Bay of Bengal Large Marine Ecosystem Project

Assessments of the Indian mackerel (*Rastrelliger kanagurta*) and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

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Small pelagic gillnet vessels in Negombo, Sri Lanka

Trawler in Phuket, Thailand

March 2011

Prepared by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms used

APFIC	Asia-Pacific Fisheries Commission
ARHMC	Aquatic Resources Health Management Centre
BDO	Block Development Officer (India)
BFRI	Bangladesh Fisheries Research Institute
BMSY	Biomass that can support harvest of the Maximum Sustainable Yield
BoB	Bay of Bengal
BOBLME	Bay of Bengal Large Marine Ecosystem
CBFM	Community-Based Fisheries Management
CCRF	Code of Conduct for Responsible Fisheries
CHARM	Coastal Habitats and Aquatic Resources Management (project)
CIFRI	Central Inland Fisheries Research Institute (India)
CITES	Convention on International Trade in Endangered Species
Cm	Centimeters
COFI	Committee on Fisheries
CPUE	Catch per Unit of Effort
DGN	Drift gillnets (India)
DNA	Deoxyribonucleic acid
DoF	Department of Fisheries (Bangladesh)
E	Exploitation rate
EAF	Ecosystem Approach to Fisheries
EC	European Commission
EEZ	Exclusive Economic Zone
ETP	Endangered, Threatened and Protected
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FMP	Fisheries Management Plan
ft	Feet
GEF	Global Environment Facility
GPS	Geographical Positioning System
GT	Gross Tons
HFMAP	Hilsa Fishery Management Action Plan
hp	Horse Power
ICM	Integrated Coastal Management
ID	Indonesia
IN	India
INR	Rupees (India(
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action
IUCN	International Union for the Conservation of Nature
IUU	Illegal Unreported and Unregulated (fishing)

kg	Kilogrammes
km	Kilometer
L-F	Length-Frequency
LK	Sri Lanka
LL	Longlines (India)
LME	Large Marine Ecosystem
M	Meters
M&E	Monitoring and Evaluation
MCS	Monitoring, Control and Surveillance
mm	Millimeter
MM	Myanmar
MPA	Marine Protected Area
MSBN	Marine Set Bag Nets (India)
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
MTRB	Motorized Traditional Boats (Sri Lanka)
MY	Malaysia
NPOA	National Plan of Action
NTRB	Non-motorized Traditional Boats (Sri Lanka).
OFRP	Out-board engine Fiberglass Reinforced plastic Boats (Sri Lanka)
P	Principle (MSC)
PI	Performance Indicator
PSA	Productivity Susceptibility Analysis
RBF	Risk-Based Framework
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
RPOA	Regional Plan of Action
Rs	Rupees (Sri Lanka)
SAP	Strategic Action Plan
SICA	Scale Intensity and Consequence Analysis
t	Tonnes
TAC	Total Allowable Catch
TED	Turtle Exclusion Device
TH	Thailand
Tk	Taka (Bangladesh)
TURF	Territorial use rights in fisheries
UK	United Kingdom
UNEP	United Nations Environment Program

Abstract

This report presents an assessment of Indian mackerel (*Rastrelliger kanagurta*) and Hilsa shad (*Tenualosa ilisha*) fisheries in the Bay of Bengal Large Marine Ecosystem (BOBLME). The report assesses: Indian mackerel fisheries in Sri Lanka, Tamil Nadu in India, Myanmar, Thailand, Malaysia and Indonesia; and hilsa shad fisheries in West Bengal in India, Bangladesh, and Myanmar. The assessments were made on behalf of the BOBLME project, following visits to all eight countries, with the fishery in each country 'scored' and benchmarked against three main issues, or 'Principles' related to: the status of the stocks; the impacts of the fisheries on the ecosystem; and the management frameworks in place. Under each of these three Principles, a number of specific indicators are used to determine whether performance can be viewed as weak (scored as 0 and red), intermediate (scored as 1 and amber), or good (scored as 2 and green). The use of a wide range of indicators, and a simple color-coded scoring system, allows for easy identification of both the strengths and the weaknesses in the status, impacts and management of these fisheries. It also allows for an objective basis on which to compare performance between countries. This report includes Appendices which present all individual country assessments, while the main text provides a regional summary of performance for the two main species under examination. In both cases, examples of best practice are highlighted, along with key weaknesses and recommendations for improved performance.

Disclaimer

Acknowledgements

The contents of this report are based on a literature review, and on visits made by the consultants to all eight countries within the Bay of Bengal region. The consultants would like to formally acknowledge the important contribution, both technically and logistically, made by the BOBLME coordination unit and by the BOBLME project national coordinators. We would also like to thank all those who so readily gave up their time to meet with the consulting team during the country visits, and who provided information which was critically important in completing the assessments presented in this report.

EXECUTIVE SUMMARY

Background, objectives and methodology of the study

Fish are a critical component of the Bay of Bengal Large Marine Ecosystem (BOBLME) with fisheries landing around four million tonnes a year; they form both an important source of nutrition and income for the inhabitants of its bordering countries. Two species - Indian mackerel and hilsa shad - account for around 577,826 and 200,000 tonnes respectively[1] and are of particular interest as their single stocks are shared throughout the Bay of Bengal.

Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia are working together through the five year, US$31 million BOBLME Project. One of the sub-components (2.3) is to '*Devise regional fishery assessments and management plans for hilsa shad, Indian mackerel and sharks'*. This study is a first step in this process (sharks are being covered separately) and acts to benchmark the Indian mackerel and hilsa fisheries, providing a starting point for the development of regional *Fisheries Management Plans* (FMPs).

This study has used a benchmarking standard developed by the Marine Stewardship Council (MSC). This methodology analyses the fisheries against three 'Principles'; *stock status* (Principle 1), *ecosystem impacts* (Principle 2) and *fisheries management (*Principle 3). Within these there are a number of performance indicators with associated scoring guide posts against which the performance of the fishery can be judged. It should be emphasized that this is not a formal MSC assessment, but the MSC framework is used as a comprehensive assessment method on which to base our analyses and subsequent recommendations.

Indian mackerel (Rastrelliger kanagurta)

The Indian mackerel is a productive small pelagic species found throughout the Bay of Bengal region. The results of the assessment are summarized below and in Figure 1.

Stock status: despite its relative robustness there is evidence for considerable concern over the status of this species as it is over-fished throughout much of the region. A Productivity-Susceptibility Analysis (PSA) suggests that it is particularly vulnerable to purse seines and bottom otter trawlers, and is extensively caught by coastal gillnet fisheries in Sri Lanka, India and Indonesia. There are no reference points used in management of this species and as a result, harvest rules and controls are weak.

Ecosystem impacts: the main issue with these fisheries is the poor stock status of other retained species landed together with Indian mackerel, especially in trawl and purse seine fisheries. However very little is discarded and with the exception of bottom trawlers, they have limited impact on habitats. Other issues raised included interactions with sea turtles in bottom trawls and larger-mesh gillnets, and sharks in large purse seines. There is also some concern over the trophic effects of such a large fishery.

Management: legal and institutional structures are mainly in place. Weaknesses were observed in the continued use of subsidies that serve to increase fishing effort as well as weak fisheries-specific objectives, decision-making process, research plans, MCS strategies and performance evaluation. Weaknesses were both specific to Indian mackerel management as well as being generally applicable to management of small pelagic species.

[1] FAO online landings statistics for 2007 (all Indian Ocean landings for Maldives, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia). See http://www.fao.org/fishery/topic/16140/en

Figure 1: Summary Scores for Indian mackerel

Principle 1

Country	UoA	Principle 1: Stock status – Outcome – 1.1.1 Stock status	1.1.2 Reference points	1.1.3 Stock rebuilding if necessary	Harvest strategy – 1.2.1 Performance of Harvest Strategy	1.2.2 Harvest control rules and tools	1.2.3 Information and monitoring	1.2.4 Assessment
ID	Indian mackerel	0	0	*	0	0	1	0
TH	Indian mackerel	0	0	*	0	0	1	1
MY	Indian mackerel	0	0	*	0	0	1	1
MM	Indian mackerel	0	0	*	0	0	1	0
IN	Indian mackerel	1	0	*	0	0	1	1
LK	Indian mackerel	2	0	*	0	0	0	0

Principle 2

Country	UoA	Principle 2: Ecosystem impacts – Retained – 2.1.1 Retained status	2.1.2 Retained management	2.1.3 Retained info / monitoring	Discards – 2.2.1 Discards status	2.2.2 Discards management	2.2.3 Discards- info / monitoring	ETP – 2.3.1 ETP status	2.3.2 ETP management	2.3.3 ETP info / monitoring	Habitat – 2.4.1 Habitat status	2.4.2 Habitat management	2.4.3 Habitat info / monitoring	Ecosystem – 2.5.1 Ecosystem status	2.5.2 Ecosystem management	2.5.3 Ecosystem info / monitoring
ID	Purse seine	1	0	1	2	2	1	1	0	1	2	2	1	1	1	1
ID	Btm Otter trawl	0	0	1	2	2	1	1	0	1	0	1	1	0	0	1
ID	Gill nets	0	0	0	2	2	1	0	0	1	2	1	1	1	1	1
TH	Purse seine	1	1	2	2	2	1	1	1	1	2	2	1	1	1	1
TH	Btm Otter trawl	0	0	2	2	2	1	0	1	1	0	1	1	0	0	1
MY	Purse seine	1	0	2	2	2	1	0	1	1	2	2	2	1	1	1
MY	Btm Otter trawl	0	0	2	2	2	1	0	1	2	0	1	2	0	0	1
MY	Gill nets	0	0	2	2	2	1	0	1	1	2	1	1	1	1	1
MM	Purse seine	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0
MM	Btm Otter trawl	0	1	1	2	2	1	0	1	1	0	1	1	0	0	0
IN	High opening bottom trawl	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0
IN	Gill nets 50-65mm	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Small mesh gillnet	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Beach seine	1	0	1	2	2	1	2	2	1	2	2	1	1	1	1

Principle 3

Country	UoA	Principle 3: Governance & Management – Governance & Policy – 3.1.1 Legal customary framework	3.1.2 Consultation, roles & responsibilities	3.1.3 Long-term objectives	3.1.4 Incentives for sustainable fishing	Fishery specific management – 3.2.1 Fishery-specific objectives	3.2.2 Decision-making processes	3.2.3 Compliance & enforcement	3.2.4 Research plan	3.2.5 Management performance evaluation
ID	PS, BOT, GN	1	2	1	0	0	0	1	1	1
TH	PS, BOT	1	2	1	0	0	1	1	1	1
MY	PS, BOT, GN	2	2	1	1	0	0	1	0	1
MM	PS, BOT	1	1	1	0	0	0	1	0	0
IN	BOT, GN	1	2	0	0	0	0	1	1	1
LK	GN, BS	1	2	1	1	0	0	0	1	0

Ranking

Ranking	
Good	green
Intermediate	yellow
Weak	red
Not applicable	light blue

Hilda shad (<u>Tenualosa ilisha</u>)

The hilsa shad is a highly productive migratory species found mainly along the coasts of India, Bangladesh and Myanmar. It migrates into freshwater to spawn and is heavily fished over the marine, brackish and freshwater phases of its life. The results of the assessment are summarized in the table overleaf and described below.

<u>Stock status</u>: the hilsa shad is likely to be over-exploited throughout the Bay of Bengal, especially during their juvenile phase. There also signs from PSA analyses that overall productivity of this species is dropping, possibly due to the declining volume and quality of water in its main watersheds. As yet no biomass-based reference points have been utilized for management of hilsa stocks in the Bay of Bengal and stock reference points need to be agreed in order to base regional harvest control rules and controls. However Bangladesh's Hilsa Fisheries Management Action Plan demonstrates that science and stakeholder-based management regimes can be effective.

<u>Ecosystem impacts</u>: the widespread use of small-mesh gillnets in all three countries, especially by subsistence fishers in riverine areas, has led to large number of juvenile fish being caught in these fisheries. The larger mesh gears used in the estuarine and marine areas are less of a concern. There are no discards in any of these fisheries. There are also some concerns over the impact of the small-mesh fisheries on aquatic biodiversity in rivers and floodplains, and the larger-mesh fisheries are also implicated in some catch of sea turtles and cetaceans. There are few habitat issues associated with these fisheries. As with Indian mackerel, there is some concern over the trophic impact of taking such large volumes of fish, especially given this species' anadramous life style.

<u>Management</u>: the comments made on Indian mackerel are broadly relevant to hilsa. Of special concern is the continued use of subsidies which serve to increase fishing capacity/effort. However unlike Indian mackerel, in some of the hilsa fisheries assessed there are also some positive incentives provided for greater sustainability in the form of social and financial support to reduce the need for fishers to fish for hilsa at particularly important times of the year or in particularly sensitive locations. Performance against the fisheries-specific management system displays a rather different picture to the Indian mackerel assessments, primarily because hilsa is such an important fish in economic terms, especially in Bangladesh. Thus there is generally a much greater level of specification of hilsa-specific objectives, decision-making process, research plans, MCS strategies, and performance evaluation. Performance in Bangladesh is particularly encouraging for most P3 indicators, and many lessons can be learned from this country for wider applicability within the region.

Recommendations

For the two fisheries, recommendations have been made for the preparation of 'Regional Fisheries Management Plans', which includes a sub-set of eight actions in both cases. In addition to these FMPs are a series of supporting activities to improve gear selectivity, to manage ETP interactions, improve habitat protection and to increase the knowledge of the impact of these fisheries on the wider Bay of Bengal ecosystem. In effect we are proposing that the FMPs are accompanied by activities that provide an ecosystem-based approach. The non-fisheries specific recommendations are divided into four main elements: (i) policy development, (ii) information support, (iii) fisheries control and (iv) human capacity development.

Figure 2: Summary scores for hilsa shad

Principle 1: Stock status

Country	UoA	Outcome 1.1.1 Stock status	Outcome 1.1.2 Reference points	Outcome 1.1.3 Stock rebuilding if necessary	Harvest strategy 1.2.1 Performance of Harvest Strategy	Harvest strategy 1.2.2 Harvest control rules and tools	Harvest strategy 1.2.3 Information and monitoring	Harvest strategy 1.2.4 Assessment
MM	Hilsa	1 (Intermediate)	0 (Weak)	* (Not applicable)	0 (Weak)	0 (Weak)	0 (Weak)	0 (Weak)
BD	Hilsa	0 (Weak)	0 (Weak)	* (Not applicable)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)
IN	Hilsa	0 (Weak)	0 (Weak)	* (Not applicable)	0 (Weak)	0 (Weak)	0 (Weak)	0 (Weak)

Principle 2: Ecosystem impacts

Country	UoA	Retained 2.1.1 Retained status	Retained 2.1.2 Retained management	Retained 2.1.3 Retained info / monitoring	Bycatch 2.2.1 Discards status	Bycatch 2.2.2 Discards management	Bycatch 2.2.3 Discards-info / monitoring	ETP 2.3.1 ETP status	ETP 2.3.2 ETP management	ETP 2.3.3 ETP info / monitoring	Habitat 2.4.1 Habitat status	Habitat 2.4.2 Habitat management	Habitat 2.4.3 Habitat info / monitoring	Ecosystem 2.5.1 Ecosystem status	Ecosystem 2.5.2 Ecosystem management	Ecosystem 2.5.3 Ecosystem info / monitoring
MM	Gill nets & river mouth	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	0 (Weak)
MM	Stow net in river	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	0 (Weak)
MM	Purse seine @ sea	1 (Intermediate)	1 (Intermediate)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	0 (Weak)
BD	Gill nets 40-60mm	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)
BD	Gill net 60-120mm	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)
IN	Gill nets min 12mm	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	0 (Weak)	1 (Intermediate)	0 (Weak)	2 (Good)	1 (Intermediate)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)
IN	Gill nets min 85mm	0 (Weak)	0 (Weak)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	0 (Weak)	2 (Good)	1 (Intermediate)	1 (Intermediate)	2 (Good)	2 (Good)	1 (Intermediate)
MM	Purse seine	1 (Intermediate)	1 (Intermediate)	0 (Weak)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	0 (Weak)

Principle 3: Governance & Management

Country	other UoA if necessary	Governance & Policy 3.1.1 Legal customary framework	Governance & Policy 3.1.2 Consultation, roles & responsibilities	Governance & Policy 3.1.3 Long-term objectives	Governance & Policy 3.1.4 Incentives for sustainable fishing	Fishery specific management 3.2.1 Fishery-specific objectives	Fishery specific management 3.2.2 Decision-making processes	Fishery specific management 3.2.3 Compliance & enforcement	Fishery specific management 3.2.4 Research plan	Fishery specific management 3.2.5 Management performance evaluation
MM	GN, SN, PS	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	0 (Weak)	0 (Weak)	0 (Weak)	1 (Intermediate)	0 (Weak)	0 (Weak)
BD	GN, GN	2 (Good)	2 (Good)	2 (Good)	2 (Good)	2 (Good)	2 (Good)	1 (Intermediate)	1 (Intermediate)	2 (Good)
IN	GN, GN	1 (Intermediate)	2 (Good)	2 (Good)	0 (Weak)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)	1 (Intermediate)

Ranking

- Good (green)
- Intermediate (yellow)
- Weak (red)
- Not applicable (blue)

1 INTRODUCTION AND METHODOLOGY

1.1 BACKGROUND TO THE BOBLME PROJECT

1.1.1 Environment and fisheries in the Bay of Bengal

The Bay of Bengal (BOB) is an area of the Indian Ocean, between India on the west and the Malay Peninsula on the east, measuring about 2,090 km long by about 1,600 km wide. The BOB region is defined as comprising the coastal watersheds, islands, reefs, continental shelves and coastal and marine waters of the Maldives, Sri Lanka, the east coast of India, Bangladesh, Myanmar, the west coast of Thailand, the west coast of Peninsular Malaysia, and the Indonesian provinces of Aceh, Riau, and North and West Sumatra. This body of water, measuring approximately 3.3 million km^2 in area, together with the coastal drainage systems, has been identified as one of the world's sixty-four Large Marine Ecosystems (LMEs) sharing a distinct bathymetry, hydrography, productivity, and trophically dependent population. (FAO/GEF, 2005)

The surface circulation of the BOB is characterized by a large cyclonic gyre, which reverses during the monsoon period (clockwise from January to July, anticlockwise from August to December). The influx of fresh water from the major rivers impacts the salinity and productivity of the coastal and estuarine waters as well as coastal circulation patterns, especially in the north of the Bay. Conversely, during the season of current reversal, saline water invades the estuaries and lower reaches of coastal rivers. Monsoon rain and flood waters have a strong influence on the dynamics of the Bay, producing a warm, low-salinity, nutrient and oxygen-rich layer to a depth of 100 meters. The BOBLME is considered a moderately productive (150-300 gC/m2-yr) ecosystem. Benthic phytoplankton and zooplankton production is higher in the coastal areas, which receive nutrient-rich waters (Preston, 2004).

About 400 million people live in the Bay's catchment area, many subsisting at or below the poverty level. The BOB supports numerous coastal fisheries, many of which are of significant socio-economic importance to the bordering countries. There are an estimated two million fishers directly employed in the sector. Included amongst these fisheries are coastal demersal, shrimp and small pelagic fisheries, as well as offshore fisheries for tuna and similar species. Catch data for the BOBLME are rather unreliable and fragmented between different data collection areas making accurate estimates problematic, but catches are thought to be around 4 million tonnes a year.

Many fish resources in the region are already heavily exploited with adverse impacts on the large number of small-scale fishers, their families and communities dependent on these resources for their livelihoods and as a source of food security. The socio-economic implications of non-sustainable exploitation of fish stocks is further exacerbated by: the illegal incursion of foreign fleets; increased competition and conflicts between artisanal and large-scale fisherman; encroachment by nationals into the territorial waters of neighboring countries; and an increase in non-sustainable fishing practices (FAO/GEF, 2005).

1.1.2 The Bay of Bengal Large Marine Ecosystem (BOBLME) Project

Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia, have declared their willingness to work together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project, and to lay the foundations for a coordinated programme of action designed to *improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries*. The BOBLME project is a five year project with a total estimated budget of US$ 31 million. It covers five areas, as follows (the sub-component relating to this project is in **bold**):

1. Development of a Strategic Action Plan (SAP) to protect the health of the ecosystem and manage the living resources of the Bay on a sustainable basis to improve the food and livelihood security of the region's coastal population
    - Finalizing an analysis of trans-boundary issues
    - Establishing regional management arrangements with sustainable financing
    - The adoption of a SAP by member countries to address the issues identified above
2. Improving Coastal/Marine Natural Resources Management and Sustainable Use
    - Promoting community-based management
    - Improving policy harmonization
    - **Devising regional fishery assessments and management plans for hilsa shad, Indian mackerel and sharks**
    - Demonstrating collaborative critical habitat management in selected areas
3. Better understanding of the BOBLME Environment
    - Improving understanding of the large-scale processes and dynamics affecting the BOB
    - Promoting use of Marine Protected Areas to conserve regional fish stocks
    - Improving regional cooperation with regional and global assessment and monitoring programmes
4. Maintenance of Ecosystem Health and Management of Pollution
    - Establishing an effective ecosystem indicator framework
    - Developing a regional approach to identifying and managing important coastal pollution issues
5. Project Management
    - Developing a Monitoring and Evaluation system for the Project
    - Developing a Project information and dissemination system.

1.2 INTRODUCTION TO THIS REPORT

1.2.1 Objectives

In line with the 2010 Annual Regional Work Plan adopted by the Project Steering Committee in March 2010, and the Terms of Reference provided to Poseidon, the objective of this report is to present 'assessments' of Indian mackerel (*Rastrelliger kanagurta*) and Hilsa shad (*Tenualosa ilisha*) fisheries in each country in the BOBLME region[2]. These assessments represent a 'benchmarking' of the fisheries, and are considered an important *starting point* from which regional management plans can then be developed. The objective of this report is not however to present regional management plans.

Hilsa shad and Indian mackerel were selected during the BOBLME project preparation as species to be considered by the BOBLME project based on consultation with, and agreement by, all countries in the region. The motivation for their selection was the perceived benefit and added-value of focusing on species not covered by other regional fisheries management organizations (i.e. tuna and tuna-like species which are under the remit of the Indian Ocean Tuna Commission [IOTC]), but which nevertheless represent shared stocks within the Bay of Bengal. The management of sharks is being addressed under a separate project.

1.2.2 Methodology

The assessments presented in this report were made based on a literature review, and visits to all eight countries in the BOB region. These visits were necessarily short in duration[3] given the budget provided, and the assessments presented in this report therefore represent a 'rapid appraisal' of the fisheries.

Due to the relative abundance of the two species and their differing commercial importance in the countries in the region, assessments were made as follows:[4]

- **Hilsa shad**: West Bengal (India), Bangladesh, and Myanmar
- **Indian mackerel**: Sri Lanka, Tamil Nadu (India), Myanmar, Thailand, Malaysia and Indonesia.

The assessment of each fishery in each country is based on an assessment of performance against three main issues, or 'Principles':

- The fishery should be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery should be conducted in a manner that demonstrably leads to their recovery. This principle is thus related most strongly to the status of the stocks;

[2] An assessment of shark fisheries under sub-component 2.3 is to be completed under a separate consultancy contract and does not form part of this output.

[3] Typically 6-8 man days per country.

[4] A visit was also made to Maldives to consider potential areas of support by the BOBLME project under sub-component 2.3 as there is no commercial fishery for either Indian mackerel of hilsa shad in the Maldives. While an Indian mackerel fishery is present in Bangladesh, an assessment was not completed but some information is provided on the fishery in this report.

- Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends. This principle is thus related most strongly to the impacts of the fisheries on the ecosystem; and
- The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable. This principle is thus related most strongly to the governance and management frameworks in place.

Under each of these three Principles, the fisheries are 'scored' based on a number of specific indicators used to assess performance. These three main Principles are the three principles of the Marine Stewardship Council (MSC) eco-labeling certification scheme (see **Appendix B**), and the indicators are those specified by the MSC and used when assessing fisheries against the MSC standard. <u>It is important to note however that the assessments presented in this report are **NOT** MSC (pre-)assessments</u>. The MSC framework is used only because it serves as a useful tool for assessing key strengths and weaknesses in the fisheries under review.[5]

The MSC indicators under each main Principle are retained in our analysis, but rather than complete a full scoring for each indicator in accordance with the complex Fisheries Assessment Methodology used in MSC assessments, we have adapted and simplified the scoring process, and have determined for each indicator whether performance can be viewed as weak (scored as 0 and red), intermediate (scored as 1 and amber), or good (scored as 2 and green)[6]. The use of a wide range of indicators, and a simple color-coded scoring system, allows for easy identification of both the strengths and the weaknesses in the status, impacts and management of these fisheries. The consultants have also completed a 'harmonization' process across the different assessments to ensure that where performance for an indicator is considered equivalent in more than one fishery, the indicators are attributed with the same color/score. This allows for an objective basis on which to compare performance between countries.

The assessment process is further informed by the completion of performance reviews for what we call 'units of assessment'. Thus, and for example, within a particular country where Indian mackerel may be targeted, there may be a number of distinct fishing methods/gears and practices used to catch the fish. A separate assessment has been completed for each 'unit of assessment' because of the potential differences in the management regulations, harvest strategies, and the ecosystems impacts, of particular fisheries. For example, the regulation and impacts of an artisanal gillnet fishery for Indian mackerel in a particular country may be very different to the regulation and impacts of an offshore trawl fishery for Indian mackerel. In the country reports provided in the Appendices, we therefore first define the unit of assessment, and then undertake a performance review and scoring of each unit of assessment individually. Sections 2 and 3 of this report also provide a complete

[5] The MSC is a non-profit organisation (www.msc.org). The MSC framework and standards for assessing fisheries have been developed over many years through extensive global consultation with stakeholders, and are compliant with the FAO guidelines on eco-labeling.

[6] <u>Very broadly</u>, a green/2 score can be considered equivalent to >80 (pass) in the MSC scoring system, amber/1 equivalent to 60-80 (conditional pass), and a red/0 equivalent to <60 (a fail).

list of all the units of assessment which have been scored for both hilsa and Indian mackerel respectively.

The Principles and related performance indicators (PIs) used in the assessments are presented in the three tables below (Table 1, Table 2, and Table 3). For each indicator, text is provided in the right-hand column of each table to show the key issues examined when assessing/scoring performance.

Table 1: Indicators associated with Principle 1 (stock status) used to assess Indian mackerel and hilsa fisheries

Indicator Number	Indicator title	Issues considered within indicator
Principle 1: Stock Status		
1.1.1	Stock Status	Is the stock is at a level that maintains high productivity and has a low probability of recruitment overfishing? How likely is it that this is the case?
1.1.2	Reference points	Are limit and target reference points appropriate for the stock? Are any limit reference points set above the level at which there is an appreciable risk of impairing reproductive capacity, and are they precautionary? Any target reference points (such that the stock is maintained at a level consistent with BMSY or some measure or surrogate with similar intent or outcome)?
1.1.3	Stock rebuilding	Where the stock is depleted, is there evidence of stock rebuilding? How likely are strategies to succeed, and how long will rebuilding take?
1.2.1	Harvest control strategy	Is there is a robust and precautionary harvest strategy in place? How likely is the harvest strategy to work? Is the harvest strategy working together with objectives reflected in the target and limit reference points? Is there monitoring in place to determine the effectiveness of the strategy, and is it working? Is the strategy periodically reviewed and updated?
1.2.2	Harvest control tools and rules	Are there well defined and effective harvest control rules in place? To what extent are they consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached? Is there evidence to indicate that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules?
1.2.3	Information and monitoring	What level of relevant information related to stock structure, stock productivity and fleet composition is available to support the harvest strategy? To what extent are stock abundance and fishery removals monitored?
1.2.4	Assessment of stock status	Is there an adequate assessment of the stock status? Is the assessment appropriate for the stock and for the harvest control rule, and is it evaluating stock status relative to reference points? To what extent is the assessment considered robust? Does it take into account uncertainty? Is it peer reviewed?

Table 2: Principle 2 (ecosystems impacts) indicators used to assess Indian mackerel & hilsa fisheries

Indicator Number	Indicator title	Issues considered within indicator
Principle 2: Ecosystem Impacts		
2.1.1	Retained species status/outcome	Does the fishery pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species? How likely is it that the main retained species are within biologically based limits, or if outside the limits are there are measures / strategies in place to ensure that the fishery does not hinder recovery and rebuilding of the depleted species (and how likely are such measures/strategies to be successful)?
2.1.2	Retained species management	To what extent is there is a partial or comprehensive strategy or set of measures in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species? And to what extent is there evidence available to show that it is successful and achieving its objective?
2.1.3	Retained species information and monitoring	To what extent is information on the nature and extent of retained species adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species? Is such information qualitative, or quantitative, and how certain can we be of it? Is the information sufficient to enable to specification of strategy, and how complete a strategy? Does information cover all or only some retained species?
2.2.1	Discarded species status/outcome	As for retained species in 2.1.1, but for discarded species
2.2.1	Discarded species management	As for retained species in 2.1.2, but for discarded species
2.2.3	Discarded species information and monitoring	As for retained species in 2.1.3, but for discarded species
2.3.1	Endangered, Threatened and Protected (ETP) species status/outcome	As for retained species in 2.1.1, but for ETP species e.g. the fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species. In addition, does the fishery meets national and international requirements for protection of ETP species.
2.3.2	ETP species management	As for retained species in 2.1.2, but for ETP species
2.3.3	ETP species information and monitoring	As for retained species in 2.1.3, but for ETP species
2.4.1	Critical habitat status/outcome	As for retained species in 2.1.1, but for habitats such as corals, seagrass benthic environments, etc. e.g. The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.
2.4.2	Critical habitat management	As for retained species in 2.1.2, but for habitats

Indicator Number	Indicator title	Issues considered within indicator
2.4.3	Critical habitat information and monitoring	As for retained species in 2.1.3, but for habitats
2.5.1	Ecosystem status/outcome	How likely is it that the fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function, and is there evidence to support a particular view?
2.5.2	Ecosystem management	As for retained species in 2.1.2, but for ecosystem status
2.5.3	Ecosystem information and monitoring	Is there is adequate knowledge of the impacts of the fishery on the ecosystem? To what extent is there information to broadly understand the key elements of the ecosystem? Are the main impacts of the fishery on these key ecosystem elements just inferred or fully investigated? To what extent are the impacts of the fishery on target, discard, retained and ETP species and habitats are identified and the main functions of these components in the ecosystem understood? Are sufficient data collected to detect any increase in risk level, and/or to develop a strategy?

Table 3: Indicators associated with Principle 3 (management frameworks) used to assess Indian mackerel and hilsa fisheries

Indicator Number	Indicator title	Issues considered within indicator
Principle 3: Management framework [7]		
3.1.1	Legal and/or customary framework	Does the management system exist within an appropriate and effective legal and/or customary framework? How capable is it of delivering sustainable fisheries in accordance with Principles 1 and 2? To what extent does it observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood? e.g. implicitly, is it required to do so in law? Does it incorporate an appropriate dispute resolution framework, and how transparent is any such mechanism?
3.1.2	Consultation roles and responsibilities	How open to interested and affected parties is the management system and how effective are consultation processes? To what extent are the roles and responsibilities of organizations and individuals who are involved in the management process clear, understood and/or implicitly/explicitly defined, for/by all relevant parties?
3.1.3	Long term objectives	Does the management policy have clear long-term objectives to guide decision-making that are consistent with the principles of sustainability and the precautionary approach, and how implicit/explicit, and required, are such objectives?
3.1.4	Incentives for	Does the management system provide economic and social

[7] Indicators 3.1.1 to 3.1.4 relate to the overall governance and policy framework in place. Indicators 3.2.1 to 3.2.5 relate to the fishery-specific management system i.e. specific management systems for Indian mackerel and hilsa shad.

Indicator Number	Indicator title	Issues considered within indicator
	sustainable fishing	incentives for sustainable fishing, and avoid subsidies that contribute to unsustainable fishing? Is there any review of the impacts of such incentives/subsidies on sustainability?
3.2.1	Fishery-specific objectives	To what extent does the fishery have clear, specific objectives designed to achieve the outcomes expressed by Principles 1 and 2? Are such objectives implicit or explicit, and are they measurable in the short- and long-term?
3.2.2	Decision-making processes	Does the fishery-specific management system include effective decision-making processes that result in measures and strategies to achieve the objectives? Are such processes informal, or formally established? Do they respond to all or just some issues? And does decision-making enable responses to issues to be made in a transparent and timely manner? How, if at all, are decisions which are taken justified and reported to stakeholders?
3.2.3	Compliance and enforcement	Do monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with? How comprehensive and effective are MCS systems? Are sanctions applied, and are they sufficient to act as a deterrent? What sort of evidence is there to determine whether fishers are compliant, and how compliant are they thought to be? Is there evidence of any systematic non-compliance?
3.2.4	Research plan	Does the fishery have a research plan that addresses the information needs of management? Is research available to inform management, and to what extent does it do so in a timely and reliable manner? To what extent are research results made available to interested parties in a timely manner?
3.2.5	Monitoring and management performance evaluation	Is there a system for monitoring and evaluating the performance of the fishery-specific management system against its objective? Is there is effective and timely review of the fishery-specific management system? Does the fishery have in place mechanisms to evaluate some or all parts of the management system, and is it subject to occasional, periodic or regular review, and is any such review internal or external?

One other critical aspect of the assessment process needs to be mentioned, and relates to the scoring of some indicators where data may not be available on which to determine a score. Due to a desire to ensure that developing country fisheries (where data may often be lacking) can also engage with the MSC certification process, a Risk-Based Framework (RBF) has been developed by the MSC and can be used to evaluate and score *some* outcome performance indicators when data-deficiency is encountered.

The RBF includes two methods for assessing the risk to each of the ecological components from activities associated with the fishery under assessment. The first is a system based on expert judgment (Scale Intensity Consequence Analysis - SICA), which is a qualitative analysis which aims to identify which activities lead to a significant impact on any species, habitat or ecosystem. The SICA operates as a screening tool; a "worst case" approach that is used to measure the impacts of a range of activities on particular scoring elements. The second is a semi-quantitative analysis to assess potential risk (Productivity Susceptibility Analysis - PSA). The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities.

Given that in practice most SICA assessments are deliberately weighted to conclude high risk (given the low level of information), and indeed are not on their own sufficient for use to assess the target stock (Principle 1), the PSA analysis forms a more useful and insightful tool for use during this assessment.

Under the PSA methodology, productivity is determined according to species growth and maturity characteristics, trophic level and fecundity[8]. The productivity attributes and scores as defined by MSC methodology are presented in Table 4. Generally speaking quicker growing, fast maturing, low trophic level smaller species are more productive than slower growing species with large maximum size and age, which are typically high trophic level are deemed to be low productivity.

Low productivity species are potentially easier to over exploit so fisheries for these stocks (all other things being equal) are higher risk. However in order to finally determine the level of risk, productivity scores must be combined with information about the susceptibility to capture.

Table 4: Productivity attributes and scores

Productivity attribute	**Low productivity** (high risk)	**Medium productivity** (medium risk)	**High productivity** (Low risk)
Average age at maturity	>15 years	5-15 years	<5 years
Average maximum age	>25 years	10-25 years	<10 years
Fecundity	<100 eggs / yr	100-20,000 eggs / yr	>20,000 eggs / year
Average maximum size	>300 cm	100-300 cm	<100 cm
Average size at maturity	>200 cm	40-200 cm	<40 cm
Reproductive strategy	Live bearer	Demersal egg layer	Broadcast spawner
Trophic level	>3.25	2.75-3.25	<2.75

Source: MSC Fisheries Assessment Methodology

The susceptibility is assessed according to the overlap of the fishing area compared with the species range (geographical spread and depth / habitat overlap), the probability of capture if the fishing gear is encountered (i.e. species size v mesh size) and the likelihood of post capture survival. The susceptibility attributes and scores as defined by MSC methodology are presented in Table 5. When considering the risk based scores as target species (i.e. under P1) it is important to recognize that the area overlap considerations are for all fishing activity on the stock, not just the vessels belonging to the unit of assessment. It is also the case when considering the likelihood of post capture survival which is only really of any relevance to discarded species. Retained species obviously do not survive post capture.

[8] This information can be found for most finfish (not shellfish) species from the 'Fishbase' on-line database.

Table 5: Susceptibility attributes and scores

Susceptibility attribute	Low susceptibility (low risk)	Medium susceptibility (medium risk)	High susceptibility (High risk)
Availability – overlap of species range with fishery	<10% overlap	10-30% overlap	>30% overlap
Encounterability – Habitat and depth check	Low overlap with fishing gear	Medium overlap with fishing gear	High overlap with fishing gear
Selectivity (varies per gear type)	< mesh size, or >5m in length	1-2 times mesh size, or 4-5m in length	>2 times mesh size or up to 4m in length
Post capture mortality	Evidence of post capture release and survival	Released alive	Retained spp. or majority dead when released

Source: MSC Fisheries Assessment Methodology

In the context of the assessments for Indian mackerel and hilsa shad, the PSA has been used to determine an appropriate score for the stock status of these target species. The PSA methodology has also been used for assessing stock status of retained species, where applicable.

1.2.3 Report Structure

Following this introductory section (Section 1), this report has three main sections.

Section 2 provides a regional synthesis of the findings with regards to the assessment of Indian mackerel fisheries.

Section 3 provides a regional synthesis of the findings with regards to the assessment of Hilsa shad fisheries.

In both Sections 2 and 3, we first provide an overview in terms of:

- The biology of the fish species (including a Productivity Susceptibility Analysis);
- The main fleets and gears exploiting the species and the ‘units of assessment’ that have been considered; and
- The current levels of effort, catches, and socio-economic importance of the fisheries.

Each section then presents the key findings of the assessments, for each of the three main Principles (stocks, ecosystem impacts, and management frameworks) and the performance indicators related to each Principle. The text draws out some common threads across the assessments, presents some key weaknesses and key strengths, and refers to the individual assessments to provide particular examples to illustrate key points.

A final section of the report (Section 4) draws together some key recommendations for improvements in performance, and suggests how the BOBLME project might support such improvements over the coming years.

The main text of this report is based on greater detail provided in eight country Appendices. Other Appendices provide information on references used, and on the MSC Principles and Criteria.

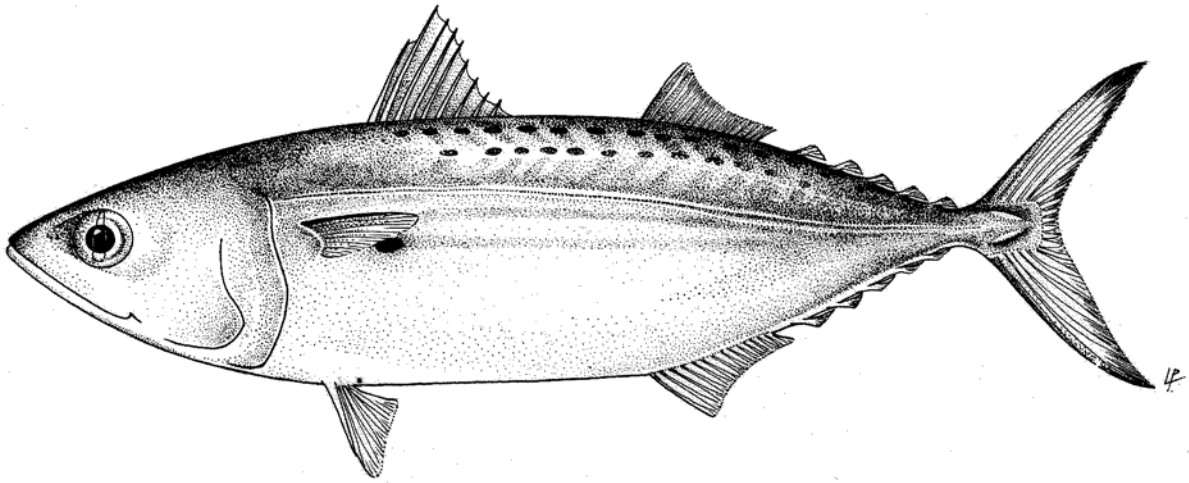
2 REGIONAL SYNTHESIS – INDIAN MACKEREL

2.1 OVERVIEW

2.1.1 Biology of Indian mackerel

The Indian mackerel, *Rastrelliger kanagurta* (Cuvier) is a pelagic shoaling scombroid fish widely distributed in the Indo-West Pacific region (see Fishbase for distribution map). It is a neritic species (inhabiting the ocean waters between the low tide mark and a depth 200 m) and occurs in areas where surface water temperatures are at least 17°C. Adults occur in coastal bays, harbors and deep lagoons, usually in some turbid plankton-rich waters.

Figure 3: Indian mackerel, *Rastrelliger kanagurta*



Source: FAO, 1983

Juveniles feed on phytoplankton (diatoms) and small zooplankton (cladocerans, ostracods and larval polychaetes). With growth dietary habits change to preying primarily on macroplankton such as larval shrimps and fish. Indian mackerel reach a size of 18 cm within six months and 22 cm within the first year. It is reproductively active at size of 18 cm for males and 19 cm for females. Longevity is believed to be at least 4 years.

Indian mackerel shoal by size moving in semicircular or arrow head formations with a speed of 8-10 mph. They scatter, when pursued by seerfish but, when the shoals are chased by sharks or porpoises, the mackerel submerge with the head downwards into a compact mass.

Indian mackerel is a migratory species, however only limited information is available on its migration pattern (Jayasankar *et al*, 2004). It is understood that pelagic fishes migrate for their ecological demand of spawning and feeding habits to the optimum environmental conditions on current, water temperature, salinity, chlorophyll and prey. It is thought that adult Indian mackerel migrate from coastal waters for the purpose of spawning. Spawning occurs in several batches with eggs fertilized externally. Both eggs and larvae are pelagic (Collette, 1986).

Details of species migration provide important information for stock identification and shared stock of pelagic fishes. Reproductive isolation between fish stocks may arise by homing to different spawning areas or by hydrographic features which reduce or prevent migration between areas. Menezes *et al.* (1993) studied the genetic variation between Indian mackerel populations on the West and East coast of India and the Andaman Sea. They found some genetic variance between the populations, as well as differences in many biological and fisheries characteristics. However, the information on migration patterns of Indian mackerel in this region remains fragmentary and inadequate for the purpose of managing the fishery.

Tagging experiments of four small pelagic species, including Indian mackerel, have been undertaken by the Marine Fishery Resources Development and Management Department of SEAFDEC since 2007 and continued until end of 2010. In the Andaman Sea, tagging operations were conducted in Indonesia, Malaysia, Myanmar and Thailand, with a total of 11,351 tails of fish (including 4,310 *R. kanagurta*) tagged and released in 2008 and 2009. The recovery data are planned to be used for analysis of migration and other biological parameters (SEAFDEC, 2009).

Indian mackerel is a very important species in many parts of its range. Catches are usually recorded as *Rastrelliger* spp. or combined with *R. brachysoma*. Common names for *R. kanagurta* throughout the BOBLME area include the following:

India: Ayala, Ayila (Malayalam), Ailai , Augalai (Tamil), Bangada (Canarese), Indian mackerel, Kaula Gedar (Marathi), Kanagurta (Telugu), Kanangeluthi (Tamil), Kannangadatha (Telugu), Kumla (Tamil), Karan-Kita (Oriya), Oibia Gedar (Sindhi), Bangadi (Hindi).

Indonesia: Banjar, Kembung, Kembunglelaki.

Malaysia: Kedah, Kembong, Kuala Muda.

Myanmar: Indian mackerel.

Sri Lanka: Ailai (Tamil), Indian mackerel, Karung Kuluttan, Kumbala (Tamil), Kumbalava, Maha Kara Bolla (Sinhalese).

Thailand: Pla-Long, Pla-Thu, Tu.

A **Productivity Susceptibility Analysis** (PSA) was undertaken utilizing the risk-based approach to fisheries assessment developed by the MSC. The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities. The seven productivity attributes are specific to the species and scores will be consistent across a single stock, regardless of which countries or gears are targeting the fishery. Based on current evidence, for the purpose of the PSA, the Indian mackerel present in the BOBLME area is considered to be a single stock.

The selectivity analysis considers attributes that are specific to the gear that is targeting the fishery – its overlap with the species' range, encounterability across the species' habitats and selectivity of the gear.

Indian mackerel scores highly on six productivity attributes (i.e is a highly productive species) and intermediately for trophic level (Table 6). It has a minimum population doubling time of less than 15 months. Overall in terms of its physiology and reproductive strategy it can be considered a highly productive species with a high resilience and low vulnerability.

Table 6: Indian mackerel - key productivity attributes

Attribute	Indian mackerel	Risk level
Av. age at maturity	6 months – 1 year	Low
Av. maximum age	4 years	Low
Fecundity	22,000-94,000	Low
Av. maximum size	35 cm	Low
Av. size at maturity	18-19 cm	Low
Reproductive strategy	Broadcast spawner	Low
Trophic level	3.19	Medium

Source: FishBase

The susceptibility of Indian mackerel to different gears deployed within the BOBLME area are presented in Table 7; combined with the productivity, the overall risk from the fisheries is determined.

Table 7: Productivity Susceptibility Analysis for Indian mackerel

		Productivity								Susceptibility					PSA Scores		
Country	Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total Selectivity	PSA Score	Risk Category	MSC score
Indonesia	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Gill nets	1	1	1	1	1	1	2	1.14	1	2	3	3	1.43	1.83	Low	>80
Malaysia	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Gill nets	1	1	1	1	1	1	2	1.14	1	2	3	3	1.43	1.83	Low	>80
Thailand	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
Myanmar	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
India (Tamil Nadu)	Gill nets (40-65mm)	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80
Sri Lanka	Gill nets (<9cm)	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80
	Beach seine	1	1	1	1	1	1	2	1.14	1	3	3	3	1.65	2.01	Low	>80

Availability: overlap of species range with fishery
Encounterability: overlap of gear with fish distribution in the water column
Selectivity: selectivity of gear and likelihood of capture
Post-capture mortality: whether fish is retained (or dead if released)
Source: Poseidon

Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets operating in Indonesia, Malaysia, Thailand and Myanmar. Vessels deploying these gears are likely to overlap > 30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. Due to the mesh sizes of these gears, they have a low selectivity in that most fish encountered will be captured. From a stock status perspective both purse seine and trawl fisheries are considered to be high risk to Indian mackerel.

The gillnet fisheries in Indonesia, Malaysia, India and Sri Lanka and the beach seine fishery in Sri Lanka are, however, predominately carried out in the coastal areas and so have a lower risk score based on availability and encounterability attributes. While selectivity scores poorly due to the small mesh sizes compared to the fish length, overall the impact of this fishery on the stock is considered low risk.

2.1.2 Description of main fleets and gears, and 'units of assessment'

The main fleets and gears catching Indian mackerel in countries/areas in the BOB which have been examined by the consultants, are described in the table below (Table 8), along with the 'units of assessment' for which performance has been assessed. As can be seen from the table, the eastern BOBLME countries (Indonesia, Malaysia, Thailand and Myanmar) have targeted purse seine fisheries for small pelagics, including Indian mackerel, with other gears of bottom otter trawling and gill nets taking this species as a retained bycatch, while the western BOBLME countries (India and Sri Lanka) catch Indian mackerel as part of their small scale coastal gill net and beach seine fisheries.

Table 8: Main fleets/gears targeting Indian mackerel, and units of assessment

Country/ Area	Description of main fleets/gears catching Indian mackerel	Units of assessment considered in this report
Sri Lanka	• Small-mesh (2 to 4.5 cm) gillnets deployed from 15-30 hp out-board engine fiberglass reinforced plastic boats (OFRP); motorized traditional boats ((MTRB); & non-motorized traditional boats (NTRB). Indian mackerel is mainly landed as a minor bycatch (1-3% of total catches) with other small pelagic species being the target species, primarily the spotted sardinella (*Amblygaster sirm*). Operating mainly over the continental shelf out to 25 km from the shore • Beach seines (< 1 cm mesh) up to a kilometer in length, and manually hauled. Seines consist of an encircling net with an additional cod end. The net has a large number of small (*c*. 1 kg) weights to keep the footrope on the bottom. Catches average around 100 – 300 kg per haul, mostly of sardines (*Sardinella* spp.), anchovies (*Stolephorus* spp.) and silver bellies (*Leiognathus* spp.) Indian mackerel represents a small bycatch (3-7% of catches).	• Small mesh gillnet fishery (mesh size 2-4.5cm / 1-2.5 inches), used by fiberglass reinforced plastic boats (OFRP), motorized traditional boats ((MTRB), & non-motorized traditional boats (NTRB) throughout Sri Lanka; and • Beach seines (mesh size <1cm) throughout Sri Lanka.
Tamil Nadu (India)	• Gillnets targeting Indian mackerel, mesh size of 50-65mm, around 5m deep and up to a kilometer in length. They are surface set and tend to operate in shallower water (<50 m depth). The vessels fishing gillnets are mainly outboard (8.5–11hp) powered fiberglass skiffs, fishing 8 – 10nm offshore.	• Small-mesh (50 – 65 mm), surface-set gillnet fishery in Tamil Nadu prosecuted by motorized (outboard and inboard) vessels with Indian mackerel as the main retained species; and

Country/ Area	Description of main fleets/gears catching Indian mackerel	Units of assessment considered in this report
	• Trawl vessels targeting shrimp, demersal fish and cephalopods, using a high opening trawl net with a headline height of around 20-30m. Cod end mesh should be a minimum of 35mm, but 8-10mm is often used. Trawlers along the Coromandel Coast are restricted to a maximum length of 50ft, and a maximum engine size of 110 hp, and are not allowed to fish within 3 nautical miles of the shore. • Ring seines using traditional gillnets as described above, targeting Indian mackerel. As purse seine-type gear is illegal in India, there is little detail on the scale and nature of these fisheries, especially on the east coast of India where they are only just being introduced, but their use is said to be increasing.	• 'High opening' bottom trawl fisheries in Tamil Nadu targeting shrimp, finfish or cephalopods with a retained and commercially important bycatch of Indian mackerel.
Bangladesh	• Catches are thought to be made primarily by drift gillnets (DGN), longlines (LL), and marine set bag nets (MSBN) in the coastal artisanal fishery, using mechanized and non-mechanized boats. Industrial trawlers (shrimp, fish, and cephalopod) also catch some mackerel. The relative importance of the different gear types in contributing to total Indian mackerel catches is thought to be approximately: drift gillnets (95%), longlines (1%), marine set bag nets (2%) and industrial trawl nets (2%). Indian mackerel is mostly caught as a by-catch of the hilsa fishery, but only in very small quantities.	• None
Myanmar	• The purse seine fishery mainly harvests small mackerels and sardine species and are operated in a traditional manner, without fish aggregating devices. Most purse seiners have a skipper with expertise in seeking out fish schools relative to the "fish lures", and at night, free-school scouting purse nets using lights. • Otter bottom trawl nets are the main gear for demersal finfish and penaeid prawns and the trawl fisheries contributed > 40% to marine landings in Myanmar. Indian mackerel is caught as a bycatch in this fishery.	• Purse seine vessels with 1 inch mesh size targeting small pelagic species with Indian mackerel landed as a minor bycatch species. • Bottom otter trawl fishery with 1.5 inch mesh size targeting shrimp and 2.5 inch mesh size targeting demersal fish and landing Indian mackerel as a minor bycatch species.

Country/ Area	Description of main fleets/gears catching Indian mackerel	Units of assessment considered in this report
Thailand	• 74% by volume taken by purse seiners, 25% from trawlers and 1% by gill netters. The purse seiners use a net length 700-1,300m, depth 80-140m with mesh size 25mm operated with 1-3 day/trip, about 24 day/month. The vessels range in length from 14 to 27m and use engines of 250 to 300hp.	• Purse seine vessels targeting small pelagic species within Thailand EEZ waters with nets of mesh size 1 inch. • Bottom otter trawl vessels targeting demersal finfish and shrimps, taking Indian mackerel as a bycatch, operating within Thailand EEZ waters with nets of mesh size 1 inch
Malaysia	• Landings by volume are predominately from the purse seiners (56% of west coast landings), trawlers (42%) and only a very small amount (1%) from drift/gill netter	• Purse seine vessels with 1 inch (25mm) mesh size targeting small pelagic with Indian mackerel as one of these target species and those targeting tunas that catch Indian mackerel as a bycatch species. • Bottom otter trawl fishery with 1 inch (25mm) mesh size targeting shrimp and demersal fish and landing Indian mackerel as a bycatch species. • Set gillnet fishery with mesh sizes ranging from 1 inch (25mm) upwards targeting demersal fish and landing Indian mackerel as a bycatch species.
Indonesia	• There are four main targeted fisheries for large pelagic species (namely tunas), demersal species, shrimp and small pelagic species. Indian mackerel are caught as part of the mixed small pelagic fishery which also lands a number of other species including Indo-Pacific mackerel and juvenile tunas. • Indian mackerel are predominately targeted by 5-30GT purse seiners; although they are also taken as bycatch in the >30GT purse seine fishery targeting tuna, the demersal trawl fishery targeting shrimp and the gill net fisheries targeting demersal finfish.	• Purse seine 5-30GT vessels with 1 inch mesh size targeting small pelagic with Indian mackerel as one of the target species and purse seine >30GT vessels with 1 inch mesh size targeting tunas and landing Indian mackerel as a bycatch species. • Bottom otter trawl fishery with 1 inch mesh size targeting shrimp and demersal fish and landing Indian mackerel as a bycatch species. • Set gillnet fishery with mesh sizes ranging from 1 to 8 inches targeting demersal fish and landing Indian mackerel as a bycatch species.

Source: Poseidon. NB Indian mackerel is not caught commercially in the Maldives in any meaningful volumes (see Appendix G)

2.1.3 Current effort, catches (volume & value) and socio-economic importance

Summary information on vessel numbers catching Indian mackerel, catches (volumes and estimated values, and CPUE trends), and main markets, is provided in the table below (Table 9). The table shows that in Sri Lanka, Tamil Nadu, West Bengal, Thailand and Indonesia catches of Indian mackerel are low (compared to total national landings), and that the socio-economic importance of Indian mackerel fisheries may be small in terms of total employment and income generation. Landings into Malaysia are significantly higher than any of the other BOBLME countries, at 140,000 tonnes in 2008.

