prevention of fish diseases.

OBJECTIVES

- To develop appropriate methodologies and guidelines to monitor coastal pollution and assess its impact on aquatic resources and their habitats

EXPECTED OUTPUTS AND RESULTS

- Establishment of norms, guidelines, methodologies for monitoring pollution in coastal waters
- Development of methodologies for assessing the impact of pollution on aquatic resources and their habitats
- Establishment of standards to facilitate conservation and protection of coastal aquatic resources and fish products
- Manuals
- Staff of national fishery and other concerned agencies trained in such efforts

MAJOR ACTIVITIES

Ecosystems analysis

Identification of indicators of the status of ecosystems, including indicator species

Identification and classification of pollutants

Studies to determine action of pollutants on ecosystems

Development of impact assessment methodologies

Testing of methodologies

Determination of standards

Development of guidelines, protocols

Development of methodologies to set values for resources

Development of monitoring protocols

Training

IMPLEMENTATION

National fisheries agencies working in close cooperation with environmental agencies and research institutions, including universities, could undertake the effort. Facilitation and coordination by regional and international bodies concerned with such efforts, such as IMO, UNEP, IOC, ESCAP and UNESCO, would be beneficial. External inputs may be necessary to supplement national efforts and expertise.

3. Methods and Capacity for Community-Based Management

JUSTIFICATION

Open access to coastal resources and uncoordinated and unregulated use of the resources causes conflicts among the various stakeholders. Many measures for aquatic resource management have failed because of lack of cooperation and participation of the concerned stakeholders. Monitoring, control and surveillance are capital-intensive and time-consuming. Community participation could reduce cost and time, and produce tangible and sustainable results. Community-based management is a relatively new concept in the fisheries sector and, hence, has to be introduced through building awareness, the development of methodologies, training and pilot efforts.

OBJECTIVES

To strengthen capacities of national fishery agencies and NGOs to enable and facilitate community-based coastal fisheries management. Specifically:

- to develop and test methodologies of and approaches for community-based coastal fisheries management
- to strengthen skills of the national fishery agencies in undertaking such efforts

EXPECTED OUTPUTS AND RESULTS

- Methodologies of, and approaches to, community-based management
- Staff of national fishery agencies trained in facilitating and enabling community-based coastal fisheries management
- Manuals for training and implementation

MAJOR ACTIVITIES

Awareness-building

Learning from existing efforts

Rapid resources assessment

Rapid community appraisals

Development of approaches and methods

Testing methods in pilot projects

Development of training and implementation manuals and guidelines

Training of national fishery agency staff and TGOs

IMPLEMENTATION

National fisheries agencies, other concerned government agencies, and NGOs, in selected countries. Regional coordination and facilitation through regional fishery bodies would be beneficial. External inputs may be required for the development of methodologies and for regional training.

4. Assessment of Fisheries Conservation and Management Measures

JUSTIFICATION

Overfishing, partly resulting from increasing fisherfolk populations and increases in the intensity of fishing effort, has led to declining catch rates in the coastal fisheries of the region. In response, several countries bordering the Bay of Bengal have introduced a number of management measures, such as the construction of artificial reefs, establishment of marine parks, and introduction of closed fishing areas and seasons. Preliminary studies, especially underwater observations of artificial reefs and marine parks, indicate encouraging results, in the form of greater diversity and abundance of aquatic organisms. And fisherfolk generally claim improved catches after seasonal and area closures are lifted. However, the cost-effectiveness of these measures has not been conclusively established, and fishery agencies face problems in convincing governments to continue spending on such efforts. Development of appropriate methodologies are needed to assess the biological impact of these interventions and, possibly, quantify the cost-effectiveness of these efforts so that the proposed increased investments in the coming years could be justified. In the case of marine parks, additional benefits in the form of income generated by increasing ecotourism also need to be taken into consideration in determining cost-effectiveness. While assessment of the management measures is of immediate concern and interest to the Southeast Asian countries, other countries in the region and elsewhere would also benefit from the methodologies resulting from this activity.

OBJECTIVES

- To develop appropriate methodologies for assessing the biological impacts and cost-effectiveness of fisheries conservation and management measures, such as artificial reefs, marine parks, closed areas and closed seasons

EXPECTED OUTPUTS AND RESULTS

- Methodologies for assessment of biological impacts and cost-effectiveness of fisheries conservation and management measures
- Staff of national fisheries agencies trained in undertaking such efforts

MAJOR ACTIVITIES

Pre-deployment and post-deployment studies of fisheries conservation and management measures in terms of ecosystem appraisals and exploratory fishing

Identification of critical indicators

Development of data-collection guidelines

Development of appropriate methodologies for assessment of biological impact and cost-effectiveness of such measures, keeping in mind that the methodologies themselves should be cost-effective and be able to generate timely information

Testing of methodologies in on-going and pilot efforts in the region

Dissemination of learnings

Training of staff

IMPLEMENTATION

National fisheries agencies and their research institutions, working closely with universities and other research organizations concerned with aquatic ecosystems research, could undertake these efforts. Facilitation and coordination of national efforts by regional fishery bodies would be beneficial. Some external inputs in the form of expertise and equipment may be necessary to supplement national efforts and expertise

5. Development of Selective, Ecofriendly Fishing Gear

JUSTIFICATION

It is known that fishing gear, such as demersal trawls and pushnets, when used in coastal waters generate significant by-catch, with figures as high as 70 per cent being reported. A large portion of the by-catch are juveniles of commercially valuable fish. Such indiscriminate fishing obviously has an adverse effect on fisheries stocks. The outright ban of gear, such as the ban of trawls, a highly efficient gear, as practised in Indonesia, is difficult to enforce and probably too drastic a measure to be acceptable to fishing communities in the region. Further, in the post,-UNCED context, there is quite some concern over incidental catches and mortality of endangered species in fishing operations. The other side of the coin is that there are several under- and untapped species that could provide fish for consumption, provided there are appropriate fishing gear and practices to harvest them. Finally, fishing gear need to be designed keeping in mind their costs and, more importantly, the costs in terms of fuel consumption required to operate them. There is, hence, a real need to look into the possibility of modifying existing gear and, where necessary, designing new types of gear to increase their selectivity, avoid by-catch, particularly of juveniles, conserve endangered species, tap under- and untapped species, and reduce the costs of fishing operations.

OBJECTIVES

- To modify existing fishing gear and, where necessary, design new types of fishing gear to reduce by-catch, avoid incidental catch of endangered species, harvest under- and untapped species, and enable cost-effective fishing operations

EXPECTED OUTPUTS AND RESULTS

- New and improved types of fishing gear to address ecological and economic concerns

MAJOR ACTIVITIES

Analysis of performance of existing gear

Modification and development of gear to address ecological and economic concerns

Laboratory testing of gear in flume tanks

Exploratory fishing to test gear in fishing operations

Refinement of designs

Recommendations for, and specification of, fishing gear

Dissemination and extension of findings

IMPLEMENTATION

National fisheries agencies and their research institutions could undertake the task. External inputs in the form of expertise and access to laboratory facilities may be required. Regional coordination and facilitation through regional fishery bodies would be beneficial.

6. Utilization of Trawler By-Catch

JUSTIFICATION

Large amounts of by-catch, including juveniles of commercially valuable species, are being discarded by trawlers in the region because of shortage of hold-space in the vessels and relatively low market value of the by-catch species. There is a need to consider ways by which such by-catch can be reduced through appropriate gear modifications. However, given that such modifications may be difficult to achieve and may, in the process, make the fishery unviable, there is need for an alternative approach which considers ways and means of ensuring that the by-catch is not discarded but brought ashore and utilized economically, through appropriate product development and post-harvest processing, to provide much-needed fish for human consumption and feed for livestock.