Small pelagics such as Indian mackerel are generally low cost to consumers, and have high micro-nutrient content as well as providing an important source of animal protein. They thus serve an important socio-economic role in terms of food security.

Table 9: Vessel numbers, catches, and markets for Indian mackerel

Country/ Area	Estimated vessel numbers (trends)	Estimated catch volumes (trends)	CPUE trends	Estimated catch values	Main markets
Sri Lanka	Not known (but increasing). 975 beach seines in 2009	1,000-2,000 tonnes per year (trends not known for Indian mackerel but up for small pelagics)	Not known	Rs 86 million / $758,816 (2009)	All to domestic markets
Tamil Nadu (India)	Not known	14,430 tonnes/year average 2001 – 2008 (static)	Not known	INR 616 million / $15.6 million (2007)	All to domestic markets
Bangladesh	Not known	58 tonnes per year	Not known	Not known	Almost all to domestic markets but some exports reported
Myanmar	Not known	Volume consumed domestically is not known; 10.5 tonnes exported, 2009	Not known	Value of fish consumed domestically is not known; US$8,000 exported, 2009	Domestic and export

Country/ Area	Estimated vessel numbers (trends)	Estimated catch volumes (trends)	CPUE trends	Estimated catch values	Main markets
Thailand	212 purse seine vessels in 2007	Average of 20,000 tonnes per annum over the past 10 years	Estimated at 467.57 kg/day in 2007	34,000 baht per tonne	Domestic and export
Malaysia	2,978 trawlers, 326 purse seiners and 12,520 gill/drift nets.	140,000 tonnes landed in 2008	Not known	Not known	Domestic and export
Indonesia	For entire Indonesia: 50 purse seine (>30GT), 10,433 purse seine (5-30GT), 90 trawlers (>30GT), 43,500 gill netters/trawlers/line (5-30GT)	Unknown	Not known	Not known	All to domestic markets

Sources: Various, collated by Poseidon over current study

2.2 PRINCIPLE 1: STOCK STATUS AND MANAGEMENT

The table below (Table 10) provides a summary of the assessment of both stock status/outcome, and harvest strategy/stock management for Indian mackerel in the countries for which assessments have been made.

Table 10: Summary table for Principle 1; Indian mackerel

Principle 1			Principle 1: Stock status						
			Outcome			Harvest strategy			
			1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4
	Country	UoA	Stock status	Reference points	Stock rebuilding if necessary	Performance of Harvest Strategy	Harvest control rules and tools	Information and monitoring	Assessment
	ID	Indian mackerel	0	0	-	0	0	1	0
	TH	Indian mackerel	0	0	-	0	0	1	1
	MY	Indian mackerel	0	0	-	0	0	1	1
	MM	Indian mackerel	0	0	-	0	0	1	0
	IN	Indian mackerel	1	0	-	0	0	1	1
	LK	Indian mackerel	2	0	-	0	0	0	0

Source: Poseidon. ID = Indonesia, TH = Thailand, MY = Malaysia, MM = Myanmar, IN = India, LK = Sri Lanka

Indian mackerel is a migratory species and Jayasankar *et al* (2004) found no genetic differences between three areas on the East and West coasts of India. Such findings along with species characteristics such as planktonic early life stages and the connectivity of the BOBLME region's hydrography, lead many to assume Indian mackerel in the Bay of Bengal is a single stock. To date there has been no region-wide research to determine whether this is the case or whether a number of distinct stocks exist. This is an important area of research that will be required to inform the functional unit(s) for regional and co-operative management of the resource.

2.2.1 Stock status/outcome

Stock status

Where some form of stock assessment has been conducted for Indian mackerel, the status of the stock is identified as being poor. Most of these assessments are based on estimates of catch per unit effort (CPUE). For example, estimates for Thailand suggest that catch levels in the Andaman Sea are 30% over MSY. In Malaysia, where biomass estimates are available from occasional research surveys as well as fisheries-dependent population estimates, there are also signs that the resource is being overfished. On the West coast of Peninsula Malaysia, an area totaling nearly 28,000km^2, a pelagic resource of 210,000t was estimated (Hassan *et al*, 2006), which is 23.8% lower than that estimated in a previous survey conducted in 1998.

The more favorable scores for India and Sri Lanka should be viewed with caution as no estimates were available and therefore the scores are based on the PSA analysis. Indian catches have been above a 1991 estimate of MSY for many years and so the stock is thought to be overfished. It is only the expected resilience this species shows to overfishing and its reported expansion northwards up India's East coast that leads to an 'intermediate' score. For Sri Lanka, the score derived from PSA analysis gives a 'low risk' score mainly due to the artisanal nature of the fishery that accesses only a small proportion of the resource compared to its range across the Sri Lankan EEZ.

Overall where some form of stock assessment is available, indications are that the Indian mackerel resource is showing signs of being overfished, but the species shows cyclical population levels and has a short recovery time making recruitment overfishing less likely. The lack of information on stock status currently limits the confidence in any assessment.

Reference points

Some countries such as Thailand, Malaysia and India report an MSY level, but this is derived from CPUE estimates rather than biomass estimates including predictions for recruitment into the fishery. *R. kanagurta* populations are known to be cyclical and therefore full reliance on fishery-dependent data would mean any such estimate should be treated with caution.

For all countries, even those with the potential to use MSY estimates as *de facto* reference points, no reference points are currently used in the management of the resource.

Reference points are important as they are an objective basis on which to make management decisions; if a reference point for fishing mortality, such as $F_{MSY,}$ is exceeded managers know that action may be required and stakeholders can agree in advance what the extent of action should be, e.g. a proportional cut in fishing effort.

Stock rebuilding

Stock rebuilding is not scored when the RBF is applied. As there is a lack of stock status information across all countries, stock rebuilding is not relevant at this stage.

2.2.2 Harvest strategy / stock management

Performance of harvest strategy

Consideration of the harvest strategy explores how management of the fishery works to keep stock levels consistent with reference points. As described above, no formal reference points are currently used by BOBLME countries. For those where MSY is reported, there is no evidence that a harvest strategy has been introduced or amended to achieve MSY.

Harvest control rules and tools

There are no harvest control rules and tools that are triggered by reference points. Some countries apply more general harvest control rules such as India's season ban on mechanized vessels, which could be expected to benefit Indian mackerel spawning within this period. Indonesia sets TACs and minimum mesh sizes at a national level, but at a provincial level there is no evidence that these are well applied and enforced.

Information and monitoring

The scoring of 'information and monitoring' considers the various elements that would be required to fully inform management of a particular stock:

Stock structure (e.g. the distribution and geographical range of the stock, the relationship of the geographical range to the harvest control, and the age, size, sex and genetic structure of the stock);

- **Stock productivity** (e.g. could incorporate maturity, growth, natural mortality, density dependent processes, the stock recruit relationship and fecundity);
- **Fleet composition** (e.g. effort by gear type/method of capture);
- **Stock abundance** (e.g. information relating to absolute or relative abundance indices including recruitment, age size sex and genetic structure of the stock);
- **Fishery removals** (e.g. the level, size, age, sex and genetic structure of landings, discards, illegal, unreported, unregulated, recreational, customary and incidental mortality of the target stock by location and method of capture);
- **Other data** (such as temperature, weather and other factors which may influence fish populations and fishing).

The team's investigations identified that some of the above information was available and, in a number of cases, regularly monitored by countries. For example, Malaysia's statistics on catch composition by gear are consistently well presented and detailed. Similarly some of Indonesia's provincial-level statistics can be highly detailed, but the appreciable logistical problems of compiling these, results in a lower resolution at national level.

The obvious gap in information and monitoring across all countries is in relation to 'stock abundance'.

Scores on information and monitoring for nearly all countries are given as 'intermediate', in recognition of countries' efforts to research the resource and the noticeable improvements in recording fishing activity. However it is evident in every country that more frequent and accurate information through systematic monitoring is required.

Assessment

With no evidence of stock assessment for Indian mackerel, most countries are inevitably scored as 'weak'. Only Thailand and India achieved an 'intermediate' score. For India this was in recognition of the considerable research into population dynamics and stocks of Indian mackerel, although much of these have been focused on the Arabian Sea stock, which may be separate from that of the Bay of Bengal. In the case of Thailand and Malaysia, a number of population parameters have been calculated for this species, which is a positive step toward stock assessment requirements. These are, however, based on *ad hoc* research projects rather than regular assessments.

2.3 PRINCIPLE 2: ECOSYSTEMS

The table overleaf (Table 11) shows the assessments made for each indicator under Principle 2 across all countries in the region.

Table 11: Summary table for Principle 2; Indian mackerel

		Principle 2: Ecosystem impacts														
		Retained			Discards			ETP			Habitat			Ecosystem		
		2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.3.3	2.4.1	2.4.2	2.4.3	2.5.1	2.5.2	2.5.3
Country	UoA	Retained status	Retained management	Retained info / monitoring	Discards status	Discards management	Discards- info / monitoring	ETP status	ETP management	ETP info / monitoring	Habitat status	Habitat management	Habitat info / monitoring	Ecosystem status	Ecosystem management	Ecosystem info / monitoring
ID	Purse seine	1	0	1	2	2	1	1	0	1	2	2	1	1	1	1
ID	Btm Otter trawl	0	0	1	2	2	1	1	0	1	0	1	1	0	0	1
ID	Gill nets	0	0	0	2	2	1	0	0	1	2	1	1	1	1	1
TH	Purse seine	1	1	2	2	2	1	1	1	1	2	2	1	1	1	1
TH	Btm Otter trawl	0	0	2	2	2	1	0	1	1	0	1	1	0	0	1
MY	Purse seine	1	0	2	2	2	1	0	1	1	2	2	2	1	1	1
MY	Btm Otter trawl	0	0	2	2	2	1	0	1	2	0	1	2	0	0	1
MY	Gill nets	0	0	2	2	2	1	0	1	1	2	1	1	1	1	1
MM	Purse seine	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0
MM	Btm Otter trawl	0	1	1	2	2	1	0	1	1	0	1	1	0	0	0
IN	High opening bottom trawl	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0
IN	Gill nets 50-65mm	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Small mesh gillnet	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Beach seine	1	0	1	2	2	1	2	2	1	2	2	1	1	1	1

Source: Poseidon. ID = Indonesia, TH = Thailand, MY = Malaysia, MM = Myanmar, IN = India, LK = Sri Lanka

2.3.1 Retained bycatch

Status

A Productivity and Susceptibility analysis (PSA) has been undertaken for the main retained species in each of the gear types targeting Indian mackerel (Table 12).

Table 12: Productivity and Susceptibility analysis (PSA) for main retained species by gear type

Gear	Species	Scientific name	Productivity								Susceptibility					PSA Scores		
			Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total	PSA Score	Risk Category	MSC score
Purse seine	Indo-pacific mackerel	*Rastrelliger brachysoma*	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Skipjack tuna	*Katsuwonus pelamis*	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
	Longtail tuna	*Thunnus tonggol*	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
	Frigate tuna	*Auxis thazard*	1	1	2	1	1	1	3	1.43	3	3	3	3	3.00	3.32	High	<60
	Bigeye tuna	*Thunnus obesus*	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
	Bullet tuna	*Auxis rochei*	2	2	2	2	1	1	3	1.86	3	3	3	3	3.00	3.53	High	<60
	Eastern little tuna	*Euthynnus affinis*	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
	Yellowfin tuna	*Thunnus albacares*	2	1	2	2	2	1	3	1.86	3	3	3	3	3.00	3.53	High	<60
	Round scad	*Decapterus maruadsi*	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
	Hardtail scad	*Megalaspis cordyla*	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
	Anchovy	*Stolephorus* spp.	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
Bottom otter trawl	Round scad	*Decapterus maruadsi*	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
	Hardtail scad	*Megalaspis cordyla*	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
	Penaeid shrimp	*Penaeus monodon*	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Penaeid shrimp	*Penaeus semisulcatus*	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Indo-pacific mackerel	*Rastrelliger brachysoma*	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Squid	*Loligo* spp.	1	1	1	1	1	2	3	1.43	3	3	3	3	3.00	3.32	High	<60
	Pomphret	*Pampus argenteus*	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Snapper	*Lutjanus bohar*	1	3	1	1	2	1	3	1.71	3	3	3	3	3.00	3.46	High	<60
	Grouper	*Epinephelus tauvina*	2	2	1	1	2	1	3	1.71	3	3	3	3	3.00	3.46	High	<60
	Small carangids	*Decapterus russelli*	1	1	1	1	1	1	3	1.29	3	3	3	3	3.00	3.26	High	<60
Gill nets	Indo-pacific mackerel	*Rastrelliger brachysoma*	1	1	1	1	1	1	1	1.00	1	2	3	3	1.43	1.74	Low	>80
	Seerfish	*Scomberomorus commerson*	2	1	1	2	2	1	3	1.71	1	2	3	3	1.43	2.23	Low	>80
	Indo-Pacific king mackerel	*Scomberomorus guttatus*	1	2	1	1	2	1	3	1.57	1	2	3	3	1.43	2.12	Low	>80
	Small carangids	*Decapterus russeli*	1	1	1	1	1	1	3	1.29	1	2	3	3	1.43	1.92	Low	>80
	Sardine species	*Amblygaster sirm*	1	1	1	1	1	1	3	1.29	1	2	3	3	1.43	1.92	Low	>80
Beach seines	Sardine species	*Sardinella gibbosa*	1	1	1	1	1	1	3	1.29	1	1	3	3	1.20	1.76	Low	>80
	Sardine species	*Sardinella albella*	1	1	1	1	1	1	3	1.29	1	1	3	3	1.20	1.76	Low	>80
	Sardine species	*Amblygaster sirm*	1	1	1	1	1	1	3	1.29	1	1	3	3	1.20	1.76	Low	>80
	Pony fish	*Leiognathus equulus*	1	1	1	1	1	1	2	1.14	1	1	3	3	1.20	1.66	Low	>80
	Small carangids	*Decapterus russelli*	1	1	1	1	1	1	3	1.29	1	1	3	3	1.20	1.76	Low	>80

Source: Poseidon

The purse seine fleet that lands Indian mackerel predominately occurs in the Eastern Bay of Bengal countries including Indonesia, Malaysia, Thailand and Myanmar. Two fleet types are in operation throughout the area with larger >30 GT vessels targeting tuna species skipjack tuna *Katsuwonus pelamis,* longtail tuna *Thunnus tonggol*, frigate tuna *Auxis thazard*, bigeye tuna *Thunnus obesus*, bullet tuna *Auxis rochei*, eastern little tuna *Euthynnus affinis* and yellowfin tuna *Thunnus albacores*; and smaller purse seine vessels targeting small pelagic species including Indo-pacific mackerel *Rastrelliger brachysoma,* round scad *Decapterus* *maruadsi*, hard tail scad *Megalaspis cordyla* and anchovy *Stolephorus* species, with a bycatch of juvenile tunas. The PSA analysis indicates that purse seine vessels present a high risk to the majority of small and large pelagic species with the exception of three species assessed as medium risk: Indo-Pacific mackerel on account of extremely high productivity and associated low risk; and skipjack and bigeye tuna on account of their distribution throughout tropical and warm-temperate waters. Despite other small pelagic species falling within the high risk category, due to the medium trophic levels (>3.25) and high overlap between fishing gear and species range, they all are understood to have a high resilience with a minimum population doubling time of 15 months (Fishbase, 2010). For this reason, overall retained species within the purse seine fleet achieves an intermediate performance level.

Indian mackerel is landed as a bycatch by bottom otter trawlers operating in Indonesia, Malaysia, Myanmar and India. The species is caught principally by vessels targeting penaeid shrimp *Penaeus monodon* and *P. semisulcatus*, squid *Loligo* species, various demersal fish including pomfret *Pampus argenteus*, snapper *Lutjanus bohar* and grouper *Epinephelus tauvina* and small pelagic such as Indo-Pacific mackerel, round scad *Decapterus maruadsi*, hard tail scad *Megalaspis cordyla* and small carangids predominately *Decapterus russelli*

These bottom otter trawling gears can operate with high opening nets, so as to capture small pelagic species during the trawling process (as is seen in India); or can capture these species as the nets are hauled through the water column (as seen in Thailand).

On account of excellent productivity the shrimp and Indo-Pacific mackerel are considered at medium risk, as are squid which has a medium encounterability due to its depth range. All other main retained species are at high risk from trawling due to high trophic status and high overlap with species range, as well as habitat and depth distributions. Due to the diversity and quantities of demersal fish species taken by this gear, together with the fact that a higher proportion of juveniles across all species are likely to be captured as a consequence of the indiscriminate nature of this gear, the overall performance is assessed as weak for all countries.

Gill nets operated by smaller vessels in Sri Lanka and India land a mixture of small pelagic including Indo-Pacific mackerel, seerfish *Scomberomorus commersan* and *S. guttatus*, small carangids and sardine species predominately *Amblygaster sirm*. Beach seines operated from shore in Sri Lanka also land a mixture of small pelagic including sardine species, namely *Sardinella gibbosa, S. albella* and *A.sirm*, small carangids, as well as pony fish *Leiognathus equulus*.

Gill nets and beach seines pose a low risk to these retained species since there is a low overlap of the gears across the species' geographic range and low-medium encounterability across their habitat and depth distribution. Sardine species, pony fish and small carangids also have good productivity for all attributes with the exception of a medium-high risk score for trophic level. However, less is known of the status of these stocks in the Bay of Bengal.

In 1999 Devaraj *et al* indicated that all the states on the east coast of Indian over exploit stocks of scombrids by 80% higher effort than the optimum (MSY), and noted that "small meshed gillnets exploit the juvenile seerfish incidentally causing recruitment overfishing". Muthiah *et al* (2000) suggest that over 80% of seerfish catches from small-mesh (60-100 mm) gillnets have not reached maturity. So while retained fish in the gill net and beach seine fisheries in India and Sri Lanka are reasonably resilient to overfishing, it appears that increases in effort need to be considered with caution. Therefore an overall intermediate performance is achieved for these units of assessment.

No verification or information on the species associated with the gill net fisheries in Indonesia and Malaysia have been available. It is understood that they are targeting a range of demersal species using bottom set gill nets. Hutomo *et al* (2009) reports overexploitation of demersal species in the Malacca Straight and Andaman Sea. The overall performance is therefore considered weak.

Management

All gear types have a weak performance for retained species management, with the exception of purse seine in Thailand and Myanmar and bottom otter trawl in Myanmar, which achieve intermediate performance.

In general for all retained species associated with Indian mackerel fisheries, no management plans or species specific measures have been developed nor are there any measures to ensure that these species are maintained within any biologically-based limits.

None of the main bycatch species, including tuna, have undergone any formal stock assessment in the Bay of Bengal or at a larger scale for the Indian Ocean. In relation to tuna species, which are targeted by the large purse seiners, there are no formal harvest strategies and no current limitation of catches in Indian Ocean Tuna Commission (IOTC) region. IOTC has begun introducing limits on fishing capacity for some tuna species but the effectiveness of these is uncertain.

Most fisheries remain open access. Across all countries there is little in the way of input controls (licenses, effort limitation etc) or output controls (catch limitations, minimum landing sizes etc). There are minimum mesh sizes of 1 inch (25.4mm) across most of the Indonesian, Malaysian and Thai purse seine and bottom otter trawl fisheries. The introduction of increased mesh sizes are being seen in some areas (Box 1). Small mesh sizes are used in gill nets throughout the BOBLME countries and in beach seines in Sri Lanka.

Box 1: Increase mesh sizes for purse seine (Sabang, Indonesia) and bottom otter trawling fisheries (Myanmar)

A mesh size of 4 inches (102mm) is used for nets deployed around Sabang Island, Indonesia, as part of a voluntary agreement to protect spawning areas in response to the Coral Cay Conservation project that is active in the area. Such voluntary agreements are commendable; however the extent of compliance is unknown or whether any positive effects have been measurable.

In Myanmar the minimum mesh size for demersal trawling fleet was recently increased under a Regulation introduced on 1st September 2010. This increased prawn trawl nets to 1.5 inch (38mm) mesh size and finfish trawl nets to 2.5 inches (63.5mm). While these remain small mesh sizes that are likely to continue to land juveniles, it does represent a significant step in the right direction for retained (and target) species management.

Small mesh sizes have low selectivity and are not appropriate to control the volume or size of fish landed. High proportions of juvenile fish across a diverse range of species are expected to be landed to enter the fish supplement and fish oil trade. This market for 'trash' fish provides an incentive to land all species and sizes caught, which works to minimize discards but is likely to have implications for recruitment and could lead to growth overfishing and possibly ecosystem overfishing.

There are no effective management measures in place to control retained species taken throughout the BOBLME area, with two exceptions: increased mesh sizes throughout Myanmar and in one area in Indonesian waters (Box 1), and seasonal protected spawning grounds in inshore Thai waters (Box 2).

Box 2: Protected spawning grounds in inshore Malacca Strait, Thailand

Thailand operates seasonal closed areas in inshore locations, specifically to protect spawning periods for a combination of small pelagic species. The area of seasonal closure is from the coast out to the white boundary shown in the adjacent figure. The breeding of Indo Pacific mackerel have been protected by temporal closure of the Phang-nga Bay during 15 April to 15 June, since 1985.

Temporal and seasonal closures are important marine resource management strategies which are easily enforced and often accepted by fishers because of their simplicity.

Information/monitoring

Catch information is available from a number of different sources, including logbooks and sales data. These are more consistently recorded and reported for larger purse seine and trawling fleets, and in particular where produce is exported. Robust data on landings has been provided by Thailand and Malaysia documenting the volume of species and gear type; in India, Sri Lanka and Indonesia total volumes are recorded but there is little detail in relation to gear-specific records. In addition, it is likely that there is a significant level of under-reporting from smaller vessels landing outside the main ports and this will be particularly true for gill netters, small purse seiners and beach seiners. In Myanmar export data has been available and it is known that the trawling fleet maintains a logbook scheme, although data has not been available from this.

The Aceh Provincial Marine and Fisheries Agency, Panglima Laots within the Aceh Province and Syiah Kuala University, Banda Aceh worked in collaboration to collate landings data to provide catch profiles by gear type and port of landing and species and port of landing. However, data are not available for species landed by gear types. It is also unknown what levels of data are available for other Provincial areas or whether data collection can continue in Aceh Province due to lack of resources.

In general reporting of landings throughout the BOBLME could be improved, and an example of good practice from outside the region is provided in Box 3.

Box 3: UK Registration of Buyers and Sellers

The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations came into force in the UK in 2005. This implements two EU regulations:

- Council Regulation (EC) No. 2371/2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy
- Council Regulation (EC) No. 2847/93 establishing a control system applicable to the Common Fisheries Policy

This has had a significant impact on the recording of first-hand sales in the fish trade, especially for vessels under 10m. Under these regulations buyers and sellers must be registered and therefore all landings are captured in official statistics that provide an accurate representation of the UK commercial fishing industry. This has worked to provide verifiable landings data as well as reducing the level of any IUU fishing activity.

2.3.2 Discarded bycatch

Status

Discards are understood to be minimal for all the fisheries under pre-assessment in the BOBLME area.

The reasons for low levels of discards in South and Southeast Asian countries are documented by Kelleher (2005) and include:

(i) Overfishing, particularly in inshore and coastal waters;

(ii) Rising demand due to population increase, rising urban incomes and export of better quality fish;

(iii) Poverty leading to consumption of lower value food fish

(iv) Product development, e.g. production of surimi and fish oil; and

(v) Increased production of fishmeal for animal and fish feeds.

All gears and countries therefore have a good performance in relation to discard status, with the exception of Indian high opening bottom trawl which historically has a degree of discarding within the shrimp freezer trawler fleet.

Management

Given the very low level of discarding in any of the fleets, discard management strategies are largely unnecessary.

However, this is a consequence of poor management for the retained species. Efforts should be made to reduce landings of juveniles, but not by discarding them. Any management measures introduced for retained species should give due regard to the associated implications for discarding e.g. if TACs and quotas were implemented without management of high grading, discarding of smaller and/or lesser value fish could occur.

The good performance of these fisheries is a result of the lack of requirement for management. This is the case for all units of assessment, except the Indian high opening bottom trawl which has a weak performance in management of discards.

Information/monitoring

While discarding is understood to be low, there are very few records or evidence of discarding behavior from the fisheries under consideration. An observer programme across all gear types and countries (which could be linked with other research e.g. ETP species) would be a sufficient approach to bridge this gap. This is, however, of low priority for these fisheries, given the status of discarding and is likely to only be necessary should formal environmental sustainable certification be sought.

2.3.3 ETP species interactions

Status

Most capture fisheries have at least some potential to interact with ETP species. The ETP interaction profile for each gear type varies and is greatly influenced by the manner in which it is utilized. Factors such as frequency of use, duration of deployment, season, and location all play a role in defining a gear types ETP interaction profile.

The distribution of ETP species in the Bay of Bengal is reasonably well known. Four main taxa are considered in this assessment: Elasmobranchs, reptiles, marine mammals and seabirds. ETP species likely to interact with fisheries in the Bay of Bengal are listed in Table 13 which has been populated based on vulnerability assessed by IUCN Red List and the range of the species. This table does not represent an exhaustive list of potential ETP species that may interact with Indian mackerel fisheries.

Shark species included in the WCPFC Regional Plan of Action include the blue shark, oceanic whitetip shark, mako sharks and thresher sharks. A risk assessment in the Pacific Ocean (Kirby, 2006) indicates that sharks are the highest risk group in purse seines – at greatest risk are the low fecundity silky shark, short-finned mako, porbeagle, and oceanic whitetip rather than the more fecund blue shark sharks and hammerheads. Silky shark stocks are also of particular concern in the Indian Ocean. Sharks and rays are by nature slow growing, low fecundity species and thus are particularly vulnerable to over-exploitation. Sharks in general are well known to be declining in both the Indian Ocean and the Pacific.

The Bay of Bengal is rich in cetacean diversity and abundance with over 30 species of whales, dolphins and porpoises throughout the region. Other marine mammals that inhabit the Bay of Bengal include the dugong which generally frequent coastal waters in shallow protected bays and mangrove channels. These areas are coincident with sizable seagrass beds which form the main diet of dugongs. Dugongs are vulnerable to anthropogenic influences largely due to their dependence on seagrasses that are restricted to coastal habitats. Targeted hunting of dugong is now banned and habitat loss represents one of the most significant threats to this species. Accidental entangling in gill and mesh nets or traps set by fishers is considered a major, but largely unquantified, cause of dugong mortality (UNEP, 1996).

Six, out of the seven species of marine turtle in the world, are found in the Bay of Bengal: green, hawksbill, flatback, leatherback, loggerhead and olive Ridley turtles. All species are known to nest on the beaches of one or more of the Bay of Bengal countries. The principle threat to turtles is shore based due to illegal poaching and egg harvesting, but they are also incidentally caught in fishing activities notably by demersal trawling, but also gill netting. Both juveniles and adults are captured during migration and fisheries interactions are therefore considered an important threat (Sarti, 2000).

In relation to performance all purse seine fisheries, except Malaysia, are assessed as intermediate due to accepted practice of releasing of dolphins and turtles by lowering nets to allow them to escape. A good performance is not reached due to potential interaction with ETP shark species, and the Malaysian purse seine fishery scores weakly due to interactions with critically endangered sawfish species.

The beach seine in Sri Lanka has a good performance since it does not interact with any ETP species due to the inshore nature of this fishery.

Bottom otter trawl in Thailand, Malaysia and Myanmar has a weak performance primarily due to turtle interaction, but also due to incidental capture of demersal elasmobranchs. In Indonesia it is recognized that the major threat to turtles is land based and therefore an intermediate score is appropriate. In India all sea turtle species are protected with considerable financial penalties for their deliberate capture and therefore also has an intermediate performance.

Gill nets in Indonesia and Myanmar have a weak performance on account of incidental capture or entanglement of cetaceans and dugongs, as well as turtles. However, Indian and Sri Lankan gill nets have a good performance since mesh sizes are considered to be too small to ensnare turtles or marine mammals.

Table 13: ETP species in the Bay of Bengal

	Species	Status	Details - Habitat & Fisheries Threat	Country	Ref
Elasmobranchs	*Lamiopsis temmincki* (Broadfin Shark)	Endangered	Found inshore on the continental shelf (mostly close inshore). Regularly taken by fishermen in India and Indonesia in bottom and floating gill nets	All countries	White *et al*, 2008
	Sphyrna lewini (Scalloped Hammerhead)	Endangered	This is a coastal and semi-oceanic pelagic shark, found over continental and insular shelves and in deep water near to them, ranging from the intertidal and surface to at least 275 m depth	All countries	Baum *et al*, 2007
	Sphyrna mokarran (Squat-headed Hammerhead Shark)	Endangered	Mainly taken by drift gillnets, bottom gillnets and on longlines, hook and line, pelagic and bottom trawls. This species is a bycatch in both the industrial and artisanal fisheries	All countries	Denham *et al*, 2007
	Carcharhinus falciformis (Silky Shark)	Near threatened	Silky Sharks are taken in pelagic commercial fisheries and also artisanal fisheries in this region and fishing pressure from purse seine fisheries targeting tunas and swordfish is high. Silky Sharks are the most commonly caught species of shark in the purse seine fishery for tunas in the eastern Pacific Ocean.	All countries	Bonfil *et al*, 2007
	Isurus oxyrinchus (Shortfin Mako)	Vulnerable	Taken by a number of fisheries, most predominately longline, but also gill net and purse seine	All countries	Cailliet *et al*, 2004
	Alopias vulpinus (Common Thresher Shark)	Vulnerable	This species is frequently caught by offshore longline and pelagic gillnet fisheries, is also fished with anchored bottom and surface gillnets, and is a bycatch of other gear including bottom trawls and fish traps.	All countries	Goldman *et al*, 2007
	Carcharhinus longimanus (Oceanic Whitetip Shark)	Vulnerable	This formerly widespread and abundant large oceanic shark is subject to fishing pressure virtually throughout its range. It is caught in large numbers as a bycatch in pelagic fisheries, with pelagic longlines, probably pelagic gillnets, handlines and occasionally pelagic and even bottom trawls	All countries	Baum *et al*, 2006
	Carcharhinus hemiodon (Pondicherry Shark)	Critically endangered	This rare shark occurs (or occurred) in inshore localities and habitats subject to large, expanding, and unregulated artisanal and commercial fisheries.	All countries	Compagno *et al*, 2003
	Glyphis siamensis (Irrawaddy River Shark)	Critically endangered	The Irrawaddy River Shark is known from only a single specimen collected in the Irrawaddy River delta, near the city of Yangon, Myanmar. It is assumed to be euryhaline, having been recorded from brackish water, and with congeners recorded from inshore marine waters	Myanmar	Barnett *et al*, 2008
	Rostroraja alba (Bottlenose Skate)	Endangered	This is a benthic species of sandy and detrital bottoms from coastal waters to the upper slope region between about 40 to 400 m	India	Dulvy *et al*, 2006

Species	Status	Details - Habitat & Fisheries Threat	Country	Ref
Rhinobatos typus (Common Shovelnose Ray)	Vulnerable	The fins from *Rhinobatos typus* are widely considered as being amongst the most valuable of elasmobranchs (i.e., white-fin) and there is a significant incentive for fishers to remove the fins from large individuals when they are taken as either target catch or bycatch	All countries	White *et al, 2003*
Himantura fluviatilis (Ganges Stingray)	Endangered	This species is mostly restricted to freshwater habitats in the Ganges river system, extending 1,000 miles (1,609 km) above the tidal reach and from several localities, however there are also marine records of the species in the Bay of Bengal	Bangladesh, India	Compagno, 2005
Aetobatus flagellum (Longheaded Eagle Ray)	Endangered	Highly susceptible to a variety of inshore demersal fisheries, including trawls, gillnets and trammel nets. There is very high level of exploitation on the habitat that this species occurs in throughout its entire range	India & Sri Lanka	White, 2006
Aetomylaeus maculatus (Mottled Eagle Ray)	Endangered	Highly susceptible to a variety of inshore demersal fisheries, including trawls, gillnets and trammel nets which operate intensively throughout its range. All caught are retained in most areas.	All countries	White, 2006
*Aetomylaeus vespertilio (*Reticulate Eagle Ray)	Endangered	Highly susceptible to a variety of inshore demersal fisheries, including trawls, gillnets and trammel nets which operate intensively throughout its range. All individuals caught are retained in most areas.	Maldives, India, Thailand, Malaysia, Indonesia	White, 2006
Anoxypristis cuspidata (Knifetooth Sawfish)	Critically endangered	A marine, euryhaline (moving between fresh and salt water) or marginal (brackish water) species found from inshore waters to a depth of 40 m. The principal threat to all sawfishes is fisheries, both targeted and bycatch, commercial and subsistence	All countries	Compagno *et al*, 2006
Pristis clavata (Queensland Sawfish)	Critically endangered	Coastal and estuarine habitats (predominately in Australia, but potential distribution in Bay of Bengal). CITES Appendix I.	Indonesia; Malaysia; Thailand; India	Cook *et al*, 2006
Pristis pectinata (Wide Sawfish)	Critically endangered	A large (to 700 cm) euryhaline sawfish found in marine, brackish and freshwater environments. CITES Appendix I.	All countries	IUCN, 2010
Pristis zijsron (Narrowsnout Sawfish)	Critically endangered	Inhabits muddy bottom habitats and enters estuaries (Allen 1997). It has been recorded in inshore marine waters to at least 40 m depth, in brackish water (estuaries and coastal lakes) and in rivers. It is the largest sawfish species (at least 5m). CITES Appendix I.	India, Indonesia, Malaysia, Myanmar, Sri Lanka, Thailand	Compagno *et al*, 2006

	Species	Status	Details - Habitat & Fisheries Threat	Country	Ref
Reptiles	*Eretmochelys imbricata* (Hawksbill Turtle)	Critically endangered	Many threats to this species including bycatch in fisheries (gill nets and trawl) and ingestion of marine debris is also significant	All countries	Mortimer *et al*, 2008
	Caretta caretta (Loggerhead)	Endangered		Indonesia, Malaysia, Thailand, Bangladesh, Sri Lanka	MTSG, 1996
	Chelonia mydas (Green Turtle)	Endangered	Primary threat relating to legal and illegal harvesting of turtle eggs from nesting sites, also taken as bycatch in fisheries, notably shrimp trawling. CITES Appendix I.	All countries	Seminoff, 2004
	Lepidochelys olivacea (Olive Ridley)	Vulnerable	The incidental capture of Olive Ridleys occurs worldwide in trawl fisheries, longline fisheries, purse seines, gill net and other net fisheries	All countries	Grobois *et al*, 2008
	Natator depressus (Flatback)	Data deficient		All countries	IUCN 2010
	Dermochelys coriacea (Leatherback)	Critically endangered	Egg harvest and illegal poaching has removed more than 95% of the clutches, and this has been recognized as the main cause for the collapse in the Malaysia population (Chan and Liew 1996). Fishing activities using longline and driftnets are an important threat since juvenile and adult are captured in migratory routes. In some areas females are killed on the nesting beaches for oil extraction. CITES Appendix I.	All countries	Martinez, 2000
Marine mammals	*Neophocaena phocaenoides* (Finless Porpoise)	Vulnerable	The finless porpoise is found mainly in coastal waters, including shallow bays, mangrove swamps, estuaries, and some large rivers. However, it can also occur in shallow waters (< 200 m deep) quite far from shore (up to 240 km). It appears to have a strong preference for waters with a sandy or soft bottom. CITES Appendix I.	All countries	Reeves *et al*, 2008
	Orcaella brevirostris (Irrawaddy Dolphin)	Vulnerable	Irrawaddy dolphins prefer coastal areas associated with the muddy, brackish waters at river mouths, ranging offshore as far as the extent of the freshwater plume – often only a few km but more than 60 km at the Meghna River mouth in Bangladesh. Main impact in relation to fisheries is from fixed nets. CITES Appendix I.	All countries	Reeves *et al*, 2008
	Sousa chinensis (Indo-pacific Hump-backed Dolphin)	Near threatened	Most humpback dolphins inhabit coastal or estuarine waters. Chinensis-type dolphins are not known to be hunted directly in significant numbers anywhere in their range. However, they are often caught in fishing nets, such as gillnets and trawls. CITES Appendix I.	All countries	Reeves *et al*, 2008
	Dugong dugon (Dugong)	Vulnerable	Range is predominately coastal and island waters, it is vulnerable to being by caught in gill netting and also targeted hunting. CITES Appendix I.	India, Sri Lanka, Myanmar, Thailand, Malaysia, Indonesia	IUCN 2010

	Species	Status	Details - Habitat & Fisheries Threat	Country	Ref
	Tursiops aduncus (Indo-pacific Bottlenose Dolphin)	Data deficient	The species' near-shore distribution makes it vulnerable to fishery conflicts. Incidental catches occur in a number of fisheries throughout the range, including gillnets and purse seines. CITES Appendix II.	All countries	Hammond *et al*, 2008
	Stenella longirostris (Spinner Dolphin)	Data deficient	The association of spinner dolphins with yellowfin tuna results in their entanglement in tuna purse seines. CITES Appendix II.	All countries	Hammond *et al*, 2008
	Delphinus capensis (Long-beaked Common Dolphin)	Data deficient	Long-beaked common dolphin are known to be taken in bottom-set gillnets and purse seine fisheries. CITES Appendix II.	India, Sri Lanka, Thailand, Malaysia, Indonesia	IUCN 2010
Seabirds	*Puffinus pacificus* (Wedge-tailed Shearwater)	*Least concern*	These species have an extremely large range and population sizes. Despite the fact that the population trends appear to be decreasing for these species, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable	India; Indonesia; Malaysia; Maldives; Sri Lanka	BirdLife Int, 2009
	Puffinus tenuirostris (Short-tailed Shearwater)	*Least concern*		India; Sri Lanka; Thailand	BirdLife Int, 2009
	Puffinus carneipes (Flesh-footed Shearwater)	*Least concern*		Maldives; Sri Lanka; Indonesia	BirdLife Int, 2009
	*Puffinus heinrothi (*Heinroth's Shearwater)	*Vulnerable*	Very little is known about these species, although main threats are thought to occur at breeding colonies	All countries?	IUCN 2010
	*Pterodroma ultima (*Murphy's Petrel)	*Near threatened*		All countries?	IUCN 2010
	*Pterodroma externa (*Juan Fernandez Petrel)	*Vulnerable*	It is highly pelagic, rarely approaching land except at breeding colonies. It is dependent on subsurface predators, especially yellowfin tuna, to drive prey to the surface.	All countries?	IUCN 2010

Source: IUCN Red List, 2010

Management

There are a number of specific management actions taken by countries throughout the BOBLME area to protect ETP species.

The International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks), developed by FAO's Technical Working Group on the Conservation and Management of Sharks in 1999, is a voluntary agreement to promote the conservation and sustainable management of sharks and their long-term sustainable use. As a result of this National Plans of Action for the Conservation of Sharks (NPOA-Sharks) are being developed on a country basis. The NPOA-Sharks developed by Thailand and Malaysia entered implementation in 2006[9]; the Indonesian plan was drafted in 2004, but has only recently begun implementation; the Indian plan is in development and the status for Sri Lanka, Bangladesh and Myanmar is unknown. It is also noted that regional efforts to develop a management plan for shark fisheries are currently being carried out by BOBP-IGO and BOBLME.

Although not included in the Indian mackerel assessment, it is notable that the Maldives introduced a total ban on shark fishing in 2009, see Box 4 for further details.

Box 4: Maldives ban on shark fishing

In 1992 an economic analysis estimated that the revenue generated for shark based tourism in the Maldives was US$2.3 million; compared to revenue of US$ 0.7 million for the export of shark fins and meat (Marine Research Centre, 2007). With the conclusion that sharks are more valuable alive than dead, shark fishing in the Maldives was initially banned at 25 popular dive sites that have been protected under the Environmental Protection and Preservation Act. In 1998, a 10 year moratorium was then imposed on shark fishing within 20km from the atoll rims of 7 major atolls popular with dive tourists. A complete ban on fishing for any species of sharks within twelve miles from the atoll rim of all atolls of the Maldives was introduced on 1st March 2009, and has now been extended to cover all national waters.

All species of marine turtles are protected from domestic consumption and trade by national laws and from international trade through being a party to CITES. In addition there are a number of country specific measures in place to protect turtles, for example Myanmar has closed areas in inshore locations specifically to protect turtles when they are returning to breed.

Most of the BOBLME countries have at least some marine protected areas closed to fishing pressure in order to protect coral reefs and other sensitive habitats. Thailand has banned all demersal trawling fisheries within 3km of the shore to protect spawning areas. Such management measures are not specifically designed to protect ETP species, but indirectly contribute to their management. Therefore, overall the majority of countries and gears score intermediately for ETP management, with the exception of Indonesia which scores poorly due to lack of NPOA implementation and lack of Turtle Exclusion Device enforcement. Sri Lankan gill net and beach seine and Indian gill net score 'good' performance due to their limited interaction with ETP species and robust management procedures for turtle interactions.

[9] See Lack, M. and Sant, G. (2006)

Information/monitoring

There is sufficient information to broadly understand the impact of the different fisheries targeting Indian mackerel on ETP species throughout the BOBLME area. The types of ETP species, their range and distribution is also broadly understood. However, the level of interaction is not quantitatively known or even estimated, with the exception of Malaysia where turtle landings have historically been recorded. All countries and gears therefore have an intermediate performance with the exception of Malaysian bottom trawl which scores good performance.

2.3.4 Habitat interactions

Status

Fishing activities lead to changes in the structure of marine habitats and can determine the diversity, composition, biomass and productivity of the associated biota (Jennings & Kaiser, 1998). The direct effects of fishing on habitats vary according to the gears used and the habitats fished. The Indian mackerel fisheries in the BOBLME area include the following gears: purse seine, gill nets, beach seine and bottom otter trawling.

Purse seines are deployed from the surface down into the water column to various depths, depending on where the school of fish being targeted are located. Contact with seabed or reef habitats are minimal and bottom contact is actively avoided by fishermen as the small mesh nylon netting is easily damaged. Habitat status for purse seiners throughout the BOBLME area has a good performance.

Gill nets can be set on the bottom, in the water column or at the surface, depending on what species are being targeted. In all cases there will be some degree of contact with the seabed via anchors used to hold nets in position. The scale of this damage is small and unlikely to cause significant concern. Lost gill netting gear may entangle and impact sensitive habitats, notably coral reefs which can be threatened by derelict gill nets abrading and scouring living coral polyps and altering reef structure through large-scale destruction of the reefs' coral skeleton foundation (Donohue and Schorr, 2004; Macfadyen *et al,* 2009). The rates and magnitude of gill net loss in the BOBLME area (and wider Indian Ocean) remains largely unknown (Macfadyen *et al,* 2009). While an overall good performance is achieved by this gear type, further research to understand the occurrence and risk of gear loss would benefit the entire region.

The beach seine fishery in Sri Lanka is entirely undertaken over sandy and muddy habitats without any complex rocks or coral, which are specifically avoided by the fishermen since they would render the gear unusable. These habitats, much of which are within or near to the surf zone, are highly dynamic and therefore this fishing gear is likely to only cause little or very short-lived changes to the habitat. It should be noted that beach seine sites in Sri Lanka have remained fixed for many years at traditional locations and are not used in sensitive habitat areas. The beach seine fishery has a good performance in relation to habitat status.

Mobile demersal fishing gears are known to have significant potential to impact seabed habitats and biological communities. Impacts are generally greatest in habitats that support sensitive communities such as corals and seagrass beds.

With bottom trawl gears, the main impact is associated with the heavy steel trawl doors that are used to keep the net open and are towed along the seabed. The heavy nature of the gear results in physical damage to the seabed that is evidenced by scour tracks. Repeated trawling of an area can cause long-term changes in seabed communities and tends to reduce the seabed to a two dimensional structure. Long lived and slow growing species tend to be removed by multiple passes of trawls or by the effects of sedimentation as each pass of the net re-suspends sediment which then may settle on and smother sessile fauna. In this way, large, long lived and slow growing fauna are gradually replaced by small, short lived and fast growing organisms that are capable of rapid reproduction and re-colonization. The magnitude of bottom trawl impact on habitat is dependent on a number of factors including the speed of towing, physical dimensions and weight of the gear, type of substratum and strength of currents or tides in the area fished. The effects may persist for a few hours in shallow waters with strong tides or for decades in the deep sea. Overall the bottom trawl fisheries in the BOBLME area have a weak performance in relation to this impact.

Management

Both purse seine and beach seine have good performance for this component because management strategies are not necessary given the minimal impact of these gears.

While gill nets also have minimal habitat impact, there is no management structure in place across all BOBLME countries to control the potential loss of gear e.g. due to rigging and gear failure. Nor is there a code of practice for gear retrieval or reporting of lost gear incidents. For these reasons an intermediate performance is appropriate.

The bottom otter trawling fisheries in Indonesia, Thailand, Malaysia and Myanmar are managed in relation to closed areas to protect coral reefs (and other sensitive habitats) and/or spawning grounds for fish species. The latter is applicable to Thailand with the aforementioned seasonal closure to protect target and retained species spawning grounds. This represents a partial strategy in that it does not directly manage sensitive habitats, but this measure is appropriate for an intermediate performance level.

In Malaysia, habitats such as mangroves and coral reefs are managed as reserves and marine parks respectively, some of which have no take zones. Furthermore zoned licensing prevents trawling within 5nm of the shore, however there is thought to be some encroachment by trawlers into this zone.

In Indonesia and Myanmar there are closed areas specifically to manage coral reef interactions. However in Indonesia the extent and spatial distribution of protected areas is unknown, as is the level of compliance for the demersal trawl fleet to abstain from fishing within these areas.

For all of these countries the protected areas are only in certain select areas rather than providing widespread protection of these habitat types. This is partly due to lack of information on the distribution of these habitats. Furthermore attention is focused purely on coral reefs and mangrove areas and further management of other habitats would be beneficial. As a result Indonesia, Thailand, Malaysia and Myanmar all have an intermediate performance for habitat management.

In India management of the trawl fisheries is mainly through a coastal buffer zone and a short 'no fishing period'. The latter is not sufficient for habitat protection requirements and it is understood that there is regular non-compliance with the former. No other targeted spatial protection exists and therefore this fishery has a weak performance for this component.

Information/monitoring

The majority of countries have an intermediate performance in relation to habitat information. There is generally sufficient information on the occurrence of the most sensitive habitats (coral reefs, mangroves and seagrass), although the extent of coverage is not complete and mapping is not available to a scale that allows biotope identification. There is an encouraging project being undertaken in Indonesian waters which aims to map habitats (see Box 5 for further details). This level of detail provides an intermediate performance for Indonesian, Thailand, Myanmar and Sri Lanka. Information on coral reef distribution is lacking for India resulting in a weak performance for the bottom otter trawl unit of assessment.

In order to determine impact of fishing gear on habitats it is important to gain an understanding of where effort occurs, by which gear type and at what frequency. This level of detail is not available for any of the fisheries being studied, with the exception of Malaysia where zonal management provides insight into the gears operating throughout four distinct zones. For this reason Malaysian purse seine and bottom otter trawl fisheries have good performance.

Box 5: Aceh Province Community Based Bathymetric Survey

A Community Based Bathymetric Survey is currently in operation for Aceh Province through the voluntary use of sonar and GPS to map bathymetry and habitats. While significant areas have been monitored, the survey coverage is dependent on fishing vessels and therefore is not complete. This provides an excellent example of community based research to map habitat resources.

2.3.5 Ecosystem impacts

Status

The ecosystem component considers the broad ecological community and ecosystem in which the fisheries operate. The status of the previous environmental components (retained, discarded and ETP species and habitats) are not repeated but rather the system-wide issues are addressed. Primarily the indirect impacts of the fishery are considered including ecosystem structure, trophic relationships and biodiversity.

The purse seine, beach seine and gill net fisheries catch a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is no ecosystem modeling to predict impacts of removal at current rates. Overall these gears score intermediate performance as natural mortality is high for these species over early life stages.

Bottom otter trawling is a less selective gear, indiscriminately removing a wider range of species, as well as having a higher degree of indirect effects associated with habitat impacts. These trawling fisheries therefore score poorly for ecosystem status.

Management

Small pelagic species have a short population doubling time and therefore removal in large quantities may not have such a significant effect as for other species such as larger demersal fish. Despite this, the indirect effects of removing target and retained species from the food web requires some degree of management, which would also be applicable for management of retained species. For this reason gill nets, purse seine and beach seine score intermediately.

Due to the weak ecosystem status performance of bottom otter trawling, which primarily targets shrimp and demersal fish, a higher degree of ecosystem management is necessary and the fisheries overall score weakly.

Information/monitoring

There is little information on the ecological impacts of the removal of target and retained species by these fisheries and ecosystem modeling has not been undertaken. Despite this the general structure of the food web, associated trophic levels and key elements of the ecosystem are understood. Sufficient information on the overall impact of trawling gear on the wider ecosystem can be inferred and is sufficient to allow appropriate management measures to be implemented. Most of the fishing gears and countries score intermediately with the exception of Indian otter trawl and Myanmar otter trawl and purse seine fisheries where total removals are not well known.

2.4 PRINCIPLE 3: FISHERIES GOVERNANCE AND MANAGEMENT

Table 14 provides a summary of the assessment of performance for Principle 3 indicators, relating to both the general governance and policy framework (the broad, high-level context of the fishery management system within which the fisheries are found), and also to fishery specific management (noting that specific management *rules* are covered under P1 and P2). As there is no regional management of Indian mackerel at the present time, even though stocks are shared, the assessments have been completed on a national basis rather than assessing policy and management at a regional level.

Table 14: Summary table for Principle 3; Indian mackerel

		Principle 3: Governance & Management								
		Governance & Policy				Fishery specific management				
		3.1.1	3.1.2	3.1.3	3.1.4	3.2.1	3.2.2	3.2.3	3.2.4	3.2.5
Country	UoA	Legal customary framework	Consultation, roles & responsibilities	Long-term objectives	Incentives for sustainable fishing	Fishery-specific objectives	Decision-making processes	Compliance & enforcement	Research plan	Management performance evaluation
ID	PS, BOT, GN	1	2	1	0	0	0	1	1	1
TH	PS, BOT	1	2	1	0	0	1	1	1	1
MY	PS, BOT, GN	2	2	1	1	0	0	1	0	1
MM	PS, BOT	1	1	1	0	0	0	1	0	0
IN	BOT, GN	1	2	0	0	0	0	1	1	1
LK	GN, BS	1	2	1	1	0	0	0	1	0

Source: Poseidon. ID = Indonesia, TH = Thailand, MY = Malaysia, MM = Myanmar, IN = India, LK = Sri Lanka

2.4.1 Governance and policy

Legal and customary framework

For most of the units of assessment, the fisheries management system rests within an over-arching legal and/or customary framework that is broadly supportive of stock and ecosystem protection, but which could be improved.

In Sri Lanka, the fisheries law includes detailed provisions, through the appointment of a Committee of Inquiry or a Commissioner, to deal with fishing disputes. But in many other countries formal processes *enshrined in law* to resolve disputes are not in place. Many countries in the region also require revision of existing fisheries laws to better support fisheries management and to better reflect recent international developments and the need for regional action. Revision of fisheries law is a process that is underway in some countries, such as Thailand.

In a number of countries there are strong customary frameworks in place, with rights created explicitly or established by custom for people dependent on fishing for food or livelihood. Though sometimes motivated primarily by conflict mitigation, such rights often also serve to provide measures in support of resource protection. In Sri Lanka, the use of beach seines in particular locales is well-established through custom and respected within the current fisheries management regime. The *panchayat* system in Tamil Nadu in India (see Box 6) is another good example of a customary management framework continuing to be used with fisheries management benefits.

Box 6: The *panchayats* and fisheries management in Tamil Nadu, India

In Tamil Nadu in India for example, there is a traditional/customary system for artisanal fisheries management, strongly based on territoriality. The main driver of this traditional system is conflict management and resolution, rather than resource management. Fishermen of each hamlet, represented by their *panchayat*, cannot restrict who can fish (i.e. there is a system of open access and fishermen can fish within zones under the responsibility of different *panchayats*) but *panchayats* can restrict how/when fishermen fish. Non-governmental fisher councils have strong authority to restrict or prohibit gear types considered to be harmful to the stock, to other gear users and to the community as a whole. *Pancharats* for fishing village/hamlets may not be elected as is the case in 'formal' villages. So while such formal villages are provided for in law by government, fishing villages/hamlets and the decisions they make may not be, so customary rights may not be legally recognized even if they are respected.

Many countries have legal frameworks which provide for decentralization and devolved fisheries management powers. In Indonesia for example, the 1999 Autonomy Act devolves power to district and Provincial levels. In India, the Constitution provides for all fisheries management powers within territorial waters (12 nautical miles) to rest at State level. However, while decentralization in theory should enable more effective fisheries management tailored to the needs of particular locations, it is often the case that overarching national policy is not applicable in different locations, and/or that administrations at a more local level have insufficient capacity to plan, formulate and implement policies.

Malaysia's legal framework may be considered as one of the more progressive in the region. The current Act is the Fisheries Act 1985, and the regulations made under the Act provide the legal framework for the management of fishery resources and aquaculture. There is a strong deterrent mechanism within the laws, as well as a certified ISO 9000 approved, integrated licensing system. The Federal Constitution of Malaysia clearly divides the law-making authority of the Federation into its legislative authority, judicial authority and executive authority. The separation of power also occurs both at federal and state levels. The fisheries system recognizes the rights of traditional fishers and there is a sound legal system to consider and resolve disputes in addition to supporting enforcement.

Consultation, roles and responsibilities

Effective governance requires that all those involved have a clear idea of what their responsibilities and obligations are within the management system. The assessments found that, leaving aside the question of implementation, this is almost universally the case. The reason for this may be the decentralization referred to above, as well as the strongly hierarchical and structured nature of many fisheries departments. Likewise, those in research institutions tend to have clearly defined roles and responsibilities, as do those involved with enforcement activities. Thus, whether or not they have the financial resources and human capacity to undertake the specified roles, those involved know what they should be doing in support of effective fisheries management.