OBJECTIVES

- Development of methods of collecting, transporting, processing and utilizing trawler by-catch human consumption and livestock feed, and determination of their techno-economic feasibility

EXPECTED OUTPUTS AND RESULTS

- Recommendations on viable collection, transportation and processing methods of trawler by-catch

MAJOR ACTIVITIES

Studies of alternative collection/transportation/processing system options through pilot-scale studies

Techno-economic feasibility studies

Dissemination of recommendations

IMPLEMENTATION

National fisheries agencies and their research institutions working closely with fisherfolk and the private sector could undertake the tasks. Regional coordination and facilitation through regional fishery bodies would be beneficial.

MANAGEMENT OF OFFSHORE FISHERIES RESOURCES

1. Assessment of Offshore and High Seas Fisheries Resources

JUSTIFICATION

Fisheries resources beyond the immediate coastal areas, in the EEZs and in the high seas are the only ones in the region that are not heavily exploited. No recent and reliable assessment exists of these resources and the understanding of the potential that exists is inadequate. Not only are large areas of EEZs of some of the countries not fully exploited, but a large area of high seas exists in the region. There is every prospect that as a result of the UN Conference on Straddling and Highly Migratory Stocks, some form of international involvement in the management of high seas resources will become a reality in the near future and there is an urgent need for the countries in the region to have a better understanding of the resources and potential to facilitate and enable their participation in such management regimes. With increasing demands from the private sector for offshore and high seas fishing, governments need timely, and reliable, information to take rational decisions on the use of these fisheries resources. This requires national as well as coordinated efforts in the region. Some countries in the region have the capacity to conduct surveys of marine resources and have collected data on some areas of their national waters. However, the region does not have current data and information to assess the resource potential of the Bay nor adequate capability to analyze and interpret data to facilitate policy decisions. The very nature of the resources requires the countries of the region to evolve a regional mechanism to share in the generation of data and information, to share information, and to coordinate and facilitate monitoring, control, surveillance and management of shared resources. While the region as a whole has the capacity to undertake resource surveys and assessments of such nature, the effort required is beyond the means of any one country.

OBJECTIVES

Improved understanding of fisheries resources and potential in the offshore regions of EEZs and in the high seas to facilitate policy decisions and management measures. Specifically:

- To develop and establish common survey and assessment methodologies for fisheries resource assessments in offshore regions of EEZs and in the high seas
- To undertake national and joint regional assessments and surveys
- To strengthen the skills of national personnel in data analysis and interpretation
- To develop regional mechanisms to share relevant data and information

MAJOR ACTIVITIES

Consolidation and appraisal of existing data/information
Design and conduct of offshore and high seas resources surveys
Analysis and interpretation of results of surveys
Establishment of databases and mechanisms of data-sharing
Sharing of data and information

EXPECTED OUTPUTS AND RESULTS

- Better understanding of fisheries resources and potential in offshore regions of EEZs and in the high seas
- Timely information to facilitate policy decisions and to enable monitoring, control, surveillance and management measures

IMPLEMENTATION

Expertise and some capacity exist in the region to undertake the task and can be utilized through TCDC. Some external inputs, such as expertise and operational costs of surveys, would be necessary. Regional coordination and facilitation through regional fisheries bodies is vital and would be necessary.

MANAGEMENT OF COASTAL AQUACULTURE

1. Methodologies for Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) in Coastal Aquaculture

JUSTIFICATION

The rapid growth of marine shrimp culture throughout the region, with its large-scale clearing of mangroves, conversion of agricultural land to shrimp ponds, pumping of seawater into the freshwater zone leading to salinization of soils and groundwater, excessive extraction of groundwater, and discharge of polluting pond effluents has led to serious environmental degradation and social conflicts between the shrimp farmers and other land- and water-users. At present, there are either no legal requirements for EIA or SIA for shrimp farming in most countries, or, in cases where they exist, the EIA or SIA is not always effective as there are no clear guidelines for assessments or standards. There are also cases where EIA or SIA are not given due consideration by decision-makers. Appropriate methodologies for undertaking EIA and SIA are urgently needed to ensure that aquaculture development is environmentally and socially sustainable and to predict the types of adverse impacts that aquaculture can have. Thus enabling the development of mitigating measures. Appropriate and timely EIA and SIA would greatly assist decision-makers to decide whether the ecological and social consequences of aquaculture projects would be acceptable or not, thereby enabling speedy and better policy decisions to guide the development.

OBJECTIVES

To develop EIA and SIA methodologies to guide the sustainable development of coastal aquaculture

EXPECTED OUTPUTS AND RESULTS

- Methodologies for EIA and SIA of coastal aquaculture

- Manuals and guidelines
- Staff of concerned agencies trained in undertaking EIA and SIA

MAJOR ACTIVITIES

Studies to better understand coastal ecosystems, including soil systems and water regimes

Identification of critical parameters to indicate status of ecosystems in the context of existing environmental laws and regulations

Identification of pollutants and environment degrading actions

Development of EIA methodologies

Assessment of impacts in pilot cases to test and refine methods

Development of EIA guidelines and protocols

Studies to better understand coastal communities

Studies to better understand factors leading to conflict in coastal areas

Identification of critical social, economic, and cultural parameters to enable social assessments

Development of SIA methodologies and development of SIA guidelines and protocols

Assessment of impacts in pilot cases to test and refine methods

Development of manuals

Training of staff of concerned agencies

IMPLEMENTATION

National fishery agencies working closely with research institutions concerned with environmental and social sciences, universities and concerned planning and regulatory authorities could undertake these tasks. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise and learnings from similar efforts may be necessary to supplement national efforts.

2. Environmental Standards for Effluents of Coastal Aquaculture

JUSTIFICATION

With the rapid growth and increasing intensification in coastal aquaculture, effluents from shrimp farms, especially shrimp ponds and marine fish cages, have been recognized as a serious source of pollution in the coastal environment. Such discharges are known to increase the nutrient, organic and sediment loads of the receiving waters, leading occasionally to anoxic conditions in the bottom sediments and harmful algal blooms. In cases where the clustering density of farms is high, self-pollution has increasingly been recognized as a major factor leading to disease outbreak and culture failure, and subsequent abandonment of culture. Establishment of environmental standards for effluents of coastal aquaculture, based on both best available treatment technology and the carrying capacity of the environment, is needed to reduce the pollution load and social conflicts among the coastal communities. Eventually, it is in the best interest of the aquaculture industry to maintain the health of the coastal environment, thus ensuring the long-term sustainability of aquaculture development.

OBJECTIVES

Within the overall objective of sustainable coastal development and reduction of social conflicts, specifically:

- To recommend environmental standards for effluents of coastal aquaculture

EXPECTED OUTPUTS AND RESULTS

- Recommendations of standards for effluent discharge from coastal aquaculture
- Identification of best available treatment methods and technologies to deal with effluents and waste from coastal aquaculture
- Guidelines and standards for EIA of coastal aquaculture

MAJOR ACTIVITIES

Identification of effluents and discharges

Analysis of ecosystems and studies of impacts of effluents and discharges to estimate carrying capacity of ecosystems

Development of guidelines and criteria to set standards based on carrying capacity and best available treatment methods and technologies

Identification and analysis of best available treatment methods and technologies

Development of standards in the context of existing environmental rules and laws

Dissemination of results

IMPLEMENTATION

National fisheries research institutions and fisheries agencies working closely with environmental research and regulatory research institutions and planning authorities could undertake the task. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise and learnings from similar efforts may be necessary to supplement national efforts.