With respect to consultation, processes to develop policy and involvement in the management system, is also found to be good and open to interested and affected parties, again generally due to both decentralization and to traditional institutional structures which have been incorporated into the modern fisheries management process. The Box below (Box 7) provides an example from Indonesia, while in Thailand a multi-stakeholder fishery conservation committee (made up of the Department of Fisheries, research institutions, community NGOs and fishermen's representatives) receives research analysis and information each year which is then debated and recommendations are made to the Department which may then make rule changes (e.g. closed areas and seasons) where advised. Many countries, such as India and Malaysia, also have a system of fisheries extension officers meeting regularly with fishermen, which serves to support consultation.

Box 7: Panglima Laot, Aceh

Within Aceh Province in Indonesia, there are approximately 193 *Panglima Laot*, which are typically located in an estuary or a harbor. A Panglima Laot is a fishermen's institution which has played a dominant role in governing the fishing industry in Aceh for over four centuries. The traditional institution is composed of a loose network of localized fishermen associations that follow a strict set of rules and regulations. The term "Panglima Laot" is both the name of the institution as well as the title of the elder fishermen who lead the organization. The Panglima Laot communicate changes in regulations to the fishing industry. They have regular weekly meetings and provide an important framework for regular consultation between Government and fishermen.

Long-term objectives

This indicator explores the extent to which management policy has clear long-term objectives to guide decision-making that are consistent with the principles of sustainability and the precautionary approach, and assesses how implicit/explicit are any such objectives. Generally performance in all units of assessment and countries can only be considered 'intermediate' at best.

Policy in many countries in the Bay of Bengal refers to sustainable production and future generations, implying long-term objectives, and may require a 'precautionary approach' (e.g. Sri Lanka). But of particular concern (and the primary reason most countries' performance is only rated as intermediate, is that in many countries policy places a very strong emphasis on production increases. Sri Lanka, Indonesia, Thailand, Malaysia, for example, all have specific production targets specified in their policies, which may not be consistent with sustainability and a precautionary approach, especially as there remain considerable gaps in knowledge about Indian mackerel stocks. There is far less clarity in policy and management frameworks of management objectives/targets, such as increasing marine protected areas or reducing fleet capacities. Thus it appears that there may not always be the explicit recognition that there should be when setting objectives of important policy trade-offs, for example of 'short-term pain' in exchange for 'long-term gain', or trade-offs between social objectives (e.g. maximizing participation/employment) and resource management objectives (e.g. limiting access).

Policy is also often rather silent on the need for objectives in relation to cooperation with regional fishery management organizations and international conventions.

Incentives for sustainable fishing

India, Thailand, Myanmar and Indonesia are all assessed as 'weak' in terms of their performance against this indicator, as in all these countries some form of subsidies are provided which are almost certainly contributing to overcapacity in the fleets targeting Indian mackerel. The most common form of subsidy relates to cheap fuel. Subsidies of this nature distort the costs of fishing making it artificially cheap to catch fish, thereby encouraging increases in fishing effort/capacity compared to a situation without the use of such subsidies. Malaysia also scores poorly due to the welfare-related subsidy levels.

Box 8: Subsidies in Tamil Nadu, India

There are a very large number of subsidy schemes provided by the government to the fisheries sector in Tamil Nadu. One or two of these could arguably be considered as 'good' subsidies in terms of their ability to assist with resource management e.g. relief to fishermen during the ban period which encourage compliance. But almost all other schemes are of a welfare or financial nature that serves to maintain/increase fishing capacity, even if they also serve an important function in terms of poverty prevention / alleviation. The Tamil Nadu policy note for example (which is primarily only a list of fisheries subsidies/support programmes) includes subsidies for both motorization of vessels and for fuel. There appears to be no mechanism by which the impact of such support is evaluated in terms of its impact on resource sustainability.

In Thailand, and to a lesser extent in some other countries, the heavy reliance on trash fish to support fish meal and other processing, has meant that mesh sizes used in both the fish and shrimp trawl sectors have been maintained at a level that results in very high levels of bycatch. The high demand for trash fish incentivizes the use of small mesh and there has been little done to counteract this.

Sri Lanka and Malaysia's performance is scored as weak, because although they do not provide any 'negative' subsidies, they also do not provide any subsidies which might be construed as 'positive' in the sense of encouraging and incentivizing changes to more sustainable fishing methods e.g. funds for gear selectivity improvements, moves towards rights-based management (i.e. transferable quotas) in Indian mackerel fisheries.

A note should also be made with regards to post-tsunami support. While the need for free/cheap fishing inputs (boats, fishing gear) in the region was absolutely necessary due to the devastating impact of the tsunami on the fisheries sector, it is also true that the provision and re-equipping of those in the sector, however well-intentioned, could/should have been better planned so as to guard against excess fleet capacities (and the resulting risks to resource sustainability). And while it is also certainly the case that many marginalized fishers have still not recovered from the livelihood effects of the disaster, continuing post-tsunami support in some countries should be carefully evaluated to assess its impacts on sustainability and the danger of incentivizing over-exploitation.

2.4.2 Fisheries-specific management systems

Fishery-specific objectives

This indicator assesses whether the units of assessment for Indian mackerel have clearly articulated objectives that serve to emphasize sustainability, the precautionary approach, ecosystems-based management etc. A best case scenario for example would be one in which such objectives were clearly articulated as part of a fisheries management plan (along with decision-making processes, compliance and enforcement arrangements, research, and monitoring/evaluation of the plan i.e. the following indicators). In none of the countries or units assessed is this the case, and all units of assessment therefore have a weak performance for this indicator.

This may in part be explained by the fact that for some countries, such as Sri Lanka, Indian mackerel catches are very small in absolute terms (as well as being just a couple of percent of small-pelagic catches). Perhaps more important is the multi-species nature of many fisheries in the region, with Indian mackerel generally caught as bycatch in multi-species small pelagic fisheries. Only on the west coast of Malaysia are *Rastrelliger* spp. the predominant group in mixed catches (both *Rastrelliger brachysoma and Rastrelliger kanagurta).* For all other units of assessment, Indian mackerel is just one of, and generally a relatively small component of, the many species landed. This means that developing species-specific management plans for Indian mackerel has not been a priority in the region.

But the assessments found that none of the countries even have 'small pelagic management plans', which could serve to clearly articulate fishery-specific objectives of such multi-species fisheries (rather than general objectives associated with broader fisheries policy), and which might serve to guide fisheries management of Indian mackerel (and other small pelagic species) so as to ensure sustainable exploitation. The situation is particularly worrying in some countries such as Sri Lanka, where objectives consistent with sustainability are not even implicit given that there are no management regulations at all aimed at regulating effort or catches in the small pelagic fishery, and not even any minimum mesh sizes in operation. Most of the units of assessment are in a similar position, and are characterized by open-access. There are however some positive signs of movement towards fisheries-specific management plans which would include fishery-specific objectives, as described in the Box below (see Box 9).

Box 9: Fisheries management plans in Indonesia

Indonesia has a requirement, as part of its National Law 31/2004 to implement fishery specific management plans. The Ministry has identified 44 management units in 11 fishery management areas. Each unit is divided into demersal, shrimp, small pelagic and tunas. Currently three test cases are being explored by the Ministry for implementation via management groups that are being set up for each case study. At the present time however there is no Indian mackerel specific management plan, nor one covering all small pelagic species.

Decision-making processes

The comments made above on the indicator for fishery-specific objectives, generally apply also to fishery-specific decision-making processes, in the sense that there are no Indian-mackerel-specific processes in place to decide how best to manage the fisheries in a way that responds quickly and effectively to research, stock assessment advice, etc, and that result in measures and strategies to achieve the objectives. The assessments therefore result in weak scores across all units of assessment.

If Indian mackerel (or small-pelagic) fisheries-specific management plans were in place for example, one could envisage such plans stipulating decision-making processes such as the composition and responsibilities of Indian mackerel (or small pelagic) working groups. But this is not the case at the present time.

Compliance and enforcement

Assessment of the compliance and enforcement of relevant regulations in Indian mackerel fisheries suggests intermediate performance in most countries in the region. It is frequently the case that budgets for Monitoring, Control and Surveillance (MCS) operations are insufficient, and that there is a lack of adequate planning of MCS operations so as to ensure the greatest benefit from scare financial resources. Sanctions may not always be applied in a consistent and transparent manner, and thus do not always act as a sufficient deterrent. The result in mixed levels of compliance in many of the fisheries assessed.

However there are also some positive aspects to compliance and enforcement in the region. The MCS system in Malaysia for example has a hull color coding system that enables prompt establishment of a vessel's right to fish in a certain area. In Tamil Nadu, compliance and enforcement of larger vessels operating in harbors is considered to be relatively effective, especially with regards to the main management measure which is the fishing ban period; fishing vessels are required to obtain a token from the government to obtain subsidized fuel, and such tokens are not provided during the ban period. This provides a strong financial incentive for compliance, and it is of course very easy to determine whether a fishing vessel is fishing or not. And in both Indonesia and India, the traditional *Panglima Laot* and *Panchayat* systems serve to support enhanced compliance. Other community-based measures of a more recent nature are also being developed, and could serve as a useful model for replicability within the region (see Box 10).

Box 10: Pilot community-based MCS in Thailand

There are approximately 20 pilot MCS groups operating at the Tambon level. These groups are trained and provided with basic equipment – binoculars, life jackets and radios – to police their own zones. The initiative for the MCS pilot projects came from fishers and follows the EU-funded CHARM project in which community groups were engaged in community-based fisheries management (CBFM).

Despite these encouraging examples, it is generally the case across the region that enforcement activities could be much improved if documented risk-based (MCS) plans were prepared annually focusing on locations, seasons, and stakeholders felt to be of special concern in terms of compliance. Such plans could also help to further articulate roles and responsibilities of those engaged in enforcement activities, and could at some stage in the future incorporate regional initiatives such as joint deployment plans.

Research plan

Fisheries-specific management requires fisheries-specific research so as to address the information needs of management, and to provide research in a timely and reliable manner.

Performance for this indicator is generally scored as intermediate. It is undoubtedly the case that there are very many high-qualified and experienced fisheries researchers based in the various research institutions in the region. There are also some research topics that are well researched and documented.

However, none of the countries have documented Indian mackerel (or small pelagic) fisheries-specific research plans, and there remain considerable research gaps. In many countries ‘research plans’ to the extent that they exist at all, are purely the annual research plans/budgets prepared by the research institutions, rather than research plans justifying particular research topics and explaining their link to management needs. It is also the case that in a number of countries research outputs are now reliant on data that is considerably out of date. Earlier sections in the report have already highlighted a number of weaknesses in research and information on both fish stocks and ecosystems.

Research on small-pelagic species is typically neglected in favor of the use of scarce financial and human resources for research on other species viewed as being of greater commercial significance (e.g. large tunas, demersal and shellfish stocks). To some extent this may be justified, although the very significant socio-economic importance of small-pelagics in terms of food security should not be forgotten, but the use of scare resources to cover research across all fisheries further justifies the need for species-specific research plans which are strategic in focusing on key research needs for individual fisheries. Thus for Indian mackerel and small-pelagic species more generally, carefully justified and documented research plans would be a significant step forward in providing key information needed for management. Such plans, as part of, or linked to wider Indian mackerel or small-pelagic management plans, could also be effective in seeking funding from both government and bilateral/international donors, as they would demonstrate and justify the need for particular research in support of management.

Management performance evaluation

This indicator considers whether there is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives, and whether there is effective and timely review of the fishery-specific management system. Performance against this indicator is to some extent self-evidently weak, given that there are no fisheries-specific management systems to evaluate. For this indicator we have therefore taken a slightly broader view of the extent to which fisheries management performance in general is evaluated.

Some positive examples of performance evaluation of a more general nature are evident in the region. In Indonesia, the Ministry provides a guide for consistent implementation of fisheries policy and management according to general fisheries legislation and implementation of this is checked, National to Province, and Province to District, through annual audit processes. In India, there are various internal evaluation mechanisms in place in the Fisheries Department whereby staff at state level monitor district level staff and their activities. In addition, where the Ministry of Agriculture at national level provides funds for specific activities, evaluators/monitors from the Comptroller Auditor General periodically check on the implementation of activities in terms of both budget expenditure and effectiveness.

But despite these examples, performance for this indicator can only be scored as intermediate in the best cases. There is a general failure in the region to set and then assess performance against any defined and measurable objectives and indicators.

This failure could be resolved through documented monitoring and evaluation plans (linked to, or part of management plans). In this context it is helpful to consider separately monitoring indicators and evaluation indicators - although they are often referred to together (i.e. as M&E indicators), as the purpose and characteristics of the two are rather different.

Monitoring indicators should be used for the continuous frequent measuring of the extent to which the activities specified in the policy and management framework are being successfully completed. Generally, managers with responsibility for policy implementation use indicators to assess outputs and progress. Monitoring indicators can then be used to take corrective action on implementation through appropriate feedback mechanisms i.e. by highlighting that a specific activity is being carried out too slowly. Monitoring indicators can therefore be viewed as process indicators. Evaluation indicators on the other hand are used to measure results/impacts/benefits. They can be considered equivalent to ‘policy/management impact indicators’, and are generally strongly focused on performance. Usually assessments should be made less frequently, and at the mid-term and final stage of a policy planning period i.e. after 2.5 years, and again after 5 years, if a formal policy/management review process takes place every five years.

2.5 CONCLUSIONS - KEY STRENGTHS AND WEAKNESSES

As evidenced from the two tables below (Table 15 and Table 16), there is a wide variety of performance against the different indicators between the different units of assessment. Section 2 has highlighted a number of key strengths in some countries/fisheries, but overall there remains much room for improvement. This is perhaps particularly the case for Principle 1, where indicators of Indian mackerel stock status, and the specific harvest/management strategy, generally provide considerable cause for concern despite the generally robust nature of a small-pelagic species such as Indian mackerel.

Performance against Principle 2 is more generally positive, but again, considerable weaknesses exist in the status of some critical habitats, endangered species, and retained bycatch species. On a positive note is the fact that there are virtually no discards in the fisheries assessed.

For Principle 3, with respect to the overall governance and policy framework, while some improvements would be useful, performance against the indicators is generally reasonable for the legal and customary frameworks in place, the levels of consultation and the clarity in the roles and responsibilities of those involved in management, and the nature of long-term objectives (save for a failure to resolve conflicting policy objectives and a strong emphasis on production increases). Of special concern however is the continued use of subsidies which serve to increase fishing capacity/effort, and few positive incentives provided for greater sustainability e.g. gear selectivity, rights based mechanisms. Performance against the fisheries-specific management system is generally much weaker, with virtually no specific objectives, decision-making process, research plans, MCS strategies, or performance evaluation, for either Indian-mackerel management in particular, or even for management of small-pelagic species more generally.

Table 15: Average scores by Principles -Indian mackerel

Country	Unit of Assessment	P1 average	P2 average	P3 average
ID	Purse seine	0.17	1.13	0.78
ID	Btm Otter trawl		0.73	
ID	Gill nets		0.87	
TH	Purse seine	0.33	1.33	0.89
TH	Btm Otter trawl		0.80	
MY	Purse seine	0.17	1.27	0.89
MY	Btm Otter trawl		0.93	
MY	Gill nets		1.07	
MM	Purse seine	0.17	1.13	0.44
MM	Btm Otter trawl		0.73	
IN	High opening bottom trawl	0.50	0.40	0.67
IN	Gill nets 50-65mm		1.27	
LK	Small mesh gillnet	0.33	1.27	0.67
LK	Beach seine		1.33	

Source: Poseidon. ID = Indonesia, TH = Thailand, MY = Malaysia, MM = Myanmar, IN = India, LK = Sri Lanka

Table 16: Summary assessment for all Principles and indicators; Indian mackerel

Principle 1

		Principle 1: Stock status						
		Outcome			Harvest strategy			
		1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4
Country	UoA	Stock status	Reference points	Stock rebuilding if necessary	Performance of Harvest Strategy	Harvest control rules and tools	Information and monitoring	Assessment
ID	Indian mackerel	0	0	*	0	0	1	0
TH	Indian mackerel	0	0	*	0	0	1	1
MY	Indian mackerel	0	0	*	0	0	1	1
MM	Indian mackerel	0	0	*	0	0	1	0
IN	Indian mackerel	1	0	*	0	0	1	1
LK	Indian mackerel	2	0	*	0	0	0	0

Principle 2

		Principle 2: Ecosystem impacts														
		Retained			Discards			ETP			Habitat			Ecosystem		
		2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.3.3	2.4.1	2.4.2	2.4.3	2.5.1	2.5.2	2.5.3
Country	UoA	Retained status	Retained management	Retained info / monitoring	Discards status	Discards management	Discards- info / monitoring	ETP status	ETP management	ETP info / monitoring	Habitat status	Habitat management	Habitat info / monitoring	Ecosystem status	Ecosystem management	Ecosystem info / monitoring
ID	Purse seine	1	0	1	2	2	1	1	0	1	2	2	1	1	1	1
ID	Btm Otter trawl	0	0	1	2	2	1	1	0	1	0	1	1	0	0	1
ID	Gill nets	0	0	0	2	2	1	0	0	1	2	1	1	1	1	1
TH	Purse seine	1	1	2	2	2	1	1	1	1	2	2	1	1	1	1
TH	Btm Otter trawl	0	0	2	2	2	1	0	1	1	0	1	1	0	0	1
MY	Purse seine	1	0	2	2	2	1	0	1	1	2	2	2	1	1	1
MY	Btm Otter trawl	0	0	2	2	2	1	0	1	2	0	1	2	0	0	1
MY	Gill nets	0	0	2	2	2	1	0	1	1	2	1	1	1	1	1
MM	Purse seine	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0
MM	Btm Otter trawl	0	1	1	2	2	1	0	1	1	0	1	1	0	0	0
IN	High opening bottom trawl	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0
IN	Gill nets 50-65mm	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Small mesh gillnet	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1
LK	Beach seine	1	0	1	2	2	1	2	2	1	2	2	1	1	1	1

Principle 3

		Principle 3: Governance & Management								
		Governance & Policy				Fishery specific management				
		3.1.1	3.1.2	3.1.3	3.1.4	3.2.1	3.2.2	3.2.3	3.2.4	3.2.5
Country	UoA	Legal customary framework	Consultation, roles & responsibilities	Long-term objectives	Incentives for sustainable fishing	Fishery-specific objectives	Decision-making processes	Compliance & enforcement	Research plan	Management performance evaluation
ID	PS, BOT, GN	1	2	1	0	0	0	1	1	1
TH	PS, BOT	1	2	1	0	0	1	1	1	1
MY	PS, BOT, GN	2	2	1	1	0	0	1	0	1
MM	PS, BOT	1	1	1	0	0	0	1	0	0
IN	BOT, GN	1	2	0	0	0	0	1	1	1
LK	GN, BS	1	2	1	1	0	0	0	1	0

Ranking	
Good	(green)
Intermediate	(amber)
Weak	(red)

Source: Poseidon. ID = Indonesia, TH = Thailand, MY = Malaysia, MM = Myanmar, IN = India, LK = Sri Lanka

3 REGIONAL SYNTHESIS – HILSA SHAD

3.1 OVERVIEW

3.1.1 Biology of the hilsa shad

The hilsa shad, *Tenualosa ilisha*, is a clupeid (i.e. of the herring family) and is an anadromous species (e.g. spawns in freshwater but has a significant seawater growth phase), although two other eco-types - a fluvial potamodromous type (i.e. migrates in freshwater only) and a marine type - have also been recognized. It is found in the Tigris River basin in the Arabian / Persian Gulf on the west eastward to Myanmar, although may rarely be found as far east as the Gulf of Tonkin in Vietnam (see FishBase for more information on the geographical distribution).

During the breeding season hilsa ascend the rivers and after spawning, return to the original habitat where they remain till the next breeding season. The riverine stocks appear to remain in the freshwater areas throughout the year but there is a greater concentration in the lower reaches during the period between breeding seasons (Pillay and Rosa, 1963), thus indicating that one segment of the population is not truly anadromous. During the marine phase of their life they are mainly found in nearshore waters, although may be dispersed in the wider areas of Bay of Bengal and extended up to 200-250 km from the coastline (Milton, 2010).

The upstream migration during the main breeding season appears to depend largely on the commencement of the south-west monsoon and consequent flooding of all the rivers of Bangladesh, Myanmar and India. The variations in the intensity of the monsoon during the breeding season appear to cause considerable fluctuations of the fish catches in different places. According to Day (1873) the minor breeding migration in March-April in the upper Irrawaddy takes place when the rivers are flooded by melting snow, not by monsoon rains.

Figure 4: Hilsa shad, *Tenualosa ilisha*

Source: FishBase

The extent of migration in the rivers varies considerably. In the Irrawaddy, hilsa is known to ascend to a distance of over 700 km from the sea. The range of migration in the Brahmaputra is up to Tezpur, a distance of about 306 km from the Bangladesh border. The stock of hilsa in the river Ganga is reported to migrate as far as Agra and Delhi, covering a distance of about 1 287km. In West Bengal, hilsa once ascended the Hooghly River for about

298 km, but with the building of the Farakka Barrage in 1974, the hilsa catch has declined to less than 1 kg/km above Farakka Barrage after its commissioning as compared to the pre-Farakka (11.61 kg/km) scenario (Ghosh *et al*, 1978).

Pillay *et al* concluded through a combination of tagging studies and morphometric comparisons that hilsa populations show little or no movement between rivers, with little intermingling of populations (Pillay *et al*, 1962; and Pillay *et al*, 1963). More recently hilsa from the Ganga, Yamuna and Hooghly rivers were sampled using DNA-based genetic analysis, which showed the existence of genetic variation within and between hilsa populations in these rivers, indicating the presence of sub-populations that may be due to differing environmental conditions in each river system (CIFRI, 2008). Therefore, despite recent conclusions that there is one main hilsa stock in the Bay of Bengal (Hussain *et al*. 1998; Milton & Chenery, 2001; Salini *et al*, 2004), care should be taken to preserve the identity of sub-populations, especially if hatchery-based restocking is to be considered.

The fish is known to be a fast swimmer (Southwell and Prashad, 1918). Tagging experiments have shown that a fish may cover as much as 70.8 km in one day (Pillay *et al*., 1963). According to Mojumdar (1939), hilsa move in the sea on the surface whereas in the river they move at a depth of 14 to 18 metres, though on a cool or drizzly day they may rise to within 2 metres from the surface. During migrations upstream, the fish do congregate, but they have never been observed to form very dense schools as observed in the case of many pelagic fishes. During winter months, however, they have been found to form very large schools at the entrance of the Hooghly estuary.

A **Productivity Susceptibility Analysis** (PSA) was undertaken utilizing the risk-based approach to fisheries assessment developed by the MSC. The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities. Productivity is the average of seven attributes, while susceptibility is the product of four aspects. MSC's PSA process examines the productivity of each species and then factors in the susceptibility to different gears, thus coming up with a composite 'risk' for each species / gear composition.

Hilsa scores highly on all seven *productivity* attributes (see table below), and thus in terms of its physiology and reproductive strategy, can be considered a highly productive species.

Table 17: Hilsa - key productivity attributes

Attribute	Hilsa	Risk level	Source
Av. age at maturity	9 months – 1 year	Low	GC Halder, pers. comm.;
Av. maximum age	5 – 6 years	Low	FishBase
Fecundity	450,000 to 2,000,000	Low	Rahman *et al*, 2010
Av. maximum size	60 cm	Low	Fishbase
Av. size at maturity	20 cm	Low	Haldar & Rahman, 1998
Reproductive strategy	Broadcast spawner	Low	GC Halder, pers. comm..
Trophic level	2.04	Low	FishBase

When the *susceptibility* to different fishing gears is introduced, the overall risk from fisheries can be determined. The table below shows that large-mesh gillnet fisheries tend to be lower risk because of the lower proportion of the distribution fished (thus reducing availability score) and the lower level of encounterability (the gillnet only fishes surface waters in the deeper estuarine and marine waters). Otherwise, despite the larger mesh size, selectivity and post-capture mortality is broadly the same. Similarly Myanmar purse seine fisheries, which are only operated at sea, have a lower chance of catching hilsa and therefore a better availability score. Furthermore, the recent increase in mesh size to 2.5 inches allows a relatively better selectivity score. The smaller mesh gillnet fishery scores poorly on all elements of the analysis, as much of the available area is fished with a high level of encounterability (e.g. the net covers much of the water column), with a low level of selectivity from the small mesh sizes used and the lack of discards and the high level of post-capture mortality. However, because of the resilience of hilsa as a species, the overall risk to hilsa is considered medium i.e. could be addressed through improved management conditions.

Table 18: Gear-wise PSA table for hilsa shad in the Bay of Bengal fisheries

Country & gear type		Productivity								Susceptibility					PSA Scores		
Country	Gear type	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
India	Gill nets (min 12mm)	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Gillnets (min 85mm)	1	1	1	1	1	1	1	1.00	2	2	3	3	1.88	2.13	Low	>80
Bangladesh	Gill nets (<60mm)	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Gillnets (>60mm)	1	1	1	1	1	1	1	1.00	2	2	3	3	1.88	2.13	Low	>80
Myanmar	Purse seine	1	1	1	1	1	1	1	1.00	2	3	2	3	1.88	2.13	Low	>80
	Gillnets	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Stow nets	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80

<u>Availability</u>: overlap of species range with fishery

<u>Encounterability</u>: overlap of gear with fish distribution in the water column

<u>Selectivity</u>: selectivity of gear and likelihood of capture

<u>Post-capture mortality</u>: whether fish is retained (or dead if released)

In a separate PSA analysis for hilsa in the Bay of Bengal, Milton (2010) examined a range of weighted susceptibility and productivity attributes, including (for susceptibility) the effect of river flows, protected areas and the life stages fished. The results of the PSA analysis show that there is great uncertainty in the status of trends in the attributes from India and Myanmar (see Table 19 overleaf).

Table 19: PSA for hilsa

Criteria	Weighting	India	Bangladesh	Myanmar
Susceptibility				
Adult habitat quality	3	1	1	*2*
Juvenile habitat quality	3	1	1	*2*
Life stages fished	3	2	3	*2*
River flows	2	1	1	*2*
Protected areas	2	2	3	*2*
Range	2	*2*	2	*2*
Overall susceptibility		**1.47**	**1.80**	**2.00**
Productivity				
Probability of breeding	3	*2*	2	*2*
Mortality index	1	*2*	1	*2*
Age composition	2	*2*	1	*2*
Fecundity	3	*2*	1	*2*
Commercial catch rates	3	*2*	1	*2*
Growth rates	2	*2*	2	*2*
Overall productivity		**2.00**	**1.36**	**2.00**

Source: Milton (2010) NB: Numbers in *italics* have not been investigated in detail

3.1.2 Description of main fleets and gears, and 'units of assessment'

The main fleets and gears catching Hilsa shad in countries/areas in the BOB which have been examined by the consultants, are described in the table below (Table 20), along with the 'units of assessment' for which performance has been assessed. As can be seen from the table, these mainly consist of gillnets of various mesh sizes, although fishers in Myanmar also use purse seines (in marine waters only) and stow nets in rivers.

Table 20: Main fleets/gears targeting Hilsa shad, and units of assessment

Country/ Area	Description of main fleets/gears catching Hilsa shad	Units of assessment considered in this report
West Bengal (India)	• The main gear used to catch hilsa are drift or set gillnets (accounting around 96% of production), with the balance being "traditional" gears such as the clap net (*sangla jal*). The majority of these are multifilament, although a small proportion (c. 7%) are nylon monofilament nets. Mesh sizes vary from 15 to 140mm, but are more normally in the range of 75 to 85mm. The minimum legal mesh size is 12mm in riverine areas, except during the breeding season (15th June – 30th September) when this is increased to 25mm. In the estuarine and marine areas, the minimum mesh size is 85mm. Other gears of only minor importance in terms of catch volumes are the *behunti jal*, a stationary bag net with a wide mouth of 27m and with very small cod end of mesh size (about 2mm), *char-pata jal*, a screen barrier with a very small mesh for harvesting juveniles, and *sitki jal*, a skimming net made up of polyethylene netting	• Gillnets (both drift and set) in West Bengal with a minimum mesh size of 12mm targeting hilsa and other species in riverine waters (operated predominantly by unmechanised vessels). • Gillnets (both drift and set) in West Bengal with a minimum mesh size of 85mm targeting hilsa in estuarine and marine waters (operated predominantly by mechanized vessels) The numerous other small gear types used in the riverine areas

Country/ Area	Description of main fleets/gears catching Hilsa shad	Units of assessment considered in this report
	of mesh size of about 2mm for collecting fry. • Around ¾ of boats targeting hilsa in West Bengal are unmechanised and largely (80%) made of wood. These are usually fishing in the riverine areas over day trips. The rest of the fleet is mechanized and works multi-day (5-10 days) trips in estuarine and marine areas.	are not considered by the assessment given the very small percentage of the catches by these gears
Bangladesh	• The main fishing gears are the drift gillnet (*Gulti* or *Kona Jal*) which takes around 75-80% of the catch, the set gill net (*Chandi jal*) which takes around 10-15% of the catch, and the monofilament drift gillnet (*current jal*) which takes around 5% of the catch. In addition there are numerous other small gears that are used to catch hilsa (and other fish), including the seine net (*Jagat ber jal*), fixed encircling net (*Char ghera jal*), etc. Mesh sizes must be at least 90mm, with the exception of the current jal which must have a mesh size of at least 100mm. However there is widespread use of smaller mesh sizes (50-60mm) gillnets used in the rivers over February – March targeting new recruits to the fishery despite the ban on fishing juvenile fish and the minimum mesh size of 90cm. The marine fishery targets adult fish utilizing a wide variety of mesh sizes (65 – 120 mm), mainly over July to September • Vessel types similar to those in West Bengal	• Gillnets in Bangladesh (both drift and set) with a mesh size of 40–60mm targeting juvenile hilsa (*jatka*) in riverine waters (operated predominantly by unmechanised vessels) • Gillnets in Bangladesh (both drift & set) with a min. mesh size of 60-120mm targeting adult hilsa in estuarine and marine waters (operated predominantly by mechanized vessels). The numerous other small gear types used in the riverine areas are not considered by the assessment given the very small percentage of the catches by these gears
Myanmar	• Purse seine are mobile gear that consist of a large netting wall which is set by the vessel from the surface to surround aggregated fish, both from the sides and underneath, thus preventing them escaping from the bottom of the net. • Gill nets are stationary gear consisting of a single netting wall kept more or less vertical by a float line and a weighted ground line. The net is generally set on the bottom when targeting demersal species and from the top when targeting pelagic species. • Stow nets are stationary gear made from very fine netting, with mesh sizes typically 12mm. The nets are fixed to the benthos by anchors or stakes and placed according to the direction and strength of the current (FAO, 2010). The net endings, which are in a cone or pyramid shape, are usually hauled by hand while the body and stakes are left in position. As a consequence the gear can remain in the same location for a long period of time, with emptying of the conical ends on a regular basis.	• Purse seines in Myanmar set in marine waters • Gillnets in Myanmar (both drift and set) with a mesh size of 25–65mm in river mouths and estuaries • Stationary stow nets set within rivers from very fine netting, with mesh sizes typically 12mm

Source: Poseidon. NB Hilsa is not caught commercially in other countries/areas in any meaningful volumes

3.1.3 Current effort, catches (volume & value) and socio-economic importance

Summary information on vessel numbers catching hilsa, catches (volumes and estimated values, and CPUE trends), and main markets, is provided in the table below (Table 21). The table shows:

- CPUE trends show declines and indicate overfishing on stocks;
- Hilsa fisheries are particular important in Bangladesh in terms of vessel numbers and catch volumes/values; and
- While there are some exports, hilsa is mostly consumed domestically in the countries in which it is caught.

Hidden with the catch data provided in the table is an important shift in the relative importance of marine and inland catches in each country. In both West Bengal and Bangladesh, inland catches have been contributing a decreasing proportion of total hilsa catches over time. The main causes are likely to be increasing levels of pollution and sedimentation in riverine systems, and reduced water flow from upstream (which results in the drying-up of rivers, and saline intrusion). Also not reflected in the table is that yearly/cyclical fluctuations in catches due to environmental conditions, can be very considerable.

Table 21: Vessel numbers, catches, and markets for Hilsa shad

Country/ Area	Estimated vessel numbers (trends)	Estimated catch volumes (trends)	CPUE trends	Estimated catch values	Main markets
West Bengal (India)	Not accurately known but >20,000 (increasing)	<20,000 (declined rapidly in recent years)	Decreasing	INR 2 billion/ $50 million (2008)	Mostly domestic
Bangladesh	c. 100,000 inland and 25,000 marine	298,921 tonnes in 2008-2009 (increasing)	Decreasing	Tk 45-60 billion / $640-850 million (2009)	Mostly domestic, but also some exports
Myanmar	Not known	Volume consumed domestically is not known; 12,606 tonnes exported, 2009	Not known	Value of fish consumed domestically is not known; US$20.4 million exported, 2009	Domestic and export

Source: Poseidon.

The hilsa fisheries in all three countries/areas, but especially in Bangladesh and West Bengal, play a critical role in terms of the generation of employment and income. In Bangladesh for example, while exact numbers of people involved with hilsa fisheries (catching, processing/marketing, etc) are not reliably known, some recent estimates have suggested around 500,000 fishers may catch hilsa and another 2-2.5 million people indirectly involved in the distribution and sale of hilsa, as well as in ancillary activities such as net and boat making, ice production, processing and export (Rahman *et al*, 2010). The socio-economic status of most hilsa fishermen can be categorized as socio-economically disadvantaged in terms of access to services (education, health, banking, electricity, piped water), and income. However, given the relatively high value of hilsa given strong local demand, the hilsa fishery may provide higher daily incomes than when fishing for many other species.

3.2 PRINCIPLE 1: STOCK STATUS AND MANAGEMENT

Table 22: Summary table for Principle 1 - Hilsa shad

Principle 1			Principle 1: Stock status						
			Outcome			Harvest strategy			
			1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4
	Country	UoA	Stock status	Reference points	Stock rebuilding if necessary	Performance of Harvest Strategy	Harvest control rules and tools	Information and monitoring	Assessment
	MM	Stock 1	1	0	*	0	0	0	0
	BD	Stock 1	0	0	*	1	1	1	1
	IN	Stock 1	0	0	*	0	0	0	0

Source: Poseidon. MM = Myanmar, BD = Bangladesh, IN = India

3.2.1 Stock status/outcome

Stock status

For the purpose of this assessment, we have assumed that there is a single stock of hilsa shad in the Bay of Bengal (see Section 3.1.1 on page 50 for more discussion). Hilsa are a robust and productive species by nature (see the PSA in Table 17, also Section 3.1.1) but are under intense regional fishing pressure. The limited studies to date suggest that that hilsa are almost certainly over-exploited in both West Bengal (Nath *et al,* 2010) and Bangladesh (Milton, 2010), mainly due to the high levels of juvenile exploitation during their estuarine and riverine migration phase, mainly by small-mesh gillnets. There are also suggestions that the productivity of the Bangladesh hilsa population appears to be declining. The cause of this decline is unclear and a more detailed ecosystem-wide analysis would be required to identify the key ecosystem components or services that may be affecting hilsa productivity. It is important to recognize that the Ganges/Brahmaputra and Irrawaddy deltas are all subject to considerable environmental change, largely stemming from over-abstraction of water within the watershed as a whole, a large numbers of pollution points within the river system as well as a physical barrages that is likely to further inhibit recruitment success (Madhumita Mukherjee, ARHMC, pers. comm., 2010; Bill Collis, WorldFish Bangladesh, pers. comm., 2010).

In summary, the stock status of hilsa in the Bay of Bengal is considered weak. However, given its inherent productivity, it should respond rapidly to robust conservation measures embedded in a regional recovery plan.

Reference points

Although various estimates of B_{MSY} have been calculated, mainly based on large length-frequency (L-F) analyses (see Amin, 2008 & Milton, 2010), no biomass-based reference points have been utilized for management of hilsa stocks in the Bay of Bengal. The main reference point that has been adopted in Bangladesh is the exploitation rate (E). This has been calculated since 1995 where it has varied between 0.55 and 0.66 up to 2003. Given the complexities involved in measuring hilsa abundance, the current length-frequency based stock assessments used in Bangladesh are a realistic and practical approach given data limitations. Despite this, it is considered that the current use of reference points is weak, and that - considering that this is considered a single stock for management purposes - the development of regional management reference points for this stock would be a useful management approach.

Stock rebuilding

Despite the acknowledged recruitment over-fishing of the hilsa stock, there is no evidence that the stock is currently depleted e.g. the stock has been driven by over-fishing to the level that there is a drastically reduced spawning stock biomass and reproductive capacity. India does not currently have a rebuilding plan, although a 'National Plan of Action' has been developed by CIFRI in Barrackpure (Singh & Sharma, 2008) but is yet to be implemented. Bangladesh has been implementing a Hilsa Fisheries Management Action Plan (HFMAP) since about 2003 with some notable success. Regional conservation work is addressed both by BOBP-IGO and BOBLME.

As the stock is not yet at a stage where it needs rebuilding, this PI was not scored for any of the fisheries. However it is recognized that a regional stock conservation and recovery plan is required (see stock status elements above).

3.2.2 Harvest strategy / stock management

Performance of harvest strategy

Bangladesh has a defined harvest strategy within the Hilsa Fisheries Management Action Plan (HFMAP) and is based on the understanding that recruitment is being compromised by over-fishing of juveniles in riverine areas and it is necessary to respond to this in a practical way that recognizes the socio-economic dependencies that have evolved to the fishery, and the difficulties of enforcement (requiring a strategy based on ban period that is relatively easy to monitor compared to other potential strategies). The main elements of the strategy – spatial and temporal protection of critical spawning grounds as well as precautionary minimum mesh sizes – are well proven but there is some concern over the adequate scale of the former and compliance levels with the latter. As such, Bangladesh's harvest strategy is scored as 'intermediate'.

Neither India nor Myanmar have an effective strategy to reduce fishing effort or mortality. Both have minimum mesh size rules and India has a seasonal marine fishing ban, but these measures are not sufficient to effectively manage the fisheries and both are scored weak as a result.

Harvest control rules and tools

Bangladesh has a reasonably comprehensive set of management rules and tools, including mesh restrictions, juvenile fishing bans, spatial bans in spawning areas and closed hilsa nursery areas (see box below).

Box 11: Hilsa harvest control rules and tools in Bangladesh

The harvest control tools essentially consist of the following:

1. Mesh size restrictions (>90 mm except for current nets which are 100mm)
2. No fishing of juveniles (e.g. fish <30 cm)
3. Complete fishing ban for 10 days in four spawning locations during 5 days before & 5 days after the first full-moon of the peak spawning season in 4 spawning grounds of approx. 7,000 km².
4. Four hilsa nursery areas:
    a. Shatnol of Chandpur district up to Char Alexander of Laxmipur district, about 100 km area of the lower Meghna estuary (closed 1 March -30 April).
    b. Madanpur/Char Ilisha up to Char Piyal of Bhola district, about 90 km area of the Sahabazpur channel and tributary of the Meghna River (closed 1 March -30 April).
    c. Veduriya of Bhola district up to Char Rustum of Patuakhali district, about 100 km area of the Tetulia river, sanctuary (closed 1 March through 30 April).
    d. 40 km area of the Andharmanik river of Patuakhali district (closed 1 November -31 January).
    e. A fifth area is currently being proposed in Shariatpur.

Milton (2010) concurs that spatial and temporal controls like those described above are more likely to work in terms of stock management than controlling fishing effort directly. However, whilst the approach is likely to work, there is a considerable lag period between estimating yields, matching exploitation rates and then expanding management measures. As such, Bangladesh's harvest strategy implementation is scored as 'intermediate'.

As mentioned above, apart from minimum mesh size restrictions, neither India nor Myanmar have any harvest control rules in place for hilsa and have been scored as 'weak' in this respect.

Information and monitoring

In all three countries monitoring of fishing effort and yields is hampered by the wide geographic spread of numerous, largely small-scale fishers targeting hilsa and other pelagic species in marine, estuarine and freshwaters, as well as the limited resources dedicated to information collection. In India this situation is further compromised by the apparent overlap between central and state-level data collection, especially regarding hilsa research. In Myanmar information on both gear-wise data collection and domestic landings is limited. Bangladesh suffers from similar logistical challenges, but with the need to feed information to the on-going HFMAP, appears to have greater information on gear-wise CPUEs and length-frequency at capture.

Stock assessment

There is an inadequate assessment of hilsa stocks in either India's West Bengal nor Myanmar. Using the Risk-Based Framework (RBF) this would normally be scored a default 'Intermediate' status. However given the lack information on which to base a stock assessment and the lack of 'management drivers' to demand an assessment of this stock, stock assessment is scored as 'weak' in both countries. In Bangladesh, researchers have undertaken several stock assessments of hilsa based on analysis of large samples of fish length frequencies.

Although only one of these analyses adjusted the data for gill net selectivity, the results were remarkably consistent (see table in the Bangladesh country report). This approach is not rigorous and thus the estimated exploitation rates are highly uncertain and would not form the basis of management changes in most situations. However, alternative more rigorous stock assessment approaches require an index of hilsa abundance. These data are not available and are unlikely to be reliably collected in any of the countries in the region. Thus, the stock assessments of Bangladesh scientists probably provide the only realistic indicators of hilsa population status in Bangladesh.

3.3 PRINCIPLE 2: ECOSYSTEMS

As outlined earlier in the methodology, Principle 2 examines the ecosystem impacts of the individual fisheries in terms of their retained and discarded bycatch, interactions with endangered, threatened or protected species, the habitat and the wider ecosystem structure and function.

The table overleaf (Table 23) shows the assessments made for each indicator across all countries in the region. As these potential impacts are directly related to the type and nature of the fishing gears involved, this analysis is conducted at gear level. As can be seen from this table there are seven fisheries considered in the country reports. To simplify the analysis, we have categorized these as follows:

Broad gear category	Gear / country combination
1. **Small mesh (<60 mm) gill nets & stow nets (India, Bangladesh & Myanmar).** Mainly freshwater.	• Gillnets (min. 12 mm) - India • Gillnets (<60 mm) - Bangladesh • Gillnets (25 - 65 mm) - Myanmar • Stow nets - Myanmar
2. **Larger mesh (>60 mm) gillnets (India & Bangladesh).** Mainly estuarine & marine.	• Gillnets (>85 mm) - India • Gillnets (>60 mm) - Bangladesh
3. **Purse seine (Myanmar).** Marine.	• Purse seines - Myanmar

It should be stated that, due to the wide range of mesh sizes used and the different gear setting configurations, there is very little detailed information on the impacts of these gears, especially the gillnets. The following analysis is based on both discussions in country with researchers, managers and fishers, as well as a review of published literature.

3.3.1 Retained bycatch

Retained bycatch are the species retained by the fishery (with the exception of the species under assessment, hilsa) because they are commercially valuable or because they are required to be retained by management rules.

Small mesh (<60mm) gill nets & stow nets (India, Myanmar & Bangladesh)

Status

These small-mesh nets tend to be used in the freshwater river channels and operated by artisanal fishers in non-motorized boats. Whilst hilsa is a high-value catch, this is very much a mixed fishery with a wide spectrum of target species. Due to the small meshes used, they are non-selective and are likely to catch a high proportion of juvenile or immature fish. As they are often used in smaller channels, there is a high level of encounterability and thus these gears are extremely effective. Given their non-selective nature they are likely to contribute to recruitment overfishing of both hilsa and other species.

Management

These gears are difficult to manage as they are extensively used by small-scale fishers in all three countries. The main form of management is through minimum mesh size restrictions which are largest in Bangladesh (90 mm), Myanmar (6.5” or 63 mm) and India (12 mm, with a seasonal 25mm restriction). However these restrictions are widely ignored with inadequate enforcement.

Table 23: Summary table for Principle 2 - Hilsa

Principle 2			Principle 2: Ecosystem impacts														
			Retained			Bycatch			ETP			Habitat			Ecosystem		
			2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.3.3	2.4.1	2.4.2	2.4.3	2.5.1	2.5.2	2.5.3
	Country	UoA	Retained status	Retained management	Retained info / monitoring	Discards status	Discards management	Discards-info / monitoring	ETP status	ETP management	ETP info / monitoring	Habitat status	Habitat management	Habitat info / monitoring	Ecosystem status	Ecosystem management	Ecosystem info / monitoring
	MM	Gill nets & river mouth	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
	MM	Stow net in river	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
	MM	Purse seine @ sea	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0
	BD	Gill nets 40-60mm	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1
	BD	Gill net 60-120mm	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1
	IN	Gill nets min 12mm	0	0	0	2	2	1	0	1	0	2	1	1	0	0	0
	IN	Gill nets min 85mm	0	0	0	2	2	1	1	1	0	2	1	1	2	2	1

Source: Poseidon. MM = Myanmar, BD = Bangladesh, IN = India

Information/monitoring

Information on catches and landings varies between countries. In both India and Myanmar, marine landings are reasonably well known, but freshwater landings are less well estimated. In Bangladesh the opposite situation exists, with poor marine landing records, but a better understanding of freshwater landings. In all cases there is very little ability to estimate catches by gear-type, thus complicating the targeting of management efforts.

Larger mesh (>60mm) gillnets (India & Bangladesh)

Status

These larger-mesh gillnets tend to be used by hilsa specialists in large river, estuarine and marine environments. Although there is little information on their selectivity, it is likely that they will restrict catches to larger fish, with lower bycatches of juveniles and immature fish.

Management

Again mesh size is the key management approach and tends to be more robustly implemented in marine waters e.g. an 85mm limit in India and 90mm in Bangladesh. Given that fishers tend to have larger, motorized vessels landing in main centers, the degree of compliance is likely to be much higher than in freshwaters.

Information/monitoring

Information on catches and landings varies between countries. In both India and Myanmar, marine landings are reasonably well known, but freshwater landings are less well estimated. In Bangladesh the opposite situation exits, with poor marine landing records, but a better understanding of freshwater landings. In all cases there is very little ability to estimate catches by gear-type, thus complicating the targeting of management efforts.

Purse seine (Myanmar)

Status

There are no published statistics on the species-wise landings from purse seine nets in Myanmar, but the PSA suggests that this gear is of low risk to hilsa stocks.

Management

There is seasonal closure for 3 months during May-July to protect spawning grounds. There is no other effective management of the small pelagic purse seine fishery. The minimum mesh size of 1 inch is not appropriate to control the volume or size of fish landed and juveniles are expected to be landed in high proportions to enter the fish supplement and fish oil trade. The effect on recruitment for these small pelagic species due to high juvenile catch rates is unknown. There are no other controls over the size of fish landed or the volumes landed.

Information/monitoring

Export data has been provided. However, no accurate landings data is available reporting both exported and domestically consumed volumes. It is not possible to determine catch composition for the purse seine fleet landing small pelagics.

3.3.2 Discarded bycatch

All gears

Status

Although not recorded, it is highly likely that discards from these fisheries are negligible. As such, they do not pose a risk of serious or irreversible harm to any species group.

Management

Discards from these fisheries are understood to be non-existent. As a result no bycatch minimization management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.

Information/monitoring

No formal assessment of discard rates and their nature has been carried out. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.

3.3.3 ETP species interactions

Small mesh (<60 mm) gill nets & stow nets (India, Myanmar & Bangladesh)

Status

There is a high degree of biodiversity in the freshwater riverine and floodplain systems where these small-mesh gillnets are operated. These include a number of species that are formally considered as endangered, threatened or protected, including freshwater turtles, fish and riverine dolphins.

There has been very little work done in all three countries on the interactions between gillnet fisheries and freshwater ETP species. There is likely to be considerable potential for such interactions, although this will depend upon the location, gear configuration and design.

Management

Relatively little management attention has been placed on reducing ETP interactions in freshwater gillnet and stow net fisheries. This is a result of the lack of knowledge of the extent and consequences of these interactions, the large and diverse fisheries involved, and the socio-economic dependence of rural communities on such fisheries resources.

Information/monitoring

As mentioned above, there has been very little investigation into the scale or consequences of interactions between these freshwater fisheries and ETP species.

Larger mesh (>60mm) gillnets (India & Bangladesh)

Status

The main ETP species at risk from larger-mesh gillnets are sea turtles, cetaceans, dugongs and vulnerable shark species. Sea turtles have been highlighted as of concern off the East coast of India (especially the State of Orissa) for some time, and there is an increasing awareness of their vulnerability in Bangladesh (especially St. Martin’s Island) and Myanmar.

However there is virtually no information from any of the three countries on the levels of interaction between the estuarine and marine large mesh gillnet fisheries, although the WWF-India's Sundarban Programme indicates no reports to ETP species being at risk from hilsa gillnet fisheries (Ratul Saha, WWF-India Sundarbans Programme, pers. comm., 17 Oct. 2010; T.K. Chatterjee, pers. comm., 25 Oct., 2010). However the drifting gillnets deployed from large mechanized boats from Cox's Bazaar and Chittagong are one of the major sectors that have been attributed as responsible for turtle by-catch (Rashid 1997), although it is not known whether these are targeting hilsa or other marine species.

Management

Sea turtles are formally protected in India and proposed for protection in Bangladesh. Conservation of marine turtles has not received high priority in Bangladesh, where scientific publications and systematic surveys have only appeared in the recent past. There are also a number of spatial protected areas for sea turtle nesting areas in all three countries, including shark sanctuaries in the Mergui Archipelago of Myanmar.

Information/monitoring

As mentioned above, there has been very little investigation into the scale or consequences of interactions between these freshwater fisheries and ETP species.

Purse seine (Myanmar)

Status

Potential purse seine interaction with ETP species is likely to be limited to dolphins and turtles, both of which are released alive prior to hauling nets. A high survivability rate (>90%) is expected. In addition a risk assessment in the Pacific Ocean (Kirby, 2006) indicates that sharks are the highest risk group in purse seines – at greatest risk are the low fecundity silky shark, short-finned mako, porbeagle, and oceanic whitetip rather than the more fecund blue sharks and hammerheads. These shark species are at more risk from the tuna fisheries than the small pelagic fisheries since they often trail schools of tuna for prey. Overall the risk of the small pelagic purse seine fishery is of intermediate concern, based primarily on shark interactions.

Management

There are closed areas in inshore locations specifically to protect turtles when they are returning to breed. The locations of these areas are unknown. The Myeik Archipelago Islands have large areas closed to fishing, primarily to protect coral reef habitats, but this also acts to protect ETP species in this area. No management is known to reduce interactions with sharks.

Information/monitoring

Data on the presence and distribution of ETP species around the Myeik Archipelago Islands is well understood and protection of this area is regarded as having high national importance. However, data for ETP species outside this area are limited, with the exception of turtle breeding areas which have informed closure of certain locations.

Data on specific purse seine interactions with ETP species is lacking. In particular observer data to monitor shark bycatch in Myanmar fisheries is rare and effort should be focused to address this issue across the fleet.

3.3.4 Habitat interactions

All gillnets and stow nets

Status

Habitat interactions with these gillnets are minimal, especially in marine and estuarine areas where they are surface set and do not touch the bottom. In faster flowing river and estuarine areas some gears and/or boats may be fixed to the ground causing temporary and low level physical impacts. However, due to the highly dynamic nature of these environments (e.g. fast and chasing currents, high sediment loads, etc) it is highly unlikely that these impacts will be significant in terms of damage to aquatic biodiversity. The loss and discarding of monofilament gillnets may be very high, with potential for high rates of persistence and ghost-fishing in the riverine environment.

Stow nets tend to be fixed in position for a long period of time and therefore do not have a large footprint of habitat impact. Although operated in high tidal conditions, lost gears are considered highly unlikely.

Management

At present there are no habitat management measures in place, nor is there any known reason why this might be necessary, esp. given the dynamic nature of the environment involved. No management structure exists to control the potential loss of gear e.g. due to rigging and gear failure. Nor is there a code of practice for gear retrieval or reporting of lost gear incidents.

Information/monitoring

There is a basic understanding of the types and distribution of the main habitats in the fishery areas, although this has not been extensively studied. The spatial distribution of fishing effort is reasonably well known, although not formally recorded. The dynamic nature of the riverine system and its changeable nature is also known and is periodically recorded. The nature of the impacts of these gears on the habitat are not known, but given the dynamic nature of the environment, the risk posed is likely to be low, but could nevertheless be further verified.

Purse seine (Myanmar)

Status

Habitat impacts from this surface pelagic fishery are highly likely to be minimal. Lost gear is rare, although the occasional FAD is lost.

Management

Due to minimal impact, management strategies are not necessary.

Information/monitoring

As with ETP species, the extent and location of important habitats including coral reefs, sea grass beds and mangroves are well understood for the areas surrounding the Myeik Archipelago Islands. Information is generally lacking for other areas.

3.3.5 Ecosystem impacts

Small mesh (<60 mm) gill nets & stow nets (India, Myanmar & Bangladesh)

Status

The main issue with these fisheries are their low level of size selectivity. As a result they have high catch rates of juvenile fish, especially in the river and estuarine areas. This is likely to have consequences for fish and other populations within the lower watershed in terms of a depleted prey population and possible implications on recruitment, notwithstanding the high natural mortality of many species involved. Stow nets, with a mesh size of 12 mm and high levels of effort are likely to be particularly destructive.

Other than the target species it is unknown what other species are removed from the ecosystem by this gear. The overall impact on the ecosystem is therefore difficult to determine. There is no ecosystem modeling to predict impacts within these estuarine and riverine environments. Therefore at present, it is not possible to say that the existing fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to the point where there will be serious and irreversible harm.

Management

In India there is little evidence of an ecosystem-based strategy for hilsa fisheries management, although this is embedded into the as yet unimplemented National Plan of Action for Hilsa. The State management of small-scale freshwater fisheries are, for understandable reasons, focused on livelihoods maintenance, but this has resulted in conflicts with enabling long-term ecosystem-based fisheries management approaches. The measures adopted – minimum mesh sizes and seasonal fisheries bans – are insufficiently focused or adequate in scale to address the potential impacts of this fishery on key elements of the ecosystem. The Bangladesh HFMAP, whilst focused on the conservation of hilsa, does little to restrain the impacts of this fishery on the overall ecosystem, although it should reduce the level of fishing mortality on other small and juvenile species potentially impacted by this fishery.