3. Establishment of Protocols and Guidelines for Siting and Clustering Density of Coastal Aquaculture

JUSTIFICATION

Over the last two decades, aquaculture has been identified as one of many human activities that has had serious impacts on the coastal environment. Besides the extensive destruction of valuable mangrove forests, there has also been conversion of agricultural land into brackishwater ponds. The pumping of seawater into freshwater zones for aquaculture, coupled with the extensive extraction of groundwater for dilution purpose, has led to both land and groundwater salinization. Effluents from intensive shrimp ponds, in the forms of discharge waters and sludge from pond bottom maintenance, have been identified as major sources of pollution, increasingly leading to self-pollution and culture-failure. In view of the rapid pace of brackishwater aquaculture development, often unplanned, siting protocols that will guide appropriate zoning of the coastal areas and recommendations to regulate the clustering density of farms in a particular zone, keeping in mind the carrying capacity of the ecosystems, are critical not only for sustainable management of the coastal resources, but also to accelerate pace of development and to reduce social conflicts among the coastal communities.

OBJECTIVES

- To develop methodologies and guidelines for identifying suitable sites for aquaculture development in the context of sustainable coastal zone development

EXPECTED OUTPUTS AND RESULTS

- To develop methodologies and guidelines for identifying suitable sites for aquaculture development in the context of sustainable coastal zone development
- To develop methodologies and guidelines for determining clustering density levels for aquaculture farms in particular sites identified for aquaculture

EXPECTED OUTPUTS AND RESULTS

- Guidelines and protocols for identifying zones suitable for sustainable aquaculture
- Guidelines and protocols of determining clustering density levels in particular sites

MAJOR ACTIVITIES

Ecological studies of coastal aquaculture in various ecozones to understand carrying capacities of ecosystems and suitability of ecosystems for aquaculture

Identification of factors and characteristics which suggest suitability of areas for aquaculture

Development of criteria of selection of areas for aquaculture in the context of competing use of the same areas by other sectors

Methodologies for determination of carrying capacity of ecosystems for aquaculture discharges and uses, to set loading limits which, in turn, would specify clustering densities

Development of guidelines and protocols for siting and setting clustering density

Dissemination of recommendations

Training of concerned staff in undertaking such appraisals

IMPLEMENTATION

National fisheries research institutions, environmental and social research institutions, universities and planning and regulatory authorities working in close cooperation could undertake these tasks. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise and learnings from similar efforts may be necessary to supplement national efforts.

4. Prevention and Control of Disease in Coastal Aquaculture

JUSTIFICATION

With the trend towards greater intensification in aquaculture development, there has been increased incidence and severity of disease outbreaks, leading to culture failure, and, eventually, collapse of the culture industry, as has already happened in several countries in Asia. Unfortunately, instead of adopting sustainable culture practices, many farmers have resorted to the indiscriminate and excessive use of chemicals and drugs, in an attempt to control disease problems. Besides leading to the development of resistance of pathogens, such practices also lead to additional problems in the form of antibiotic residues both in the culture organisms and the environment. It is now realized that culture practices that do not take into consideration the carrying capacity of the environment are simply not sustainable. There is need for research on what constitutes sustainable culture practice and to determine judicious use of chemicals and drugs in disease prevention and control. The development of vaccines for the prevention of specific diseases, as already successfully attempted for salmon culture in Europe, should also be given priority in future disease-prevention efforts.

OBJECTIVES

In the context of producing wholesome fish and reducing economic loss due to disease, specifically:

- To develop sustainable culture practices
- To develop methods to prevent and control diseases

EXPECTED OUTPUTS AND RESULTS

- Appropriate culture management measures and practices
- Methods for disease control and treatment
- Commercial vaccine for disease prevention
- Recommendations for judicious use of drugs and chemicals
- Concerned staff trained in extension of above

MAJOR ACTIVITIES

Development and refinement of culture practice in pilot efforts

Identification of common diseases and development of prevention and treatment methods and approaches through laboratory research and field trials

Promotion of vaccine development by private sector

IMPLEMENTATION

National fisheries agencies and research institutions working closely with farmers and the private sector could undertake the task. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise and learnings from similar efforts may be necessary to supplement national efforts

5. Seed Supply and Hatchery Development

JUSTIFICATION

One of the major constraints in aquaculture development has been inadequate supply of seed for culture purpose. This is especially true in the case of marine finfish culture. It is well accepted that one of the major factors leading to the rapid growth of the marine shrimp culture industry in the region has been the ready availability of hatchery-produced fry. It is likely that successful development of hatchery technology, together with improvement and development of appropriate culture systems, would lead to the needed diversification and an accelerated pace of aquaculture development in the region. Furthermore, the availability of hatchery-produced seed would negate the need for wild fry collection, which is in most cases a destructive practice, and, hence, would contribute to conservation of the coastal fisheries resources.

OBJECTIVES

- To ensure greater availability of seed, in terms of quantity, quality and variety
- To diversify the aquaculture base and accelerate the pace of aquaculture development
- To reduce the need for wild fry collection, and contribute to the conservation of fisheries resources

EXPECTED OUTPUTS AND RESULTS

- Greater supply of seed both in quality, quantity and variety

MAJOR ACTIVITIES

Development of hatchery technologies, including disease prevention and control, development of larval nutrition and feeds, and water quality management for a variety of species, particularly marine finfish, through basic and applied research and testing in pilot efforts

Development of conservation measures and regulations to ensure sustained supply of broodstock and spawners

IMPLEMENTATION

National fisheries agencies and research institutions working closely with the private sector could undertake the task. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise and learnings from similar efforts may be necessary to supplement national efforts.

6. Development of Feeds for Culture of Marine Finfish

JUSTIFICATION

The growth of marine finfish culture industry has, to some extent, been hampered by the lack of suitable formulated feeds. The present dependence on trashfish is unsatisfactory due to inconsistency both in terms of quality and quantity, besides causing serious pollution problems resulting in the form of putrefying leftovers accumulated in the bottom sediment. The pollution has led to serious disease outbreaks resulting in culture failure. Development of appropriate formulated feed would ensure greater consistency in quality, steady supply, and reduction of the pollution problem, including self-pollution, caused by the use of trashfish.

OBJECTIVES

- To ensure availability of commercially formulated feeds for marine finfish
- To reduce demand for trashfish

EXPECTED OUTPUTS AND RESULTS

- Formulated feeds for culture of marine finfish

MAJOR ACTIVITIES

Study of nutritional requirements of culture species of interest

Development of formulated feeds in laboratory and at pilot scale

Feeding trials, appraisal of performance, and technology transfer to private sector

IMPLEMENTATION

National fisheries agencies and research institutions working closely with the private sector could undertake the task. Regional coordination and facilitation through regional fisheries bodies would be beneficial. External inputs in terms of expertise may be necessary to supplement national efforts.

PUBLICATIONS OF THE BAY OF BENGAL PROGRAMME (BOBP)

The BOBP brings out the following types of publications:

Reports (BOBP/REP/...) which describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/...) which are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (*Bay of Bengal News*) which are issued quarterly and which contain illustrated articles and features in nontechnical style on BOBP work and related subjects.

Other publications which include books and other miscellaneous reports.

Those marked with an asterisk (*) are out of stock but photocopies can be supplied.

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35. *Brackishwater Shrimp Culture Demonstration in Bangladesh.* M. Karim. (Madras, 1986.)
36. *Hilsa Investigations in Bangladesh.* (Colombo, 1987.)
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39. *Investigations on the Mackerel and Scad Resources of the Malacca Straits.* (Colombo, 1987.)
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47. *Exploratory Fishing for Large Pelagic Species in Sri Lanka.* R. Maldeniya and S. L. Suraweera. (Madras, 1991.)
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52. *Feeds for Artisanal Shrimp Culture in India — Their Development and Evaluation.* J.F. Wood *et al.* (Madras, 1992.)
53. *A Radio Programme for Fisherfolk in Sri Lanka.* R.N. Roy. (Madras, 1992.)
54. *Developing and Introducing a Beachlanding Craft on the East Coast of India.* V.L.C. Pietersz. (Madras, 1993.)
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61. *Small Offshore Fishing Boats in Sri Lanka.* G. Pajot. (Madras, 1993.)