In order to manage the ecosystem impacts of these fisheries more work is required to determine the impact of removing 300,000 - 400,000 t of a mid-trophic level species from an albeit highly productive ecosystem, as well as reducing bycatch levels of non-target species.

Information/monitoring

CIFRI in India has conducted a number of studies into the riverine and estuarine environments of the wider Ganga/Meghna delta and, importantly, the impact of environmental change (e.g. pollution and reduced water flow) on these. As a result it is possible to identify the key elements of the ecosystem. In addition, considerable work has also been conducted by BFRI to identify key spawning and nursery habitats in the Meghna river system, which has been an essential step in creating spatial protection of recruiting fish.

The main impacts of the fishery, especially on the target fish stock can be inferred from research to date. However it is not possible to determine the impacts of this fishery (in particular those smaller-mesh gears) on the population dynamics of retained bycatch species.

Larger mesh (>60mm) gillnets (India & Bangladesh)

Status

Whilst the selectivity of the larger mesh gillnets has not been studied in detail, it is likely that these gears have a relatively low bycatch in terms of both number of species as well as a much more limited size range that mainly encompasses larger, mature fish. As such, their impact is largely restricted to target species such as hilsa and the wider ecosystem impacts are therefore more limited.

Management

As discussed for small mesh gillnets above, steps have not been taken to manage the hilsa fisheries at an ecosystem level. The Bangladesh HFMAP and the proposed National Plan of Action for Hilsa in India both include some elements of an ecosystem approach but also need to examine the impact of these fisheries on stocks of other retained bycatches species, ETP interactions with the hilsa fishery and its impact on the ecosystem as a whole e.g. the trophic impacts of removing large quantities of a mid-level trophic species from the marine and riverine ecosystems.

Information/monitoring

The main impacts of the fishery, especially on the target fish stock can be inferred from research to date. However it is not possible to determine the impacts of these fisheries on the population dynamics of retained bycatch species.

Purse seine (Myanmar)

Status

The fishery catches a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is no ecosystem modeling to predict impacts of removal at current rates.

Management

No specific ecosystem management measures are undertaken at national level. However, there are closed areas for habitat protection and turtle management measures. Current levels of removals of small pelagic species are not considered to be heavily over exploited; furthermore most small pelagic species have a short population doubling time. Despite this, management of the indirect effect of removing target and retained species from the food web requires management measures, which would also be applicable for retained species.

Information/monitoring

Total removals are not well known for Myanmar fisheries. There is little information on the ecological impacts of this fishery and ecosystem modeling has not been undertaken.

3.4 PRINCIPLE 3: FISHERIES GOVERNANCE AND MANAGEMENT

Table 24 provides a summary of the assessment of performance for Principle 3 indicators, relating to both the general governance and policy framework (i.e. the broad, high-level context of the fishery management system within which the fisheries are found), and also to fishery specific management (noting that specific management rules are covered under P1 and P2). As there is no regional management of Hilsa at the present time, even though stocks are shared the assessments have been completed on a national basis, rather than assessing policy and management at a regional level.

Table 24: Summary table for Principle 3- Hilsa

Principle 3		Principle 3: Governance & Management									
			Governance & Policy				Fishery specific management				
			3.1.1	3.1.2	3.1.3	3.1.4	3.2.1	3.2.2	3.2.3	3.2.4	3.2.5
	Country	other UoA if necessary	Legal customary framework	Consultation, roles & responsibilities	Long-term objectives	Incentives for sustainable fishing	Fishery-specific objectives	Decision-making processes	Compliance & enforcement	Research plan	Management performance evaluation
	MM	GN, SN, PS	1	1	1	0	0	0	1	0	0
	BD	GN, GN	2	2	2	2	2	2	1	1	2
	IN	GN, GN	1	2	2	0	1	1	1	1	1

Source: Poseidon. MM = Myanmar, BD = Bangladesh, IN = India

3.4.1 Governance and policy

Legal and customary framework

Comments made on the legal and customary framework in Section 2 on Indian mackerel, are also broadly relevant to hilsa management in Myanmar and India. Bangladesh, which was not included in the Indian mackerel assessments, performs particularly well against this indicator (and subsequent indicators under Principle 3 as will be seen).

In Bangladesh, the National Fisheries Strategy (2006) is guided by the Poverty Reduction Strategy Paper, and by international agreements signed by the government. The management framework observes traditional rights, and the 2006 National Fisheries Strategy has specific text on 'pro-poor' which recognizes the need to 'ensure that the poor retain their traditional rights to the resources through community leasing (inland) or allocation of fishing rights (marine)'. Disputes and conflicts certainly exist within the fishery (e.g. between industrial trawlers and inshore net fisheries), but levels of participation in decision-making, and the National Task Force for hilsa management and sub-level committees at Upazila and Union level serve as a mechanism for resolution of conflict. Where conflict cannot be resolved through such measures, systems of arbitration and legal recourse through the courts are reported to be available.

Consultation, roles and responsibilities

Consultation, roles and responsibilities in West Bengal in India, are perhaps slightly better articulated than in Tamil Nadu, hence why this indicator is scored as intermediate for West Bengal. There are 350 'blocks' (the administrative unit under the districts) in West Bengal and the Fisheries Department has a 'block development officer' (BDO) in each one. Each block may cover 3-4 *panchayats*. The Fisheries Department also has extension officers working under the BDOs, and fisheries inspectors (responsible for both collecting data and enforcement). Thus, while not always working perfectly, there is generally a good flow of local information and knowledge from the catching sector to the government. In addition to a regular flow of information from ongoing activities and responsibilities, the Fisheries Department has also been engaged recently in a number of specific *ad hoc* research studies to obtain information on the hilsa fisheries in estuarine/inland areas. The department also regularly runs awareness and consultation camps with fishers.

Hilsa management in Bangladesh also performs well against this indicator, as show in the Box below (see Box 12).

Box 12: Consultation, roles and responsibilities for hilsa management in Bangladesh

There is a provision in law that if rules and regulations are to be amended, the Department of Fisheries (DoF) must seek public opinion on any proposed changes. It is also mandatory for the DoF to invite local Members of Parliament and *Upazila* chairmen to awareness-building campaigns about hilsa management measures. Hilsa management committees meet regularly and generally on a monthly basis, with a national-level Task Force typically meeting on an annual basis. Roles and responsibilities of all those involved in the management process are clear and well articulated: The Ministry of Fisheries and Livestock has responsibility for policy making; DoF for management implementation (and the Fisheries Resources Survey System for the monitoring of catches); the Bangladesh Fisheries Research Institute (BFRI) for fisheries research; the Coast Guard for enforcement up to 15 km from the shore; the Navy for enforcement outside of 15 km; the police for arrest and prosecutions; and two major fishermen's' associations represent the interests of fishermen. The roles and responsibilities of the hilsa management Task Force (which includes representatives of all those listed above) is also clear, with specified working mechanisms.

Long-term objectives

In Bangladesh, DoFs mission is to 'support *sustainable* [author's emphasis] growth in fish and shrimp production….', and the 2006 Strategy has a specific section on 'long term objective planning'. It is also clear that with the introduction and implementation of the hilsa management plan, long-term objectives focusing on sustainability are now a driving force in the overall governance and policy framework. Likewise, performance against this indicator is good in West Bengal, where long-term objectives are much more clearly articulated than in Tamil Nadu. The Fisheries Department publishes 'Annual Reports', which serve to guide activities. These reports are often not widely available in hard copy and there exists a time-lag in their publication, but they nonetheless appear to be used to guide the management activities of the fisheries department, as well as to report on activities. The most recent Annual Report states policy and management objectives relating to sustainability and the precautionary approach, refers to the FAO Code of Conduct for Responsible Fisheries, and the national 11th 5-year plan which also mentions similar objectives. Detailed information for Myanmar is less available, but it is understood that there are long term objectives for the management of Myanmar's fisheries and their environmental sustainability with high level objectives presented under 'Fisheries 2020', but that these objectives are not hilsa-fishery specific.

Despite an assessment of good performance against this indicator in West Bengal and in Bangladesh, all three countries should be cognizant of the need for explicit and carefully articulation of policy trade-offs as highlighted in Section 2.4.1.

Incentives for sustainable fishing

Positive incentives for sustainable fisheries e.g. gear selectivity, rights based mechanisms, are not thought to be provided in either Myanmar or West Bengal at the present time, while 'negative' incentives potentially contributing to fleet capacity/effort in the form of fuel subsidies are. Thus performance is weak for this indicator for the units of assessment in both West Bengal, and in Myanmar.

Bangladesh, by contrast, provides a good example of positive incentives for sustainable fishing that might be replicated in other areas (see Box 13).

Box 13: Incentives for sustainable hilsa fishing in Bangladesh

A critical aspect of compliance with management measures that are now in place to protect *jatka*/juvenile fish is ensuring that livelihoods are not too adversely affected by the fishing ban periods. The DoF has in place a number of mechanisms which can be viewed as 'positive incentives' for compliance with the fishing ban periods, and therefore of overall sustainability – they include the provision of 30 kg rice / month / fishing family, and micro-credit support to fishermen for alternative livelihood activities in non-fishing activities. There are no fuel subsidies provided to gillnet hilsa fishermen (only to the trawl sector based on a rationale that it generates foreign exchange and therefore deserves special support), or any other 'negative subsidies' of any note which might serve to increase capacity in the hilsa fleet.

3.4.2 Fisheries-specific management systems

Fishery-specific objectives

There are not thought to be any fishery-specific objectives in Myanmar for hilsa, so the units of assessment in Myanmar are scored as weak. In Bangladesh, the detailed BFRI papers underpinning the formal DoF hilsa management plan have clear objectives in support of sustainability, and the resulting management measures put in place aim to ensure that the exploitation is under 50% of the stock biomass (e.g. the exploitation rate is 0.50). At present the exploitation rate is above 0.6 and thus needs to be further reduced, but there are nonetheless implicit fishery-specific management objectives and the units of assessment are therefore scored as good. Performance for this indicator in West Bengal lies somewhere in between that for Myanmar and Bangladesh. There is, as yet, no specific fisheries management plan for hilsa fisheries, and no clearly articulated *fishery specific* objectives for hilsa fisheries. However, objectives of sustainability are somewhat implicit in the ongoing work of the fisheries department which has included awareness camps on hilsa sustainability and management issues, the overall objectives as stated in the Annual reports, and the regulatory ban period designed to protect spawning stocks. The Department also expresses a willingness to learn from the recent developments in hilsa management in Bangladesh, and hilsa is now given a high priority in the State having been declared a 'State fish'.

Decision-making processes

There are not thought to be any fishery-specific decision-making processes in Myanmar for hilsa, so the units of assessment in Myanmar are scored as weak. Performance for this indicator in West Bengal is rated as intermediate. Consultation processes provide a strong basis for bottom-up participatory decision making, and these decision-making processes are established and are beginning to respond to the serious issue of resource depletion, while recognizing the difficulty of imposing regulations that will have short-term livelihoods impacts on fishers. However, it cannot yet be claimed that decision-making is resulting in strategies and measures to achieve sustainability. Fishers appear to generally agree with, and be supportive of, the hilsa fishing ban period. But reaching agreement on increases in minimum mesh sizes or closed areas may be more problematic, and the fishery remains one of open access.

Again, hilsa management in Bangladesh performs well against this indicator, as described in the Box below (Box 14).

Box 14: Decision-making processes in Bangladesh

As already noted, there is generally good consultation and decision-making process in place for the specification of hilsa management measures, and a provision in law that if rules and regulations are to be amended, the Department must seek public opinion. These decision making processes, and indeed compliance with regulations, are supported by an extensive programme of awareness campaigns through both print and electronic media. The DoF has a number of television slots each year at critical periods, and uses well-known personalities/actors to convey fisheries management messages. Ideas about management decision-making are well supported by research scientists and their outputs, with good research-policy-management linkages. This is facilitated through an annual two-day BFRI workshop, attended by DoF staff, at which BFRI reports on all past/ongoing research activities, and makes proposals for future research activities which might generate research outputs in support of DoF decision-making. The most recent workshop (October 2010) coincided with the visit of the consultants to Bangladesh, and the consultants observed some sessions of the workshop and noted that participation included around 100 BFRI and DoF staff.

Compliance and enforcement

Performance against this indicator is rated as intermediate in all three countries, and in all units of assessment.

There are not thought to be any fishery-specific fisheries control planning in Myanmar for hilsa, but compliance activities do take place.

In West Bengal, there are few regulations to enforce at the present time, but even so MCS activities are not well funded, are insufficient and are not well able to control fishing activity. This is especially the case in inland areas (18 districts), where enforcement relies on fisheries inspectors operating under the statistical wing of the Department, local police, and local administrations. Recent research by the Department revealed that many fishermen were infringing regulations, primarily due to the socio-economic difficulties of abiding by them, coupled with the lack of effective enforcement. Typical infringements included the use of very small mesh size ‘mosquito nets’ and the sale of undersized fish. Marine fishing activity is generally easier to control due to the presence of seven major fishing harbors, strong marine fishing associations, and close relationships between these associations and the Department. On the positive side, the West Bengal fisheries department is actively engaged with improvements in compliance and enforcement, in particular through education and awareness campaigns, and in the provision of financial support during ban periods in an effort to increase compliance.

In Bangladesh, in 2005 the government delegated powers of implementation of rules under the Marine Fisheries Ordinance to the DFOs of coastal districts, but in the absence of technically capable marine fisheries staff at district and Upazila levels, the system has not always worked well. MCS in marine areas is strongly focused on the industrial trawl fishery, and a lack of effort/input control has led to a huge expansion of unregulated gillnet activity by the uncontrolled numbers of mechanized and non-mechanized artisanal fishery in the marine sector. Compliance and enforcement in marine areas is not helped by the fact there is only one 'surveillance check-post' where vessels can be inspected as they report out/in. The lack of regulation and control over vessel numbers and licensing also applies to the inland/estuarine areas. Other key weaknesses in the enforcement of regulations appear to be the local police force and local magistrates, who may not apply penalties that could be enforced for infringements. And while food security support is provided (as already discussed), there remain very strong livelihood and financial incentives not to comply with regulations, due to the low socio-economic status of many fishermen.

However, there are also some notable strengths in the compliance and enforcement system, which are hilsa-specific in Bangladesh. These are presented in the Box below.

Box 15: Decision-making processes in Bangladesh

In inland areas, the seasonal fishing bans in nursery areas and the 10-day spawning ban period are reported to be quite well enforced, with effective Coast Guard activities (which also operates in estuarine/inland areas). Support for MCS activities is also programmed into the DoF budget, and DoF provides finances to the Coast Guard and other relevant parties to conduct enforcement activities. There is also reported to be a National Action Plan for MCS (DoF, 2009), and the Coast Guard reports on its activities each year to the hilsa management National Task Force, and gains approval of activities for the coming year. The public awareness activities mentioned above also serve to support compliance.

In all countries, sanctions for infringements include the seizing of both nets and catch, which bearing in mind the low socio-economic status of fishermen can be considered a considerable deterrent, *if enforced*.

Myanmar and West Bengal would also benefit from the suggestions made in Section 2.4.2 on the need for documented, risk-based MCS plans, so as to better use scarce financial and human resources.

Research plan

There is not thought to be any fishery-specific research plan in Myanmar for hilsa, so the units of assessment in Myanmar are scored as weak.

In West Bengal, as is the case Tamil Nadu, performance for this indicator is scored as intermediate; there are very many high-qualified and experienced fisheries researchers in the various research institutions but no hilsa (or small pelagic) fisheries-specific research plan, and there remain considerable research gaps. 'Research plans' to the extent that they exist at all, are the annual research plans/budgets prepared by the research institutions (the Central Inland Fisheries Research Institute [CIFRI] operating under the Council of Agricultural Research, and the Aquatic Resources Health Management Centre [ARHMC] operating under the Department of Fisheries), rather than research plans justifying particular research topics and explaining their link to management needs. There is also rather poor collaboration between the two main research organizations.

In Bangladesh, the BFRI annual workshop highlighted above is used to present results, and discuss and agree future activities (but is not hilsa specific). This workshop, coupled with annual budgetary planning, serves to provide the basis for a research plan. The process itself, and the working relationships between BFRI and DoF staff also appear to suggest relatively good linkages between research and management. BFRI has more than 50 PhD scientists, many of them trained overseas through previous donor-funded projects at high quality research institutes and universities, so human capacity for research is generally good. However, there are some notable weaknesses in hilsa research. There is a very strong focus in the country on aquaculture research, and many of the qualified research staff with strong hilsa knowledge are now nearing retirement age. The numbers of younger staff receiving good training has drastically declined, and there are therefore concerns about the lack of a new ‘cohort’ of research scientists entering government employment. There is also no hilsa specific research plan documented.

Management performance evaluation

There is not thought to be any fishery-specific evaluation in Myanmar for hilsa (as there is no hilsa-specific management plan), so the units of assessment in Myanmar are scored as weak.

In India, performance is intermediate. There is no formal assessment of the impact of any management regulations for hilsa or small pelagics, and no fishery-specific management plan to evaluate. There are however various internal evaluation mechanisms in place in the Department of fisheries whereby staff at State level monitor district level staff and their activities. Monthly meetings take place at State level to monitor the activities of district level activities, and monthly meetings take place at district level to monitor the activities of the block officers. In addition, where the Ministry of Agriculture at national level provides funds for specific activities, evaluators/monitors from the Comptroller auditor general periodically check on the implementation of activities in terms of both budget expenditure and effectiveness.

In Bangladesh, monitoring and evaluation (M&E) of the hilsa management plan appears to be quite robust. There is good M&E of hilsa management strategies through an annual workshop on *jatka* management, to which all stakeholders are invited, and feedback includes research results, the views of fishers and *Upazila* committees which submit reports, a report by the Coast Guard their activities, etc. This is followed by a ‘controlling workshop’ with the Minister of Fisheries and Livestock and other stakeholders, which makes recommendations for improvements/changes. The annual BFRI research workshop also serves as a useful M&E mechanism to assess the effectiveness of the hilsa management plan. There is also more general ongoing M&E through the activities of the hilsa management Task Force and the various sub-level committees, which typically meet on a monthly basis. Thus the system of monitoring the performance of the hilsa management system is both regular and frequent. Given the participatory nature of the M&E and broad range of stakeholders involved, it can also be viewed as being both ‘internal’ and ‘external’ i.e. it provides for M&E by those not directly involved in implementation of the management system itself.

3.5 CONCLUSIONS - KEY STRENGTHS AND WEAKNESSES

As evidenced from the two tables below (Table 25 and Table 26), and similar to the findings in the Indian mackerel assessments, there is a wide variety of performance against the different indicators between the different countries and units of assessment.

There is perhaps particular concern over Principle 1, where indicators of hilsa stock status, and the specific harvest/management strategy, generally provide considerable cause for concern (although less so in Bangladesh than in other countries).

Performance against Principle 2 is a little more positive, but again, considerable weaknesses exist in the status of some critical habitats, endangered species, and retained bycatch species. On a positive note is the fact that there are virtually no discards in the fisheries assessed.

For Principle 3, with respect to the overall governance and policy framework, while some improvements would be useful, performance against the indicators is generally reasonable for the legal and customary frameworks in place, the levels of consultation and the clarity in the roles and responsibilities of those involved in management, and the nature of long-term objectives (save for a failure to resolve conflicting policy objectives and a strong emphasis on production increases). As with Indian mackerel, of special concern however for hilsa management is the continued use of subsidies which serve to increase fishing capacity/effort. However unlike Indian mackerel, in some of the hilsa fisheries assessed there are also some positive incentives provided for greater sustainability in the form of social and financial support to reduce the need for fishers to fish for hilsa at particularly important times of the year or in particularly sensitive locations. Like Indian mackerel however, there are no positive incentives in place in the form of support for gear selectivity or rights-based mechanisms. Performance against the fisheries-specific management system displays a rather different picture to the Indian mackerel assessments, primarily because hilsa is such an important fish in economic terms, especially in Bangladesh. Thus there is generally a much greater level of specification of hilsa-specific objectives, decision-making process, research plans, MCS strategies, and performance evaluation. Performance in Bangladesh is particularly encouraging for most P3 indicators, and many lessons can be learned from this country for wider applicability within the region.

Table 25: Average scores by Principles - Hilsa

<table>
<tr><th>Country</th><th>Unit of Assessment</th><th>P1 average</th><th>P2 average</th><th>P3 average</th></tr>
<tr><td>MM</td><td>Gill nets & river mouth</td><td rowspan="3">0.17</td><td>0.53</td><td rowspan="3">0.44</td></tr>
<tr><td>MM</td><td>Stow net in river</td><td>0.53</td></tr>
<tr><td>MM</td><td>Purse seine @ sea</td><td>1.13</td></tr>
<tr><td>BD</td><td>Gill nets 40-60mm</td><td rowspan="2">0.67</td><td>0.80</td><td rowspan="2">1.78</td></tr>
<tr><td>BD</td><td>Gill net 60-120mm</td><td>0.80</td></tr>
<tr><td>IN</td><td>Gill nets min 12mm</td><td rowspan="2">0.00</td><td>0.67</td><td rowspan="2">1.11</td></tr>
<tr><td>IN</td><td>Gill nets min 85mm</td><td>1.07</td></tr>
</table>

Source: Poseidon. MM = Myanmar, BD = Bangladesh, IN = India

Table 26: Summary assessment for all Principles and indicators - Hilsa

Principle 1

		Principle 1: Stock status						
		Outcome			Harvest strategy			
		1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4
Country	UoA	Stock status	Reference points	Stock rebuilding if necessary	Performance of Harvest Strategy	Harvest control rules and tools	Information and monitoring	Assessment
MM	Hilsa	1	0	*	0	0	0	0
BD	Hilsa	0	0	*	1	1	1	1
IN	Hilsa	0	0	*	0	0	0	0

Principle 2

		Principle 2: Ecosystem impacts														
		Retained			Bycatch			ETP			Habitat			Ecosystem		
		2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.3.3	2.4.1	2.4.2	2.4.3	2.5.1	2.5.2	2.5.3
Country	UoA	Retained status	Retained management	Retained info / monitoring	Discards status	Discards management	Discards-info / monitoring	ETP status	ETP management	ETP info / monitoring	Habitat status	Habitat management	Habitat info / monitoring	Ecosystem status	Ecosystem management	Ecosystem info / monitoring
MM	Gill nets & river mouth	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
MM	Stow net in river	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
MM	Purse seine @ sea	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0
BD	Gill nets 40-60mm	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1
BD	Gill net 60-120mm	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1
IN	Gill nets min 12mm	0	0	0	2	2	1	0	1	0	2	1	1	0	0	0
IN	Gill nets min 85mm	0	0	0	2	2	1	1	1	0	2	1	1	2	2	1
MM	Purse seine	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0

Principle 3

		Principle 3: Governance & Management								
		Governance & Policy				Fishery specific management				
		3.1.1	3.1.2	3.1.3	3.1.4	3.2.1	3.2.2	3.2.3	3.2.4	3.2.5
Country	other UoA if necessary	Legal customary framework	Consultation, roles & responsibilities	Long-term objectives	Incentives for sustainable fishing	Fishery-specific objectives	Decision-making processes	Compliance & enforcement	Research plan	Management performance evaluation
MM	GN, SN, PS	1	1	1	0	0	0	1	0	0
BD	GN, GN	2	2	2	2	2	2	1	1	2
IN	GN, GN	1	2	2	0	1	1	1	1	1

Ranking

Good

Intermediate

Weak

Source: Poseidon. MM = Myanmar, BD = Bangladesh, IN = India

4 RECOMMENDATIONS AND THE INTEGRATION OF THE FINDINGS INTO THE BOBLME PROJECT

4.1 RECOMMENDATIONS

In this synthesis report recommendations have been prepared at a regional level. Although they have emerged from the eight country reports, those presented here apply across the different fisheries and are intended to address common issues and reflect the fact that both Indian mackerel and hilsa shad fisheries are connected within the BOBLME region. Country-specific recommendations can be found in the eight country reports in Appendices C - J.

Three sets of findings are presented:

1. Recommendations specific to the Indian mackerel fisheries;
2. Recommendations specific to the hilsa shad fisheries; and
3. Recommendations that are generic across the region and not applicable to any fishery in particular.

4.1.1 Indian mackerel Conservation and Management

The Indian mackerel is an important small pelagic species for both small-scale and industrial fisheries in much of the Bay of Bengal. Whilst there may be a degree of reproductive isolation, considerable mixing occurs at both the juvenile planktonic stage as well as later in adult life and it appears that the entire Indian Ocean population consists of a single stock and needs to be managed as such.

Based on the analysis of the different national Indian mackerel fisheries in Section 2, we have formulated the following recommendations to address the main weaknesses identified. As discussed above, these recommendations are made with regional action in mind. This said, there are particular areas of overlap of fishing interests between BOB nations, including between **SW India (Tamil Nadu) / Sri Lanka gillnet fisheries** and **Myanmar / Thailand purse seine and trawl fisheries**. Therefore, whilst a regional approach to managing this wide-ranging stock is appropriate, further bi-lateral initiatives may be required for some particular fisheries.

Recommendations: Stock management

- **Regional stock assessment**: although it is a productive and resilient species, the Indian mackerel stock is under considerable fishing pressure and considered to be over-fished through most of the region. However information on stock status comes largely from CPUE-based fisheries data and there is a need to use fisheries-independent data to improve the knowledge of both adult biomass as well as recruitment (and its variability) of juveniles into the fishery. It would also be beneficial to use increasingly affordable DNA techniques to improve knowledge of the stock's genetic structure and the possibility of the presence of distinct sub-populations.
- **Development of a regional fisheries management plan** for Indian mackerel. Ideally this should be at stock level e.g. the whole of the Indian Ocean, but could be considered at the sub-oceanic regional level e.g. Arabian Sea and BoB regions, so long as it accounts for recruitment and fishing mortality outside of the management

area. Fisheries Management Plans are usually set over 3-5 years (FAO, 2003) with a shorter cycle of management implementation and review at the operational level.

- This ***Indian mackerel Regional Fisheries Management Plan*** should, using the precautionary principle where necessary, develop the following:
    - *Overview of the fishery:* participants, location, landings / markets / value, consultative process, management approaches, international considerations
    - *Stock status:* biology, environment, habitat, species interactions, stock assessment, research and prospects
    - *Management objectives for the fishery:* establishment of reference points (target and limit[10]) for key measurable indicators such as spawning stock biomass, spatial distribution, age structure, recruitment, by-catch levels, fishing capacity, etc.
    - *Decision rules:* a series of decision rules based upon the management objectives of the fishery and more particularly, on pre-established reference points. In effect, allows fisheries managers to say what action should be taken when a certain indicator level is reached e.g. when the number of boats in the fishery reaches *x*, no further licenses will be issued for a period of *y* months or when the spawning stock biomass reaches the reference limit, the fishery will be closed for *z* months.
    - *Current management measures:* established for the short-term and reviewed periodically e.g. annually, might include fishing seasons, closed areas, quota allocations, licensing restrictions and other relevant elements.
    - *Enforcement strategies:* prioritization of MCS issues to develop objectives and strategies, inc. surveillance techniques by sea, land and air, enforcement of technical measures e.g. mesh sizes, by-catch reduction methods, observer trips, and awareness building and education.
- **Development of an Indian mackerel recovery plan:** In the event that Indian mackerel stocks should show an unacceptable decline, (e.g. a reference indicator drops below a pre-agreed limit), a recovery plan should be developed to restore depleted populations:
    - This might include a revision of the management measures being used over the short and medium term (see above), including the imposition of temporary capacity limits, or restricted fishing areas and periods as well as possible gear restrictions.
    - The plan should have specified recovery targets over time.
    - Where there is a lack of scientific information or uncertainty, the recovery plan should be precautionary in its outlook.
- **Investigation into the impact of climate change on Indian mackerel stock dynamics and distribution**. Recent research in India has demonstrated the influence of seawater temperature changes and nutrient availability on the stock distribution and behavior of this species and the fundamental impact this is having on coastal fishing

[10] The *target reference point* is the desired state of the indicator and the *limit reference point* is the boundary beyond which it is undesirable to go

populations. A greater understanding of this, and application to other parts of the Bay of Bengal, would assist fisheries administrations in targeting the relative abundance of this species.

Recommendations: Ecosystem-based management

- Whilst discards are not an issue in these fisheries, the varying levels of juvenile bycatch are, as greater control over this issue would provide better adult recruitment into the fishery as well as improving spawning stock biomass.
    - **Joint regional review of mesh sizes used in Indian mackerel gillnet fisheries** to investigate mesh sizes that improve selectivity for target species and reduce the capture of juvenile large pelagics such as seer fish and carangids. Following this review, if necessary some gear selectivity studies might be conducted in high risk gillnet fisheries to both determine mesh sizes that perform well as well as provide supporting evidence for developing technical measures (such as minimum mesh sizes) where required.
    - **The mesh sizes and other technical parameters could also be reviewed for other gear types targeting Indian mackerel**. Purse seines and bottom trawls are already used to catch this species in many countries, with the former (inc. ring seines) gaining popularity in India in particular. Although purse seines are usually fairly selective gears, they are extremely efficient so some form of effort limitation may need to be considered in response to the need for harvest controls (see previous section).
- **Improved conservation and management of shark species**. Although some BOB countries have developed national plans of action (NPOAs) for sharks e.g. Thailand and Malaysia, in some of the other countries they are still in early stages of development. Therefore assistance should be provided - possibly through joint workshops and other fora - to develop national plans and progress towards a regional plan of action (RPOA). The latter approach is a necessary progression, but will need to consider the wider issues of the Indian Ocean, such as tuna longline and purse seine fishing. However there are advantages in a RPOA, including building on the Maldivian and Myanmar examples of spatial restrictions and bans on shark catching, as well as more robust regional agreements on technical measures such as finning restrictions. We note that a separate BOBLME activity will be looking at fisheries management plans for sharks.
- **Improved conservation and management of ETP species**. Whilst interactions between Indian mackerel fisheries and ETP species are not particularly widespread and serious, a number of gear types do present problems such as large-mesh gillnets (which tend to entangle larger animals more than smaller-mesh multifilament nets), non-TED equipped bottom trawl nets and some purse seines. The level of interactions varies widely within the region, but is more serious in Indonesian waters as well as adjacent to key turtle rookeries, such as along the Indian Orissa coast. Therefore improved levels of harmonization between BOB countries in adopting both technical measures to reduce ETP mortalities (e.g. greater adoption of TEDs) as well as a wider network of spatial and seasonal protection is required.

- **Improved habitat protection**: although most Indian mackerel fisheries are pelagic in nature with limited direct impact on the seabed, there are a couple of issues that need addressing:
  - **Improved legislation and, critically, enforcement capacity** to prevent bottom trawling in inshore or otherwise vulnerable areas. There is wide variation in approaches (e.g. distances / depths where bottom trawling is banned) and the use of marine protected areas to protect areas of high biodiversity or productivity.
  - **Improvements to the marking and anchoring of fishing gear** to reduce the level of loss and abandonment and subsequent interactions with the seabed and its inhabitants.
- **Improved knowledge of trophic impacts from Indian mackerel fisheries**: the large-scale removal of this albeit highly productive small pelagic species could be further investigated as a longer-term priority. In particular it might be useful to examine its predator - prey relationships, especially with other commercial species in order to assess the impact of the Indian mackerel fishery on other important fisheries - and *vice versa*. Such work could be conducted in association with parallel work to examine the impact of climate change on species productivity and distribution. Modeling approaches such as SEPODYM (Spatial Ecosystem and Population Dynamics Model)

Box 16: Spatial Ecosystem and Population Dynamics Model

SEPODYM is a model developed initially for investigating spatial tuna population dynamics under the influence of both fishing and environmental effects. The main features of this model are: (i) forcing by environmental data (temperature, currents, primary production and dissolved oxygen concentration), (ii) prediction of both temporal and spatial distribution of mid-trophic functional groups, (iii) prediction of both temporal and spatial distribution of age-structured predator populations, (iv) prediction of total catch and size frequency of catch by fleet when fishing data (catch and effort) are available, and (v) parameter optimization based on fishing data assimilation techniques (see Senina *et al*., 2008). The associated modeling of sea temperature rise, its pattern within natural cyclical variability and the impact on the recruitment, growth and distribution of tunas has received increasing attention and is one of the main applications of SEPODYM.

Recommendations: Policy development and fisheries management

See **Section 4.2 (Non-fisheries specific recommendations)**.

4.1.2 Hilsa shad conservation and Management

The hilsa shad is also a highly productive species that provides large volume (but mainly small-scale) fisheries in West Bengal (India), Bangladesh and Myanmar. Its predictable migratory behavior makes it particularly vulnerable to fishing, esp. during the ascending riverine phase, but this does make it equally suitable for targeted management actions.

Given that the main fisheries all take place in the northern part of the Bay of Bengal, and that these are prosecuting what is essentially a single stock, regional coordination of hilsa management is particularly important. It is also key to understand that whilst fisheries-related management is obviously vital, it is also evident that wider ecosystem conservation and management is also very essential, as the overall productivity of these large floodplain / delta systems is affected by water sharing and management, water quality and the impact of pollution as well as the longer-term effects of climate change.

Recommendations: Stock management

- **Regional stock assessment**: the hilsa shad stock is under considerable fishing pressure and considered to be over-fished. Again like Indian mackerel, information on stock status comes largely from CPUE-based fisheries data and there is a need to use fisheries-independent data to improve the knowledge of both adult biomass as well as recruitment (and its variability) of juveniles into the fishery. Further fisheries-independent verification of both spawning stock biomass is required, possibly though biomass surveys during the marine phase. Other information such as the age structure of hilsa as well as the size composition of different fisheries would also assist develop current fisheries-dependent models.
- **Development of a regional fisheries management plan** for hilsa shad. This should be at stock level, which could be reasonably limited to those fish utilizing the main river systems bordering the BoB in India, Bangladesh and Myanmar. This ***Hilsa Shad Regional Fisheries Management Plan*** should, using the precautionary principle where necessary, develop the following:
    - *Overview of the fishery:* participants, location, landings / markets / value, consultative process, management approaches, international considerations
    - *Stock status:* biology, environment, habitat, species interactions, stock assessment, research and prospects
    - *Management objectives for the fishery:* establishment of reference points (target and limit[11]) for key measurable indicators such as spawning stock biomass, spatial distribution, age structure, recruitment, by-catch levels, hilsa escapement rates, fishing capacity, etc.
    - *Decision rules:* a series of decision rules based upon the management objectives of the fishery and more particularly, on pre-established reference points. In effect, allows fisheries managers to say what action should be taken when a certain indicator level is reached e.g. when the number of boats in the fishery reaches *x*, no further licenses will be issued for a period of *y* months or when annual escapement rates drop below the minimum reference limit, the fisheries will be closed for *z* months.

[11] The *target reference point* is the desired state of the indicator and the *limit reference point* is the boundary beyond which it is undesirable to go

  - *Current management measures:* established for the short-term and reviewed periodically e.g. annually, might include fishing seasons, closed areas, quota allocations, licensing restrictions and other relevant elements.
  - *Enforcement strategies:* prioritization of MCS issues to develop objectives and strategies, inc. surveillance techniques by sea, land and air, enforcement of technical measures e.g. mesh sizes, by-catch reduction methods, observer trips, and awareness building and education.

- **Development of an Hilsa shad recovery plan:** In the event that the hilsa shad stock should show an unacceptable decline, (e.g. a reference indicator drops below a pre-agreed limit), a regional recovery plan should be developed to restore depleted populations:
  - This might include a revision of the management measures being used over the short and medium term (see above), including the imposition of temporary capacity limits, no or restricted fishing areas and periods as well as possible gear restrictions.
  - The plan should have specified recovery targets over time.
  - Where there is a lack of scientific information or uncertainty, the recovery plan should be precautionary in its outlook.

- **Harmonization of existing and proposed national / regional Plans of Action:** Bangladesh currently has a *Hilsha Fisheries Management Action Plan* (HFMAP) and India is developing a *National Plan of Action (NPOA) for the Conservation and Sustainable Development of Hilsa Fisheries*. Furthermore there have been a number of consultations on preparing a *Regional Plan of Action (RPOA) for hilsa management in the Bay of Bengal* through the BOBP-IGO. It is essential that these various plans are harmonized at the national[12] and regional levels to reduce institutional competition that is an ineffective use of finite financial resources and can confuse fishers and other stakeholders.

Recommendations: Ecosystem-based management

- Whilst discards are not an issue in these fisheries, the varying levels of juvenile bycatch are, and greater control over this issue would provide better adult recruitment into the fishery as well as improving spawning stock biomass.
  - **Joint regional review of mesh sizes used in hilsa gillnet fisheries** to investigate mesh sizes that improve selectivity for target species and reduce the capture of juveniles (both hilsa and other target species). Following this review, if necessary some gear selectivity studies might be conducted in high risk gillnet fisheries to both determine mesh sizes that perform well as well as provide supporting evidence for developing technical measures (such as minimum mesh sizes) where required.
  - **Bio-economic modeling of different mesh size / net configuration combinations** to optimize the minimum daily economic catch per fisher,

[12] It is noted that in India fisheries management takes place at both central and state levels. It is our view that agreement on the roles of the different state government (e.g. of West Bengal, Orissa, Andhra Pradesh and Tamil Nadu) and central government organizations (e.g. CMFRI & CIMFRI) need to be carefully and objectively considered in order to avoid the apparent disconnect observed in field work (see Appendix D).

maximize the overall profitability of the fishery while accounting for sustainability by estimating the total length of net the hilsa population can sustain.

- **Improved conservation and management of ETP species**. It appears that virtually nothing is known about the level of interactions between hilsa gillnet fisheries and ETP fisheries in either the marine or freshwater phases of their life cycle. It is recommended that:
  - A **risk assessment** is conducted to determine in what circumstances interactions might take place and to assess the potential impact on ETP species populations. This might require some field assessments, esp. of the larger mesh gillnets at sea (e.g. sea turtle interactions) as well as with gillnets in the smaller river systems (where interactions with freshwater turtles and other fauna / avifauna).
  - If the risk assessment does show interactions that threaten the status of ETP species, then it should be used to develop **ETP mitigation and management measures** to reduce these in high risk fisheries.

- **Improvements to the marking and anchoring of fishing gear** to reduce the level of loss and abandonment and subsequent interactions with the sea/riverbed and its inhabitants.

- **Improved habitat mapping**: the merits of spatial protection are increasingly evident and it is recommended that a regional programme develops both a harmonized approach as well as compatible outputs (in the form of a regional Geographic Information System, GIS) to identify critical habitats such as spawning and nursery grounds to assist with development of spatial protection zones. This GIS could also integrate catch distribution in the marine, estuarine and freshwater reaches of the main rivers in order to further optimize temporal and spatial closures to reduce total catch by the desired amount. This database could also integrate other factors such as water quality indices in order to fine tune management approaches.

- **Improved knowledge of trophic impacts from hilsa fisheries**: the large-scale removal of this albeit highly productive pelagic species could be further investigated as a longer-term priority. In particular it might be useful to examine its predator - prey relationships, especially with other commercial species in order to assess the impact of the hilsa fishery on other important fisheries - and *vice versa*.
- **Improved linkages with watershed management**: there is a need to build upon CIFRI's research into the linkages between the wider decline in watershed status (e.g. seasonal water flows, water quality, etc), the productivity of hilsa and the impacts on the livelihoods of rural communities dependent upon hilsa (and other) fisheries. This should lead to a more integrated level of watershed management planning, including wide-ranging (inc. trans-boundary) impact assessments when considering major interventions such as barrages and water sharing agreements. This information can also be used to fine-tune productivity-susceptibility analyses.

Recommendations: Policy development and fisheries management

See **Section 4.2 (Non-fisheries specific recommendations)**.

4.2 NON-FISHERIES SPECIFIC RECOMMENDATIONS

In addition to the fisheries-specific recommendations provided above, the assessments also revealed a number of weaknesses across the region which are outlined below.

- **Improved consistency and harmonization of fisheries statistics collection**. The development of stock assessments and management approaches depends upon robust reporting of catches and landings. This needs to be disaggregated where possible to gear type, vessel class, sea area of capture and point of landing. This will require harmonization of both data collection approaches as well as data storage and distribution protocols.
- **Landing and market input data improvement:** In addition to the improved and harmonized statistics systems recommended above, there is a need to improve data collection on local landings and inputs into the domestic market. This could include some system to register first-point buyers (see Box 3 on page 28 for example). If considered appropriate, the approach would need to be developed to take into account the particular value-chain and distributional structure of the Bay of Bengal countries.
- **Greater participation of the private sector in information provision**: there is great potential for the private sector to become more involved in fisheries research and reporting in a variety of ways. This includes improved recording and submission of fish catches and discards, ETP interactions as well as assistance in reducing infringements against management measures.
- **Development of longer-term objectives**: a core part of a sound fisheries management policy is to have clear long-term objectives. Essentially these determine what the purpose of the fishery is and how this can be maintained over the longer-term. Many of the BOB countries have either the immediate maintenance of coastal livelihoods or fisheries productivity as their main policy directives, but these frequently conflict with longer-term sustainability objectives. It is therefore recommended that a review of national policies explores this in order to balance social and resource management objectives.
- **Removal of 'bad' subsidies**: many well meaning financial incentive schemes that are aimed at poverty alleviation also serve to maintained or even increase fishing capacity above sustainable levels. Such subsidies need to be reviewed in terms of their impact on the resource base. Less obvious incentives to fish with unsustainable gear, such as the demand for trash fish, also need examining and adjustments made to national and regional policy where appropriate. This should also be applied to disaster relief schemes, such as that after the 2004 tsunami, which have again, however well-intentioned, increased fishing capacity to unsustainable levels.
- **Updating of fisheries laws**: there is a general need to revise existing fisheries laws to better support fisheries management, reflect recent international developments and the need for regional action. One example is the need to embed approaches for dispute resolution to be enshrined in law, especially as coastal populations grow and increase the risk of dispute over finite fisheries and other resources.
- **Improved risk-based Monitoring, Control and Surveillance (MCS) approaches**: enforcement activities could be much improved if documented risk-based MCS plans

were prepared annually focusing on locations, seasons, and stakeholders felt to be of special concern in terms of compliance. Such plans could also help to further articulate roles and responsibilities of those engaged in enforcement activities, and could at some stage in the future incorporate regional initiatives such as joint deployment plans.

- **Improved, priority-based research planning**. In many countries 'research plans' to the extent that they exist at all, are purely the annual research plans/budgets prepared by the research institutions, rather than research plans justifying particular research topics and explaining their link to management needs. This is an issue at two levels: (i) firstly there is little coordination of research into Indian mackerel stock levels and biology within the region and thus much scope for duplication and (ii) at a wider level there is often a wide gap between the information needs of fisheries managers and the research agendas of fisheries scientists. This is particularly so for small pelagic stocks like Indian mackerel, with research focus often on more iconic (and thus often better funded) species such as tuna. In some countries there is also a much stronger focus on aquaculture, which has often been at the detriment of marine capture fisheries. This balance needs to be addressed at both policy level as well as in terms of the institutional mechanisms for linking fisheries science with fisheries management information needs.
- **Increased human capacity development, especially at local administration level**. Whilst decentralization of governance can have its advantages and is the core of many national development strategies, its effectiveness may be limited by both (i) limited human capacity at local level and (ii) poor institutional coordination between central and local levels.
- **Establish regional centers of excellence for different fisheries science and management topics**: it is evident from our visits that there is some good fisheries science and management capacity in the region. There is considerable potential to share this expertise within the region. It is suggested that key capacity-building topics are identified and acknowledged regional centers of excellence proposed. Regional partnerships can then be developed to capitalize on existing regional experience and knowledge and to further harmonize common stock management. The 'centers of excellence' approach is one of the mechanisms advocated by FAO's Advisory Committee on Fisheries Research (FAO, 2004).

4.3 SUMMARY AND INTEGRATION OF FINDINGS INTO THE BOBLME PROJECT

This report has been commissioned as part of the BOBLME Component 2, Sub-component 2.3 (*Collaborative regional fishery assessments and management plans*). The ultimate objective of this sub-component is to develop regional (or where appropriate, sub-regional) fisheries management plans for three key shared stocks e.g. Indian mackerel, hilsa shad and sharks. This sub-component will also see essential supporting but non-fisheries specific goals of the harmonization of data collection and standardization to promote collaborative fisheries management approaches.

The table overleaf provides a summary of the findings, sub-divided into those for (i) *Indian mackerel*, (ii) *hilsa shad* and (iii) *non-fisheries specific activities*. For the two fisheries, the main activity will be the preparation of '**Regional Fisheries Management Plans'**, which includes a sub-set of eight actions in both cases. In addition to these FMPs are a series of supporting activities to improve gear selectivity, to manage ETP interactions, improve habitat protection and to increase the knowledge of the impact of these fisheries on the wider Bay of Bengal ecosystem. In effect we are proposing that the FMPs are accompanied by activities that provide an ecosystem-based approach.

The non-fisheries specific recommendations are divided into four main elements: (i) *Policy development,* (ii) *information support*, (iii) *fisheries control* and (iv) *human capacity development*.

In each case we have suggested the priority of response required, the most appropriate partner countries, supporting partners and the BOBLME component(s) involved. In terms of the priority, we consider all the recommendations necessary but those with high priority should be addressed first. We have also suggested partner countries and supporting partners as a starting point - these will need verification through the BOBLME process in due course. Finally most of the actions belong to BOBLME sub-component 2.3. However there are a number of actions that cross-cut with other BOBLME sub-components and these are identified.

Table 27: Summary of recommendations

Activity	Action	Priority	Partner countries *	Supporting partners	BOBLME component(s)
INDIAN MACKEREL					
Regional Fisheries Management Plan	National assessment of fisheries consolidated into a regional overview	High	All BOBLME countries	FAO	2.3
	Characterization of stock status, inc. options for stock reference points	High	All BOBLME countries		
	Regional stock assessment studies	High	LK, IN, MM, TH, MY, ID		2.3
	Workshops to agree management objectives, inc, establishment of preliminary reference points (to be periodically reviewed)	High	LK, IN, MM, TH, MY, ID		2.3
	Development of national management measures to be harmonized at regional level.	High	LK, IN, MM, TH, MY, ID		2.3
	Development of enforcement strategies at national and regional levels.	Medium	LK, IN, MM, TH, MY, ID		2.3
	Development of a precautionary Indian Mackerel Recovery Plan	Medium	LK, IN, MM, TH, MY, ID		2.3
	Investigate impact of climate change on Indian mackerel stock dynamics	Low	LK, IN, MM, TH, MY, ID		2.3 / 3.1
Gear selectivity studies	Regional review of information on gillnet selectivity for small pelagic species in the Indian mackerel fishery	High	LK, IN, MY, ID		2.3
	Field studies to address information gaps	Medium	LK, IN, MY, ID		2.3
	Development of recommendations for optimal mesh sizes and gillnet rigging configurations, tested with bio-economic modeling where necessary.	High	LK, IN, MY, ID		2.3
	Conduct similar studies for other gears catching Indian mackerel e.g. ring nets, purse seine and bottom trawl	Medium	IN, MM, TH, MY, ID		2.3
ETP species	Harmonization of NPOAs and RPOAs on shark conservation and management	Medium	All BOBLME countries		2.3
	Harmonization of both technical measures to reduce ETP mortalities as well as a wider network of spatial and seasonal protection	Medium	All BOBLME countries		3.2
Habitat protection	Improved legislation and enforcement capacity	Medium	All BOBLME countries		2.3
	Improvements to the marking and anchoring of fishing gear	Low	All BOBLME countries		2.3
Improved knowledge of trophic impacts from Indian mackerel fisheries	Development of trophic modeling of the Bay of Bengal to determine predator / prey relationships and the impact of fishery removals on the food web, inc. other commercial stocks and species (in combination with hilsa shad studies, but will be restricted to marine waters)	Low	Open		2.3 / 3.1
	Spatial population modeling to examine the impact of climate change on species productivity and distribution.	Low	Open		2.3 / 3.1

Activity	Action	Priority	Partner countries *	Supporting partners	BOBLME component(s)
HILSA SHAD					
Regional Fisheries Management Plan	National assessment of fisheries consolidated into a regional overview	High	IN, BD, MM	FAO	2.3
	Characterization of stock status, inc. options for stock reference points	High	IN, BD, MM		2.3
	Regional stock assessment studies	High	IN, BD, MM		2.3
	Workshops to agree management objectives, inc, establishment of preliminary reference points (to be periodically reviewed)	High	IN, BD, MM		2.3
	Development of national management measures to be harmonized at regional level.	High	IN, BD, MM		2.3
	Development of enforcement strategies at national and regional levels.	Medium	IN, BD, MM		2.3
	Development of a precautionary hilsa shad Recovery Plan	Medium	IN, BD, MM		2.3
	Harmonization of existing and proposed national / regional Plans of Action	High	IN, BD, MM		2.3
Gear selectivity studies	Regional review of information on gillnet selectivity for hilsa shad fisheries	High	IN, BD, MM		2.3
	Field studies to address information gaps	Medium	IN, BD, MM		2.3
	Development of recommendations for optimal mesh sizes and gillnet rigging configurations, tested with bio-economic modeling where necessary.	Medium	IN, BD, MM		2.3
ETP species	Risk assessment for ETP interactions with hilsa fisheries	Medium	IN, BD, MM		2.3
	Guidelines for ETP mitigation and management measures in high risk fisheries	Medium	IN, BD, MM		2.3
Habitat protection	Improvements to the marking and anchoring of fishing gear	Low	IN, BD, MM		2.3
	GIS-based mapping of critical hilsa habitats, fishing pressure and environmental conditions.	Medium	IN, BD, MM		2.3 / 3.2
Improved knowledge of trophic impacts from hilsa fisheries	Development of trophic modeling of the Bay of Bengal to determine predator / prey relationships and the impact of fishery removals on the food web, inc. other commercial stocks and key stone species (in combination with Indian mackerel studies, but will include a freshwater component)	Low	IN, BD, MM		2.3 / 3.1
	Improved linkages with watershed management	High	IN, BD, MM		2.3 / 4.1 / 4.2

Activity	Action	Priority	Partner countries *	Supporting partners	BOBLME component(s)
NON-FISHERIES SPECIFIC ACTIVITIES					
Policy development	Development of longer-term objectives for fisheries sector development	High	All BOBLME countries		2.3 / 2.2
	Removal of 'bad' subsidies to the fisheries sector	Medium	All BOBLME countries		2.3 / 2.2
Information support	Improved, priority-based research planning	High	All BOBLME countries		2.3
	Improving consistency and harmonization of fisheries statistics collection	High	All BOBLME countries		2.3
	Improving landing and market input data provision	Medium	All BOBLME countries		2.3
	Increasing private sector role in fisheries information provision	Medium	All BOBLME countries		2.3 / 2.1
Fisheries control	Updating and harmonization of fisheries laws	Medium	All BOBLME countries		2.3 / 2.2
	Improved risk-based Monitoring, Control and Surveillance (MCS) approaches	Medium	All BOBLME countries		2.3
Human capacity development	Increased human capacity development, especially at local administration level	High	All BOBLME countries		2.3
	Establish regional centers of excellence for different fisheries science and management topics	Medium	All BOBLME countries		2.3 / 3.3

* Country codes: MD Maldives; LK Sri Lanka; IN India; BD Bangladesh, MM Myanmar; TH Thailand; MY Malaysia; ID Indonesia

Appendix A: References

This Appendix provides references for the main summary report text only. Additional references used in the compilation of each country Appendix, are provided in Annexes to the country Appendices.

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Appendix B: The MSC Principles and Criteria for Sustainable Fisheries

The MSC Principles and Criteria for Sustainable Fisheries form the standard against which the fishery is assessed and are organised in terms of three principles. Principle 1 addresses the need to maintain the target stock at a sustainable level; Principle 2 addresses the need to maintain the ecosystem in which the target stock exists, and Principle 3 addresses the need for an effective fishery management system to fulfil Principles 1 and 2 and ensure compliance with national and international regulations. The Principles and their supporting Criteria are presented below.

Principle 1

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery. [13]**:**

The intent of this principle is to ensure that the productive capacities of resources are maintained at high levels and are not sacrificed in favor of short term interests. Thus, exploited populations would be maintained at high levels of abundance designed to retain their productivity, provide margins of safety for error and uncertainty, and restore and retain their capacities for yields over the long term.

Criteria:

1. The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity.
2. Where the exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level consistent with the precautionary approach and the ability of the populations to produce long-term potential yields within a specified time frame.
3. Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

Principle 2

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

Criteria:

1. The fishery is conducted in a way that maintains natural functional relationships among species and should not lead to trophic cascades or ecosystem state changes.

[13] *The sequence in which the Principles and Criteria appear does not represent a ranking of their significance, but is rather intended to provide a logical guide to certifiers when assessing a fishery. The criteria by which the MSC Principles will be implemented will be reviewed and revised as appropriate in light of relevant new information, technologies and additional consultations*

2. The fishery is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels and avoids or minimises mortality of, or injuries to endangered, threatened or protected species.
3. Where exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

Principle 3

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

A. Management System Criteria:

1. The fishery shall not be conducted under a controversial unilateral exemption to an international agreement.

The management system shall:

2. Demonstrate clear long-term objectives consistent with MSC Principles and Criteria and contain a consultative process that is transparent and involves all interested and affected parties so as to consider all relevant information, including local knowledge. The impact of fishery management decisions on all those who depend on the fishery for their livelihoods, including, but not confined to subsistence, artisanal, and fishing-dependent communities shall be addressed as part of this process.
3. Be appropriate to the cultural context, scale and intensity of the fishery – reflecting specific objectives, incorporating operational criteria, containing procedures for implementation and a process for monitoring and evaluating performance and acting on findings.
4. Observe the legal and customary rights and long term interests of people dependent on fishing for food and livelihood, in a manner consistent with ecological sustainability.
5. Incorporates an appropriate mechanism for the resolution of disputes arising within the system[14].
6. Provide economic and social incentives that contribute to sustainable fishing and shall not operate with subsidies that contribute to unsustainable fishing.
7. Act in a timely and adaptive fashion on the basis of the best available information using a precautionary approach particularly when dealing with scientific uncertainty.

[14] Outstanding disputes of substantial magnitude involving a significant number of interests will normally disqualify a fishery from certification.

8. Incorporate a research plan – appropriate to the scale and intensity of the fishery – that addresses the information needs of management and provides for the dissemination of research results to all interested parties in a timely fashion.
9. Require that assessments of the biological status of the resource and impacts of the fishery have been and are periodically conducted.
10. Specify measures and strategies that demonstrably control the degree of exploitation of the resource, including, but not limited to:
    a) setting catch levels that will maintain the target population and ecological community's high productivity relative to its potential productivity, and account for the non-target species (or size, age, sex) captured and landed in association with, or as a consequence of, fishing for target species;
    b) identifying appropriate fishing methods that minimize adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
    c) providing for the recovery and rebuilding of depleted fish populations to specified levels within specified time frames;
    d) mechanisms in place to limit or close fisheries when designated catch limits are reached;
    e) establishing no-take zones where appropriate.
11. Contains appropriate procedures for effective compliance, monitoring, control, surveillance and enforcement which ensure that established limits to exploitation are not exceeded and specifies corrective actions to be taken in the event that they are.

B. Operational Criteria

Fishing operation shall:

12. Make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimize mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive.
13. Implement appropriate fishing methods designed to minimize adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas.
14. Not use destructive fishing practices such as fishing with poisons or explosives;
15. Minimise operational waste such as lost fishing gear, oil spills, on-board spoilage of catch etc.
16. Be conducted in compliance with the fishery management system and all legal and administrative requirements.
17. Assist and co-operate with management authorities in the collection of catch, discard, and other information of importance to effective management of the resources and the fishery.

Risk-based Framework

The risk-based framework (RBF) was designed for use in association with the Default Assessment Tree for Principles 1 and 2 presented. The RBF was adopted by MSC to enable scoring of fisheries in data-deficient situations, particularly for the “outcome” performance indicators (PIs) associated with Principles 1 and 2. If it is determined by the assessment team that there is insufficient data to score a given outcome PI using the default scoring guideposts, the risk-based framework can be used as an alternative means of assessment.

Appendix C: Country Report – Bangladesh

Eight countries, connected by one ecosystem, working together to secure its future.

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Country Report: Bangladesh

Undertaken by

Poseidon Aquatic Resource Management Ltd

711-REG

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Tables and Figures

Acronyms

BFRI	Bangladesh Fisheries Research Institute
BOBLME	Bay of Bengal Large Marine Ecosystem
BRD	Bycatch reduction device
CIFRI	Central Inland Fisheries Research Institute (India)
CPUE	Catch Per Unit of Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoF	Department of Fisheries
ETP	Endangered, Threatened and Protected (species)
FAO	Food and Agriculture Organisation (of the United Nations)
FRSS	Fisheries Resources Survey System
IOTC	Indian Ocean Tuna Commission
M&E	Monitoring and Evaluation
MCS	Monitoring , Control and Surveillance
PCSL	Pathways Consulting Services Ltd.
PSA	Productivity and Susceptibility Analysis
RBF	Risk Based Framework
SEFDEC	Southeast Asian Fisheries Development Center
SICA	Scale, Intensity and Consequences analysis
TED	Turtle exclusion device

1 OVERVIEW

1.1 INTRODUCTION

This Appendix focuses on an assessment of hilsa (*Tenualosa ilisha*) fisheries (stock status, ecosystems impacts, and management), and related recommendations. The hilsa assessment is presented in Section 3 of this Appendix.

An overview of the available information and current knowledge is however also provided for Indian mackerel (*Rastrelliger kanagurta*) in Section 2 of this Appendix. Indian mackerel is a species of very minor importance in Bangladesh, with catches currently estimated at less than 100 tonnes per year. Information on the fishery is lacking and there is no specific management of the species, and no targeted fishery (Indian mackerel is caught in small quantities as bycatch in industrial trawl fisheries, and as bycatch of small-scale gillnet fisheries). There are signs however that the fishery may become increasingly important in the future if stocks move northwards as has been suggested (Vivekanandan, 2005), and as the importance of small pelagic species grows as Bangladesh 'fishes down the food chain' (WorldFish, 2008). As a result, an assessment of this species at the present time is neither appropriate nor possible. However, as suggested by stakeholders in Bangladesh[1], this Appendix presents the limited information on Indian mackerel that is available, along with some recommendations for BOBLME actions in relation to this species, as stakeholders are keen for the project to support the generation of additional knowledge.

Figure 1: Map of Bangladesh

[1] Meeting by the consultants with DoF staff and the BOBLME national coordinator, on 11th October 2010.

1.2 PEOPLE MET

Name	Title and Organisation	Contact details	Location of meeting
Md. Mahbubur Rahman Khan	Director-General, Department of Fisheries	dg@fisheries.gov.bd	Dhaka
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2 INDIAN MACKEREL

2.1 CURRENT INFORMATION AND STATUS OF THE FISHERY

This section is primarily based on information provided by the National Coordinator and the Technical Adviser to the BOBLME project.

Catches

Catches are officially estimated to be around 58 metric tons[2]. This figure is however unverifiable, and no trend data are available, as data for Indian mackerel are not recorded separately from other mackerels, but rather are grouped together in the Department of Fisheries (DoF) dataset (generated from logsheet information). It is therefore likely that considerably more than 58 tonnes is caught each year.

Catches are thought to be made primarily by drift gillnets (DGN), longlines (LL), and marine set bag nets (MSBN) in the coastal artisanal fishery, using mechanized and non-mechanized boats. Industrial trawlers (shrimp, fish, and cephalopod) also catch some mackerel. A landings site survey suggested that the relative importance of the different gear types in contributing to total Indian mackerel catches is: drift gillnets (95%), longlines (1%), marine set bag nets (2%) and industrial trawl nets (2%). Thus Indian mackerel is mostly caught as a by-catch of the hilsa fishery. (Rahman and Zaher 2006).

There is no separate data on any vessels exclusively fishing for mackerels. There are however estimates of total vessel numbers for DGNs, LLs, MSBNs and fin-fish trawlers. These are as follows:

- Industrial fishery: At present a total of 136 industrial trawlers are operating of which 94 are fin-fish trawlers and 42 are shrimp trawlers
- Artisanal fishery: There are about 21,400 non-mechanized boats and 22,560 mechanized boats, using the following number of gear units
  - DGNs: 95,572
  - MSBNs: 21,000
  - LLs: About 2,641 LL vessels using 24,614 LLs

Principal landing sites are: Cox's Bazar and Chittagong, Khepupara, Dubla Island and Patharghata.

Catch may be taken throughout the year, but the main fishing season during which Indian mackerel is taken as bycatch occurs November through July.

Stocks

Various surveys have been completed on marine fisheries resources of Bangladesh since 1958, but none have specifically targeted mackerel fisheries. A major survey was completed in 1988-89, and a more recent survey was completed by the Fisheries Research Vessel M. V. SEAFDEC during 25 October through 21 December 2007 (DoF Thailand 2008).

[2] Total combined catch of *S. guttatus, S. commerson* and *R. kanagurta* at Cox's Bazar and Chittagong was 1,178.5 t during 2003-04 (Rahman and Zaher 2006), but the proportion comprised of Indian mackerel is thought to be very small.

Some key findings from previous surveys include:

- The ultimate length of the individual (L_∞) and the carrying capacity (K) for *R. kanagurta* were found to be 27.4 cm and 0.90/year respectively. Wetherall plot estimates of L_∞ and Z (total mortality)/K were 26.7 cm and 4.683 respectively. Exploitation rate was 0.652 and the selection pattern L_{50} (the length at which fish have 50% probability of being captured) was 18.09 cm. Recruitment pattern suggests two seasonal pulses, one in March-May and another in September-October. Peak recruitment appeared in March-May. Maximum yield could be achieved by decreasing length at first capture to 13.0 cm. The relationship between total length and body weight was found to be $W = 0.01583\ L^{2.8952}$. Yield and stock prediction suggests that highest yield could be achieved by decreasing the fishing mortality to 2.0 coefficient rate (Mustafa and Ali 2003).
- Total catch of Indo-Pacific King mackerel, *S. guttatus* (63.0%), Narrow Barred Spanish mackerel, *S. commerson* (3.6%) and Indian mackerel, *R. kanagurta* (4.9%) were 645.3 t at Cox's Bazar, while catches of *S. guttatus* (64.0%), *S. commerson* (3.0%) and *R. kanagurta* (3.0%) were 533.2 t at Chittagong in 2003-04. *S. guttatus* was the most important contributor among the mackerels available. The total length of *R. kanagurta* varied between 19.8 and 25.1 cm with an average of 23.0 ± 3.4 cm. The values were 48.1 and 74.2 cm with an average of 56.6 ± 6.5 cm for *S. commerson* indicating fairly large size of the species. The averge total length of *S. guttatus* was 39.4 ± 5.3 cm. Larger size with higher prices of the *S. commerson* indicated very high potential for domestic and export market (Rahman and Zaher 2006).
- Indian mackerel is not a target species and a bycatch of the hilsa shad and Indian salmon fisheries. The mesh sizes of those gill nets are relatively larger and most of the Indian mackerel probably escapes with a small quantity landed as inadvertent bycatch.

Other research information is limited, as no tagging has ever been completed, and few staff in DoF, BFRI or FRSS focus their work on Indian mackerel.

2.2 RECOMMENDATIONS FOR FUTURE SUPPORT BY THE BOBLME PROJECT

Given concerns over the validity of catch data on Indian mackerel, an appropriate area of intervention/support by the BOBLME could be a specific research/data collection project to more accurately assess levels of catches by vessel and using specific gear type targeting R. kanagurta and seasonality, in an effort to obtain more reliable estimates of the volumes and values of landings, and thereby to assess the importance of the fishery and the need for management.

- BOBLME can assist initiate data collection on all mackerel species available in Bangladesh, based on its importance as plentiful source of low cost protein (for the poor Bangladeshis', like as the people of the Philippines take 70% of their protein requirement from small pelagic groups.
- BOBLME can negotiate with SEAFDEC to collect data collection on small pelagic fishes, like Indian mackerel, like as statistical data on South China Sea by SEAFDEC.

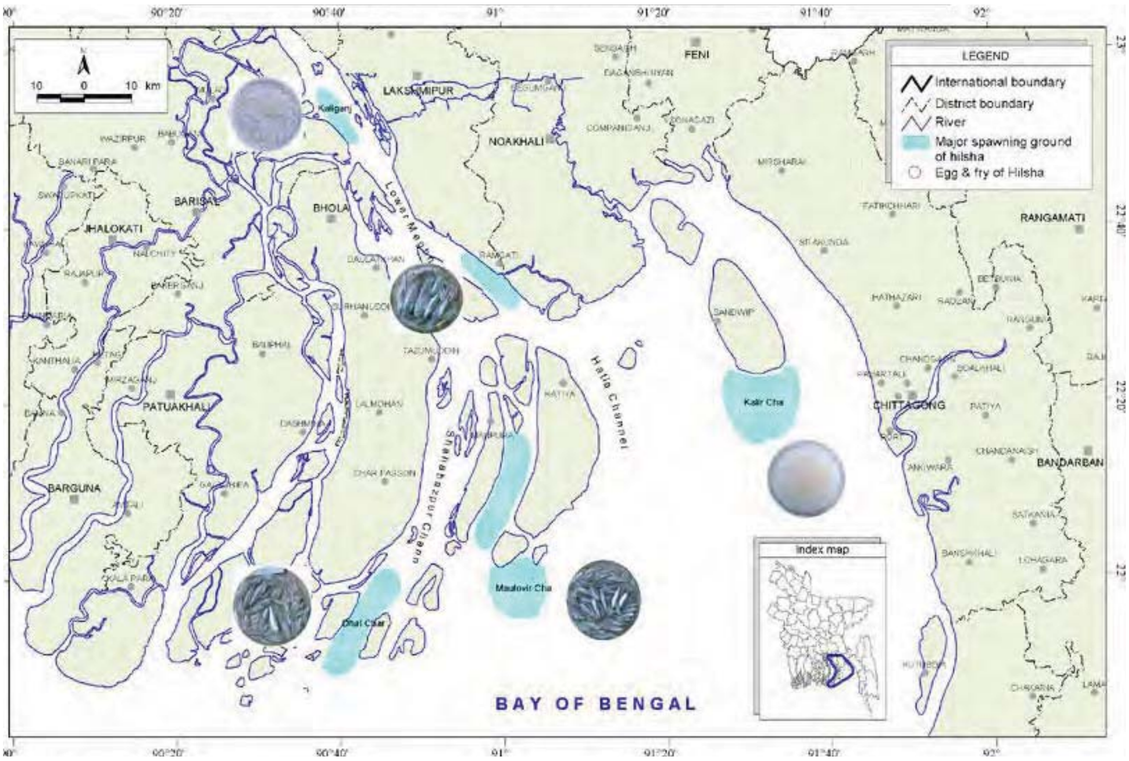
3 FISHERIES ASSESSMENTS – HILSA

3.1 HILSA IN BANGLADESH

A review of the hilsa shad (*T. ilisha*) in the Bay of Bengal is provided in the main report, but it is pertinent to provide a brief comment on the nature of hilsa stocks in the river systems of Bangladesh.

Previous studies have shown that the morphology of hilsa varies within Bangladesh and adjacent India (see India country report). Staff from the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Bangladesh Fisheries Research Institute (BFRI) undertook a collaborative research project on Hilsa from 1996 to 2001. This study (Salini *et al*, 2004) showed that regional morphological variation was similar to that found within a single site and was probably not related to population structuring. The project also examined the chemical composition of the otolith cores (from spawning grounds) of the same fish that were examined for genetic and morphological variation. These studies (Milton and Chenery 2001) showed similar variation to that found by the genetics and morphology studies. The studies of otolith chemical composition were consistent with the results from the genetic and morphological studies. All three methods indicated that the hilsa populations in the Bay of Bengal should be treated and managed as a single population.

Figure 2: Major spawning grounds of hilsa in the Meghna Estuary



Source: Halder. 2003

3.2 DESCRIPTION OF MAIN FLEETS AND GEARS

The fishing fleet consists of around 100,000 boats in inland waters and around 25,000 vessels in the marine sector, of which 75% are mechanised. The main fishing gears are the drift gillnet (*Gulti* or *Kona Jal*) which takes around 75-80% of the catch, the set gill net (*Chandi jal*) which takes around 10-15% of the catch, and the monofilament drift gillnet (*Current jal*) which takes around 5% of the catch. In addition there are numerous other gears that are used to catch hilsa (and other fish), including the seine net (*Jagat ber jal*), fixed encircling net (*Char ghera jal*), etc. Mesh sizes must be at least 90 mm, with the exception of the *current jal* which must have a mesh size of at least 100 mm. However there is widespread use of smaller mesh sizes (50-60 mm) gillnets used in the rivers over February – March targeting new recruits (25-30 cm fish) to the fishery (G.C. Halder, pers. comm., 12 Oct 2010), despite the ban on fishing juvenile fish and the minimum mesh size of 90 cm. The marine fishery targets adult fish utilising a wide variety of mesh sizes (65 – 120 mm), mainly over July to September. For the purpose of this assessment, two 'units of assessment' are defined as follows:

- Gillnets (both drift and set) with a mesh size of 40–60 mm targeting juvenile hilsa (*jatka*) in riverine waters, operated predominantly by unmechanised vessels.
- Gillnets (both drift & set) with a min. mesh size of 60-120 mm targeting adult hilsa in estuarine and marine waters, operated predominantly by mechanised vessels.

The numerous other small gear types used in the riverine areas are not considered by the assessment given the very small percentage of the catches by these gears

3.3 CURRENT EFFORT, CATCHES (VOLUME & VALUE) AND SOCIO-ECONOMIC IMPORTANCE

At present 50-60% of global hilsa catch is reported from Bangladesh waters, 20-25% from Myanmar, 15-20% from India and the remaining 5-10% from other countries (*e.g.,* Iraq, Kuwait, Malaysia, Thailand and Pakistan) (Rahman *et al*, 2010).

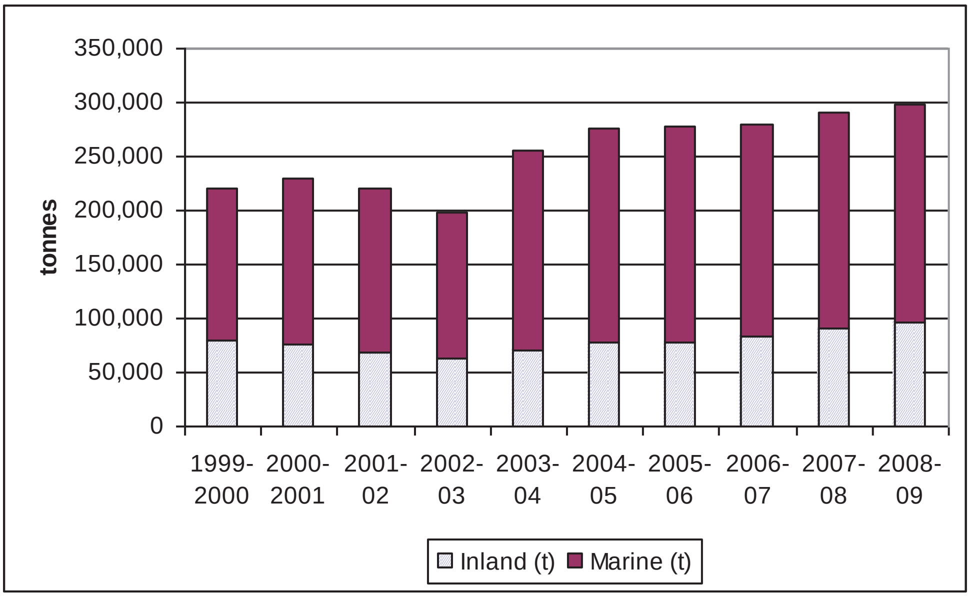
Hilsa catches in Bangladesh were 298,921 tonnes in 2008-2009 (95,970 from inland waters and 202,951 tonnes from in marine waters) and accounted for 39.4% of total marine catches, 4.3% of inland catches, and 11% of total fish production (FRSS, 2010). This catch is valued at around Tk. 90 billion / $1.3 billion at average retail prices[3]. Accurate estimates of landed values are problematic to obtain given complex relationships between money lenders and fishermen which distort prices paid to fishermen, but are thought to be around Tk. 45-60 billion / $640-850 million[4]. The peak fishing season extends from June to March, with a major peak in September-October and a minor one in February-March.

National hilsa landing ranged between 144,438 tonnes and 298,921 tonnes over the period 1983/84 to 2008/09. Catches over this period show a steady but gradual increase, and catches in 2008/09 were the highest recorded during the last 20 years. Declines over the 2001/02 to 2003/04 period appear to have been arrested by a number of management measures put in place at that time, in particular *jatka*[5] fishing ban periods. These rising trends in production however hide a shift in the relative contributions of inland and marine

[3] Tk 300/kg. G. C. Halder Pers. Comm, 2010
[4] Tk 150-200/kg G. C. Halder Pers. Comm, 2010
[5] Juvenile hilsa

catches to total production. Similar to the situation in India's West Bengal, Bangladesh's inland catches have been contributing a decreasing proportion of total hilsa catches over time, and in 2008/09 inland catches represented just 32% of total hilsa production. The main causes are likely to be increasing levels of pollution and sedimentation in riverine systems, and reduced water flow from upstream (which results in the drying-up of rivers, and saline intrusion). Over-fishing may also be playing a role despite overall catch growth in recent years, but there is considerable uncertainty that exists over the reliability of catch data (and of marine catch data in particular, which is the driving force for overall increases in estimated landings).

Figure 3: Hilsa catches in Bangladesh, 2000/01 to 2008/09



Source: Fisheries Resources Survey System

Concerns about over-fishing are supported by periodic studies on CPUE, which, while not always directly comparable, suggest slight decreases in recent years (see Table 1 below).

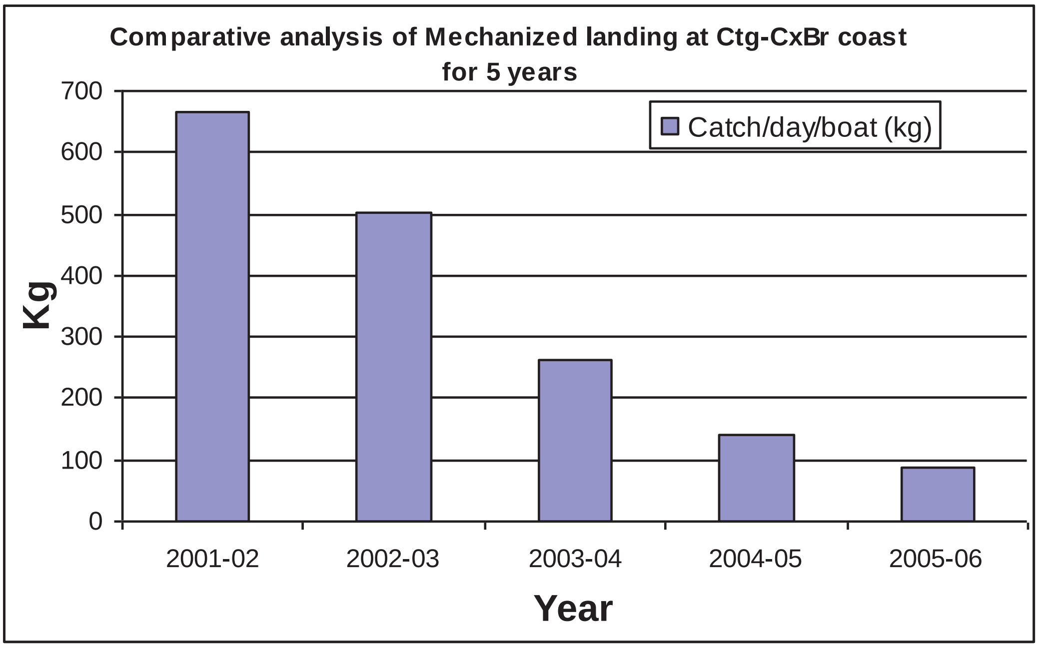
Table 1: Main gears catching hilsa, their CPUEs and areas studied

Gears	CPUE (kg/net/day)	Area covered	Source
Gill net	45.7 (mean)	Meghna River (Chandpur-Hatia)	Haldar & Rahman, 1998
	33.0 (mean)	Meghna River (Chandpur-Hatia)	
Set gill net (*Chandi jal*)	4.5 – 30.0	Meghna River (Chandpur-Sakuchia, Monpura)	Rahman, Emran & Shirajul Islam (2010)
	8.0 – 22.0	Meghna River (Chandpur-Alexander), Tetulia, Karkhana, Pyra)	BFRI, 2005
Drift gill net (*Gulti jal*)	20.0 – 50.0		
	5.8 - 50.0	Meghna River (Chandpur-Sakuchia, Monpura)	Rahman, Emran & Shirajul Islam (2010)
Current net	10.8 – 22.6	Meghna River (Chandpur-Alexander), Tetulia, Karkhana, Pyra)	BFRI, 2005
	4.0 - 9.0		Rahman, Emran & Shirajul Islam (2010)

Source: Rahman, Emran & Shirajul Islam (2010)

WorldFish (2008) also note declines of CPUE in the mechanised marine gillnet fishery[6], from about 700 kg (catch/boat/day) in 2001-2 to less than 100 kg in 2005-6, recorded at landing sites along the coasts of Chittagong and Cox's Bazar (see Figure 4).

Figure 4: Daily catch rate for mechanized gillnet vessels



Source: In WorldFish 2008, adapted from DoF Marine Survey Unit Data (Ahmed, 2007)

There may be as many as 100,000 vessels in use to catch hilsa, and vessel numbers have been increasing significantly in recent years (Rahman *et al*; 2010, WorldFish 2008), although accurate data are not available due to the presence of very many unlicenced vessels in both inland and marine areas (DoF, Pers Comm, 2010).

The fishery plays a critical role in terms of the generation of employment and income for those involved, as well as earning foreign exchange for the country. Exact numbers of people involved with hilsa fisheries (catching, processing/marketing, etc) are not reliably known, although some recent estimates have suggested around 500,000 fishers may catch hilsa (Rahman, 2010). There may be another 2-2.5 million people indirectly involved in the distribution and sale of hilsa, as well as in ancillary activities (net and boat making, ice production, processing and export). These are concentrated within the Barisal division (63%) and the Chittagong division (29%).

Some studies have examined the socio-economic status of fishermen, and it is clear that in general hilsa fishermen can be categorised as socio-economically disadvantaged in terms of access to services (education, health, banking, electricity, piped water), and income - the average annual income (gross margin) of a sample of fisheries was estimated in 2004 as being approximately Tk. 76,000 / $1,270[7], with fishers showing a high dependency on hilsa fishing as a proportion of total income. On average, 70.4% of the respondents' incomes were generated from hilsa fishing. However, given the relatively high value of hilsa given

[6] These boats use a mix of different types of fishing gears (drift bets, shark nets, rocket nets etc.) and target species such as Hilsa, grunter, , Bombay duck, jewfish, mullet, shrimp, mackerel, crabs, etc.

[7] At 2004 exchange rates

strong local demand, it has also been noted in recent research conducted in marine areas in Noakhali and Barisal that the Hilsa/Jatka fishery gave the highest average daily income of Tk. 196/- and Tk. 168/- respectively. The offshore fishery in both regions gave an average daily income of Tk. 134/- (Noakhali) and Tk. 138/- (Barisal) (PCSL, 2007).

Figure 5: Gillnet fishermen, Bangladesh

Source: Picture courtesy of WorldFish Centre

3.4 RISK ASSESSMENT

A risk assessment was undertaken for hilsa in the two main gillnet fisheries – the very small mesh (min. 12 mm) fishery mainly undertaken by non-mechanised vessels in the riverine stretches, and the larger (but still small) mesh (min. 85 mm) gillnet fishery mainly undertaken by mechanised vessels in the estuarine and marine areas.

The productivity element of the risk assessment is discussed in the main report and shows hilsa to be a highly productive species. When turning to the susceptibility element, the smaller mesh gillnet fishery scores poorly on all elements of the analysis, as much of the available area is fished with a high level of encounterability (e.g. the net covers much of the water column), with a low level of selectivity from the small mesh sizes used and the lack of discards, and the high level of post-capture mortality. However, because of the resilience of hilsa as a species, the overall risk to hilsa is considered medium i.e. could be addressed through improved management conditions.

Table 2: Risk assessment for hilsa in Bangladesh

	Productivity								Susceptibility					PSA Scores		
Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Gill nets (<60mm)	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
Gillnets (>60mm)	1	1	1	1	1	1	1	1.00	2	2	3	3	1.88	2.13	Low	>80

The larger-mesh gillnet fishery fares better in the risk assessment because of a lower proportion of the distribution fished (thus reducing the availability score) and the lower level of encounterability (the gillnet only fishes surface waters in the deeper estuarine and marine waters). Otherwise, despite the larger mesh size, selectivity and post-capture mortality is broadly the same. Combined with the high productivity score, the overall risk level of hilsa populations from the larger mesh gillnet fishery is considered low.

A similar, but more targeted risk assessment was undertaken by Milton (2010) for India, Bangladesh and Myanmar (see main report for more information). This suggested that hilsa in Bangladesh appears more susceptible to overfishing than the other two countries, mainly due to comparatively poorer mortality rates, age composition, fecundity and growth rates. However this may be related to the paucity of data from India and Myanmar.

Milton (2010) concludes that the productivity of the Bangladesh population appears to be declining. The cause of this decline is unclear and a more detailed ecosystem-wide analysis would be required to identify the key ecosystem components or services that may be affecting hilsa productivity.

3.5 ENVIRONMENT

Bangladesh lies in the delta of three great river systems the Ganges-Padma, the Brahmmaputra-Jamuna and the Meghna river system, and a complex network of 230 rivers. These three river basins drain a catchment area of 1,720,000 km² of which only seven per cent lies in Bangladesh (UN 1995). About 2.4 billion tons of sediments are carried yearly by the river system in Bangladesh (Holemen 1986). The confluence of the Padma-Meghna rivers is a very significant water body, the major nursery grounds of hilsa (*Tenualosa ilisha*) and many other commercially important riverine fishes of Bangladesh. In Bangladesh little research work has been done to-date on the primary productivity of the lakes or floodplains of Bangladesh (Hussain *et al*. 1978, ARG 1986, Haldar and Ahmed 1991, Haldar *et al*. 1992, Ahmed 1994) and no work has yet been reported from any flowing water. Ahmed *et al* (2005) prepared a paper on the primary production and fish yields on the Meghna River system and calculated a fish yield of 7 kg of fish per cubic metre of river per annum.

The greatest densities of Ganges dolphins (*Platanista gangetica*) have been observed in the Ganges mainstream in India between Maniharighat and Buxar (particularly the Vikramshila Gangetic Dolphin Sanctuary) and just downstream of there between Kahalgaon and Manihari Ghat, and in the lower Sangu River of Bangladesh (Smith & Braulik, 2008). Mortality in fishing gear, especially gillnets, is a severe problem for Ganges River dolphins throughout most of their range (Mohan 1995, Smith and Reeves 2000). They are particularly vulnerable because their preferred habitat is often in the same location as the fishing grounds. In the middle Ganges, although harpooning is now "rare", mortality in fishing nets remains “widespread” (Sinha, 2002). A specific problem is that, because dolphin oil is highly valued as a fish attractant, fishermen have a strong incentive to kill any animals found alive in their nets and even to set their nets strategically in the hope of capturing dolphins (described by Sinha, 2002 as "assisted incidental capture").

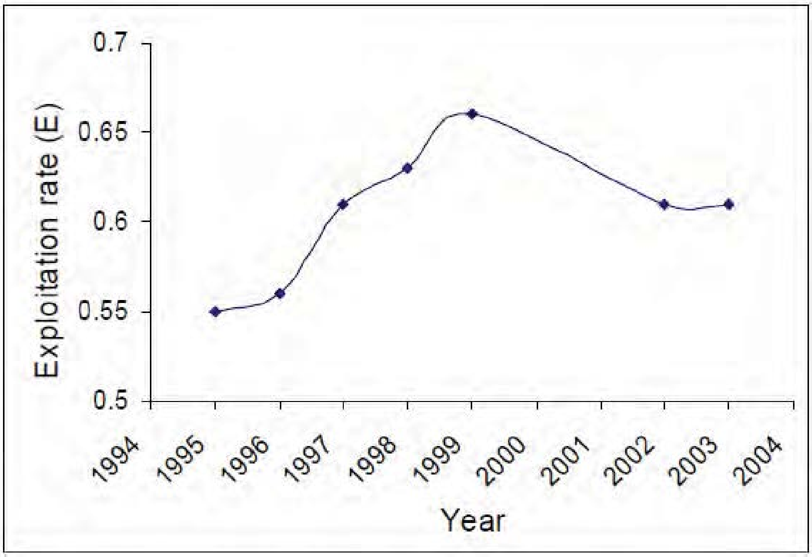
Bangladesh has a coastline of about 710 km. It supports five species of marine turtles in its territorial waters, namely the olive ridley, green, hawksbill, loggerhead and leatherback turtle. Sandy beaches, suitable for turtle nesting, are available in sections along the mainland and on offshore islands. Three species of marine turtles have been reported to nest in Bangladesh. Among them, olive ridley and green turtles are common, while hawksbills are rare with the last nests reported in 1998 at St. Martin Island.

Olive Ridley turtles have been found to nest on sandy beaches all along the mainland coast of Bangladesh and on islands stretching from the Sunderban mangrove forests in the southwest to St. Martin's Island (locally known as Narikel-Jinjira Dweep) in the southeast. Only about 13 sea turtle nesting beaches are known, and most studies are carried out on beaches in the Cox’s Bazar area. This highlights the need for detailed surveys along the entire coastline. It is estimated that the number of marine turtles nesting annually on these beaches may not exceed 1,000-1,100 individuals. Green turtles are less widespread than olive ridleys. They nest both on the mainland coasts along beaches in the southeast (from Cox's Bazar to Teknaf), and on island beaches in the south-central region and also on some offshore and coastal islands like St. Martin's, Sonadia, Kutubdia, Sandweep. They nest round the year but the frequency of nesting increases between October and February, with peak nesting occurring between November and January. They nest on the same beaches as olive Ridley’s, though there may be differences in nest site selection.

3.6 PRINCIPLE 1: STOCK STATUS

3.6.1 Assessment

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp status	✓			Milton, 2010; Rahman *et al*, 2010; Amin *et al*, 2008; Mome, 2007
Explanatory Statement		Despite the on-going implementation of the Hilsa Fisheries Management Action Plan (HFMAP), hilsa populations within Bangladeshi waters are suffering from both impaired recruitment and possibly diminishing productivity. There is still a considerable fishery for juvenile hilsa utilising nets of less than the 90 mm legal minimum mesh size. Amin *et al* (2008), estimates that if 10 - 15% of the year 2000 jatka catch had been protected, an additional 150,000-250,000t of adult hilsa could have been harvested. Amin also reports that the estimated annual yield, standing stock and MSY were 256,902, 148,498 and 210,125 t respectively in 2002. This suggests that the current catches of around 300,000 t represent overfishing this stock. A review by Milton (2010) of previous stock assessments found that although only one of these analyses adjusted the data for gill net selectivity, the results were remarkably consistent and all point to the hilsa population in Bangladesh being overexploited and that fishing mortality needs to be reduced by at least 10% if maximizing biological yield is the overall objective. An alternate analysis that optimised the economic yield of the fishery suggested that the hilsa fishing fleet needs to be reduced to as little as 33% of the existing levels (Mome, 2007). Milton (2010) concludes that the productivity of the Bangladesh hilsa population appears to be declining. The cause of this decline is unclear and a more detailed ecosystem-wide analysis would be required to identify the key ecosystem components or services that may be affecting hilsa productivity.			
1.1.2	Reference points (not if RBF)	✓			Amin, 2008 ; Milton, 2010; WorldFish, 2008; Interviews.
Explanatory Statement		Although various estimates of B_{MSY} have been calculated, mainly based on large length-frequency (L-F) analyses (see Amin, 2008 & Milton, 2010), no biomass-based reference points have been utilised for fisheries management. Given the complexities involved in measuring hilsa abundance, the current L-F based stock assessments are a realistic and practical approach given data limitations. The main reference point that has been adopted in Bangladesh is the exploitation rate (E). This has been calculated since 1995 where it has varied between 0.55 and 0.66 up to 2003 (see figure below).			

PI	Title	Weak	Intermediate	Good	Reference
		Figure 6: Exploitation levels of hilsa in Bangladesh (1995 – 2003)  Source: Amin *et al*, 2008 However the exploitation rate is not a good reference point as a stock may become more resilient to higher exploitation rates as the biomass increases. As a result, the exploitation rate is considered a reasonable indicator of fishing pressure and is not directly used in management decision-making. At present there is no intention to utilise indicator-based harvest control rules for fisheries management in Bangladesh (WorldFish, 2008).			
1.1.3	Stock rebuilding	Not scored			
Explanatory Statement		Despite the acknowledged recruitment over-fishing of the hilsa stock, there is no evidence that the stock is currently depleted e.g. the stock has been driven by over-fishing to the level that there is a drastically reduced spawning stock biomass and reproductive capacity.			
Harvest strategy					
1.2.1	Harvest Strategy		✓		Halder, 2003
Explanatory Statement		The harvest strategy is based on the understanding that recruitment is being compromised by over-fishing of juveniles in riverine areas and it is necessary to respond to this in a practical way that recognises the socio-economic dependencies that have evolved to the fishery, and the difficulties of enforcement (requiring a strategy based on ban period that is relatively easy to monitor compared to other potential strategies). The harvest strategy is defined in the Hilsa Fisheries Management Action Plan (HFMAP) , whose objectives include the statement “To achieve sustainable fishery through banning catch of jatka and gravid females from nursery and breeding grounds of hilsa during the peak breeding season)” (Halder, 2003). The main elements of the strategy – spatial and temporal protection of critical spawning grounds as well as precautionary minimum mesh sizes – are well proven but there is some concern over the adequate scale of the former and compliance levels			

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="2"></td><td colspan="4">with the latter.
There is a degree of monitoring that this approach is being implemented (e.g. data collection on length-frequency and ‘average first length at capture’), although the resources available for such monitoring are limited in comparison to the size and dispersed nature of the fishery.
We therefore consider that the strategy is both appropriate and cautionary, but have doubts as to whether the current level of implementation is adequate for the fishery.</td></tr>
<tr><td>1.2.2</td><td>Harvest control rules & tools</td><td></td><td>✓</td><td></td><td>Milton, 2010; Rahman et al, 2010.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are harvest control tools, but these are permanent restrictions, and are not triggered by any stock status indicators or harvest control rules.
The harvest control tools essentially consist of the following:
1. Mesh size restrictions (>90 mm except for current nets (100mm))
2. No fishing of juveniles (e.g. fish <30 cm)
3. Complete fishing ban for 10 days in four spawning locations during 5 days before and 5 days after the first full-moon of the peak spawning season (mid October) in 4 spawning grounds of approximately 7,000 km² area.
4. Four hilsa nursery areas:
a. Shatnol of Chandpur district up to Char Alexander of Laxmipur district, about 100 km area of the lower Meghna estuary (closed 1 March -30 April).
b. Madanpur/Char Ilisha up to Char Piyal of Bhola district, about 90 km area of the Sahabazpur channel and tributary of the Meghna River (closed 1 March -30 April.
c. Veduriya of Bhola district up to Char Rustum of Patuakhali district, about 100 km area of the Tetulia river, sanctuary (closed 1 March through 30 April).
d. 40 km area of the Andharmanik river of Patuakhali district, closed 1 November -31 January.
e. A fifth area is currently being proposed in Shariatpur.
Milton (2010) concurs that spatial and temporal controls like those described above are more likely to work in terms of stock management than controlling fishing effort directly. However, whilst the approach is likely to work, there is a considerable lag period between estimating yields, matching exploitation rates and then expanding management measures.</td></tr>
<tr><td>1.2.3</td><td>Information / monitoring</td><td></td><td>✓</td><td></td><td>WorldFish, 2008; Amin et al, 2008; Interviews.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Information on the fishing fleet is poor, with many vessels being unlicensed. Much of the effort (in numbers rather than fishing capacity) consists of unregulated and non-motorised fishing vessels in the rivers and upper estuary areas.</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
		Information on stock structure is largely determined through investigations of CPUE and length-frequency analysis of catches. This is being implemented by BFRI in Chandpur, whose activities are constrained by logistical and human resource limitations. However sampling continues to be undertaken. Stock removals are sampled through the FRSS and are reasonably well known, although data collection in marine areas (where the majority of the catch comes from) is weak.			
1.2.4	Stock Assessment (not if RBF)		✓		Milton, 2010; Interviews.
Explanatory Statement		Bangladesh scientists have undertaken several stock assessments of hilsa in Bangladesh based on analysis of large samples of fish length frequencies. Although only one of these analyses adjusted the data for gill net selectivity, the results were remarkably consistent (see table below). This approach is not rigorous and thus the estimated exploitation rates are highly uncertain and would not form the basis of management changes in most situations. However, alternative more rigorous stock assessment approaches require an index of hilsa abundance. These data are not available and are unlikely to be reliably collected in any of the countries in the region. Thus, the stock assessments of Bangladesh scientists probably provide the only realistic indicators of hilsa population status in Bangladesh.			

Period	Adjusted for selectivity?	Fishing mortality	Exploitation rate	Reference
1998	Yes	1.32 – 1.38	0.57 – 0.58	Rahman & Cowx 2008
1997-99	No	2.01 – 2.49	0.59 – 0.64	Amin *et al*, 2004
1999	No	2.49	0.59	Amin *et al*, 2002
2002	No	2.16	0.61	Halder & Amin, 2005
2003	No	1.92	0.61	Amin *et al*, 2002

Source: Milton, 2010

3.6.2 Key Weaknesses with Current P1 Performance

The hilsa fishery in Bangladesh has a well designed, species-specific management plan that provides a practical spatial approach to stock conservation efforts. However there are a number of acknowledged weak elements to this plan and the information used to inform its update and the modification of management actions:

- There is an extensive use of small gillnets (and other gears) in freshwater that do not meet the minimum mesh size regulations and will catch hilsa under the legal limit of <23 cm. This high socio-economic dependency upon juvenile hilsa is the main management challenge of this fishery;
- The productivity of hilsa in the Meghna river system appears to be declining for a number of environmental reasons – this will need to be considered in on-going fisheries assessments;
- The use of exploitation rates rather than biomass-based reference points is understandable given current knowledge, but other avenues of stock assessment and reference point establishment need to be considered; and
- The resources available for monitoring hilsa catches in riverine, estuarine and marine waters are limited, which may further compromise robust stock assessment and management decision-making.

3.6.3 Key Recommendations to Address P1 Performance Weaknesses

The issues mentioned above are widely known in the scientific community in Bangladesh, and hilsa research and management have been the subject of a number of recent reviews (Milton, undated; Milton, 2010; Amin *et al*, 2008). The main recommendations to address these weaknesses can be summarised as:

- A further review at regional level to determine the most appropriate methodologies for hilsa stock assessment. Any methodologies should reflect the current data limitations and collection challenges, as well as the skills and scientific capacity available in the region, so as to be sustainable and replicable in the longer term;
- If considered viable, and a cost-effective approach (see previous point), a regional stock assessment should be undertaken with India and Myanmar to obtain a fisheries-independent estimate of hilsa biomass in the upper Bay of Bengal in order to provide the basis for biomass-based reference points, optimal escapement rates and other potential regional harvest control rules;
- Working with other development initiatives in the watershed to ensure that the potential impacts on hilsa (and other important commercial species) productivity is included in Environmental Impact Assessment (EIA) and other processes;
- The impact of climate change issues related to hilsa shads' yearly harvest needs to be included in the future research studies to understand the synergies & linkages;
- The Governments' strong initiatives is needed for the dredging of the inland rivers (and river stretches famous for hilsa harvest and spawning) to keep the migratory route viable and active round the year, particularly during the winter lean periods;
- The size-selectivity of different gillnet gears is investigated through surveys in order to further refine the overall selectivity of this fishery;
- BFRI conduct a review of their on-going data collection programme to ensure they have sufficient data to refine and develop the hilsa stock assessment and their basis for scientific management of the fishery.

3.7 PRINCIPLE 2: ECOSYSTEM IMPACTS

3.7.1 Assessment

There are no major differences in the scoring for the two units of assessment in terms of ecosystem impacts, so only one table is provided below. Text in the table however, does highlight some key features with regards to inland and marine gillnet fisheries.

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Other retained species</td></tr>
<tr><td>2.1.1</td><td>Other retained spp. status</td><td>✓</td><td></td><td></td><td>G.C. Halder, pers. comm., 10 Oct 2010</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">No figures on the selectivity of these gears have been provided to the assessment team. It is understood that the selectivity of the larger gillnets is good and bycatch is minimal (G.C. Halder, pers. comm., 10 Oct 2010). However it is likely that the bycatch from the smaller-mesh gillnets used in freshwater will be much higher, with a larger proportion of juvenile fish (both hilsa as well as other retained species). However this is difficult to quantify due to the wide range of mesh sizes and the different gear configurations used.</td></tr>
<tr><td>2.1.2</td><td>Other retained spp. management</td><td>✓</td><td></td><td></td><td>Amin, 2008; Rahman, 2010</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The main tool used is the control of gillnet mesh sizes. All nets with a mesh size of under 90 mm are banned, but this is widely ignored, with meshes in hilsa-targeted fisheries being 50 – 80 mm in freshwaters and 65-190 mm in estuarine and marine waters.
In addition small mesh current jal, mosahri jal (mosquito net), seine nets, behundi jal (set bag net) and char ghera jal (fence-like nets operating in the char areas) are the most harmful gears being used illegally in the nursery grounds for capturing jatka of different sizes (Rahman et al, 2010).
The extensive use of small-mesh nets (e.g. <90 mm) in freshwater areas, and the limited capacity to enforce mesh-size and other regulations means that there is likely to be the extensive capture of juvenile fish of a wide number of species, thus posing a considerable risk to their recruitment and population status.</td></tr>
<tr><td>2.1.3</td><td>Other retained spp. information</td><td>✓</td><td></td><td></td><td>G.C. Halder, pers. comm., 10 Oct 2010</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Catch estimates in freshwater areas are reasonably well estimated, although there are apparently little data on gear-wise catch rates and composition.
Catch estimates in marine waters are less certain due to the challenges of sampling the wide distribution of gear use and landing points in coastal Bangladesh. It is likely that there is a high degree of under and mis-reporting from both the marine and estuarine hilsa fisheries, and the nature and quantity of retained bycatch is not well-known for these gears.</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
Discarded species					
2.2.1	Discarded spp. status			✓	G.C. Halder, pers. comm., 10 Oct 2010
Explanatory Statement		Although not recorded, it is highly likely that discards from this fishery are negligible. As such, they do not pose a risk of serious or irreversible harm to any species group.			
2.2.2	Discarded spp. management			✓	G.C. Halder, pers. comm., 10 Oct 2010; Zahirul Islam, 2006
Explanatory Statement		Discards are banned by law (except for sea turtles which can be "thrown away"). As discards are negligible and sea turtles are assessed under ETP, no management measures are required.			
2.2.3	Discarded spp. information		✓		G.C. Halder, pers. comm., 10 Oct 2010
Explanatory Statement		No formal assessment of discard rates and their nature has been carried out. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
ETP species					
2.3.1	ETP spp. status	✓			Rashid 1997; Zahirul Islam, 2006
Explanatory Statement		Conservation of marine turtles has not received high priority in Bangladesh. Scientific publications and systematic surveys have only appeared in the recent past, and all information related to marine turtles before such studies were carried out was obtained from anecdotal notes, district gazettes, forest department reports and newspaper reports of incidental catch by fishermen. What little information has been produced to date suggests that drifting gillnets deployed from large mechanised boats from Cox's Bazar and Chittagong are one of the major sectors responsible for turtle by-catch (Rashid 1997), although it is not known whether these are targeting hilsa or other marine species.			
2.3.2	ETP spp. management	✓			Sea Turtles of India, 2010; Rashid 1997; Zahirul Islam, 2006
Explanatory Statement		Until recently, marine turtles were not included in the protected list of the Bangladesh Wildlife (Preservation) (Amendment) Act of 1974. However, although the Act was later revised to include marine turtles, the amendment still exists as a draft notification today without having been included in the official gazette, rendering the inclusion of turtles within the protected list redundant (Sea Turtles of India, 2010).			
2.3.3	ETP spp. information	✓			Zahirul Islam, 2006
Explanatory Statement		At present there is little information being collected to support the management of fishery impacts on ETP species, either in terms of supporting the development of a management plan (if necessary) or in being able to estimate the outcome status of ETP species.			

PI	Title	Weak	Intermediate	Good	Reference
Habitats					
2.4.1	Habitat Status (SICA only)			✓	G.C. Halder, pers. comm., 10 Oct 2010
Explanatory Statement		Habitat interactions with these gears are minimal, especially in marine and estuarine areas where they are surface set and do not touch the bottom. In faster flowing river and estuarine areas some gears and / or boats may be fixed to the ground causing temporary and low level physical impacts. However, due to the highly dynamic nature of these environments (e.g. fast and chasing currents, high sediment loads, etc.) it is highly unlikely that these impacts are significant in terms of damage to aquatic biodiversity.			
2.4.2	Habitat Management		✓		G.C. Halder, pers. comm., 10 Oct 2010
Explanatory Statement		At present there are no habitat management measures in place, nor is there any known reason why this might be necessary, esp. given the dynamic nature of the environment involved. The one exception however, and the reason this is scored amber as opposed to green, is that it could be useful to have some measures in place to minimise any abandoned, lost or discarded fishing gear.			
2.4.3	Habitat Information		✓		Ahmed *et al*, 2005; Halder *et al*, 1992; Holeman, 1986; Khan, 2010
Explanatory Statement		There is a basic understanding of the types and distribution of the main habitats in the fishery areas, although this has not been well studied. The spatial distribution of fishing effort is reasonably well known, although not formally recorded. The dynamic nature of the riverine system and its changeable nature is also known and is periodically recorded. The nature of the impacts of these gears on the habitat are not known, but given the dynamic nature of the environment, the risk posed is likely to be low, but could nevertheless be further verified.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Milton, 2010
Explanatory Statement		The main issue with this fishery is its low level of size selectivity. Whilst most of the gears used are in the range of 60 – 80 mm, there are many smaller mesh gillnet and other gear types in use that have high catch rates of juvenile fish, especially in the river and estuarine areas. This is likely to have consequences for fish and other populations within the lower watershed in terms of a depleted prey population and possible implications on recruitment, not withstanding the high natural mortality of many species involved.			
2.5.2	Ecosystem Management		✓		Halder, 2003
Explanatory Statement		The Hilsa Fisheries Management Action Plan, whilst focused on the conservation of hilsa, does little to restrain the impacts of this fishery on the overall ecosystem, although it should reduce the level of fishing mortality on other small and juvenile species potentially impacted by this fishery. In order to manage the ecosystem impacts of this fishery, more is required to determine the impact of removing 300,000 t of a mid-			

PI	Title	Weak	Intermediate	Good	Reference
		trophic level species from an albeit highly productive ecosystem, as well as reducing bycatch levels of non-target species. The Sundarbans is a RAMSAR site which may afford this area additional protection.			
2.5.3	Ecosystem Information		✓		Ahmed *et al*, 2005; Halder *et al*, 1992; Holeman, 1986; Khan, 2010; Pathak *et al*, 2009; Satpathy *et al*, 2009; Milton, 2010
Explanatory Statement		CIFRI in India has conducted a number of studies into the riverine and estuarine environments of the wider Ganga / Meghna delta and, importantly, the impact of environmental change (e.g. pollution and reduced water flow) on these. As a result it is possible to identify the key elements of the ecosystem. Considerable work has also been conducted by BFRI to identify key spawning and nursery habitats in the Meghna river system, which has been an essential step in creating spatial protection of recruiting fish. The main impacts of the fishery, especially on the target fish stock can be inferred from research to date. However it is not possible to determine the impacts of this fishery (in particular those smaller-mesh gears) in the population dynamics of retained bycatch species.			

3.7.2 Key Weaknesses with Current P2 Performance

There is very little gear-specific information on the nature and quantity of other retained species in the hilsa fisheries, either in the smaller-mesh riverine areas or the estuaries / sea. This has made the retained species component difficult to assess.

However, anecdotal information suggests that the bycatch of juvenile fish (both hilsa as well as other retained species) in the smaller-mesh gillnets in the riverine element of the fishery is probably high. It is accepted that small-scale fishers will consider this to be a mixed fishery with few (if any) fish considered too small or valueless to discard, and thus there is limited economic incentive to be selective.

Likewise there is very little information on the impact of hilsa-directed gillnets on ETP species e.g. sea turtles in the marine areas, as well as freshwater dolphins and turtles in the river system. There are a number of reports which cite anecdotal evidence of interactions with these species, but there has been very little systematic evaluation of this issue.

Finally, beyond its migratory pattern and lifecycle behaviour, the interplay between hilsa and the ecosystem is poorly understood. In particular the role it plays as both a predator and a prey item as a mid-level trophic species is not well known and needs to be better understood before increasing exploitation rates, even if within stock limits.

3.7.3 Key Recommendations to Address P2 Performance Weaknesses

The following ecosystem-related elements need to be considered:

- The size-selectivity of different gillnet gears should be investigated through surveys in order to further refine the overall selectivity of this fishery;
- FRSS should be developed to provide more information on gear-wise catches in order to understand the biological and economic characteristics of the smaller gillnet fisheries in order to develop pro-poor, yet more environmentally sustainable management approaches;
- A risk assessment study needs to be conducted to determine the level of habitat and ETP impacts, and any discarding in hilsa-directed gillnet fisheries, especially as sea, leading to appropriate management and mitigation measures if required;
- The current temporal / spatial approach should be expanded to help conserve other retained and ETP species. This would require careful planning, together with a socio-economic impact assessment and appropriate mitigation; and
- Allied to the point above, future updates of the Hilsa Fisheries Management Action Plan should include a wider ecosystem approach, thus investigating not only the direct impacts of the fishery upon hilsa populations, but also upon the stocks of other retained bycatches species, any ETP interactions with the hilsa fishery and its impact on the ecosystem as a whole e.g. the trophic impacts of removing large quantities of a mid-level trophic species from the marine and riverine ecosystems.

Figure 7: Gillnet vessels in Kalinodi

Source: Picture courtesy of WorldFish Centre

3.8 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

PI	Title	Weak	Intermediate	Good	Reference
Governance and policy					
3.1.1	Legal Framework			✓	Interviews. Fish Act, 1950. Marine Fisheries Ordinance, 1983 (and Rules, 1983). National Fisheries Policy, 1998. The National Fisheries Strategy (2006). Hilsa management plan 2010-2011
Explanatory Statement		The management system can broadly be viewed as existing within an appropriate and effective legal and customary framework. Regulations within the overall legal framework provide for management measures to protect resources. The National Fisheries Strategy (2006) is also guided by the Poverty Reduction Strategy Paper, and by international agreements signed by the government. The management framework also observes traditional rights. The 2006 National Fisheries Strategy has specific text on 'pro-poor' which recognises the need to 'ensure that the poor retain their traditional rights to the resources through community leasing (inland) or allocation of fishing rights (marine)'. Disputes and conflicts certainly exist within the fishery (e.g. between industrial trawlers and inshore net fisheries), but levels of participation in decision-making (see 3.2.2 below), and the National Task Force for hilsa management and sub-level committees at Upazila and Union level serve as a mechanism for resolution of conflict. Where conflict can not be resolved through such measures, systems of arbitration and legal recourse through the course are (in principal/theory) available. It is not known whether such mechanisms have ever had to be relied on or how successful they were if so in resolving disputes in an effective manner.			
3.1.2	Consultation			✓	Interviews. National Fisheries Policy, 1998. The National Fisheries Strategy, 2006. Khan, 2010. Hilsa management plan 2010-2011
Explanatory Statement		The 2006 National Fisheries Strategy represents shift towards far more community participation and consultation, and has a specific section on 'people's participation' which requires a level of decentralised planning and decision making. There is also a provision in law that if rules and regulations are to be amended, the Department must seek public opinion on any proposed changes. It is also mandatory for the DoF to invite local Members of Parliament and Upazila chairmen to awareness-building campaigns about hilsa management measures. While decentralisation has not always proved especially easy, text in indicator 3.1.1 above on hilsa management committees suggest that levels of consultation are generally good. These committees meet regularly and generally on a monthly basis, with the national-level Task Force typically meeting on an annual basis. Roles and responsibilities of all those involved in the management process are clear and well articulated: The Ministry of Fisheries and			

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="2"></td><td colspan="4">Livestock has responsibility for policy making, DoF for management implementation (and FRSS for the monitoring of catches), BFRI for fisheries research, The Coast Guard for enforcement up to 15 km from the shore, the Navy for enforcement outside of 15 km, the police for arrest and prosecutions, and two major fishermen's' associations represent the interests of fishermen.