62. *Fisheries Extension in the Maldives*. A.M.H. Heelas (Madras, 1994).
63. *Small-scale Oyster Culture on the West Coast of Peninsular Malaysia*. D. Nair, R. Hall and CL. Angell. (Madras, 1993.)
64. *Chandi Boat Motorization Projects and Their Impacts, Bhola, Bangladesh*. R. Hall and A. Kashem (Madras, 1994).
65. *Learning by Doing in Bangladesh: Extension Systems Development for Coastal and Estuarine Fisherfolk Communities*. R.N. Roy. (Madras, 1994.)
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86. *Nursery Rearing of Tiger Shrimp Post-larvae in West Bengal, India.* H. Nielsen and R. Hall. (Madras, 1993.)
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90. *Socioeconomic Conditions of Estuarine Set Bagnet Fisherfolk in Bangladesh.* K.T. Thomson, S.M.D. Jahan and M.S. Hussain. (Madras, 1993.)
91. *Further Exploratory Fishing for Large Pelagic Species in South Indian Waters.* G. Pajot. (Madras, 1993.)
92. *Cage Nursery Rearing of Shrimp and Prawn Fry in Bangladesh.* **C. Angell.** (Madras, 1994.)
93. *Dealing with Fishery Harbour Pollution - The Phuket Experience.* R. Ravikumar. (Madras, 1994.)
94. *Biosocioeconomic Assessment of the Effect of the Estuarine Set Bagnet on the Marine Fisheries of Bangladesh.* Md. G. Khan, **Md. S. Islam, Md. G. Mustafa, Md. N. Sada and Z. A. Chowdhury.** (Madras, 1994.)
95. *Biosocioeconomic Assessment of the Effect of Fish Aggregating Devices in the Tuna Fishery in the Maldives.* **A. Naem and A. Latheefa.** (Madras, 1994.)
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5. *Bay of Bengal Fisheries Information System (BOBFINS). User's Manual.* (Colombo, 1987.)
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7. *Guidelines for Extension Workers in Group Management, Savings Promotion and Selection of Enterprise.* H. Setyawati and P. Limawan. (In Indonesian). (Madras, 1992).
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9. *Guidelines on Fisheries Extension in the Bay of Bengal Region.* I. Jungeling. (Madras, 1993.)
10. *Our Fish, Our Wealth.* A guide to fisherfolk on resources management— in 'comic book' style (English/Tamil/Telugu). K. Chandrakant with K. Sivasubramaniam and R.N. Roy. (Madras, 1991.)
11. *Our Shrimp, Their Lives.* A guide to fisherfolk on resources management— in 'comic book' style (English/Tamil). K. Chandrakant with K. Sivasubramaniam and R.N. Roy. (Madras, 1993.)
12. *How to Build a Timber Outrigger Canoe.* Ø. Gulbrandsen. (English/Indonesian Bahasa). (Madras 1993.)
13. *Manual for Operating a Small-scale Recirculation Freshwater Prawn Hatchery.* R. Chowdhury, H. Bhattacharjee and CL. Angell. (Madras, 1993.)
14. *Building a Liftable Propulsion System for Small Fishing Craft — The BOB Drive.* Ø. Gulbrandsen, M.R. Andersen. (Madras, 1993.)
15. *Guideline for Fisheries Extension in the Coastal Provinces of Thailand.* Fishery Extension Division, Department of Fisheries, Ministry of Agriculture and Cooperatives, Bangkok, and Bay of Bengal Programme. (In Thai). (Madras, 1993.)
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18. *A Guide to Oyster Culture in Malaysia.* H. Nawawi. (In English/Malay). (Madras, 1993.)
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2. *The Shark Fisheries of the Maldives:* R C Andersen and H Ahmed. (Madras, 1993.)

Note: Apart from these publications, the BOBP has brought out several folders, leaflets, posters etc., as part of its extension activities. These include Post-Harvest Fisheries folders in English and in some South Indian languages on anchovy drying, insulated fish boxes, fish containers, ice boxes, the use of ice etc. Several unpublished reports connected with BOBP's activities over the years are also available in its Library.

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