The roles and responsibilities of the hilsa management Task Force (which includes representatives of all those listed above) is also clear, with specified working mechanisms.</td></tr>
<tr><td>3.1.3</td><td>Long-term Objectives</td><td></td><td></td><td>✓</td><td>Interviews. National Fisheries Policy, 1998. The National Fisheries Strategy, 2006. Hilsa management plan 2010-2011</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The 1998 National Fisheries Policy is weak in terms of long-term objectives in support of sustainability and the precautionary approach – while objectives do include 'to maintain ecological balance, conserve biodiversity….', its main focus in terms of objectives are to enhance production, alleviate poverty, fulfil demands for animal protein, and obtain foreign exchange.

However, DoFs mission is to 'support sustainable [author's emphasis] growth in fish and shrimp production….', and the 2006 Strategy has a specific section on 'long term objective planning'. It is also clear that with the introduction and implementation of the hilsa management plan, long-term objectives focussing on sustainability are now a driving force in the overall governance and policy framework.</td></tr>
<tr><td>3.1.4</td><td>Incentives</td><td></td><td></td><td>✓</td><td>Interviews. Hilsa management plan 2010-2011</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">A critical aspect of compliance with management measures that are now in place to protect jatka/juvenile fish, is ensuring that livelihoods are not too adversely affected by the fishing ban periods. The DoF has in place a number of mechanisms which can be viewed as 'positive incentives' for compliance with the fishing ban periods, and therefore of overall sustainability – they include the provision of 30 kg / month / fishing family, and micro-credit support to fishermen for alternative livelihood activities in non-fishing activities.

There are no fuel subsidies provided to hilsa fishermen (only to the trawl sector based on a rationale that it generates foreign exchange and therefore deserve special support), or any other 'negative subsidies' of any note which might be serve to increase capacity in the hilsa fleet.</td></tr>
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<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Fishery specific management</td></tr>
<tr><td>3.2.1</td><td>Fishery Objectives</td><td></td><td></td><td>✓</td><td>Interviews. Hilsa management plan 2010-2011; Amin et al, 2008</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The detailed BFRI papers underpinning the formal DoF hilsa management plan have clear objectives in support of sustainability, and the resulting management measures put in place aim to ensure that the exploitation is under 50% of the stock biomass (e.g. the exploitation rate is 0.50). At present the exploitation rate is above 0.6 and thus needs to be further reduced. But there are implicit fishery-specific management objectives.</td></tr>
<tr><td>3.2.2</td><td>Decision making processes</td><td></td><td></td><td>✓</td><td>Interviews. Khan 2010.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Community management has proved successful in inland fisheries, but less so in marine fisheries (Khan 2010). The 2006 National Fisheries Strategy has a specific section on ‘people’s participation’ which requires a level of decentralised planning and decision making.

Text on indicator 3.1.2 above has also demonstrated that there is generally good consultation and decision-making process in place for the specification of hilsa management measures, and as noted there is a provision in law that if rules and regulations are to be amended, the Department must seek public opinion.

These decision making processes, and indeed compliance with regulations, are supported by an extensive programme of awareness campaigns through both print and electronic media. The DoF has a number of television slots each year at critical periods, and uses well-known personalities/actors to convey fisheries management messages.

Ideas about management decision-making are supported by research scientists and their outputs. This is facilitated through an annual two-day BFRI workshop, attended by DoF staff, at which BFRI reports on all past/ongoing research activities, and makes proposals for future research activities which might generate research outputs in support of DoF decision-making. The most recent workshop (October 2010) coincided with the visit of the consultants to Bangladesh, and the consultants observed some sessions of the workshop and noted that participation included around 100 government BFRI and DoF staff.</td></tr>
<tr><td>3.2.3</td><td>Compliance & Enforcement</td><td></td><td>✓</td><td></td><td>Interviews.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">In 2005 government delegated powers of implementation of rules under the Marine Fisheries Ordinance to the DFOs of coastal districts, but in the absence of technically capable marine fisheries staff at district and Upazila levels, the system has not always worked well (Khan, 2010). MCS in marine areas is strongly focussed on the industrial trawl fishery (Khan, 2010), and a lack of effort/input control has led to a huge expansion of unregulated gillnet activity by the uncontrolled numbers of mechanized and non-mechanized artisanal fishery in the marine sector. Compliance and enforcement in marine areas is not helped by the fact there are only DoF inspectors in marine areas, and one ‘surveillance check-post’ where</td></tr>
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<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="2"></td><td colspan="4">vessels can be inspected as they report out/in. The lack of regulation and control over vessel numbers and licensing also applies to the inland/estuarine areas.

Other key weaknesses in the enforcement of regulations appear to the local police force and local magistrates, who may not apply penalties that could be enforced for infringements. And while food security support is provided (as already discussed), there remain very strong livelihood and financial incentives not to comply with regulations, to the low socio-economic status of many fishermen.

However, there are also some strengths in the compliance and enforcement system.

In inland areas, the seasonal bans in nursery areas and the 10-day spawning ban period are reported to be quite well enforced, with effective Coast Guard activities (which also operates in estuarine/inland areas).

Support for MCS activities is programmed into the DoF budget, and DoF provides finances to the Coast Guard and other relevant parties to conduct enforcement activities. There is also reported to be a National Action Plan for MCS (DoF, 2009), and the Coast Guard reports on its activities each year to the hilsa management National Task Force, and gains approval of activities for the coming year. The public awareness activities mentioned in 3.2.1 also serve to support compliance.

Penalties for infringements are not high in financial terms, however the ability to confiscate nets can be viewed as being a considerable disincentive to break regulations (if applied).

There are also reported to be records kept of infringements (not seen by the consultants), although it is not known how comprehensive these records are in terms of the total infringements identified.</td></tr>
<tr><td>3.2.4</td><td>Research Plan</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Indicator 3.2.2 above noted that BFRI have an annual workshop to present results, and discuss and agree future activities. This workshop, and annual budgetary planning, serve to provide the basis for a research plan. The process itself, and the working relationships between BFRI and DoF staff also appear to suggest relatively good linkages between research and management.

BFRI has more than 50 PhD scientists, many of them trained overseas through previous donor-funded projects at high quality research institutes and universities. So human capacity for research is generally good.

<u>However</u>, there are some notable weaknesses in hilsa research. There is a very strong focus in the country on aquaculture research, and many of the qualified research staff are now nearing retirement age. The numbers of younger staff receiving good training has drastically declined, and there are therefore concerns about the lack of new 'cohort' of research scientists entering government employment.</td></tr>
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<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="2"></td><td colspan="4">A second key weakness so far as hilsa is concerned, is that there is very little research taking place on marine hilsa resources/fisheries. While it could be argued that it makes sense to focus activities on inshore nursery and spawning areas given their importance for both the inland and marine fisheries, the lack of marine-related research is nevertheless a concern.</td></tr>
<tr><td>3.2.5</td><td>Performance Evaluation</td><td></td><td></td><td>✓</td><td>Interviews.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The 2006 National Fisheries Strategy has a M&E sub-strategy, which requires an M&E system to be established, as well as an M&E wing in the DoF. Neither has been done.

However, this indicator is intended to assess the M&E of the fishery-specific hilsa management system. M&E of the hilsa management plan appears to be quite robust. There is good M&E of hilsa management strategies through an annual workshop on jatka management, to which all stakeholders are invited, and feedback includes research results, the views of fishers and Upazila committees which submit reports, a report by the Coast Guard their activities, etc. This is followed by a ‘controlling workshop’ with the Minister of Fisheries and Livestock and other stakeholders, which makes recommendations for improvements/changes.

The annual BFRI research workshop also serves as a useful M&E mechanism to assess the effectiveness of the hilsa management plan.

There is also more general ongoing M&E through the activities of the hilsa management Task Force and the various sub-level committees, which typically meet on a monthly basis.

Thus the system of monitoring the performance of the hilsa management system is both regular and frequent. Given the participatory nature of the M&E and broad range of stakeholders involved, it can also be viewed as being both ‘internal’ and ‘external’ i.e. it provides for M&E by those not directly involved in implementation of the management system itself.</td></tr>
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3.8.1 Key Weaknesses with Current P3 Performance

The overall governance and policy framework for hilsa management, and the fishery-specific management framework, generally performs well against the P3 indicators, as a result of the hilsa management plan. Indeed there are many positive lessons-learned of potential interest and replicability in India’s West Bengal and Myanmar.

The two principal areas of weakness relate to compliance and enforcement, and research. With respect to the former, the larger number of illegal mesh-size nets being used is a particular cause for concern, along with numbers of unlicensed and unregistered vessels. In relation to research, a long-history of donor projects in support of human capacity development has resulted in generally high levels of research skills in the country. However the long-term sustainability of this capacity is under question, and there is far less interest in marine hilsa research in particular, than in aquaculture and inland research topics.

3.8.2 Key Recommendations to Address P3 Performance Weaknesses

There is a critical need to ensure that all vessels and boats (both mechanized and non-mechanized) fishing in Bangladesh are licensed. This has to be first step in any long-term sustainable management of the sector. In addition, the hilsa management plan should include specific marine MCS activities/strategies, as well as inland/riverine ones, to ensure an appropriate balance of resources between the two areas.

In relation to research, two main areas are suggested for consideration:

- Research gaps, particularly with regard to marine hilsa fisheries, to be articulated by relevant stakeholders and incorporated into a research action plan.
- A 'capacity development succession plan' to be developed, outlining key staffing issues. This plan could detail the current numbers and qualifications of hilsa research experts in inland and marine areas, consider natural rates of loss through retirement and other factors, and specify requirements for additional training to ensure that Bangladesh does not find itself in a position of declining research expertise in the coming years. This might include both mentoring by senior staff of junior staff, additional formal training, and also mechanisms to ensure that the considerable knowledge available with senior scientists is formally 'captured and institutionalised' with the research and department community. Such knowledge could also be useful for research institutions and fisheries administrations in both India (West Bengal) and Myanmar.

Concerns over research capacity, might also hold true in relation to capacity levels in the Ministry and the Department of Fisheries – again, at present there are many highly qualified and capable staff. However, there are sure to be areas where existing staff capabilities could be further enhanced. Furthermore, planning to ensure that younger staff are also trained-up, would appear to be critical in ensuring long-term maintenance of capacity levels. Thus a "capacity development succession plan'' covering both BFRI and the Ministry/Department might be a useful output of the BOBLME project.

3.9 SUMMARY – HILSA

The table below provides a summary of the performance for hilsa in Bangladesh

Table 3: Summary performance table for hilsa in Bangladesh

Bangladesh																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts																Principle 3: Governance & Management								
		Outcome			Harvest strategy				Retained			Bycatch			ETP			Habitat			Ecosystem			Governance & Policy				Fishery specific mang				
Spp	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Other retained status	2.1.2. Other retained management	2.1.3. Other retained info /	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
Hilsa 2	Gill nets 40-60mm	0	0	*	1	1	1	1	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1	2	2	2	2	2	2	1	1	2
Hilsa 2	Gill net 60-120mm	0	0	*	1	1	1	1	0	0	0	2	2	1	0	0	0	2	1	1	1	1	1	2	2	2	2	2	2	1	1	2

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Appendix D: Country Report – India (Tamil Nadu & West Bangal)

Eight countries, connected by one ecosystem, working together to secure its future.

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Country Report: India

Prepared by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms

ARHMC	Aquatic Resources Health Management Centre
BOBLME	Bay of Bengal Large Marine Ecosystem
BRD	Bycatch reduction device
CIFRI	Central Inland Fisheries Research Institute
CMFRI	Central Marine Fisheries Research Institute
CPUE	Catch Per Unit of Effort
FAO	Food and Agriculture Organisation (of the United Nations)
MCS	Monitoring, Control and Surveillance
PSA	Productivity and Susceptibility Analysis
RBF	Risk Based Framework
SICA	Scale, Intensity and Consequences Analysis
TED	Turtle exclusion device
TN	Tamil Nadu
WB	West Bengal

1 OVERVIEW

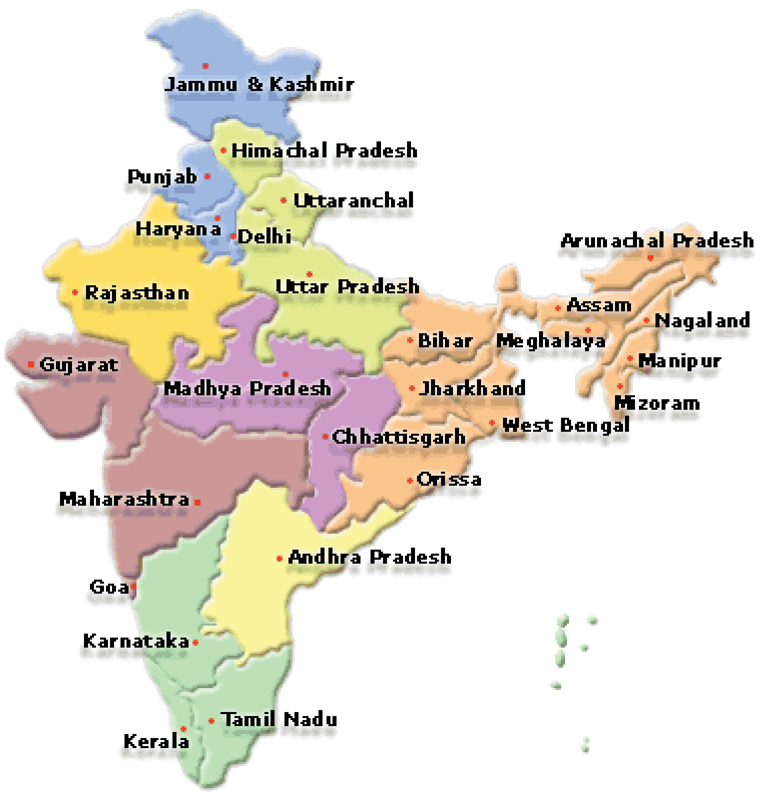
1.1 INTRODUCTION

In this country Appendix, we present two case study assessments. The first examines stock status, ecosystems impacts, and management performance for **Indian mackerel in the State of Tamil Nadu**. The second considers **hilsa in the State of West Bengal**. The case study approach was necessitated by the limited duration of the country visit made by the consultants, and the corresponding need to focus the assessment work on species of particular importance in each State, rather than trying to cover both species in all States in the Bay of Bengal (Tamil Nadu, Andhra Pradesh, Orissa, West Bengal).

In Tamil Nadu there are virtually no hilsa catches, but catches of Indian mackerel are important and are likely to be part of a shared stock with Sri Lanka. In West Bengal catches of Indian mackerel are certainly present, but hilsa represents a more important stock, and one that is shared with Bangladesh.

Like the Indian mackerel fisheries in Tamil Nadu, Indian mackerel fisheries in West Bengal are targeted by gillnets and caught as bycatch in trawl fisheries. While responsibility for management of fish resources within the 12 nautical mile limit is devolved to States in India, and thus there may certainly be important differences at State level in terms of stock status, ecosystems impacts, and management performance, the Indian mackerel assessment for Tamil Nadu can be viewed as being broadly representative of performance in other States in India.

Figure 1: States of India



1.2 PEOPLE MET

Name	Title and Organisation	Contact details	Location of meeting
Ranya R	International Collective in Support of Fisherworkers (ICSF)	icsf@icsf.net	Chennai
Dr. Vivekanandan	Central Marine Fisheries Research Institute	evivekanandan@hotmail.com	Chennai
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Mahindra Sundaran	Joint director of Fisheries, Department of Fisheries, Tamil Nadu		Chennai
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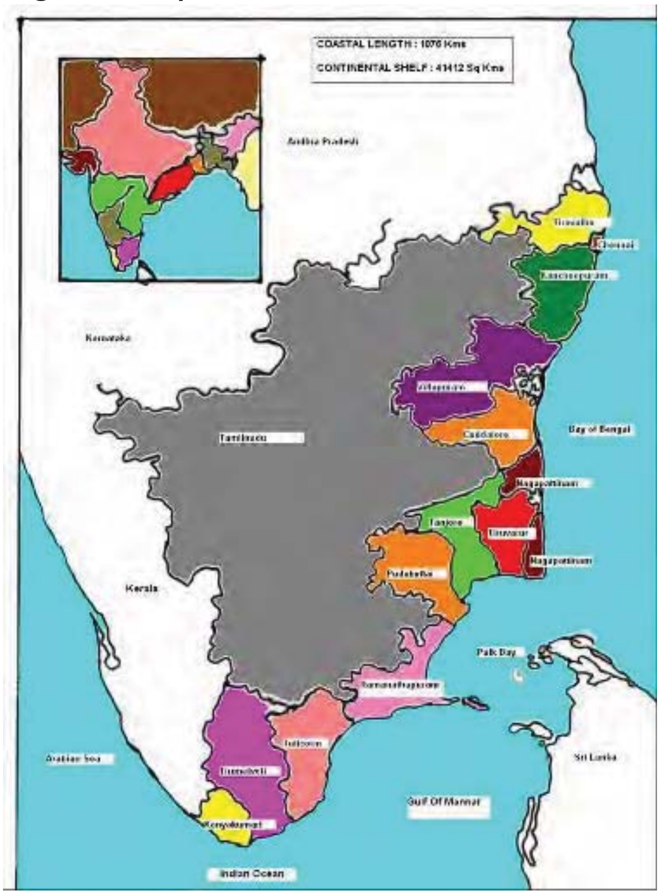
Dr. Chakrabarty	Assistant Director of Fisheries, ARHMC, DFWB	Chinmoy_aimi@yahoo.com	Kolkata
Dr. Jana	Deputy Director of Fisheries, Statistics, Dept of Fisheries, Gov of West Bengal		Kolkata
Muralidharan Chavakat Manghat	Project Director, FAO/World Bank FIMSUL project	cmmuralidharan@gmail.com	By email

2 FISHERIES ASSESSMENTS – INDIAN MACKEREL (TAMIL NADU)

2.1 DESCRIPTION OF MAIN FLEETS AND GEARS

Figure 2: Map of Tamil Nadu



The main gear targeting Indian mackerel in Tamil Nadu (and neighbouring Andhra Pradesh) is the surface gillnet. There are increasing levels of trawl catch (Dr. Anrose, FSI, pers. comm., 5 Oct., & Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010) as well as the development of a (currently illegal) ring seine fishery. The species composition of these individual gear types is not recorded by the State government's landing statistics, although they are available from CMFRI gear monitoring. These have been officially requested from CMFRI via the BOBLME National Coordinator in India (by email 7th Oct. 2010) but no response has yet been received.

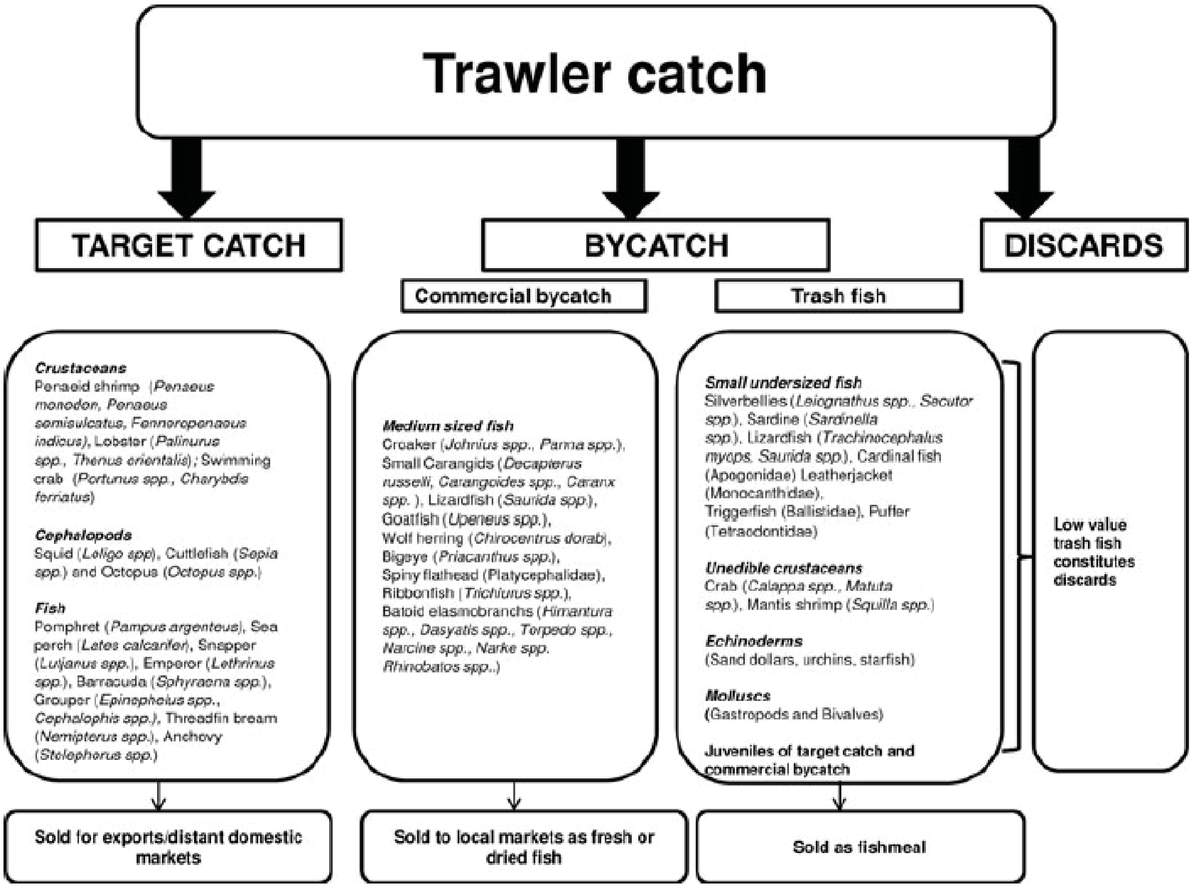
Gill net fishery: the gill net fishery, in contrast to Sri Lanka, appears to target Indian mackerel, although there is an unquantified bycatch of other species such as juvenile seerfish (*Scomberomorus commerson*), carangids and scads (e.g. *Decapterus* spp.), although such bycatch appears to be low e.g. <10%. Fishers prefer a single species catch and adjust the mesh sizes to suit a particular schooling fishery. The Indian mackerel targeted gillnets have a mesh size of 50-65mm, are around 5m deep and up to a kilometre in length (Mahindra Sundaran, pers. comm., 6 Oct 2010). The vessels fishing gillnets are mainly out-board (8.5–11hp) powered fibreglass skiffs, fishing 8 – 10nm offshore. They are surface set and tend to operate in shallower water (<50 m depth).

Trawl fishery: the Indian trawl fleet targets shrimp, demersal fish and cephalopods using a high opening trawl net introduced in the mid 1980's. It uses a headline height of around 20-30m, so when used in waters averaging 50-60m will fish the entire bottom half of the water column. The cod end mesh should be a minimum of 35mm, but 8-10mm is used by most fishers. It is understood (Dr. Vivekanandan, pers. comm., 7 Oct., 2010) that trawl catches of Indian mackerel have increased from 2% of the total east coast catch to about 15-18%, suggesting that schools are tending to move into deeper water then previously found. In addition, Indian mackerel prefer a temperature of around 27°C so tend to swim deeper over the summer as the thermocline sinks (Yohannan and Abdurahiman, 1998), thus making them more vulnerable to demersal fisheries. Indian mackerel are most abundant down to 50m water depth, but have been found as deep as 200m. The species composition of these trawls varies widely, depending on their target fishery (e.g. shrimp, demersal fish or cephalopods), the location and trawl gear setting (see Figure 3 overleaf).

Trawlers along the Coromandel Coast are restricted to a maximum length of 50ft, and a maximum engine size of 110 hp. There is a strictly enforced 45-day fishing ban (15 April–29 May) each year, common to the entire state of Tamil Nadu (Bavinck *et al*. 2008) and the Tamil Nadu Marine Fisheries Regulation Act of 1983, requires that the first three nautical miles (5.56 km) from shore be reserved for artisanal fishing. However, this is not strictly enforced, and trawlers often fish closer to the coast (Bavinck *et al*. 2008). Trawling operations are mostly restricted to a depth of 50 m, and fishing trips generally last 1–3 days (Devaraj & Vivekanandan 1999; Bavinck *et al*. 2008).

Figure 3: Diagrammatic representation of the categories and composition of the trawl catch along the Coromandel Coast.

Note that the lists are representative but not comprehensive.



Source: Lobo *et al*, 2010

Ring seines: as purse seine-type gear is illegal in India, there is little detail on the scale and nature of these fisheries, especially on the east coast of India where they are only just being introduced. They are small-mesh enclosing nets, which are set on schools of Indian mackerel and other small pelagic species and are highly effective. Some advocate the legalisation of these gears as they have no habitat impacts, so long as the size and overall capacity of these gears is controlled. Given that they are set on individual schools, they are likely to be highly mono-species specific and to have little incidental bycatch. The use of such gear is reported to be on the rise, and traditional gill nets are typically used to form such ring seines.

For the purpose of this assessment, and given the illegal nature of the ring seine nets, the two main 'units of assessment' are defined as follows:

- **Small-mesh (50 – 65 mm), surface-set gillnet fishery** in Tami Nadu prosecuted by motorised (outboard and inboard) vessels with Indian mackerel as the main retained species; and
- **'High opening' bottom trawl fisheries in Tamil Nadu** targeting shrimp, finfish or cephalopods with a retained and commercially important bycatch of Indian mackerel.

We have not included ring nets as a unit of assessment at this stage. Notwithstanding that this gear is currently illegal, its characteristics are similar to that of the small-mesh gillnet, in that the ring seine consists of a number of small-mesh gillnet panels sown together with a bottom purse draw rope. As such - and given they are used to target a number of different schooling small pelagic species - they will perform similarly to the gillnet fishery.

2.2 CURRENT EFFORT, CATCHES AND SOCIO-ECONOMIC IMPORTANCE

Current effort levels of fishing for Indian mackerel by the main gear and fleet types described above, are not known. However, the tables below provide some background data on fisheries in Tamil Nadu and on catches in the State. Some key points of interest from Table 1 and Figure 4, and from Fisheries Department data are:

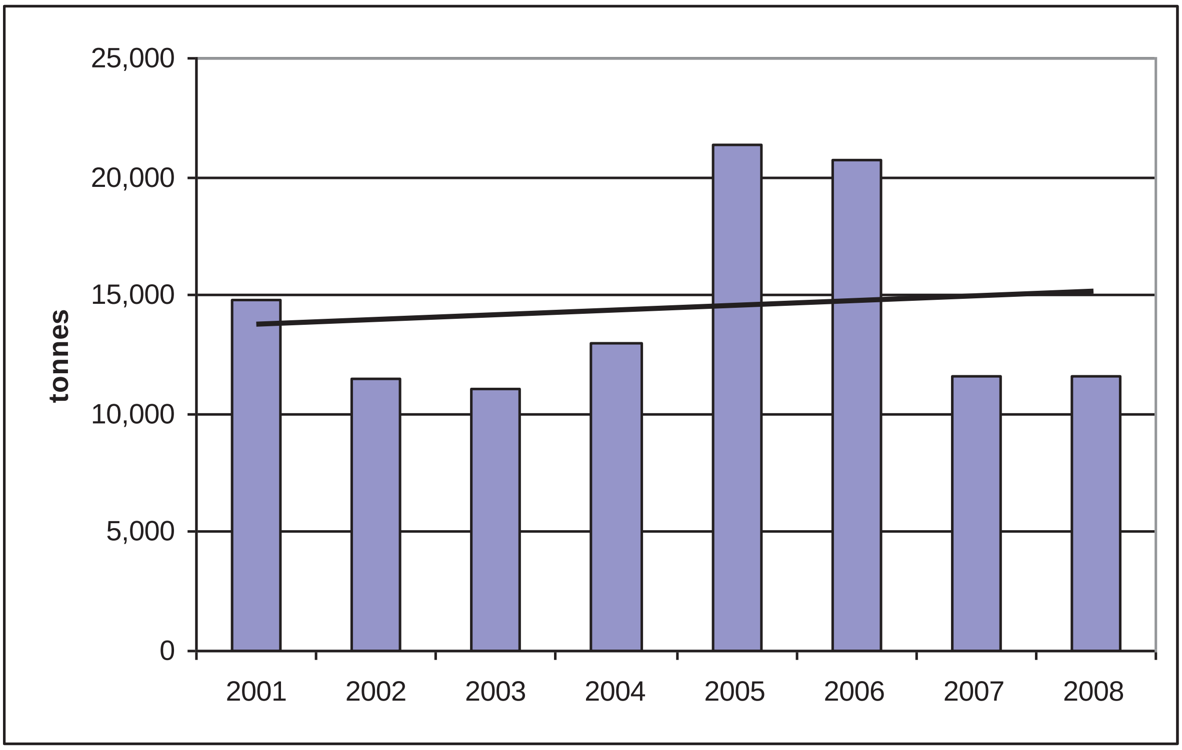
- Tami Nadu has a coastline of 1,076 km, a continental shelf of 41,412 km^2, 13 coastal districts, 591 fishing villages, and 363 marine fish landing centres;
- Tami Nadu has an estimated 206,908 active fishermen, a total employment of 324,234 for the combined catching and related marketing sectors, and 963 fishing cooperatives;
- Overall catches in Tamil Nadu are dominated by the mechanised sector (61%) (broadly classified as inboard, decked vessels, using mechanical hauling equipment);
- In the motorised and non-motorised sectors in Tami Nadu, vessel sub-types are: motorised - 53,266 catamarans, 3,285 plank built, and 9616 FRP. Non-motorised - 399 dugouts, 14,716 catamarans, 8,122 plank built, and 257 others;
- By gear, trawl nets account for 61.1% of total catches in Tamil Nadu, gill nets 19.4%, seine nets 1.2%, tangle nets 5.6%, hook nets 5.8%, bag nets 6.3%, and falling gears 0.6%;
- Indian mackerel represents around 3% of the total landed volume of catches;
- Catch levels in Tami Nadu over recent years show considerable fluctuations, and suggest a downward trend in most recent years;
- Average catches in Tamil Nadu for Indian mackerel of 14,430 over the period 2001 to 2008 compare to an estimated MSY for Indian mackerel of 13,473 tonnes (Source: Working group of Fisheries specialists constituted by Ministry of Agriculture. Government of India 1991) i.e. 7% above MSY;
- The value of Indian mackerel catches is estimated at Rs. 53/kg for 2007, giving an annual landed value of catches in 2007 of Rs. 616 million / $15.6 million.

Catches of Indian mackerel for the whole of India are highly variable, and have varied from 150,000 to 280,000t over the past 5 years, of which around 30% is caught on the east coast in the Bay of Bengal. This proportion of catch from the east coast appears to be rising and has historically been closer to around 10%. It is thought that west and east coast stocks are probably separate, but with some intermixing.

Research suggests that catches/stocks of Indian mackerel also appear to be moving towards the north, possibly as a result of increasing sea temperatures, but also due to changes in primary production patterns. Historically, there was negligible catch in the north east (Orissa/WB), but these States now account for around 20% of the east coast catch.

The socio-economic importance in Tami Nadu of small pelagics is very considerable, given their low cost to consumers and their very high nutritional value, meaning they are affordable source of animal protein. However, given the low estimated volumes of Indian mackerel landed in Tamil Nadu compared to many other species, its overall socio-economic importance may be considered minor, although it may be of high socio-economic importance for particular individuals or groups.

Figure 4: Catch volumes of Indian mackerel in Tami Nadu, 2001 to 2008 (tonnes)



Source: Department of Fisheries, Tamil Nadu

Table 1: Fish catch in Tamil Nadu by species and district, 2007 (tonnes)

Name of the Species	Nagapattinam+Thiruvarur +Thanjavur	Pudu kottai	Ramanatha puram	Thoothu-kudi	Tiru nelveli	Kanyakumari	Total	%
Sharks	1,299	0	2,499	1,259	0	27	7,086	1.80%
Skates & Rays	765	3,572	2,321	3,038	126	720	11,991	3.05%
Eels	8	0	0	34	113	78	351	0.09%
Cat fishes	750	945	369	458	253	196	3,955	1.01%
Chirocentrus	5,701	3,605	3,412	4,620	251	489	24,329	6.19%
Oil Sardines	0	0	0	4,871	0	0	4,871	1.24%
Lesser Sardines	8,526	2,819	2,809	4,774	2,131	1,462	31,487	8.01%
Hilsa Ilisha	0	3	0	4	87	67	181	0.05%
O.illisha	0	0	0	2	0	0	10	0.00%
Anchoveilla	4,668	0	0	1,043	210	1,368	13,609	3.46%
Thrissocles	1,179	0	0	83	126	18	2,654	0.67%
Clupeids	5,160	3,454	522	1,502	122	3,358	18,246	4.64%
Bombay Duck	0	0	0	0	0	0	0	0.00%
Saurida & Saurus	4	4	0	0	0	4	653	0.17%
Hemirhamphus &Belone	85	360	1,312	167	0	244	2,273	0.58%
Flying fish	75	187	0	102	167	11	1,614	0.41%
Perches	4,807	3,532	2,211	901	242	3,280	20,933	5.32%
Red Mullets	2,257	2,432	462	402	421	1,166	8,996	2.29%
Polynemids	1,308	0	0	120	0	6	1,810	0.46%
Sciaenids	3,360	4,182	334	1,161	227	99	10,919	2.78%
Ribbon fish	18	0	0	1,669	265	12	3,206	0.82%
Caranx	2,920	95	409	1,194	430	3,075	11,525	2.93%
Chironemus	555	0	71	536	0	99	1,527	0.39%
Trachyurus	638	0	11	2	177	10	864	0.22%
Other Carangids	0	0	0	0	0	0	0	0.00%
Ceryph aena	0	0	0	0	1	0	6	0.00%
Elacate	77	0	0	0	315	46	499	0.13%
Silver bellies	4,061	4,420	12,543	2,494	32	285	31,366	7.98%
Gaza	0	0	0	0	0	0	0	0.00%
Lactarius	1	0	0	41	50	25	311	0.08%
Pomfrets	927	32	132	226	31	13	2,015	0.51%
Mackerel	***2,520***	***1,514***	***0***	***272***	***586***	***1,375***	***11,633***	***2.96%***
Seerfish	1,289	0	270	1,120	148	1,010	5,959	1.52%
Tunnies	953	505	146	215	12	402	4,834	1.23%
Sphyreana	10	0	59	812	22	517	2,161	0.55%
Mullets	524	523	523	0	4	516	2,497	0.64%
Bregm Aceres	31	0	0	2	0	41	993	0.25%
Soles	12	597	6,368	0	0	6	7,132	1.81%
Penaeid Prawns	3,182	3,192	7,479	2,129	552	279	21,701	5.52%
N.P.Prawns	0	226	686	0	35	3	949	0.24%
Lobsters	18	0	0	42	20	0	628	0.16%
Crabs	3,585	4,208	10,597	2,518	2	103	24,269	6.17%
Cephalo pods	1,023	852	131	1,782	12	1,458	6,325	1.61%
Miscellan eous	13,606	12,689	19,875	2,875	1,201	10,997	69,302	17.62%
Drapone	0	0	315	0	0	9	324	0.08%
Lithrinus	679	45	754	1,236	448	1,549	6,571	1.67%
Sillago	566	0	821	3	0	1,976	4,758	1.21%
Balisters	936	0	1,103	2,653	6	1,014	5,713	1.45%
Turtle	0	0	0	0	0		0	0.00%
Ora	0	61	0	0	0		231	0.06%
Total	78,082	54,055	78,542	46,359	8,823	37,410	393,266	100.00%
% by District	20%	14%	20%	12%	2%	10%	100%	

Source: Department of Fisheries, Tamil Nadu

2.3 ENVIRONMENT

The State of Tamil Nadu is situated at the south-eastern corner of India. It has over 1,000 km of coastline. The Tamil Nadu coast is straight and narrow without many indentations except at Vedaranyam. The southern coast of Tamil Nadu has a very narrow continental shelf. In Tamil Nadu about 46 rivers drain into the Bay of Bengal, forming several estuaries adjoining coastal lagoons. The Cauvery River and its tributaries form a large delta supporting extensive agriculture.

The Gulf of Mannar in particular contains a highly heterogeneous group of flora and fauna and about 3,600 species have been identified from this region in the past. Of these, 186 species are commercially exploited and 116 vulnerable (ICMAM-PD/DOD, 2001). The latter includes five endangered species of sea turtle (Lal Mohan, 1983, CMFRI, 1998) declared under the Wild Life (Protection) Act 1972, and eleven species of marine mammal (James and Lal Mohan, 1987, CMFRI, 1998), including 6 species of whales, 4 species of dolphins and 1 species of dugong. All are placed under schedule 1 of the Wildlife (Protection) Act, 1972.

2.4 RISK ASSESSMENT

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) – which is provided for Indian mackerel in the main report – in order to determine the overall risk to the stock.

Figure 5: Productivity / Susceptibility Analysis (inc. SICA)

	PSA															
	Productivity								Susceptibility					PSA Scores		
Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Gill nets (40-65 mm)	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80
Bottom trawling	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80

The table above shows that the Indian mackerel is highly productive.

The **gillnet** fishery scores poorly in terms of all the elements of susceptibility, mainly due to the small mesh sizes compared to the fish length, the medium level of encounterability of the gear in the water column and high level of post-capture mortality. However because of the species' high productivity and low availability of the stock to the fishery (it only operates in the coastal fringes of the stock), this stock is considered low risk overall.

The **trawl** fishery scores the same in this analysis. Encounterability is different in that the trawl fishery operates in the lower portion of the water column (as opposed to the top half of the gillnets) but the result is the same. However it should be noted that both availability and encounterability is apparently increasing as the Indian mackerel extends its distribution and moves deeper in response to sea temperature changes.

2.5 PRINCIPLE 1: STOCK STATUS

2.5.1 Unit of Assessment A and B: Small mesh gillnet, and 'high level trawl'

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp. status		✓		WG of Fisheries Specialists constituted by Ministry of Agriculture (Government of India 1991); Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Devaraj et al, 1994
Explanatory Statement		The fishery is currently overfished - the MSY for Tamil Nadu was estimated to be 13,473 t in 1991 but current catches for Indian mackerel over 2001 – 2008 averaged 14,430 t. However the stock appears to be expanding northwards up the east coast and a 'vulnerability index' of key Indian marine species (unpublished) shows that Indian mackerel is a very resilient species to overfishing. This is supported by our own PSA analysis for this species (see main report). Natural mortality is likely to be highly variable as the stock fluctuates with wider oceanographic changes e.g. El Nino events. It is therefore considered likely that the stock is above the point where recruitment might be impaired, but the stock assessment needs to be updated.			
1.1.2	Reference points (not if RBF)	✓			Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010
Explanatory Statement		Although there are figures for MSY, these must be considered with caution as the stock is highly variable (typical of such highly productive small pelagic stocks). At present there are no limit or target reference points, although the MSY estimates might be considered a *de facto* target reference point.			
1.1.3	Stock rebuilding				n/a
Explanatory Statement		Not relevant			
Harvest strategy					
1.2.1	Harvest Strategy	✓			WG of Fisheries Specialists constituted by Ministry of Agriculture (Government of India 1991); Eleventh Five Year Plan (2007-2012)
Explanatory Statement		The Government publishes a broad harvest strategy for all marine species groups very 10 years, including small pelagics, but not specifically for Indian mackerel. As a result there is no specific harvest plan for Indian mackerel. The Government generally advocates fishing to MSY, although this is regularly exceeded.			

PI	Title	Weak	Intermediate	Good	Reference
1.2.2	Harvest control rules and tools	✓			Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010;
Explanatory Statement		There are no harvest rules triggered by reference points. The minimum gillnet mesh size is 10 mm, although this will still mean that the juveniles of most pelagic species will be caught. There is a tool in the form of a ban on all mechanised vessel s[1] over a 45-day seasonal period (15 April to 29 May in Tamil Nadu) that reduces pressure on spawning fish stocks. This generic tool is widely accepted by fishers. At the local level there is little resource-driven management, but regulations are specified to deal with conflicts, and generally restrict gears to specific times/days/locations, meaning that there is a default management system to reduce conflicts, but which helps to protect resources (e.g. the village *panchayat* system).			
1.2.3	Information / monitoring		✓		Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement		At State level there is a reasonable understanding of the fleet composition through vessel licence records and fishing harbour censuses and monitoring. Stock removals are also recorded, although there are currently no gear-specific records so it will be difficult to attribute these removals to specific management units. Given the limited sampling programme and wide distribution of fishing effort, there may be some under- or mis-reporting of catches. At Central level there is a growing amount of data on Indian mackerel fisheries biology through stratified sampling, with reasonable records of length-frequency information over time and in different areas, a knowledge of reproduction strategies and diet. Much of this science is based on the west coast fisheries, but there is an increasing focus on the east coast as the catch distribution moves towards the Bay of Bengal.			
1.2.4	Stock Assessment (not if RBF)		✓		Devaraj *et al*, 1998; Yohannan & Sivadas, 2003; Yohannan and Saidkoya, 2000; Y Yohannan & U.C. Abdurahiman, 1998; Yohannan & Said Koya, 2000.
Explanatory Statement		Considerable research has been put into studies on the population dynamics and stocks of Indian mackerel, although much of these have been focused on the Arabian Sea stock, which may be separate from that of the Bay of Bengal. In particular the growth parameters are well known, and there is increasing knowledge on the level of natural mortality, despite it's inherent inter-annual variability. Fishery removals are also reasonably well known, although as previously noted there may be some level of under- or mis-reporting. The major			

[1] Includes all vessels with inboard or outboard motors above 10 hp

PI	Title	Weak	Intermediate	Good	Reference
		weakness in the assessment of Indian mackerel (and other small pelagic) stocks is the lack of fisheries independent verification e.g. through acoustic biomass surveys which have not been conducted since the late 1970's.			

2.5.2 Key Weaknesses with Current P1 Performance

Despite the general resilience of Indian mackerel to fishing, the status of this stock is probably overfished, but up to date stock assessment needs to be completed.

A major worry with regards to this Principle is that there is no harvest strategy and no harvest control rules in operation. The general approach is to just to monitor catches against assumed MSY, and estimates of MSY are themselves probably not that reliable.

While considerable amounts of scientific research is available on Indian mackerel, such research has primarily been conducted on the west coast of India, and information on Indian mackerel catches and vessels on the east coast in Tamil Nadu is limited and probably rather unreliable.

2.5.3 Key Recommendations to Address P1 Performance Weaknesses

Steps to improve current performance should focus on two main areas.

Firstly it is critical to obtain more and better information on the fishery – particularly stock status through more complete and up to date stock assessments (including fisheries independent surveys).

Secondly, consideration should be given to the specification of a harvest strategy and harvest control rules for Indian mackerel. Such a strategy, and associated rules, would obviously need to be based on appropriate levels of consultation with stakeholders, and would need to take recognition of the socio-economic importance of the fishery, the short-term impacts that might result from any such strategy, and appropriate mitigating measures to alleviate such short-term impacts while the stock recovers.

2.6 PRINCIPLE 2: ECOSYSTEM IMPACTS

2.6.1 Unit of Assessment A: Small mesh gillnet

PI	Title	Weak	Intermediate	Good	Reference
Other retained species					
2.1.1	Other retained bycatch spp. Status		✓		Devaraj *et al*, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.
Explanatory Statement		Although no independent verification has been provided to the team, it is understood that the incidental bycatch of this fishery is low and mainly consists of juvenile seerfish (scombroids) as well as similar sized adult small pelagic species such as the scads and other carangids. Total bycatch of these retained species is understood to be low, and no more than 10% in total. The two main scombrid species caught are probably *Scomberomorus commerson* and *S. guttatus.* In 1999 Devaraj *et al* reported that studies indicated that all the states on the east coast over exploit this stock by 80% higher effort than the optimum (MSY), and noted that "small meshed gillnets exploit the juvenile seerfish incidentally causing recruitment overfishing". Muthiah *et al* (2000) suggest that over 80% of seerfish catches from small-mesh (60-100 mm) gillnets have not reached maturity. Less is known of the status of carangid stocks in the Bay of Bengal. Mohamed Kasim (2003) reports that most carangid species are under-fished in Tamil Nadu, although *Decapterus russelli* may be under more pressure. Although these fish are reasonably resilient to overfishing, it appears that increases in effort need to be considered with caution.			
2.1.2	Other retained bycatch spp. management	✓			Devaraj et al, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.
Explanatory Statement		There is little direct management of either seer fish or carangids, either as a bycatch of the Indian mackerel gillnet fishery or as directed fisheries. The minimum gillnet mesh size is 10 mm, although this will still mean that the juveniles of most pelagic species will be caught. There is a tool in the form of a ban on all mechanised vessels over a 45 day seasonal ban (15 April to 29 May in Tamil Nadu) that reduces pressure on spawning fish stocks. This generic tool is widely accepted by fishers. At local level there is little resource-driven management, but regulations are specified to deal with conflicts, and generally restrict gears to specific times/days/locations, meaning that there is a default management system to reduce conflicts, but which helps to protect resources (e.g. the village *panchayat* system).			
2.1.3	Other retained bycatch spp.		✓		Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;

PI	Title	Weak	Intermediate	Good	Reference
	Information				
Explanatory Statement	At State level there is a reasonable understanding of the fleet composition through vessel licence records and fishing harbour censuses and monitoring. Stock removals are also recorded, although there are currently no gear-specific records so it will be difficult to attribute these removals to specific management units. Given the limited sampling programme and wide distribution of fishing effort, there may be some under or misreporting of catches. At Central level there is a growing level of data on small pelagic fisheries biology through stratified sampling, with reasonable records of length-frequency information over time and in different areas, a knowledge of reproduction strategies and diet. Much of this science is based on the west coast fisheries, but there is an increasing focus on the east coast as the catch distribution moves towards the Bay of Bengal.				
Discard species					
2.2.1	Discarded bycatch spp. Status			✓	Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010;
Explanatory Statement	Discards from this fishery are understood to be non-existent.				
2.2.2	Discarded bycatch spp. Management			✓	Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010;
Explanatory Statement	Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required.				
2.2.3	Discarded bycatch spp. Information		✓		Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010; Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement	No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.				
ETP species					
2.3.1	ETP spp. Status			✓	Sridhar, 2005
Explanatory Statement	All sea turtle species in India are protected with considerable financial penalties for their deliberate capture. Whilst large-mesh gillnets targeting mature seerfish and other large pelagics have been attributed to considerable turtle mortality, the small-mesh nets targeting Indian mackerel are unlikely to ensnare sea turtles, although there may be some incidental snaring in the float lines, but such events are thought				

PI	Title	Weak	Intermediate	Good	Reference
		to be rare.			
2.3.2	ETP spp. Management			✓	Sridhar, 2005
Explanatory Statement		The Indian Wildlife (Protection) Act 1972 ensures that all sea turtle are protected. India is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973, which lists all species of marine turtles in Schedule I, prohibiting their international trade. India is also a signatory to the Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979. This requires India to put in place strict conservation measures for the five species of marine turtles that visit the Indian coast, as listed in Appendix 1. These – and the awareness building that has been conducted to date – ensure that any incidental capture of sea turtles leads to their immediate release. The short soak-time of these nets makes survival highly likely. (In Orissa, the State High Power Committee (HPC) permitted only catamarans and craft using motors of less than 10 hp and monofilament nets (of smaller net size and length) within the buffer zone of the Gahirmatha Marine Sanctuary — an area located beyond 10 km from the shore).			
2.3.3	ETP spp. Information		✓		Sridhar, 2005; Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement		No formal assessment of the rate and nature of ETP interactions has been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010
Explanatory Statement		This is purely a surface fishery with a very limited interaction with the substrate. There may be the occasional contact when fishing in shallow waters, but this is intermittent and temporary. The only potential habitat damage from these small-mesh gillnets is if lost gear / gear fragments become snagged on coral reefs, where they can cause considerable damage as well as continue to fish.			
2.4.2	Habitat Management		✓		Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010
Explanatory Statement		There is no management of habitat interactions in this fishery as these are rare, temporary and low impact.			
2.4.3	Habitat Information		✓		Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010
Explanatory Statement		Outside of the coral reef areas there is little information on the nature			

PI	Title	Weak	Intermediate	Good	Reference
		of marine habitats and their spatial distribution. Given the shallow nature of the fishing areas, this knowledge could be improved and any necessary spatial measures e.g. closure of shallow, rocky substrates, be considered.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Devaraj et al, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.
Explanatory Statement		The Indian mackerel-targeted fishery use a reasonably selective mesh size that is used to catch larger, mono-specific schools of fish, with a resultant low bycatch of other species and negligible discards. Furthermore this gear has a very low impact on ETP species and a negligible impact on habitats. The main impact of this fishery is therefore limited to its capture of relatively high volumes of a low to mid trophic level species with possible implications for its predators. This is likely to be low, but given that this is an open-access fishery, this cannot be considered highly certain.			
2.5.2	Ecosystem Management		✓		Devaraj et al, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.
Explanatory Statement		Most fishers targeting Indian mackerel do utilise larger meshes of 50 – 65 mm and will specifically target Indian mackerel schools where bycatch of juvenile large pelagics such as seer fish will be lowest. It is also known that adult Indian mackerel tend to school together, unlike juvenile fish that will school with a number of other species for added protection. The 45 day ban on mechanised vessels will also benefit a wide range of pelagic – as well as demersal species.			
2.5.3	Ecosystem Information		✓		Dr. Vivekanandan (pers. comm., 7 Oct., 2010); Devaraj et al, 1998;
Explanatory Statement		CMFRI have conducted considerable amount of work on the biology of the Indian mackerel (esp. on the West coast), including diet and trophic studies. There is substantial and growing information on the influence of environmental conditions (e.g. seasonal monsoon as well as longer-term climate change) on pelagic ecosystems and the status and distribution of Indian mackerel.			

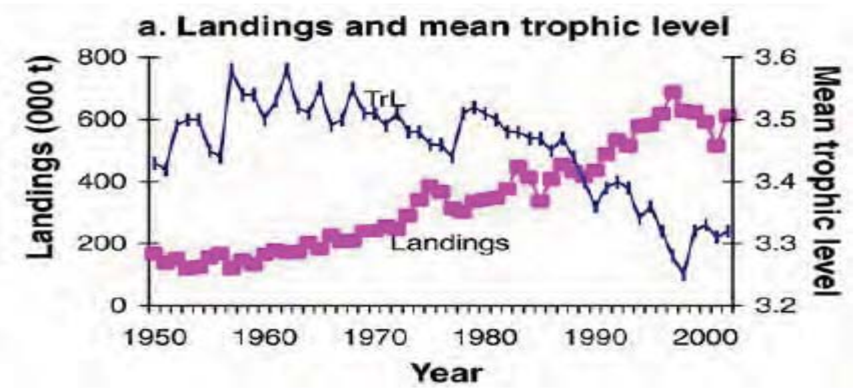
2.6.2 Unit of Assessment B: 'High opening bottom trawl'

PI	Title	Weak	Intermediate	Good	Reference
Other retained species					
2.1.1	Other retained bycatch spp. Status	✓			Lobo *et al*, 2010; Banks & Macfadyen, 2010.
Explanatory Statement		Trawl catches from the Coromandel coast consist of three main elements: target catch (i.e. shrimps, high value demersal fish and cephalopods), retained bycatch (subdivided into commercial bycatch such as Indian mackerel, and trash fish destined for fishmeal production) and discarded bycatch (very low value fish unsuitable for fishmeal production). The proportion of target to retained bycatch has historically been very high, but has declined over recent years so that target and bycatch volumes are equal, with the trend continuing so that bycatch is likely to increasingly exceed the target catches (Lobo et al, 2010). The volume of Indian mackerel being caught by this fishery is unknown, but appears to be increasingly available to trawl fisheries as it appears to be extending the duration of its 'demersal' phase (as described in Section 2.1) and may represent as much as 16-18% of the Indian mackerel catch on the East coast of Indian (Vivekanandan, pers. comm.). Day trawlers have significantly higher bycatch ratios, but this group is in rapid decline. Multi-day trawling has a record of being less damaging with lower juvenile bycatch ratios (5-10%) (Banks & Macfadyen, 2010). Other species retained by the trawl fishery include the target species (peneid shrimps and high value demersal species) as well as medium sized commercial catch (inc. Indian mackerel and carangids) and smaller species such as sardines and pony fish that are easily damaged and are destined for reduction into fish meal. For more details of the representative species involved, see Figure 3 (on page 4). Shrimp stocks, whilst overexploited (0.6 to 0.75 B_{MSY}), have a low vulnerability index and are quite robust due to high fecundity, continuous spawning, without any specific peaks identified, high species diversity, low life span and high growth span. The number and diversity of species involved is high and it is impossible to assess the impact of this fishery on them all. However the decreasing CPUE of target species beginning in the 1990s (see also Devaraj & Vivekanandan 1999) is almost certainly due to increasing fishing effort, common across India, which is now exhausting near-shore resources (Bavinck 2005). The increasing ratio of mid-size and smaller, largely pelagic species also supports those advocating that there has been a 'fishing down the food web' (Vivekanandan, 2005). Therefore it is likely that there is a strong risk this fishery poses serious harm to many of these retained species.			

PI	Title	Weak	Intermediate	Good	Reference
2.1.2	Other retained bycatch spp. management	✓			Devaraj *et al*, 1999; Muthiah *et al*, 2000; Mohamad Kasim, 2003; Bavinck *et al*. 2008; EJF, 2005
Explanatory Statement	A number of generic management measures for mechanised vessels like trawlers exist. There is a strictly enforced 45-day fishing ban (15 April–29 May) each year, common to the entire state of Tamil Nadu (Bavinck et al. 2008) that reduces pressure on spawning fish stocks. The Tamil Nadu Marine Fisheries Regulation Act of 1983 requires that the first three nautical miles (5.56 km) from shore be reserved for artisanal fishing, with larger mechanised vessels such as trawlers banned inside of 12 nm. However, this is not strictly enforced, and trawlers often fish closer to the coast (Bavinck *et al*. 2008). Although the seasonal ban will allow certain areas to recover from the trawl impact, and may allow some species to spawn undisturbed, there needs to be much greater efforts to limit the impacts on certain species as well as protect productive habitats from trawl damage.				
2.1.3	Other retained bycatch spp. Information		✓		Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement	At State level there is a reasonable understanding of the fleet composition through vessel licence records and fishing harbour censuses and monitoring. Stock removals are also recorded, although there are currently no gear-specific records so it will be difficult to attribute these removals to specific management units. Given the limited sampling programme and wide distribution of fishing effort, there may be some under or misreporting of catches. At Central level there is a growing amount of data on Indian mackerel fisheries biology through stratified sampling, with reasonable records of length-frequency information over time and in different areas, a knowledge of reproduction strategies and diet. Much of this science is based on the west coast fisheries, but there is an increasing focus on the east coast as the catch distribution moves towards the Bay of Bengal.				
Discard species					
2.2.1	Discarded bycatch spp. Status		✓		Kelleher, 2005; Mahindra Sundaran, pers. comm., 5 Oct 2010; Banks & Macfadyen, 2010)
Explanatory Statement	Shrimp freezer trawlers operating offshore from Visakhapatnam on the eastern coast of India had relatively high discards in the early 1990s. However this fleet has almost disappeared and current discards are much lower (Banks and Macfadyen, 2010). Discards are considered to be negligible in the traditional fisheries and very low in the motorised fisheries. The reasons for the decline in discards are similar to many other countries in South and Southeast Asia, including: (i) overfishing, particularly in inshore and coastal waters; (ii) rising demand due to				

PI	Title	Weak	Intermediate	Good	Reference
		population increase, rising urban incomes and export of better quality fish; (iii) poverty leading to consumption of lower value food fish (iv) product development, e.g. production of surimi; and (v) increased production of fishmeal and animal and fish feeds (Kelleher, 2005). The nature of discards from this fishery is again wide ranging, consisting over low grade trash fish and biogenic material that is unsuitable for storage and utilisation. The status of these species is unlikely to have been studied and will be unknown (see 2.2.3).			
2.2.2	Discarded bycatch spp. Management	✓			Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010;
Explanatory Statement		Discards from this fishery are understood to be low as most low value or damaged material is retained for use as trash fish. Options for bycatch minimisation are limited. The current measures include (i) a operational ban for 45 days and (ii) a no-fishing zone for large mechanised vessels within the 3 nm coastal limit (the latter not always being observed). Further measures could include extension (and further enforcement) of the no fishing zone, particularly if it can include sensitive and vulnerable habitats. The gradual introduction of VMS to this fleet will allow a greater control over their operational range. There have been no bycatch reduction devices (BRDs) applied to date. Legislation to include BRDs is contained in the forthcoming MFRA. There has been important development effort into hard and soft BRDs undertaken by the Central Institute of Fisheries Technology (CIFT). There is some discussion about developing surimi machines to optimize the use of trash fish.			
2.2.3	Discarded bycatch spp. Information		✓		Yohannan & Sividas (2003). Mahindra Sundaran, pers. comm., 5 Oct 2010; Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
ETP species					
2.3.1	ETP spp. Status		✓		Sridhar, 2005; James et al, 1989; Pandav et al, 1997; Pandav et al, 1998; Chadha and Kar, 1999; Shankar, 1999; GOI, 2000).GOI, 2000
Explanatory Statement		Five sea turtle species are known to occur in Indian coastal waters: the Olive Ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), the green sea turtle (*Chelonia mydas*), the loggerhead (*Caretta caretta*) and the leatherback (*Dermochelys coriacea*) (GOI, 2000). All are known to nest on the Indian coast, with the exception of			

PI	Title	Weak	Intermediate	Good	Reference
		the loggerhead. Most published papers and reports state trawl nets (and large mesh gillnets) are mostly responsible for the death of turtles by drowning (James et al, 1989; Pandav et al, 1997; Pandav et al, 1998; Chadha and Kar, 1999; Shankar, 1999; GOI, 2000). All sea turtle species in India are protected with considerable financial penalties for their deliberate capture.			
2.3.2	ETP spp. Management		✓		Sridhar, 2005. Banks and Macfadyen, 2010.
Explanatory Statement		The Indian Wildlife (Protection) Act 1972 ensures that all sea turtle are protected. India is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973, which lists all species of marine turtles in Schedule I, prohibiting their international trade. India is also a signatory to the Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979. This requires India to put in place strict conservation measures for the five species of marine turtles that visit the Indian coast, as listed in Appendix 1. 100% grants are available from Marine Products Export Development Authority (MPEDA) for the introduction of TEDs. In Orissa, the State High Power Committee (HPC) permitted only catamarans and craft using motors of less than 10 hp and monofilament nets (of smaller net size and length) within the buffer zone of the Gahirmatha Marine Sanctuary — an area located beyond 10 km from the shore. 3,000 boats in Orissa have been provided with TEDs where there are two large rookeries. These TEDs, funded by MPEDA, are being deployed with the support of WWF / CIFT, as part of a participatory management plan. Adoption is slow and enforcement lacking. When applied, the TEDs have been modified to suit fishers concerns, most especially to limit the loss of commercial species. Early trials have identified that commercial catch losses are reduced to under 7%, and turtle catches eliminated (Banks and Macfadyen, 2010)).			
2.3.3	ETP spp. Information		✓		Sridhar, 2005; Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010; Anrose FSI, pers. comm., 5 Oct 2010;
Explanatory Statement		No formal assessment of the rate and nature of ETP interactions has been carried out. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
Habitats					
2.4.1	Habitat Status	✓			Zacharia et al, 2006; Joice et al, 2004
Explanatory Statement		A search of the CMFRI archives did not reveal any research on the condition of trawled habitats on the east coast of India, although some work has been done on physico-chemical change. A SICA analysis suggests that this fishery represents a high risk to benthic habitats, as			

PI	Title	Weak	Intermediate	Good	Reference
		the fishery is very intensive, non-selective and with low rates of post-impact survival.			
2.4.2	Habitat Management	✓			Lobo *et al*, 2010
Explanatory Statement		Management of the trawl fisheries is mainly though a coastal buffer zone and a short ‘no fishing period’. However it is understood the former is frequently flouted and needs much greater enforcement, possibly through VMS and other remote MCS approaches. Greater and more targeted spatial protection is also required to protect particularly vulnerable or productive habitats.			
2.4.3	Habitat Information	✓			Dr. Vivekanandan, CMFRI, pers. comm., 6 Oct 2010
Explanatory Statement		Outside of the coral reef areas there is little information on the nature of marine habitats and their spatial distribution. Given the shallow nature of the fishing areas, this knowledge could be improved and any necessary spatial measures e.g. closure of shallow, rocky substrates, be considered.			
Ecosystems					
2.5.1	Ecosystem Status	✓			Devaraj et al, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.
Explanatory Statement		Although the legal minimum is 35 mm, the cod end mesh sizes used by trawlers are as low as 10 mm (Banks & Macfadyen, 2010) and thus has a high potential to disrupt recruitment, esp. give the current rate of (uncontrolled) expansion). It catches a wide variety of pelagic and epi-pelagic species at a number of trophic levels (e.g. from planktivorous carangids to piscivorous scombrids). The total landings along the SE coast increased from 0.17 million tonnes in 1950 to 0.61 million tonnes in 2002 (Figure a. below). However, the mean trophic level of catches decreased from 3.58 in 1958 to 3.32 in 2002 (see figure below), indicating a gradual transition in landings from piscivorous predators toward planktivorous pelagic fish and invertebrates (Vivekanandan, 2005). This reflects the increasing catches of oil sardine and Indian mackerel, rather than significant decreases in the volume of higher trophic level species. 			

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td>2.5.2</td><td>Ecosystem Management</td><td>✓</td><td></td><td></td><td>Devaraj et al, 1999; Muthiah et al, 2000; Mohamad Kasim, 2003.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are a number of options for measures to protect the ecosystem from this fishery. The current measures include (i) a operational ban for 45 days and (ii) a no-fishing zone for large mechanised vessels within the 12 nm coastal limit (the latter not always being observed). Further measures could include extension (and further enforcement) of the no fishing zone, particularly if it can include sensitive and vulnerable habitats. The further introduction of VMS to this fleet would allow a greater control over their operational range. The mandatory use of BRDs and TEDs where necessary should also be regulated and enforced.</td></tr>
<tr><td>2.5.3</td><td>Ecosystem Information</td><td></td><td>✓</td><td></td><td>Dr. Vivekanandan (pers. comm., 7 Oct., 2010); Devaraj et al, 1998;</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">CMFRI have conducted considerable amount of work on the biology of the Indian mackerel (esp. on the West coast), including diet and trophic studies. There is substantial and growing information on the influence of environmental conditions (e.g. seasonal monsoon as well as longer-term climate change) on pelagic ecosystems and the status and distribution of Indian mackerel, but considerable information gaps still remain on ecosystems in general.</td></tr>
</table>

2.6.3 Key Weaknesses with Current P2 Performance

In the gillnet fishery, bycatch is generally low (less than 10%), but there is only partial/limited information and no active management to reduce bycatch. For the trawl fishery, bycatch rates are much higher, but again there is no bycatch management/strategy and imperfect information.

In the gillnet fishery, there are not reported to be any discards, so there is therefore no need for any discard management strategy, although it would be useful to have verification that discards are not an issue. In the trawl fishery, discards used to be very high, but are now thought to be much lower. There is however no clear management strategy on reducing discards, and more information on the extent of the problem would certainly be useful.

ETP species interactions are probably not significant in the gillnet fishery, although some catches of turtles is possible. Such catches are more likely in the trawl fishery, where some introduction of TEDs is taking place with reported successes.

Gill nets are thought to have very little adverse impacts on habitats or ecosystem status, but the same is not true for bottom trawling. No specific strategies are in place to address these issues in the trawl fishery, except for a ban on fishing within 3 nm (widely reported not be enforced), and the availability of information on the impacts on habitats and ecosystems is poor.

In summary, assessment of performance of P2, raises considerable cause for concern, with very few ‘good scores’ recorded against the performance indicators.

2.6.4 Key Recommendations to Address P2 Performance Weaknesses

For both units of assessment, consideration should be given to the specification and implementation of an 'ecosystems impact minimisation strategy'. Such strategies would need to be discussed and agreed between all stakeholders to assess their effectiveness, practicability, and impacts. The could be risk-based, and could include a requirement for improved information and monitoring as well as the introduction of specific management strategies to minimise impacts on bycatch, discards, ETPs, habitats and ecosystems. Such strategies could of course be nested within species-specific fisheries management plans i.e. fisheries management plans could/should pay particular attention to such issues.

2.7 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Governance and policy</td></tr>
<tr><td>3.1.1</td><td>Legal and/or customary framework</td><td></td><td>✓</td><td></td><td>Interviews. Bavinck (2001, 2006). Tami Nadu Policy Note (2010). Tamil Nadu Marine Fisheries Regulation Rules 1983 (1985). Other legislation as per bibliography in Annex.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The Constitution in India provides for all fisheries management powers within territorial waters (12 nautical miles) to rest at State level.

In Tamil Nadu, legislation relates predominately to the mechanised sector (essentially inboard, decked vessels using mechanised hauling equipment) and only to motorised and non-motorised traditional vessels in a rather cursory manner, and the legal framework with regards to inshore capture fisheries is not supportive of, or driven by requirements for sustainability. It is also not consistent and/or does not cover many areas which it would need to do so to ensure coherence with international standards and best practice in fisheries management. A closed season, legislated for at State level, for example applies only to the mechanised sector (although one could argue that this observes customary rights of those high dependent on fishing for food or livelihoods).

There is however a traditional/customary system for artisanal fisheries management, strongly based on territoriality. Fishermen of each hamlet, represented by their panchayat, can not restrict <u>who</u> can fish (i.e. there is a system of open access and fishermen can fish within zones under the responsibility of different panchayats) but panchayats can restrict <u>how/when</u> fishermen fish. Non-governmental fisher councils have strong authority to restrict or prohibit gear types considered to be harmful to the stock, to other gear users and to the community as a whole. Panchayat's influence varies from place to place. They are generally very strong at village level, but not sometimes very effective in regulating a particular type of fishing across many villages along the coast e.g. regulation of ring seines or pair trawling. The positive example is that they now have a self imposed effective ban period for use of ring seines, but they are not always able to control its proliferation.

Pancharats for fishing village/hamlets may not be elected as is the case in 'formal' villages. So while such formal villages are provided for in law by government, fishing villages/hamlets and the decisions they make may not be. So customary rights may not be legally recognised even if they are respected.

The main driver of this traditional system is conflict management and resolution, rather than resource management. Thus first level resolution of conflicts tends to take place at the community level, and is very transparent at the village level. Liaison between government and village councils is not very formalised, but efforts are underway to make such relationships more formal. Where conflicts have arisen that have not been solved through traditional methods, the State is not reported to be</td></tr>
</table>

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="2"></td><td colspan="4">able to arbitrate in a particularly timely, effective and fair manner.</td></tr>
<tr><td>3.1.2</td><td>Consultation roles and responsibilities</td><td></td><td></td><td>✓</td><td>Interviews. Tamil Nadu Marine Fisheries Regulation Rules, 1983 (1985); ICSF (2003)</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Roles and responsibilities for different parties involvement in the management system are well understood.

The various departments under the Ministry of Agriculture are responsible for fisheries in the EEZ outside of 12nm, survey and assessment of fisheries resources, exploration of resources in EEZ, fisheries development, fishery technology and fisheries management, in addition to education, research, training and extension, as well as for aquaculture development.

The Planning Commission is responsible for the formulation of the Five-Year Plans for the most effective and balanced utilization and allocation of resources, while the policy and details of specific schemes are dealt with by the respective Ministries and departments.

The Coast Guard, under the Ministry of Defence, provides protection to fishermen and assistance to them at sea while in distress, regulates fishing by foreign fishing vessels in the maritime zones, and preserves and protects the marine environment from pollution. The Coast Guard also has a mandate to protect endangered marine species under the Wildlife Protection Act 1972. The Ministry of Shipping is in charge of the fishing vessel industry and fishing harbours.

Responsibilities of State level staff are very well defined through a system of job specification that is uniform across different States for different job categories. The presence of extension officers, and fisheries inspectors (with responsibility for data collection and enforcement) ensure that consultation with fishermen can take place to inform management. The district level (and below) officers of the Department of Fisheries are Assistant Directors of fisheries, Inspectors of fisheries and in many cases sub-inspectors of fisheries and field-men. Local knowledge and views can be thought to be generally incorporated into the management system, through these informal linkages, even if not always functioning perfectly.

Likewise, the roles and responsibilities of CMFRI (a national level fisheries research organisation with State branches/offices) are well defined.

And at the village level, the roles of the panchayat are well understood by all.

The Tamil Nadu Fisheries Act includes no legal requirement for consultation processes, but opportunity is generally provided for such consultation.</td></tr>
<tr><td>3.1.3</td><td>Long term objectives</td><td>✓</td><td></td><td></td><td>11th 5 year plan and fisheries working group document (2006). 2004 Comprehensive Marine Policy.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The national level 11th 5 year plan (2007-2012) has long-term objectives generally consistent with sustainability and the precautionary approach,</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
		and should guide State level policy. However, this national level plan is not translated into a State level fisheries policy in Tamil Nadu with any form of emphasis on sustainability. The State policy note provided each year, is essentially just a list of budget support areas to be provided to the fisheries sector, and has no overarching vision, specification of objectives, or coherent strategies as to how to deal with policy and management implementation. Likewise the 2004 Comprehensive Marine Policy includes objectives to increase fisheries production, to promote socioeconomic benefits from fisheries, and to ensure ecological sustainability. It is now the intention that this policy apply not just to areas outside of 12nm, but also more strongly to inshore areas. But there appears to be a disconnect between this high level national policy and the specification of similar objectives at State level.			
3.1.4	Incentives for sustainable fishing	✓			Interviews. Tami Nadu Policy Note (2010).
Explanatory Statement		There are a very large number of subsidy schemes provided by the government to the fisheries sector. One or two of these could arguably be considered as 'good' subsidies in terms of their ability to assist with resource management e.g. relief to fishermen during the ban period which encourage compliance. But almost all other schemes are of a welfare nature that certainly serves to maintain/increase fishing capacity, even if they also serve an important function in terms of poverty prevention / alleviation. The policy note for example includes subsidies for both motorisation of vessels and for fuel. There appears to be no mechanism by which the impact is evaluated of the provision of public sector support may, or may not be, impacting on resource sustainability.			
Fishery specific management					
3.2.1	Fishery Objectives	✓			Interviews
Explanatory Statement		There are currently no clearly articulated objectives at all relating specifically to either small pelagic fisheries or to Indian mackerel in particular, which could be considered consistent with achieving stock and ecosystem status. Objectives consistent with sustainability are not even implicit given that there are few management regulations at all aimed at regulating effort or catches in the small pelagic fishery (see above under assessment of stock status).			
3.2.2	Decision making processes	✓			As for 3.1.1 above
Explanatory Statement		Decision-making processes have been described above under PI 3.1.1, and while not primarily motivated by resource sustainability, do result in measures that result in some level of resource protection. However, these decision-making processes are often rather informal, are not linked to the precautionary approach as they are motivated by conflict resolution rather than resource management. They are also not linked to any clear			

PI	Title	Weak	Intermediate	Good	Reference
		specification of strategies to achieve objectives (which as noted above are generally lacking) with regards to the Indian mackerel in particular. Thus there are no fishery specific decision-making processes, for example small pelagic or Indian mackerel working groups, for the unit of assessment i.e. Indian mackerel in Tami Nadu.			
3.2.3	Compliance & Enforcement		✓		Interviews
Explanatory Statement		Compliance and enforcement of larger vessels operating in harbours is considered to be relatively effective, especially with regards to the main management measure which is the ban period – fishing vessels are required to obtain a token from government to obtain subsidised fuel, and such tokens are not provided during the ban period. This provides a strong financial incentive for compliance, and it is of course very easy to determine whether a fishing vessel is fishing or not. The Coastguard is also operational outside of 12 nautical miles. For the inshore/coastal sector, at-sea inspection by the fisheries department is limited due to budgetary constraints, but there is a strong sense of self-enforcement of traditional fishing rules established by the panchayat within communities. A weakness remains however that monitoring control and surveillance activities are disjointed, and not based on any sort of articulated MCS plan based on the use of limited control resources towards high risk locations/seasons/operators.			
3.2.4	Research Plan		✓		Interviews
Explanatory Statement		As part of the annual budgeting process, CMFRI prepares annual research 'plans' in order to specify research activities which require funding/budgets. However there is no research plan specifically designed to inform management of the Indian mackerel fishery or small pelagics in general, and work on small pelagics is more periodic/sporadic in nature than systematic, and therefore not especially able to generate reliable and timely information necessary to inform management so as to ensure sustainability. Over the years, there has however been considerable research completed on Indian mackerel, and while some research gaps remain, much information is now known and there is considerable scientific capacity in research staff working within CMFRI. Research results are made available through the CMFRI website and through publication of scientific papers and project reports.			
3.2.5	Performance Evaluation		✓		Interviews
Explanatory Statement		There is no formal management of the impact of any management regulations for Indian mackerel or small pelagics, and no fishery-specific management plan to evaluate. There are however various internal evaluations mechanisms in place in the Fisheries Department whereby staff at state level monitor district level staff and their activities. In addition, where the Ministry of Agriculture at national level provide funds for specific activities, evaluators/monitors from the Comptroller auditor general periodically check on the implementation of activities in terms of both budget expenditure and effectiveness.			

2.7.1 Key Weaknesses with Current P3 Performance

Key strengths of the management system include the fact that management powers are devolved to State level for inshore waters, and the presence of a strong traditional / community system. Roles and responsibilities of those involved in the management systems are well understood, and considerable amounts of research have also been conducted on small pelagic species in general, and on Indian mackerel. Monitoring control and enforcement is facilitated by the ease of enforcing the principal management regulation involved (i.e. ban periods), and involvement of the *panchayat* in enforcement of inshore rules.

However, the main driver of traditional system is conflict resolution, rather than resource management, and at State level the fishery as a whole suffers from a lack of any sort of coherent hierarchy of policy objectives based on sustainability and the precautionary approach, translated into a management strategy to support such objectives. Government 'policy', to the extent that it exists, is based primarily on the provision of a large number of subsidies to the fishing sector.

2.7.2 Key Recommendations to Address P3 Performance Weaknesses

Recommendations for improvements in performance include the need for a far more comprehensive and better-articulated policy and management strategy for Indian mackerel. This should include the linking in a logical manner of high level policy objectives, and then specific strategies and activities in support of these objectives. A fishery-specific research plan should also be formulated to address gaps in knowledge and to inform fisheries management decisions i.e. research should be driven by management needs so as to ensure good linkage between research and policy/management. A more formulated MCS plan could also be specified, focussing on key risk areas in terms of location, seasonality and stakeholders, so as to ensure that 'value for money' is provided. Finally, the impact of management performance itself should be better evaluated.

All such recommendations could be incorporated into an Indian mackerel management plan, with some aspects potentially integrated and coherent with similar developments in Sri Lanka. A management plan of this nature would also specify particular management measures to address weaknesses in P1 and P2 performance discussed earlier in this Appendix.

A potential avenue of collaboration by the BOBLME project on such developments is the ongoing FAO-implemented and World Bank-funded 'FIMSUL' project which has an office in Chennai and is working with government and stakeholders to improve policy development and implementation. Other locally-based stakeholders which could play an important role in facilitating the work of the BOBLME project in the coming years are the International Collective in Support of Fishworkers, and the Bay of Bengal Project International Governmental Organisation (BOBP-IGO), both also based in Chennai.

2.8 SUMMARY – INDIAN MACKEREL (TAMIL NADU)

The table below provides a summary of the performance for Indian mackerel in Tamil Nadu, India

Table 2: Summary performance table for Indian Mackerel in Tamil Nadu, India

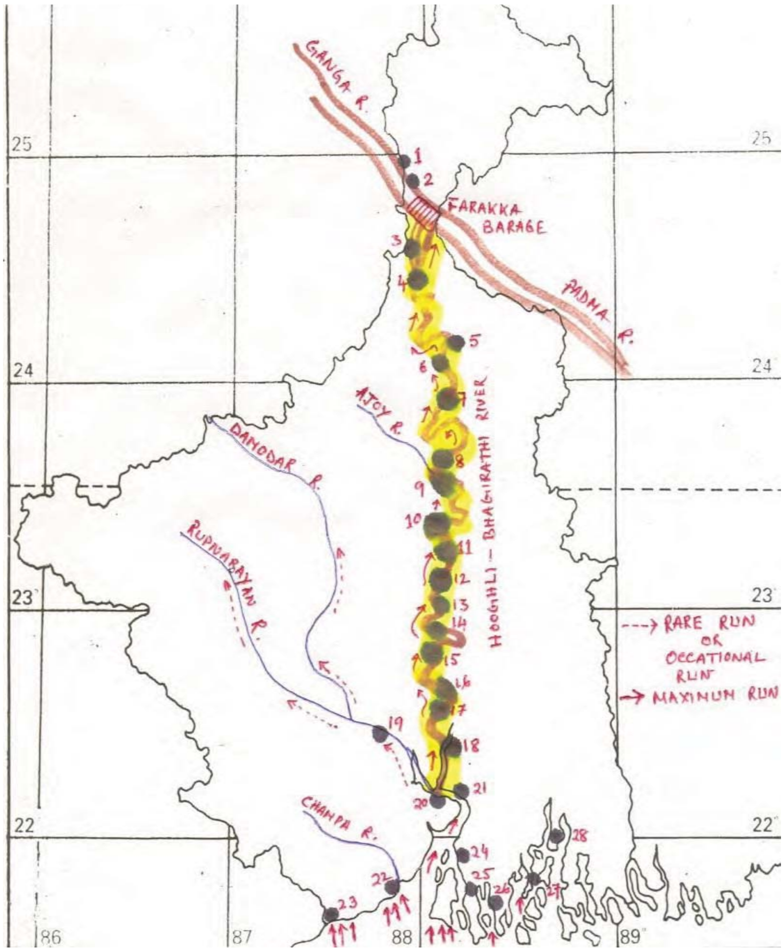
India - Tamil Nadu																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts															Principle 3: Governance & Management								
		Outcome			Harvest strategy				Retained			Bycatch			ETP			Habitat			Ecosystem			Governance & Policy				Fishery specific mang				
Spp	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
I. mackerel	High opening bottom trawl	1	0	n/a	0	0	1	1	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	1	2	0	0	0	0	1	1	1
I. mackerel	Gill nets 50-65mm	1	0	n/a	0	0	1	1	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1	1	2	0	0	0	0	1	1	1

3 FISHERIES ASSESSMENTS – HILSA SHAD (WEST BENGAL)

3.1 INTRODUCTION

A review of the hilsa shad in the Bay of Bengal is provided in the main report, but it is pertinent to provide a brief comment on nature of hilsa stocks in the river systems of West Bengal.

Figure 6: Map of West Bengal, showing main hilsa landing stations and river systems



Source: Mukherjee, M. (2010).

Hilsa in West Bengal follow the anadramous migration cycle described in the main report. In India, hilsa distribution is recorded from the Cauvery, Krishna, Giodvari, Mahanadi, Hooghly and Ganga rivers. In 1873 Day describes two classes of hilsa from rivers, (i) one year old hilsa appearing not to breed and (ii) those breeding at the start and finish of the monsoon. In a series of studies, Pillay *et al* concluded through a combination of tagging studies and morphometric comparisons that hilsa populations show little or no movement between rivers, with little intermingling of populations (Pillay *et al*, 1962; and Pillay *et al*, 1963). More recently hilsa from the Ganga, Yamuna and Hooghly rivers were sampled using DNA-based genetic analysis, which showed the existence of genetic variation within and between hilsa populations in these rivers, indicating the presence of sub-populations that may be due to differing environmental conditions in each river system (CIFRI, 2008). Therefore, despite recent conclusions that there is one main hilsa stock in the Bay of Bengal (Hussain et al. 1998; Milton & Chenery, 2001; Salini et al, 2004), care should be taken to preserve the identity of sub-populations, especially if hatchery-based restocking is to be considered.

Figure 7: Hilsa shad in West Bengal

Source: Mukherjee (2010)

Given the importance of seasonal flooding in the migration and distribution of hilsa, one important consideration is the Farakka Barrage, a large barrage across the Ganges River, located in West Bengal roughly 10 kilometres from the border with Bangladesh and completed in 1974. The barrage was built to divert the Ganges River water into the Hooghly River during the dry season, from January to June, in order to flush out the accumulating silt which in the 1950s and 1960s was a problem at the major port of Kolkata on the Hooghly River. Bangladesh and India have had many debates about how the Farakka Barrage cuts off Bangladesh's water supply and its impact on downstream conditions. The barrage is also reduced the hilsa catch to less than 1 kg/km above Farakka Barrage after its commissioning in 1975 as compared to the pre-Farakka (11.61 kg/km) scenario (Ghosh *et al*, 1978).

3.2 DESCRIPTION OF MAIN FLEETS AND GEARS

The main gear used to catch hilsa are drift or set gillnets (accounting around 96% of production), with the balance being "traditional" gears such as the clap net (*sangla jal*). The majority of these are multifilament, although a small proportion (c. 7%) are apparently (illegal) nylon monofilament nets. Mesh sizes vary from 15 to 140mm, but are more normally in the range of 75 to 85mm (Mukherjee, 2010). The minimum legal mesh size is 12mm in riverine areas, except during the breeding season (15^{th} June – 30^{th} September) when this is increased to 25mm. Certain gears such as the *chat jal* (a mosquito net of 25mm mesh size) and *behundi jal* (set bag nets) are also banned for hilsa fishing.

In the estuarine and marine areas, the minimum mesh size is 85mm and there is also a prohibition of catching fish less than 500g, although mesh sizes may vary highly from 50mm upwards. There is also a State ban for catching from 15th April to 15th June in marine sector. Remesan *et al* (2009) examined various poorly selective gears in the Hooghly-Matlah estuary, in particular the *behunti jal*, a stationary bag net with a wide mouth of 27m and with very small cod end of mesh size (about 2mm), *char-pata jal*, a screen barrier with a very small mesh for harvesting juveniles and *sitki jal*, a skimming net made up of polyethylene netting of mesh size of about 2mm for collecting fry.

Around three-quarters of boats targeting hilsa in West Bengal are unmechanised and largely (80%) made of wood. These are usually fishing in the riverine areas over day trips. The rest of the fleet is mechanised and work multi-day (5-10 days) trips in estuarine and marine areas. These boats have a much higher catch rate, and thus now account for the larger proportion of the catch (see next section).

For the purpose of this assessment, two 'units of assessment' are defined as follows:

- **Gillnets (both drift and set) with a minimum mesh size of 12mm** targeting hilsa and other species in riverine waters, operated predominantly by unmechanised vessels.
- **Gillnets (both drift and set) with a minimum mesh size of 85mm** targeting hilsa in estuarine and marine waters, operated predominantly by mechanised vessels.

Although these two fleet segments differ in some aspects (chiefly in terms of the mesh size and vessel capacity) they will be considered together in the following analysis. However some differences are highlighted in the analytical tables and the summary text.

We previously mentioned the presence of distinct sub-populations in West Bengal's hilsa. Given the wide-spread nature of the fishery, it is considered best to treat the population (including that of Bangladesh & Myanmar) as one overall stock, but to remain aware of the need to preserve these sub-populations in stock conservation planning and management.

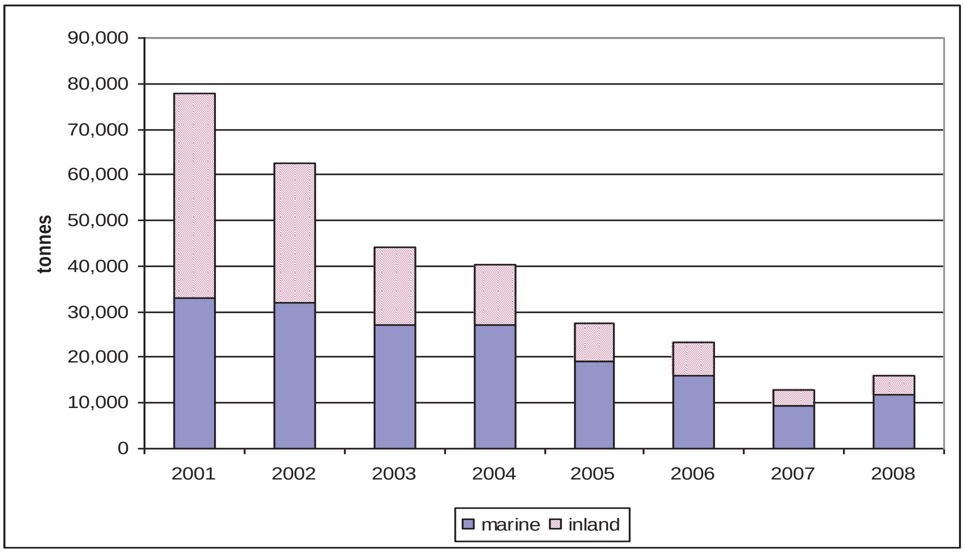
3.3 CURRENT EFFORT, CATCHES & SOCIO-ECONOMIC IMPORTANCE

Current effort levels of fishing for hilsa by the main gear and fleet types described above, are not known, however numbers of both vessels and nets have increased very significantly over many years. Some key points of interest with respect to hilsa fisheries in West Bengal in terms of catches and socio-economic importance are (Singh 2010, Mukherjee 2010):

- The Indian shad hilsa, *Tenualosa ilisha* is most abundant in the Hooghly estuarine system of West Bengal;
- Catches of hilsa in marine and inland areas have declined rapidly in recent years;
- The current balance of hilsa captures are around 50-70% in marine waters, 20-30% in estuarine and the remaining 10-20% in freshwater;
- The balance of marine and inland fish production appears to be shifting in favour of marine fisheries. Reasons may include the timing and extent of rains, sedimentation, pollution and increasing eutrophication of coastal waters;
- Catch declines may be strongly impacted not just be fishing effort, but also by levels of pollution and sedimentation in the river;
- Catch patterns over longer periods show very considerable fluctuations;
- Catches are reported to have increased in 2009 and 2010, perhaps due to the introduction of management measures that have been put in place in recent years (e.g. minimum mesh sizes and ban periods);
- Marine catch data are recorded using standard FAO sampling methodologies. Data on estuarine and inland catches are thought to be far from reliable;
- Fish prices vary considerably between districts, but average around INR 130/kg ($3/kg). Based on this average price, the value of catches in 2008 in West Bengal can be estimated at around INR 2 billion/ $50 million:

- Hilsa has been designated a 'State Fish' inferring certain obligations and priorities with respect to its management and exploitation; and
- For around 80% of those catching hilsa, fishing represents their primary occupation, and the socio-economic status of many families relying on hilsa is very low (monthly average incomes are around INR 1,300 ($31); two-thirds are without electricity).

Figure 8: Catches of hilsa in West Bengal 2001 to 2008 (tonnes)



Source: Department of Fisheries

3.4 ENVIRONMENT

The state of West Bengal has boundaries with Sikkim and Bhutan on the north, Assam and Bangladesh in the east, the Bay of Bengal in the south and Orissa, Bihar and Nepal on the west. Covering an area of 88,752 km^2, the State has 19 districts and a population of 68.1 million.

Most of the West Bengal coast consists of the Sundarbans region of the Ganges delta with many small islands, shoals, sand spits, mudflats and tidal swamps. Mud flats are exposed during low tide near Digha, part of Sundarban and opposite to the Hooghly mouth. The Hooghly Estuary in West Bengal is one of the most polluted estuaries in the world. There are 96 major factories from Nabadwip inland to the bar mouth, discharging almost half a billion litres a day of untreated waste (Sampath, 1998).

The Sundarbans mangrove forest is a UNESCO World Heritage Site. A number of rare and endangered species have been recorded in here, including the salt water crocodile (*Crocodilus porasus*), Gangetic dolphin (*Pratanista gangotica*), Olive Ridley turtle, (*Lepidochelys olivacea*), Hawksbill turtle (*Eretmochelys imbricate)* and green turtle (*Chelonia mydas*).

The Hooghly River system also contains a number of species considered endangered by IUCN, including a number of marine and freshwater turtles and the Gangetic dolphin. Two other mammals - the Irrawaddy Dolphin (*Orcaella brevirostris*) and the Little Porpoise (*Neophocaena phocaenoides*) are also considered vulnerable. See **Annex 2** for more details.

3.5 RISK ASSESSMENT

A risk assessment was undertaken for hilsa in the two main gillnet fisheries – the very small mesh (min 12mm) fishery mainly undertaken by unmechanised vessels in the riverine stretches and the larger, but still small-mesh (min 85mm) gillnet fishery mainly undertaken by mechanised vessels in the estuarine and marine areas.

The productivity element of the risk assessment is discussed in the main report and shows hilsa to be a highly productive species. When turning to the susceptibility element, the smaller mesh gillnet fishery scores poorly on all elements of the analysis, as much of the available area is fished with a high level of encounterability (e.g. the net covers much of the water column), with a low level of selectivity from the small mesh sizes used and the lack of discards and the high level of post-capture mortality. However, because of the resilience of hilsa as a species, the overall risk to hilsa is considered medium i.e. could be addressed through improved management conditions.

The larger-mesh gillnet fishery fares better because of lower proportion of the distributions fished (thus reducing availability score) and the lower level of encounterability (the gillnet only fishes surface waters in the deeper estuarine and marine waters). Otherwise, despite the larger mesh size, selectivity and post-capture mortality is broadly the same. Combined with the high productivity score, the overall risk level of hilsa populations from the larger mesh gillnet fishery is considered low.

Table 3: Risk assessment for West Bengal Fisheries

	PSA															
	Productivity								Susceptibility					PSA Scores		
Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Gill nets (min 12mm)	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
Gillnets (min 85mm)	1	1	1	1	1	1	1	1.00	2	2	3	3	1.88	2.13	Low	>80

A similar, but more targeted risk assessment was undertaken by Milton (2010) for India, Bangladesh and Myanmar (see main report for more information). This suggested that hilsa appear more susceptible in India than the other two countries, mainly due to the small-mesh gears used in the riverine areas and the current lack of protected areas for juvenile fish, both of which affect recruitment success.

3.6 PRINCIPLE 1: STOCK STATUS

3.6.1 Assessment

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp. status	✓			Mitra et al, 1998; Sing and Sharma, 2008; Milton, 2010.
Explanatory Statement		Mitra *et al*. (1998) (cited in Milton, 2010) undertook an assessment of the trend in hilsa catch in the Hooghly River. They suggested that the MSY for hilsa would be exceeded by 2000. Nath *et al*. (2004) (cited in Milton, 2010) undertook an assessment of the "total catchable potential" (TCP) of the Hooghly River system and some of the main species, including Hilsa. They estimated that the TCP for hilsa was 3,507.6 t and this has already been exceeded. Thus, the limited studies on Indian hilsa suggest that hilsa are almost certainly over-exploited in West Bengal. The main stock conservation issue is the over-exploitation of juvenile hilsa by very small mesh nets in the riverine areas. This translates into a high potential for recruitment overfishing. It is important to recognise that the whole Ganges delta is subject to considerable environmental change, largely stemming from over-abstraction of water within the Ganges watershed as a whole, a large numbers of pollution points within the river system as well as a physical barrages that is likely to further inhibit recruitment success (Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010; Bill Collis, WorldFish Bangladesh, pers. comm., 13 Oct 2010).			
1.1.2	Reference points	✓			Singh & Sharma, 2008;
Explanatory Statement		Apart from the calculation of 'total catchable potential', few reference points have been developed for hilsa stocks in India (Singh & Sharma, 2008) and therefore there is no basis for any harvest strategy. It is understood that target escapement rates have been calculated but never implemented.			
1.1.3	Stock rebuilding				Singh & Sharma, 2008
Explanatory Statement		The stock is currently likely to be depleted, although this has not been confirmed. At present, in India there is no rebuilding plan, although a 'National Plan of Action' has been developed by CIFRI in Barrackpure (Singh & Sharma, 2008) but is yet to be implemented. No score is therefore provided.			
Harvest strategy					
1.2.1	Harvest Strategy	✓			Meetings with DoF
Explanatory Statement		At present there is no effective strategy to reduce fishing effort or mortality in West Bengal. There is a seasonal fishing ban in the marine sector, but not in inland fisheries. There is no harvest strategy specified			

PI	Title	Weak	Intermediate	Good	Reference
		or being implemented.			
1.2.2	Harvest control rules and tools	✓			Singh & Sharma, 2008; Mukherjee, 2010; Milton 2010; Remesan *et al*, 2009
Explanatory Statement		There are no harvest control rules linked to exploitation rates in West Bengal. The only methods of controlling exploitation are minimum mesh sizes and a seasonal fishing ban in the marine sector. <u>Inland Sector</u> The mesh size of net under 12 mm is strictly prohibited and the *chat jal*, *behundi jal* etc. are also strictly prohibited to use for catching hilsa and other fish from river throughout the year under Inland Fishery Act, 1984 and 1985 of section 46, part 1 and 2. According to the above law, the mesh size of net under 25 mm is strictly prohibited for fishing during the breeding season of hilsa and other fish i.e. from 15th June to 30th September in river. <u>Marine sector</u> The banned period for catching hilsa is 15th April to 15th June in the marine sector. It is also prohibited to use the gill net with the mesh size of less than 85 mm, and it is prohibited to catch hilsa of under 500 gm of body weight throughout the year.			
1.2.3	Information / monitoring	✓			P.K. Jana, pers. comm., WBFD Stats Wing., 8 Oct 2010; Milton, 2010
Explanatory Statement		Catch monitoring in maritime areas is apparently reasonable as it is largely port-based around the relatively limited number of landing sites and strong support from fisheries associations. Catch monitoring in the freshwater and riverine zones is poor due to the large areas involved and the limited capacity of the Fisheries Department resources at field level (P.K. Jana, pers. comm., WBFD Stats Wing., 8 Oct 2010). Furthermore, whilst vessel licensing in the marine sector is reasonably well established, it is less prevalent in freshwater areas (which are dominated by unmechanised, small-scale fishers) and fishing effort is largely unknown. There are few details on how the jatka figures were estimated in West Bengal, nor are the main nursery areas identified. There also does not appear to be any data on the main hilsa spawning grounds in India (Milton, 2010). There are two institutions involved in data collection. The State Fisheries Department conducts scientific research through ARHMC which benefits from the wide Extension Officer network. However it faces a considerable challenge in balancing its livelihood maintenance remit with management enforcement. CIMFRI at Barrackpur has considerable scientific capacity, but lacks the management remit. This dichotomy is further compromised by the lack of cooperation between the two organisations (see Principle 3 for more discussion).			

PI	Title	Weak	Intermediate	Good	Reference
1.2.4	Stock Assessment (not if RBF)	✓			Milton, 2010;
Explanatory Statement		At present there is inadequate stock assessment of hilsa in West Bengal. There are no target or limit reference points identified, and there are considerable uncertainties involved in current assessment practises. As we understand, there is no independent peer review of stock assessment methodologies or practises.			

3.6.2 Key Weaknesses with Current P1 Performance

The limited studies on Indian hilsa suggest that hilsa are almost certainly over-exploited in West Bengal. The main stock conservation issue is the over-exploitation of juvenile hilsa by very small mesh nets in the riverine areas, and open access. Stock status is also impacted by increased levels of fishing effort over time, coupled with declining riverine water flow on which the inland catches depend.

The only methods of controlling exploitation are minimum mesh sizes in both inland and marine areas, and a seasonal fishing ban in the marine sector along with a minimum landing size. There is however no clear harvest strategy and no harvest control rules linked to exploitation rates.

Information on which to base any such a harvest/management strategy is generally, although not always, unavailable or outdated, although some good scientific outputs are available both from ARHMC and CIMFRI. Data on vessel numbers and catches in inland areas is thought to be especially weak.

3.6.3 Key Recommendations to Address P1 Performance Weaknesses

Milton (2010) suggests that the following information is required in order to manage hilsa stocks in West Bengal, and all concur with the findings of this assessment:

1. Identify and map the spatial and temporal extent of major spawning and fishing grounds
2. Identify and map the spatial and temporal extent of major juvenile nursery areas
3. Quantify the spatial extent and severity of pollution and its impacts on hilsa habitats
4. Verify age structure of hilsa populations in India and measure the size structure of the commercial catch
5. Assess the reliability of commercial catch statistics and undertake a stock assessment if feasible.

If such information were available, the next step could then be to formulate a management plan/strategy, providing for input measures, output measures, and technical measures as appropriate, so as to adequately protect the resource, while also paying due recognition of the socio-economic impacts of management measures, and their likely practicability, acceptability, and enforceability. A critical aspect of such a plan should be the inclusion of reference points and harvest control rules i.e. management actions would be triggered by the status of the stock reaching particular reference points.

3.7 PRINCIPLE 2: ECOSYSTEM IMPACTS

3.7.1 Surface set gillnets

The common features of riverine (e.g. min 12mm) and estuarine/marine (e.g. min 85mm) gillnets are considered together in this analysis. Where differences occur, they are highlighted in the relevant text. For the scoring using the ticks, where the scores for an indicator are the same for both mesh sizes, only one tick is provided. Where scores are different, the score on the *top row* in each case relates to the minimum 12mm mesh gill nets, and the score on the *bottom row* to the minimum 85mm mesh gill nets.

PI	Title	Weak	Intermediate	Good	Reference
Other retained species					
2.1.1	Other retained spp. Status	✓			Singh & Sharma, 2008; Mukherjee, 2010; Milton 2010; Remesan *et al*, 2009.
Explanatory Statement		No figures on the selectivity of these gears have been provided to the assessment team. It is understood that the selectivity of the larger gillnets is good and bycatch is minimal (Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010). However it is likely that the bycatch from the smaller-mesh gillnets used in freshwater will be much higher, with a larger proportion of juvenile fish (both hilsa as well as other retained species). However this is also difficult to quantify due to the wide range of mesh sizes and the different gear configurations used.			
2.1.2	Other retained spp. management	✓			Singh & Sharma, 2008; Mukherjee, 2010; Milton 2010; Remesan *et al*, 2009
Explanatory Statement		The main tool used is the control of gillnet mesh sizes. In freshwater the minimum mesh size is 12mm and nets under 25mm are prohibited during the breeding season of hilsa and other fish i.e. from 15th June to 30th September. In marine areas nets under 85mm are banned and the capture of hilsa under 500g is prohibited. There is also a fishing ban over 15th April to 15th June each year. In addition various gears e.g. *chat jal*, *behundi jal*, etc are also banned from catching hilsa and other fish from river throughout the year under Inland Fishery Act (1984 & 1985) although juvenile fishing is still widespread. The very small minimum mesh size allowance in freshwater (12mm) and the limited capacity to enforce this and other regulations means that there is likely to be the extensive capture of juvenile fish of a wide number of species, thus posing a considerable risk to their recruitment and population status.			
2.1.3	Other retained spp. Information	✓			Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		Catch estimates in freshwaters are based on a sampling regime limited by inadequate human and logistical resources in a challenging physical environment. As a result, catch monitoring in the freshwater and riverine zones is poor. Furthermore, whilst vessel licensing in the marine sector is reasonably well established, it is less prevalent in freshwater areas (which are dominated by unmechanised, small-scale fishers) and fishing effort is largely unknown.			

PI	Title	Weak	Intermediate	Good	Reference
Discarded species					
2.2.1	Discarded bycatch spp. Status			✓	Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		Although not recorded, it is highly likely that discards from this fishery are negligible. As such, they do not pose a risk of serious or irreversible harm to any species group.			
2.2.2	Discarded bycatch spp. Management			✓	Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		As discards are negligible, no management measures are required.			
2.2.3	Discarded bycatch spp. Information		✓		Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
ETP species					
2.3.1	ETP spp. Status	✓	✓		GOI, 2000; Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010; Ratul Saha, WWF-India sundarbans Programme, pers. comm., 17 Oct. 2010; T.K. Chatterjee, pers. comm., 25 Oct., 2010
Explanatory Statement		Five sea turtle species are known to occur in Indian coastal waters: the Olive Ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), the green sea turtle (*Chelonia mydas*), the loggerhead (*Caretta caretta*) and the leatherback (*Dermochelys coriacea*) (GOI, 2000). All are known to nest on the Indian coast, with the exception of the loggerhead. There are around 83 species of fish that are considered endangered, vulnerable, threatened or rare in the State of West Bengal (M. Mukherjee, ARHMC, pers. comm., 7 Oct 2010). Of these, 64 are freshwater species and 19 are estuarine or marine and include two hilsa species, *Tenualosa kelee* and *T. toli* (both considered "endangered"). However, the extent to which these species are threatened by the hilsa fishery is not known, although it is likely that the two endangered hilsa species continue to be caught but remain unidentified. Six fish species of Hooghly River system and adjoining areas are under Indian Wildlife (Protection) Act, 1972. Schedule-I Part 2 (A) – Fishes. The threat of this gear to other ETP species such as freshwater turtles, the Gangetic dolphin, etc is unknown, although WWF-India's Sundarban Programme indicates no reports to ETP species being at risk from hilsa gillnet fisheries.			

PI	Title	Weak	Intermediate	Good	Reference
2.3.2	ETP spp. Management		✓		GOI, 2000; Lakra *et al*, 2010; Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010; Ratul Saha, WWF-India sundarbans Programme, pers. comm., 17 Oct. 2010.
Explanatory Statement		The Indian Wildlife (Protection) Act 1972 ensures that all sea turtle are protected. Recently the Ministry of Environment and Forests, Govt. of India listed further species of marine sharks and rays and some other animals for additional protection. India is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973, which lists all species of marine turtles in Schedule I, prohibiting their international trade. India is also a signatory to the Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979. This requires India to put in place strict conservation measures for the five species of marine turtles that visit the Indian coast, as listed in Appendix 1. In the freshwater component of the fishery there is much more limited management of interactions with ETP species. As stated above, a number of freshwater fish species are considered as endangered, vulnerable, threatened or rare in the State of West Bengal (M. Mukherjee, ARHMC, pers. comm., 7 Oct 2010; Ratul Saha, WWF-India Sundarbans Programme, pers. comm., 17 Oct. 2010.), but the level of actual protection afforded to them is not known to the assessment team.			
2.3.3	ETP spp. Information	✓			Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		At present there is little information being collected to support the management of fishery impacts on ETP species, either in terms of supporting the development of a management plan (if necessary) nor being able to estimate the outcome status of ETP species.			
Habitats					
2.4.1	Habitat Status			✓	Pathak *et al*, 2009; T.K. Chatterjee, pers. comm., 25 Oct., 2010
Explanatory Statement		Habitat interactions with these gears are minimal, especially in marine and estuarine areas where they are surface set and do not touch the bottom. In faster flowing river and estuarine areas some gears and / or boats may be fixed to the ground causing temporary and low level physical impacts. However, due to the highly dynamic nature of these environments (e.g. fast and chasing currents, high sediment loads, etc) it is highly unlikely that these impacts will be significant in terms of damage to aquatic biodiversity. The loss and discarding of monofilament gillnets may be very high, with potential for high rates of persistence and ghost-fishing in the riverine environment.			
2.4.2	Habitat Management		✓		Madhumita Mukherjee, ARHMC, pers. comm., 7 Oct 2010
Explanatory Statement		At present there are no habitat management measures in place, nor is there any known reason why this might be necessary, esp. given the			

PI	Title	Weak	Intermediate	Good	Reference
		dynamic nature of the environment involved.			
2.4.3	Habitat Information		✓		Milton, 2010
Explanatory Statement		There is a basic understanding of the types and distribution of the main habitats in the fishery areas, although this has not been well studied. The spatial distribution of fishing effort is reasonably well known, although not formally recorded. The dynamic nature of the riverine system and its changeable nature is also known and is periodically recorded. The nature of impacts of these gears in the habitat are not known, but given the dynamic nature of the environment, the risk posed is likely to be low.			
Ecosystems					
2.5.1	Ecosystem Status	✓			Milton, 2010
				✓	
Explanatory Statement		The main issue with this fishery is its low level of size selectivity. Whilst most of the gears used are in the range of 60 – 80mm, there are many smaller mesh gillnet and other gear types in use that have high catch rates of juvenile fish, especially in the river and estuarine areas. This is likely to have consequences for fish and other populations within the lower watershed in terms of a depleted prey population and possible implications on recruitment, not withstanding the high natural mortality of many species involved. At present, it is not possible to say that the existing fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to the point where there will be serious and irreversible harm.			
2.5.2	Ecosystem Management	✓			Singh & Sharma, 2008
				✓	
Explanatory Statement		At present there is little evidence of an ecosystem-based strategy for hilsa fisheries management, although this is embedded into the as yet unimplemented National Plan of Action for Hilsa. The State's fisheries management policy, for very understandable reasons, is focused on livelihoods maintenance, but this has resulted in conflicts with enabling long-term ecosystem-based fisheries management approaches. The measures adopted – minimum mesh sizes and seasonal fisheries bans – are insufficiently focused or adequate in scale to address the potential impacts of this fishery on key elements of the ecosystem. The Sundarbans is a RAMSAR site which may afford this area additional protection.			
2.5.3	Ecosystem Information	✓			Pathak et al, 2009; Satpathy et al, 2009; Milton, 2010
			✓		
Explanatory Statement		CIFRI has conducted a number of studies into the riverine and estuarine environments and, importantly, the impact of environmental change (e.g. pollution and reduced water flow) on these. As a result it is possible to identify the key elements of the ecosystem. The main impacts of the fishery, esp. on the target fish stock can be inferred from research to date. However it is not possible to determine the impacts of this fishery (in particular those smaller-mesh gears) in			

PI	Title	Weak	Intermediate	Good	Reference
		the population dynamics of retained bycatch species. Little is currently known about the critical habitats of hilsa (e.g. spawning and nursery grounds).			

3.7.2 Key Weaknesses with Current P2 Performance

While the bycatch of species apart from hilsa in gillnets in the marine fishery may not be a very significant problem, this is certainly not true of the inland fishery where mesh size means that bycatches are likely to be high. The very small minimum mesh size allowance in freshwater (12mm) and the limited capacity to enforce this and other regulations means that there is likely to be the extensive capture of juvenile fish of a wide number of species, thus posing a considerable risk to their recruitment and population status. In both the marine and inland fishery, there is no specific strategy in place to try to reduce bycatch except for the use of mesh size (which itself is not especially large in the inland areas).

Discards are thought to be almost non-existent, and there is therefore no real need to manage them.

India has in place various legislation with regard to ETP species, and the interactions between the units of assessment and such species is probably relatively minor. However, current information is not really available to provide much confidence in this assumption, and there is likely to be some level (as yet unquantified) of impacts on both turtles (both marine and freshwater) and Gangetic dolphins.

Habitat interactions with hilsa gillnets are thought to be minimal, due both to fishing itself and also the highly dynamic nature of the environment, although information to understand this potential impact is not fully available. Some net loss, and resulting impact on habitats may occur for example.

Ecosystem impacts of the marine gillnet fishery are not thought to be concern. The main issue is with the inland fishery and its low level of size selectivity. There are many smaller mesh gillnet and other gear types in use that have high catch rates of juvenile fish, with likely consequences for fish and other populations within the lower watershed in terms of a depleted prey population and possible implications on recruitment, not withstanding the high natural mortality of many species involved. While some information on ecosystems is available, such information does not pertain to the impacts of the fishery per se.

3.7.3 Key Recommendations to Address P2 Performance Weaknesses

Recommendations for improving performance of P2 for hilsa in West Bengal are similar to those made for Indian mackerel in Tamil Nadu. For both units of assessment, consideration should be given to the specification and implementation of an 'ecosystems impact minimisation strategy'. Such strategies would need to be discussed and agreed between all stakeholders to assess their effectiveness, practicability, and impacts. The could be risk-based, and could include a requirement for improved information and monitoring as well as the introduction of specific management strategies to minimise impacts on bycatch, discards, ETPs, habitats and ecosystems. Such strategies could of course be nested within species-specific fisheries management plans i.e. fisheries management plans could/should pay particular attention to such issues.

3.8 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

PI	Title	Weak	Intermediate	Good	Reference
Governance and policy					
3.1.1	Legal Framework		✓		Interviews. Relevant legislation.
Explanatory Statement		The description of the extent to which the management system for Indian mackerel in Tami Nadu sits within a legal and/or customary framework which means that it is capable[2] of delivering sustainable fisheries, observes the traditional rights of local communities and incorporates a dispute resolution mechanism, also generally applies to the management system for hilsa in West Bengal. Key marine and inland fisheries legislation in West Bengal (in addition to national level legislation) includes: The West Bengal Inland Fisheries Act, 1984 and Amendments; the West Bengal Inland Fisheries Rules, 1985 and Amendments; The West Bengal Marine Fishing Regulation Act, 1993; the West Bengal Marine Fishing Regulation Rules, 1995 and Amendments; Fishing Order of Nov 28th 2000 on fishing gear. The *panchayat* system also operates in West Bengal, and there is a strong network of fisheries associations and cooperative societies which can be used by the Fisheries Department to resolve conflicts.			
3.1.2	Consultation, roles and responsibilities			✓	Interviews.
Explanatory Statement		The comments made on this indicator for Indian mackerel also generally apply in West Bengal. There are 350 'blocks' (the administrative unit under the districts) in West Bengal and the Fisheries Department has a 'block development officer' (BDO) in each one. Each block may cover 3-4 *panchayats*. The Fisheries Department also has extension officers working under the BDOs, and fisheries inspectors (responsible for both collecting data and enforcement). Thus, while not always working perfectly, there is generally a good flow of local information and knowledge from the catching sector to the government. In addition to a regular flow of information from ongoing activities/responsibilities, the Fisheries Department has also been engaged recently in a number of specific ad hoc research studies to obtain information on the hilsa fisheries in estuarine/inland areas. The department also regularly runs awareness and consultation camps with fishers. Roles and responsibilities are clear and well understood between relevant stakeholders with little confusion or overlap of responsibilities e.g. Fisheries Department (research, statistics, resource mapping), the Coastguard, fishing associations, *panchayat*, local police and local administrations, CIFRI, etc), for the same reasons specified in the assessment of Indian mackerel in Tamil Nadu.			
3.1.3	Long-term			✓	Interviews. NFDB (2007). Marine

[2] Note that this indicator is not assessing whether the legal system does result in sustainable exploitation, just that it is capable of doing so. The outcome of sustainability is assessed under P1 indicators.

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td></td><td>Objectives</td><td></td><td></td><td></td><td>Fisheries Policy (2004). Government of West Bengal Annual Report (2007).</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Long-term objectives are much more clearly articulated in West Bengal than in Tami Nadu. The Fisheries Department publishes ‘Annual Reports’, which serve to guide activities. These reports are often not widely available in hard copy and there exists a time-lag in their publication, but they nonetheless appear to be used to guide the management activities of the fisheries department, as well as to report on activities. The most recent Annual Report (2006/7) states policy and management objectives relating to sustainability and the precautionary approach, refers to the FAO Code of Conduct for Responsible Fisheries, and the national 11th 5-year plan which also mentions similar objectives.</td></tr>
<tr><td>3.1.4</td><td>Incentives</td><td>✓</td><td></td><td></td><td>Interviews.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are a very large number of subsidy schemes provided by the government to the fisheries sector. One or two of these could arguably be considered as ‘good’ subsidies in terms of their ability to assist with resource management e.g. relief to fishermen during the ban period which encourage compliance. But other schemes are of a welfare nature and certainly serve to maintain/increase fishing capacity, even if they also serve an important function in terms of poverty prevention/alleviation. Examples include subsidies for fuel, vessels and gear. There appears to be no mechanism by which the impact is evaluated of the provision of public sector support may, or may not be, impacting on resource sustainability.</td></tr>
<tr><td colspan="6">Fishery specific management</td></tr>
<tr><td>3.2.1</td><td>Fishery Objectives</td><td></td><td>✓</td><td></td><td>Interviews. Government of West Bengal Annual Report (2007).</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There is, as yet, no specific fisheries management plan for hilsa fisheries, and no clearly articulated fishery specific objectives for hilsa fisheries. However, objectives of sustainability are somewhat implicit in the ongoing work of the fisheries department which has included awareness camps on hilsa sustainability and management issues, the overall objectives as stated in the Annual reports, and the regulatory ban period designed to protect spawning stocks. The Department also expresses a willingness to learn from the recent developments in hilsa management in Bangladesh.</td></tr>
<tr><td>3.2.2</td><td>Decision making processes</td><td></td><td>✓</td><td></td><td>Interviews.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Consultation processes described under Indicator 3.1.1 provide a strong basis for bottom-up participatory decision making. These decision-making processes are established and are beginning to respond to the serious issue of resource depletion, while recognising the difficulty of imposing regulations that will have short-term livelihoods impacts on fishers. However, it can not yet be claimed that decision-making is resulting in strategies and measures to achieve sustainability. Fishers appear to generally agree with, and be supportive of, the ban period. But reaching agreement on increases in minimum mesh sizes or closed areas may be more problematic. And the fishery remains one of open access.</td></tr>
</table>

3.2.3	Compliance & Enforcement		✓		Interviews, Mukherjee (2010), Singh (2010).
Explanatory Statement		There are few regulations to enforce at the present time, but even so MCS activities are insufficient and not well able to control fishing activity. This is especially the case in inland areas (18 districts), where enforcement relies on fisheries inspectors operating under the statistical wing of the Department, local police, and local administrations. Recent research by the Department revealed that many fishermen were infringing regulations, primarily due to the socio-economic difficulties of abiding by them, coupled with the lack of effective enforcement. Typical infringements included the use of very small mesh size 'mosquito nets' and the sale of undersized fish. Marine fishing activity is generally easier to control due to the presence of seven major fishing harbours, strong marine fishing associations, and close relationships between these associations and the Department. The Department has no patrol vessels itself, but the Coastguard plays an active role in enforcement in the marine environment (but not in inland/river areas), and there are regular coordination meetings between the Coastguard and the Department (and other Government departments), although no clearly articulated MCS plan. As with aspects of the Departments activities, MCS is hampered by a lack of funds. The fisheries sector in West Bengal accounts for around 1.5% of State Gross Domestic Product, but the Fisheries Department receives less than 1% of the State budget. On the positive side, and as noted above, the Department is actively engaged with improvements in compliance and enforcement, in particular through education and awareness campaigns, and in the provision of financial support during ban periods in an effort to increase compliance. The Department has two marine training centres in two coastal districts, which are used to provide awareness on regulations to the marine catching sector, and is reported to be keen to establish 'Fishery Protection Groups' similar to the Forest Protection Groups which already exist. Records and *ad hoc* research detail fisheries infringements. Sanctions for infringements include the seizing of both nets and catch, which bearing in mind the low socio-economic status of fishermen, can be considered a considerable deterrent, *if enforced*. Identity cards can also be removed, meaning that fishers are unable to benefit from State provided financial support (e.g. insurance schemes), which again is a considerable deterrent.			
3.2.4	Research Plan		✓		Interviews.
Explanatory Statement		The Central Inland Fisheries Research Institute (CIFRI) operating under the Council of Agricultural Research, and the Aquatic Resources Health Management Centre (ARHMC) operating under the Department of Fisheries, both prepare research 'plans' as part of annual budgetary planning. Some ARHMC projects/activities are sanctioned for periods of more than a year. However, there is no hilsa-specific research plan specifying clear linkages between research activities and management needs, and there appears to be poor collaboration between the two main research organisations. The ARHMC may have better links/access to the fishers through the Department network of extension officers and may thus be better placed to provide demand-driven			

		research.			
3.2.5	Performance Evaluation		✓		Interviews.
Explanatory Statement		There is no formal evaluation of the impact of any management regulations for Indian mackerel or small pelagics, and no fishery-specific management plan to evaluate. There are however various internal evaluations mechanisms in place in the Department of fisheries whereby staff at State level monitor district level staff and their activities. Monthly meetings take place at State level to monitor the activities of district level activities, and monthly meetings take place at district level to monitor the activities of the block officers. In addition, where the Ministry of Agriculture at national level provide funds for specific activities, evaluators/monitors from the Comptroller auditor general periodically check on the implementation of activities in terms of both budget expenditure and effectiveness.			

3.8.1 Key Weaknesses with Current P3 Performance

Key strengths of the management system include the fact that management powers are devolved to State level for inshore waters, and the presence of a strong traditional/community system. Roles and responsibilities of those involved in the management systems are well understood, and considerable amounts of research have also been conducted on small pelagic species in general, and on hilsa fisheries. Monitoring control and enforcement is facilitated by the involvement of the *panchayat*, by government awareness campaigns, and by the ability to seize nets when infringements are detected. The specification of long-term management objectives in the Annual Reports also serves to guide activities, and the designation of hilsa as a State Fish elevates its importance in management terms.

However, the fishery remains one of open access, there are still many 'bad' subsidies in place, and MCS activities are far from perfect especially in inland areas. In addition, there is a worrying lack of integration between the ARHMC and CIMFRI in coordinating and planning research activities in support of management.

3.8.2 Key Recommendations to Address P3 Performance Weaknesses

Recommendations for improvements in performance include the need for a far more comprehensive and better-articulated policy and management strategy for hilsa. This should include the linking in a logical manner of high level policy objectives, and then specific strategies and activities in support of these objectives. A fishery-specific research plan should also be formulated to address gaps in knowledge and to inform fisheries management decisions i.e. research should be driven by management needs so as to ensure good linkage between research and policy/management. A more formulated MCS plan could also be specified, focussing on key risk areas in terms of location, seasonality and stakeholders, so as to ensure that 'value for money' is provided. Finally, the impact of management performance itself should be better evaluated. All such recommendations could be incorporated into formal hilsa management plan, with some aspects potentially integrated and coherent with Bangladesh. A management plan of this nature would also specify particular management measures to address weaknesses in both P1 and P2 performance discussed earlier in this Appendix.

3.9 SUMMARY – HILSA SHAD (WEST BENGAL)

The table below provides a summary of the performance for Hilsa shad in West Bengal

Table 4: Summary performance table for Hilsa shad in West Bengal

India (West Bengal)																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts															Principle 3: Governance & Management								
		Outcome			*Harvest strategy*				*Retained*			*Bycatch*			*ETP*			*Habitat*			*Ecosystem*			*Governance & Policy*				*Fishery specific mang*				
Spp	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Other retained status	2.1.2. Other retained management	2.1.3. Other retained info /	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
Hilsa 1	Gill nets min 12mm	0	0	*	0	0	0	0	0	0	0	2	2	1	0	1	0	2	1	1	0	0	0	1	2	2	0	1	1	1	1	1
Hilsa 1	Gill nets min 85mm	0	0	*	0	0	0	0	0	0	0	2	2	1	1	1	0	2	1	1	2	2	1	1	2	2	0	1	1	1	1	1

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Annex 2: ETP Species in the Hooghly River System

Source: Ratul Saha (Coordinator- Biodiversity Conservation, WWF-India Sundarbans Programme), pers. comm, 17 October 2010

Sr No.	Class	Order	Family	Species	Common English Name	Local Name	Habitat	IUCN Red List Status	Indian Wildlife Act, 1972 (Schedule)	Appendix of CITES
01	Reptilia	Chelonia	Dermochelyidae	*Dermochelys coriacea*	Leatherback Sea Turtle	Samudra kachim	Pelagic	Endangered	Schedule I	Appendix I
02	Reptilia	Chelonia	Cheloniidae	*Eretmochelys imbricata*	Hawksbill Sea Turtle	Bada samudra kachim	Pelagic	Endangered	Schedule I	Appendix I
03	Reptilia	Chelonia	Cheloniidae	*Lepidochelys olivacea*	Olive Ridley Sea Turtle	Gola kochchop / Jalpaironger kochchop / Pakhi kochchop / Samudrik katha	Pelagic	Endangered	Schedule I	Appendix I
04	Reptilia	Chelonia	Geoemydidae	*Batagur baska*	River Terrapin	Bala katha / Boro ketho / Ram kachim / Pora katha / Bali katha	Supra Littoral	Critically Endangered	Schedule I	Appendix I
05	Reptilia	Chelonia	Geoemydidae	*Batagur dhongoka*	Three-striped Roofed Turtle	Sada katha	Littoral	Endangered	-	Appendix II
06	Reptilia	Chelonia	Geoemydidae	*Batagur kachuga*	Red-crowned Roofed Turtle	Adi kori katha	Littoral	Least Concerned	Schedule I	Appendix I
07	Reptilia	Chelonia	Geoemydidae	*Geoclemys hamiltonii*	Spotted Pond Turtle	Bagh kathua / Bhut katha / Kalo katha	Littoral	Vulnerable	Schedule I	Appendix I
08	Reptilia	Chelonia	Geoemydidae	*Hardella thurjii*	Crowned River Turtle	Boro katha / Kali katha	Littoral	Vulnerable	-	-
09	Reptilia	Chelonia	Geoemydidae	*Pangshura tectum*	Indian Roofed Turtle	Kori katha	Littoral	-	Schedule I	Appendix I
10	Reptilia	Chelonia	Trionychidae	*Chitra indica*	Narrow-headed Softshell Turtle	Chitra / Dhush kachim / Gotajil	Littoral	Endangered	Schedule IV	Appendix II
11	Reptilia	Chelonia	Trionychidae	*Pelochelys*	Asian Giant	Jata kachim	Littoral	-	Schedule I	-

Sr No.	Class	Order	Family	Species	Common English Name	Local Name	Habitat	IUCN Red List Status	Indian Wildlife Act, 1972 (Schedule)	Appendix of CITES
				cantorii	Softshell Turtle					
12	Reptilia	Chelonia	Trionychidae	*Lissemys punctata*	Indian Flapshell Turtle	Chip kathua / Chiti kachim / Mete kachim / Til kachim	Littoral	Least Concerned	Schedule I	Appendix II
13	Reptilia	Chelonia	Trionychidae	*Nilssonia gangetica*	Indian Softshell Turtle	Ganga kachim / Kholua / Kaucha kachim / Kachrong kachim	Littoral	Vulnerable	Schedule I	Appendix I
14	Reptilia	Chelonia	Trionychidae	*Nilssonia hurum*	Indian Peacock Softshell Turtle	Dhalua kachim / Dhum kachim / Bukum	Littoral	Vulnerable	Schedule I	Appendix I
15	Reptilia	Croco dylia	Crocodylidae	*Crocodylus porosus*	Estuarine or Salt-water Crocodile	Sunderbaner Kumir	Marine occassional	Lower Risk/least concern	Schedule I	Appendix I

Sr No.	Aquatic Mammalian species	IUCN Red List Status	Indian Wildlife Act, 1972 (Schedule)	Appendix of CITES	Local Status
1	*Platanista gangetica* (Lebeck, 1801) - Gangetic Dolphin	Endangered	Schedule I	Appendix I	DD
2	*Orcaella brevirostris* (Owen, 1866) - Irrawaddy Dolphin	Vulnerable	Schedule I	Appendix I	DD
3	*Neophocaena phocaenoides* (G. Cuvier, 1829) Little Porpoise	Vulnerable	Schedule I	Appendix I	DD

Note: CR – Critically Endangered; EN – Endangered; LR – Lower Risk; NO – Not Threatened; DD – Data Deficient

Ref: In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. <www.iucnredlist.org>. Downloaded on **16 October 2010**.

Appendix E: Country Report – Indonesia

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries


Rastrelliger kanagurta

Country Report: Indonesia

Undertaken by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms

APFIC	Asia-Pacific Fisheries Commission
ASEAN	Association of Southeast Asian Nations
BOBLME	Bay of Bengal Large Marine Ecosystem
BRKP	Marine & Fisheries Research Organization
CBFM	Community Based Fisheries Management
CCRF	Code of Conduct for Responsible Fisheries
COFI	Committee on Fisheries
COREMAP	Coral Reef Rehabilitation and Management Program
CPUE	Catch per Unit of Effort
DGCF	Directorate General of Capture Fisheries
DKP	Dinas Perikanan Provinsi
EAF(M)	Ecosystem Approach to Fisheries (Management)
EU	European Union
F	Fishing effort
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FTDC	Fishing Technology Development Centre
GT	Gross tonnage
IPOA	International Plan of Action
IUU	Illegal, unreported and unregulated (fishing)
KG	Kilogrammes
M	Metres
MCS	Monitoring, Control and Surveillance
MEY	Maximum Economic Yield
MM	Millimetres
MMAF	Ministry of Marine Affairs and Fisheries
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MT	Metric Tons
NGO	Non Governmental Organization
PSA	Productivity Susceptibility Analysis
RBF	Risk-Based Framework
RBFM	Rights Based Fisheries Management
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
TAC	Total Allowable Catch
TED	Turtle Exclusion Device
TURF	Territorial use rights in fisheries

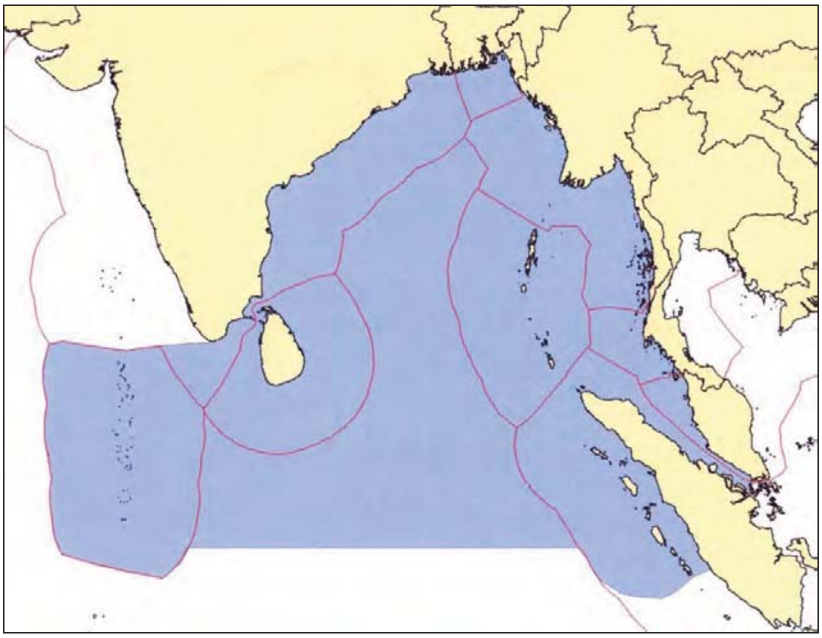
1 OVERVIEW

1.1 INTRODUCTION

The Bay of Bengal Large Marine Ecosystem (BOBLME) project boundaries include the north western portion of Sumatra and cover four provinces: Aceh Province, North Sumatra Province, West Sumatra Province, and Riau Province (Figure 1).

Two Indonesian fisheries management areas are present within the BOBLME boundary: No. 571 (Malacca Strait and Andaman Sea) and No. 572 (Indian Ocean and West Sumatra) as issued by Ministerial Decree No. 1/2009 (Figure 2).

Figure 1: BOBLME boundaries indication country exclusive economic zones



Source: BOBLME Project

Figure 2: Location of Indonesian Fisheries Management Areas

Source: Hutomo *et al*., 2009

Based on Autonomy Law No. 32/2004 the administrative arrangement and responsibilities for three main areas of fisheries management are as follows:

- Coastal baseline to 4 nautical miles (inshore waters): District
- 4 – 12 nautical miles (territorial waters): Provincial
- 12 – 200 nautical miles (to EEZ boundary): Central

1.2 DESCRIPTION OF MAIN FLEETS AND GEARS

The main gears operating within Indonesian waters that are inside the BOBLME area are purse seines, gill nets, trawl and hook and line. The number of Indonesian vessels by gear type and target species is presented in Table 1.

The main characteristics of the fleet in Aceh Province, as found in a census undertaken by Lymer *et al* (2009), are that it comprises relatively newly built and highly motorized vessels, most of which have inboard engines. The fleet is largely privately owned and the vessels were acquired by private funding, although in 2005 and 2006 a large proportion of the new boats were provided by donors following the tsunami. The vessels mainly operate nearshore, between 0 and 3 nautical miles from the coast, and are not usually equipped with navigation or communication equipment, although many of the larger vessels carry both. The fishing fleet in Aceh Province can be summarized as comprising largely small boats (average 3.2 GT) with relatively small motors (average 16 Hp). There is a general trend of these small boats being replaced by larger vessels and hence the fleet tonnage has increased in recent years (Lymer *et al*, 2009). The main areas of fleet expansion are found in Provincial and District zones, where authorities continue to support open access fisheries (Banks *et al*, 2010).

There are four main targeted fisheries for large pelagic species (namely tunas), demersal species, shrimp and small pelagic species. Indian mackerel are caught as part of the mixed small pelagic fishery which also lands a number of other species including Indo-Pacific mackerel and juvenile tunas.

Indian mackerel are predominately targeted by 5-30GT purse seiners; although they are also taken as bycatch in the >30GT purse seine fishery targeting tuna, the demersal trawl fishery targeting shrimp and the gill net fisheries targeting demersal finfish.

The purse seine fleet are split in to three categories in terms of management and location of fishing with vessels >30 GT generally operating outside 12 nautical miles and are managed by Central Government; vessels 10-30 GT operating within territorial waters and managed at a Provincial level and vessels <10 GT operating within inshore waters and managed at a District level. Purse seine nets are typically 700m in length with mesh size 1 inch; larger vessels generally have on board fish finder; radio; mercury lamps (15-150 KWh), 30 Halogen lamps (1.5 KWh), compass/GPS and FAD.

Table 1: Fleet summary

GT	Main species	Gear	# vessels	Sector
> 30 GT	Tunas	Long line	936	EEZ
	Tunas	Purse seine	50	EEZ
	Tunas	Pole&line	65	EEZ
	Shrimp	Trawl	90	EEZ/territorial
	Snapper	Drift gill net, jig	5,359	EEZ
5-30GT	Tunas and small pelagics	Purse seine	10,433	Territorial limits
	Tunas	Long line, pole & line	2,325	Territorial limits
	Finfish, squid	Line, gill net, fish trawl, drop line	43,500	Territorial limits
	Tuna, reef finfish, squid, shrimp, crab & small pelagics (*ikan terri*)	Handline, troll. drift gill net, trap, lift net, trammel net	500,000	Coastal waters

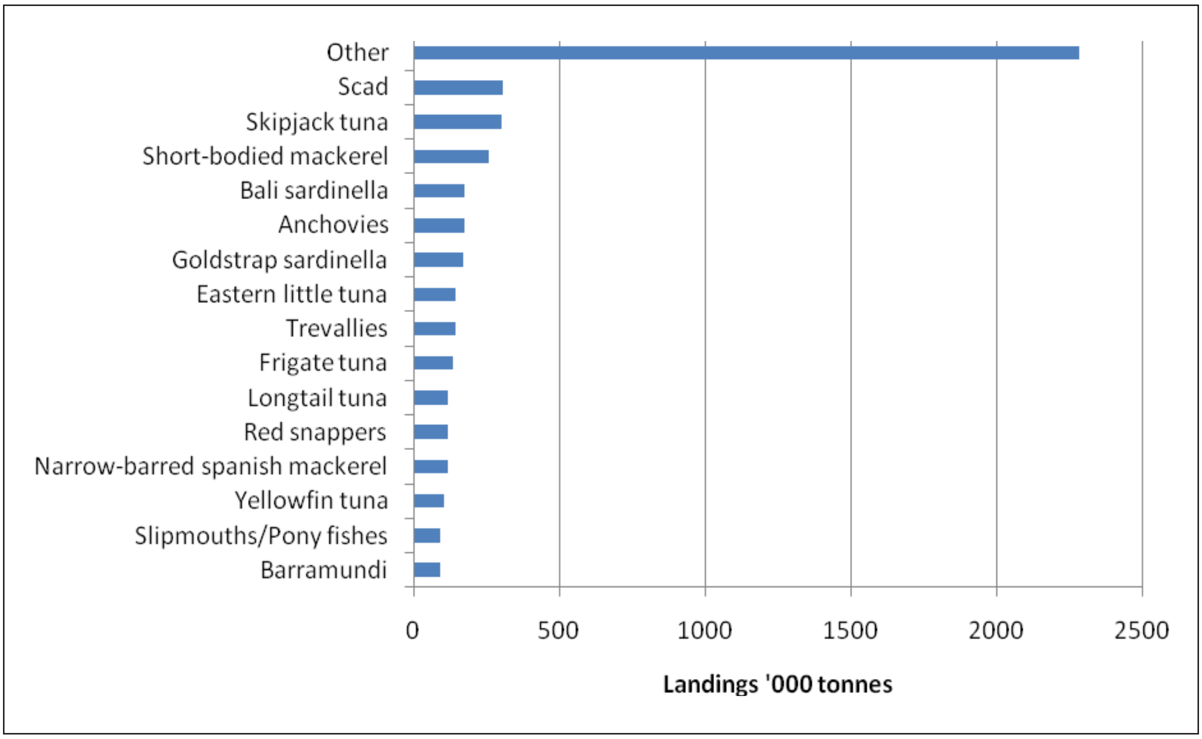
Source: (Banks *et al*., 2010)

1.3 CURRENT EFFORT, CATCHES (VOLUME & VALUE) AND SOCIO-ECONOMIC IMPORTANCE

Indonesian fleets harvest up to 4.7 million tonnes of marine fish annually with a value of US$3.4 billion (DG Capture Fisheries, 2007). Catches are recorded according to the main fishing areas – Sumatra (28%), Maluku (20%), Sulawesi (19%), Java (19%), Kalimantan (7%), Bali and NTT (6%) (Badan Pusat Statistik, 2007). The majority of landings are recorded as 'other species' followed by tunas, small pelagics and shrimp (Figure 3).

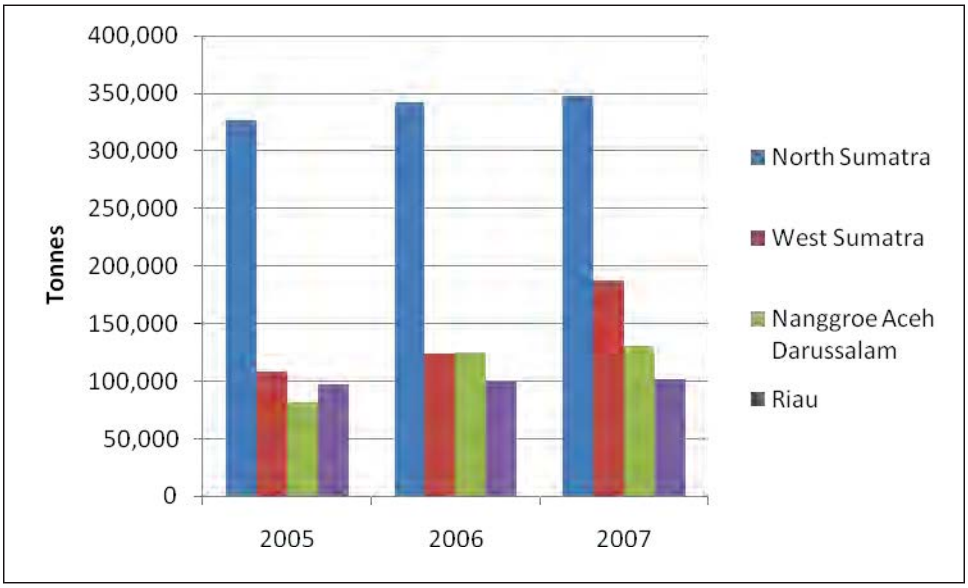
Landings into the four provincial areas that border the BOBLME area totaled just under 768,000 tonnes in 2007 with approximately half landed into North Sumatra (Figure 4).

Figure 3: Indonesia marine capture production by species, 2007



Source: Hutomo *et al*. 2009

Figure 4: Total Capture Fisheries Production for Provinces within BOBLME boundary, 2005-2007 (Tonnes)



Source: Badan Pusat Statistik, 2007

While eighty per cent of Indonesia's marine capture fisheries products are consumed domestically (FAO, 2010), it is understood that Indian mackerel is almost exclusively consumed domestically.

Approximately 4 million people are employed in the marine capture fisheries sector. Participation in the harvesting sector is exclusive to males, while women play an important role in processing and a partial role in post-harvest distribution and domestic seafood processing (Banks et al., 2010).

The small pelagics fishery which targets Indian mackerel is predominately undertaken in the Western part of Sumatra North (Kep. Banyak, Singkil to Simeleu, Sorkam, Barus, Bay of Tapanuli, Mursala Isl., Natal, Sikara-kara, Ilik Is, Pini Is., Kep. Batu, Telo Is.). The main ports of operation are Sibolga, Banda Aceh, Idie Rayeuk (Suwarso et al, 2010)

Days fished varies by location: South Aceh 13,242 days/year; Centre Tapanuli 4,878 days/year; South Tapanuli 6,871 days/year; Sibolga 2,763 days/year, West Sumatra north 2,703 days/year.

1.4 ENVIRONMENT

The marine and coastal biodiversity in Indonesia have been adversely degraded over the last few decades as a result of the direct use of coastal and marine resources (including fishing) and the indirect impacts of marine and land-based activities. This has led the Government of Indonesia to legally protect rare and endangered species under the Regulation No. 7/ 1999.

Six, out of the seven species of turtle in the world, are found in Indonesian waters: green turtle *Chelonia mydas,* hawksbill turtle *Eretmochelys imbricate,* flatback turtle *Natator depressus,* leatherback turtle *Dermochelys coriacea*, loggerhead turtle *Caretta caretta* and olive ridley turtle *Lepidochelys olivacea*. The species distribution around Indonesia is known, with all six species present in Indian Ocean/West Sumatra management area and three (olive ridley, hawksbill and green) in the Malacca Straight/Andaman Sea management area. Nesting sites for green turtles are recorded in North West Sumatra with an annual nesting population of up to 5,650. Leatherback turtles are also recorded to nest in this area, but at lower frequencies (Erdmann *et al*, 2009).

Dugong *Dugong dugon* is protected under decree of the Minister of the Department of Agriculture No. 327/Kpts/Um/1972. Dugongs feed on seagrass and their distribution is largely limited to this habitat. While scientific information on the abundance and distribution of dugong in Indonesian waters is very limited, fishermen and locals report to have seen them at numerous locations, including the coastal areas of Riau Archipelago. Population estimates are also limited with a population size of 10,000 reported in 1970s and 1,000 in 1994 (Hutomo *et al.* 2009). Latest information from the Indonesian Seagrass Committee (2004) reported sightings of dugongs associated with seagrass in the Riau Archipelago.

De Longh (1996) reports the two major threats to dugongs in Indonesian waters to be capture in fishing nets and destruction of seagrass habitats. The decline is however thought to be mainly due to targeted hunting of this species, rather than incidental capture.

There are an estimated 31 or more species of whales and dolphins that inhabit Indonesian waters (Wagey and Arifin, 2008). The blue whale *Balaenoptera musculus*, finback whale *B. physalis* and humpback whale *Megaptera novaeangliae* are fully protected, as are all dolphin species. The distribution for large scale habitat priorities for whales and dolphins are predominately recorded in central and eastern Indonesian waters, outside the BOBLME area where data deficiency means distribution is unknown.

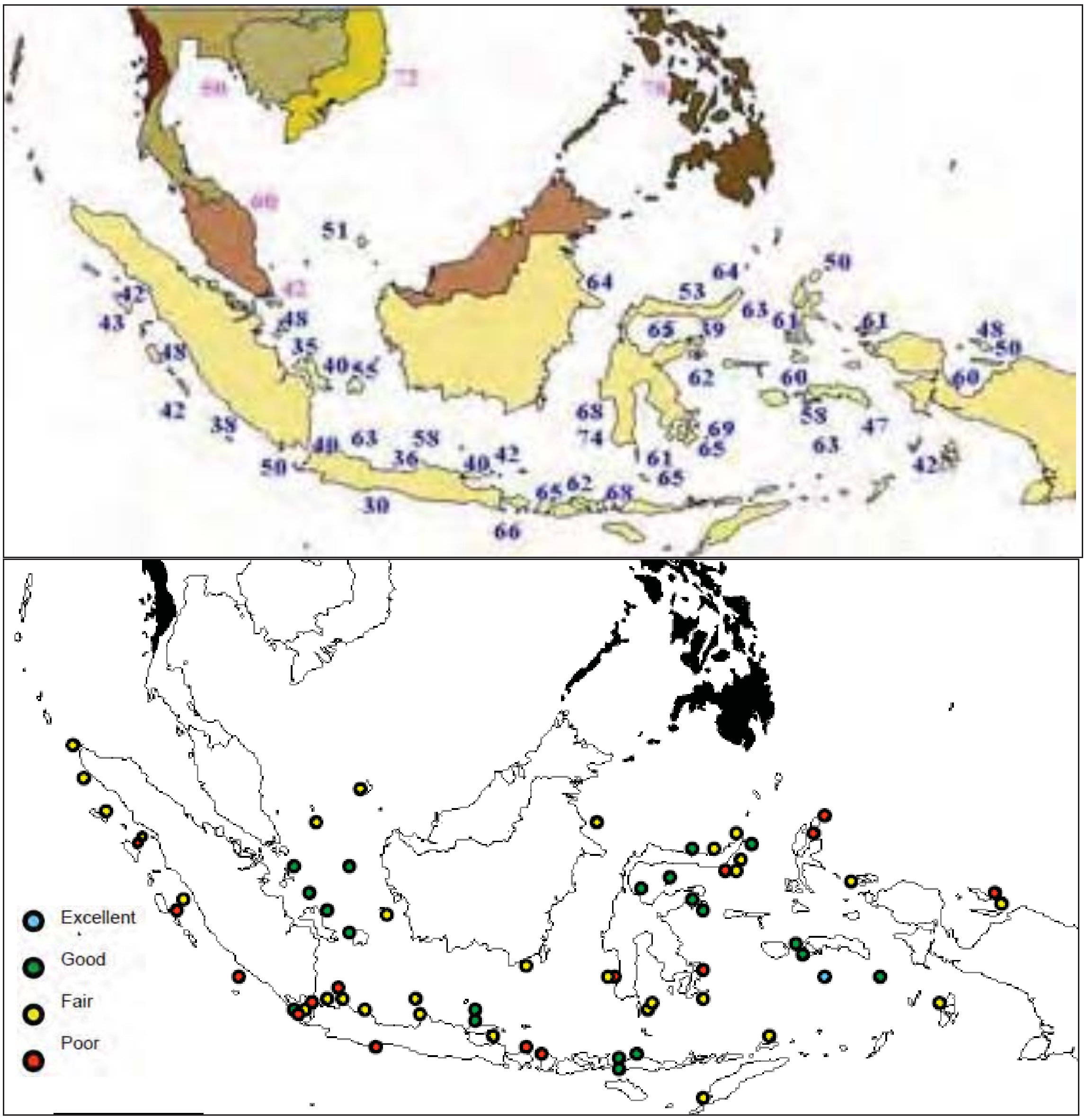
One fish species, coelacanth *Latimria manadoensis*, and sixteen invertebrate species have protected status, however some of them are widely exploited including giant clams and large snails (Moosa *et al*, 1996 as cited in Hutomo *et al*, 2009).

Indonesia contains about 14% of the world's reefs, which are distributed unevenly from Sabang to Merauke with the highest concentration around Sulawesi and Banda seas.

In 1998, the Indonesian government launched the Coral Reef Rehabilitation and Management Program (COREMAP) with the objective to enhance the health of coral reefs and to improve the welfare of coastal communities depending on coral reefs. The first National Policy, strategy and action plan was established in 2001 and implemented in 15 districts of 7 provinces. Scientific monitoring of coral reefs and socio-economic condition of dependent surrounding communities were carried out. Results indicated an improving trend in terms of live coral cover (Figure **5**).

The main threats to coral reefs are considered to be destructive fishing, bleaching events and pollution (Suharsono, 2007).

Figure 5: The Distribution of Coral genera in Indonesia (top) and the Coral Reef Condition in Indonesia (bottom)



Source: Suharsono, 2008

1.5 SCALE, INTENSITY AND CONSEQUENCES ANALYSIS

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) – which is provided in detail for Indian mackerel in the main report – in order to determine the overall risk to the stock. A summary of the PSA for Indian mackerel is provided in Table 2.

Table 2: Productivity Susceptibility Analysis for Indian Mackerel

		PSA															
		Productivity								Susceptibility					PSA Scores		
Species	Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (Fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Indian Mackerel	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Gill nets	1	1	1	1	1	1	2	1.14	1	2	3	3	1.43	1.83	Low	>80

Source: Poseidon

Based on the PSA assessment, Indian mackerel is shown to be highly productive with a minimum population doubling time less than 15 months (Fishbase, 2010).

Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets. Vessels deploying these gears are likely to overlap > 30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. Due to the mesh sizes of these gears, they have a low selectivity in that most fish encountered will be captured. From a stock status perspective both purse seine and trawl fisheries are considered to be high risk to Indian mackerel.

The gillnet fishery however, is predominately carried out in the coastal areas and so has a lower risk score based on availability and encounterability attributes. While selectivity scores poorly due to the small mesh sizes compared to the fish length, overall the impact of this fishery on the stock is considered low risk.

A PSA has also been undertaken for other species that are likely to be captured in conjunction with the small pelagic fishery, including Indo Pacific mackerel and tuna species. These results are presented in Table 3.

Table 3: Productivity Susceptibility Analysis for other retained species

Species	Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (Fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
		PSA															
		Productivity								Susceptibility					PSA Scores		
Indo-pacific mackerel	Purse seine	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Btm Otter trawl	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Gill nets	1	1	1	1	1	1	1	1.00	1	2	3	3	1.43	1.74	Low	>80
Skipjack tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Longtail tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Frigate tuna	Purse seine	1	1	2	1	1	1	3	1.43	3	3	3	3	3.00	3.32	High	<60
Bigeye tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Bullet tuna	Purse seine	2	2	2	2	1	1	3	1.86	3	3	3	3	3.00	3.53	High	<60
Eastern little tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Yellowfin tuna	Purse seine	2	1	2	2	2	1	3	1.86	3	3	3	3	3.00	3.53	High	<60

Source: Poseidon

An analysis undertaken by Indonesian Research Organizations and reported in Hutomo *et al* (2009) assessed the level of fishery exploitation and stock status for the four major fisheries (small pelagic, big pelagic, demersal and shrimp) by management area (Table 4).

In the Malacca Straight and Andaman Sea area small pelagics are classified as fully exploited due to purse seine vessels and illegal fishing. While the status of large pelagics is unknown, it is thought that based on current CPUE and their highly migratory behavior, there may be potential for further exploitation if CPUE is closely monitored. Both demersal fish and shrimps are considered overfished based on uncontrolled operations in water depths more than 20m, modification to trawl gear and illegal fishing.

In the West Sumatra and Indian Ocean management area, tuna long lining forms the main fishing gear with large pelagic considered fully exploited. Small pelagic species that inhabit the coastal waters are thought to be underexploited, with potential opportunities for purse seine vessels. Both the demersal fish and shrimp fisheries are considered fully exploited.

Table 4: Level of fishery exploitation by management area

Fishery Management Areas	Fishery	Stock status	Notes
WPP 571 Malacca Straight and Andaman Sea	Small Pelagic	Fully exploited	Fishing gears purse seine, illegal fishing
	Big Pelagic	Uncertain	Especially northern Malacca strait
	Demersal	Overfished	Uncontrolled fishing in depths more than 20m, adaption to trawl gears, illegal fishing
	Shrimp	Overfished	Illegal fishing
WPP 572 Indian Ocean, West Sumatra and Sunda Strait	Small Pelagic	Moderate	Especially oceanic small pelagic
	Big Pelagic	Fully exploited	Fishing ground in EEZ to the high seas
	Demersal	Fully exploited	Relatively narrow fishing ground, untapped
	Shrimp	Fully exploited	Relatively narrow fishing ground, untapped

Source: Poseidon (based on analysis from the Indonesian Research Organization)

1.6 PEOPLE MET

Consultation was undertaken from 4th-5th October 2010 in Jakarta and Banda Aceh. The following people were met and consulted:

Name	Title and Organization	Contact details	Location of meeting
Hary Christijanto	Directorate of Fisheries Resources, Directorate General of Capture Fisheries (DGCF)	hchristijanto@yahoo.com	Jakarta
Tuti Hariati	Research Institute for Marine Fisheries	Jalan Muarabaru Ujung Jakarta 14440	Jakarta
Suhariyanto	Fishing Technology Development Centre (FTDC),	J1. Yos Sudarso Kali Baru Barat, Pelabuhan Tanjung Emas, Samarang. 024 35702060	Jakarta
Aris Budiarto	Directorate of Fisheries Resources, DGCF, MMAF		Jakarta
S. Kamarijas	Directorate of Fisheries Resources, DGCF		Jakarta
Eric Malyad	FTDC	J1. Yos Sudarso Kali Baru Barat, Pelabuhan Tanjung Emas, Samarang. 024 35702060	Jakarta
H. B. Ganef	Directorate of Fisheries Resources, DGCF		Jakarta
Mur Bambaug	FTDC	J1. Yos Sudarso Kali Baru Barat, Pelabuhan Tanjung Emas, Samarang. 024 35702060	Jakarta
Dr. T. Raiful	Provincial Marine and Fisheries Agency		Banda Aceh
Dwi Person	Panglima Laot Lhok Krueng Aceh – team support for mapping	08136007601	Banda Aceh
Arif Fadhila	Panglima Loat Lhok Krueng Aceh	085260101692	Banda Aceh
Yusrizal (Ayi)	Community Based Bathymetric Survey Panglima Loat Lhok Krueng Aceh – Project Officer	panglimalaot@gmail.com	Banda Aceh
Ruslan	Panglima Laot Lhok Krueng Aceh		Banda Aceh

2 FISHERIES ASSESSMENTS – INDIAN MACKEREL

For the purpose of this assessment, three main ‘units of assessment’ are defined as follows:

1. **Purse seine 5-30GT vessels with 1 inch mesh size** targeting small pelagic with Indian mackerel as one of the target species and **purse seine >30GT vessels with 1 inch mesh size** targeting tunas and landing Indian mackerel as a bycatch species.
2. **Bottom otter trawl fishery with 1 inch mesh size** targeting shrimp and demersal fish and landing Indian mackerel as a bycatch species.
3. **Set gillnet fishery with mesh sizes ranging from 1 to 8 inches** targeting demersal fish and landing Indian mackerel as a bycatch species.

There are no hilsa shad catches reported in Indonesia, so this report does not cover hilsa.

2.1 PRINCIPLE 1: STOCK STATUS

2.1.1 Unit of Assessment: Purse seine and bottom otter trawl fisheries, and set gillnets

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1 **Purse seine & btm trawl**	Target spp. status	✓			Fishbase, FAO fact sheets, Hariati & Sadhotomo (2005), Hutomo *et al* (2009), Interview Hariati
1.1.1 **Gill nets**	Target spp. status			✓	Fishbase, FAO fact sheets, Hariati & Sadhotomo (2005), Hutomo *et al* (2009), Interview Hariati
Explanatory Statement		**Purse seine and bottom otter trawl** Indian mackerel *Rastrelliger kanagurta* has been assessed using the RBF PSA methodology. The species has a high productivity, with a maximum age of 4-5 years and an estimated population doubling time of 15 months. They are pelagic broadcast spawners and have a trophic level of 3.16. While this species scores well under productivity attributes, it does not under selectivity. It is likely to be fished over most of its geographic and depth range. Being a neritic species with common distribution from 20-90m depth, it is likely to have high encounterability with fisheries. The current mesh sizes that are used throughout Indonesia (with the exception of Sabang) are 1 inch and therefore selectivity is low. Partial stock assessments have been undertaken using catch per unit effort data (CPUE) collated from specific provinces around Sumatra with data for 1990-95, 1995-97, 2003-04, 2008-09 (Hariati pers. comm., 2010). It is indicated that landings of Indian mackerel are increasing, however CPUE is decreasing. In the mid-90s the stock assessment revealed that fishing mortality was at 60%, which was 10% above MSY. No recent assessments have been undertaken (Hariati pers. comm., 2010). It is unknown if there are separate regional Indian mackerel stocks, or one Bay of Bengal stock.			

PI	Title	Weak	Intermediate	Good	Reference
		Hutomo *et al* (2009) assessed small pelagic species within management area 571 (Malacca Strait and Andaman Sea) to be fully exploited and within 572 (Indian Ocean and West Sumatra) to be at a moderate level of exploitation. It is unknown how these conclusions have been drawn. **Set gill nets** In contrast to purse seine and trawl fisheries, the gill net fishery scores well under selectivity. This is due to the gill net fishery operating only in coastal waters and at the coastal fringes of the Indian mackerel distribution. The gill net fisheries are highly likely to have less than a 10% overlap with the range of this species, both in terms of its geographic and depth range. Due to the current mesh sizes in operation, the selectivity is low. Applying the RBF PSA methodology to this fishery results in an overall low impact of gill nets on the Indian mackerel stock. Stock status therefore scores 'good'.			
1.1.2	Reference points (not if RBF)	✓			n/a
Explanatory Statement		Due to the lack of stock assessment, there are no limit or target reference points for stock management and Bmsy (the biomass at which Maximum Sustainable Yield, is achieved) is unknown.			
1.1.3	Stock rebuilding				n/a
Explanatory Statement		Not expected to be rebuilding, and as RBF used to score 1.1.1 and 1.1.2 no score is given			
Harvest strategy					
1.2.1	Harvest Strategy	✓			Interviews DGCF, FTDC, Research Institute
Explanatory Statement		There is no harvest strategy in place for the fishery that combines monitoring, harvest control rules and management actions. One measure in place relates to minimum mesh size of 1 inch, however the level of compliance is unknown and this is not considered appropriate to manage the fishery.			
1.2.2	Harvest control rules and tools	✓			Interviews DGCF, FTDC, Research Institute
Explanatory Statement		There are no harvest control rules and tools in place that specifically manage the removal of Indian mackerel. There are TACs in place for some species, but with little enforcement, and knowledge of this is completely lacking at a Provincial level. Regulations stipulate a minimum mesh size of 1 inch, although the extent of compliance is unknown. Anecdotal information suggests fishermen use mesh of 0.75 inch to prevent damage to fish. This mesh size does not manage the level of Indian mackerel removals.			

PI	Title	Weak	Intermediate	Good	Reference
		While there is zonal management in place to some extent, which restricts access to District waters (out to 4 nautical miles) where only vessels <10 GT can operate, this fleet also targets Indian mackerel.			
1.2.3	Information / monitoring		✓		Interviews DGCF, FTDC, Research Institute
Explanatory Statement		There are currently no logbooks in operation, although there are plans to introduce them for purse seiners >30GT. Landing statistics are collated at point of sale from auction sales notes and/or area officer recording stats. There is no gear differentiation within landing statistics for Indian mackerel See also comments in 1.1.1 on information on stock status.			
1.2.4	Stock Assessment (not if RBF)	✓			n/a
Explanatory Statement		Using the Risk-Based Framework (RBF) this would normally be scored a default 'Intermediate' status. However given the lack information on which to base a stock assessment and the lack of 'management drivers' to demand an assessment of this stock, it is scored as 'weak'.			

2.1.2 Key Weaknesses with Current P1 Performance

There is a lack of knowledge on many aspects relating to the stock status of Indian mackerel in Indonesia. The existence of genetically distinct stocks and associated boundaries are unknown. Accurate assessments of stock biomass are not available and any data on stock assessments have been collated sporadically and from different locations at different times.

No recent reference points have been defined and there is no harvest strategy or harvest control rules and tools in place to manage the fishery, other than a minimum mesh size which (at the current size) is not appropriate to manage the Indian mackerel stock.

While detailed landing statistics have been provided for the Aceh Province for 2008, there is no indication that records of this type exist for other Provincial areas or indeed that data collation will continue for Aceh Province due to lack of resources. National data is aggregated into a small pelagic grouping and there is not appropriate reporting for individual species or by gear types.

2.1.3 Key Recommendations to Address P1 Performance Weaknesses

Specific recommendations to address weaknesses highlighted above include:

- Support to planned and future genetic studies to determine Indian mackerel stock units;
- Provide training and capacity building on stock assessment methodologies for small pelagic species;
- Undertake coordinated and complete stock assessments on a regular (annual) basis to determine stock status of Indian mackerel and establish appropriate reference points;
- Collect data on landings by species for all vessel sizes and gear types. Ensure appropriate detail to allow analysis of catch/effort and size composition;
- Ensure successful implementation of logbook scheme for >30GT vessels and explore potential to introduce this to smaller vessels such as those operating in territorial waters; and
- Develop appropriate harvest control rules (such as increase in mesh size).

2.2 PRINCIPLE 2: ECOSYSTEM IMPACTS

2.2.1 Unit of Assessment: Purse seine

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Retained species</td></tr>
<tr><td>2.1.1</td><td>Retained spp. Status</td><td></td><td>✓</td><td></td><td>Indonesian Research Organization, Hutomo et al 2009, Fishbase</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Based on landing statistics collated for Aceh Province it is known that a number of small pelagic species and juvenile tunas are taken within the purse seine fishery in territorial waters, and that Indian mackerel are landed in conjunction with a number of tuna species by the purse seine fleet operating outside territorial waters.

Indo pacific mackerel Rastrelliger brachysoma is one of the main small pelagic species landed with R. kanaguta. As reported by Hutomo et al (2009) the Indonesian Research Organization classifies the small pelagic stock to be fully exploited in the Malacca Straight and Andaman and underexploited in West Sumatra and Indian Ocean (see Table 4). A PSA assessment supports that the purse seine fishery is of low risk to Indo Pacific mackerel.

Large pelagic species recorded include skipjack Katsuwonus pelamis, longtail Thunnus tonggol, frigate Auxis thazard, bigeye Thunnus obesus, bullet A. rochei, eastern little Euthynnus affinis and yellowfin T. albacares. The Indonesian Research Organization classifies large pelagic to be potentially under exploited in the Malacca Straight and Andaman Sea and fully exploited in West Sumatra and Indian Ocean, but this is primarily due to long line fisheries. Overall the PSA finds the purse seine fishery to be medium to high risk.

In balance, for all retained species, an intermediate score is therefore attributed.</td></tr>
<tr><td>2.1.2</td><td>Retained spp. management</td><td>✓</td><td></td><td></td><td>Interviews DGCF, FTDC, Provincial Marine and Fisheries Agency and Panglima Laot</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There is no effective management of the small pelagic purse seine fishery. The minimum mesh size of 1 inch is not appropriate to control the volume or size of fish landed and juveniles are expected to be landed in high proportions to enter the fish supplement and fish oil trade. The effect on recruitment for these small pelagic species due to high juvenile catch rates is unknown. There are no other controls over the size of fish landed or the volumes landed.

A mesh size of 4 inches is used for nets deployed around Sabang Island as part of a voluntary agreement. This is to protect spawning areas and is in response to Coral Cay Conservation project in the area. While this is commendable it is unknown the extent of compliance or whether any positive effects have been measurable.</td></tr>
</table>

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td>2.1.3</td><td>Retained spp. Information</td><td></td><td>✓</td><td></td><td>Interviews Provincial Marine and Fisheries Agency and Panglima Laot</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Landing statistics have been provided to indicate landings by species and total landings by gear type for Aceh Province. This has allowed determination of likely retained species. However, data is not available for species landed by gear types or area. It is also unknown what level of data is available for other Provincial areas or whether data collection can continue in Aceh Province due to lack of resources.</td></tr>
<tr><td colspan="6">Discard species</td></tr>
<tr><td>2.2.1</td><td>Discard spp. Status</td><td></td><td></td><td>✓</td><td>Interviews Panglima Laot</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Discards from this fishery are understood to be non-existent.</td></tr>
<tr><td>2.2.2</td><td>Discard spp. Management</td><td></td><td></td><td>✓</td><td>Interviews DGCF, FTDC Provincial Marine and Fisheries Agency</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Discards from this fishery are understood to be non-existent. As a result no bycatch minimization management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.</td></tr>
<tr><td>2.2.3</td><td>Discard spp. Information</td><td></td><td>✓</td><td></td><td>Interviews DGCF, Research Institute</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved.

This fishery would thus benefit from an observer programme to verify this low level/ negligible impact.</td></tr>
<tr><td colspan="6">ETP species</td></tr>
<tr><td>2.3.1</td><td>ETP spp. Status</td><td></td><td>✓</td><td></td><td>Interviews Provincial Marine and Fisheries Agency and Panglima Laot

Kirby, 2006</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Potential purse seine interaction with ETP species is likely to be limited to dolphins and turtles, both of which are released alive prior to hauling nets. A high survivability rate (>90%) is expected.

A risk assessment in the Pacific Ocean (Kirby, 2006) indicates that sharks are the highest risk group in purse seines – at greatest risk are the low fecundity silky shark, short-finned mako, porbeagle, and oceanic whitetip rather than the more fecund blue sharks and hammerheads. These shark species are at more risk from the tuna fisheries than the small pelagic fisheries since they often trail schools of tuna for prey.

Overall the risk of the small pelagic purse seine fishery is of intermediate concern, based primarily on shark interactions.</td></tr>
<tr><td>2.3.2</td><td>ETP spp. Management</td><td>✓</td><td></td><td></td><td>Interviews DGCF, Research Institute, Provincial Marine and</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
					Fisheries Agency and Panglima Laot
Explanatory Statement		There are no known management procedures to avoid interaction with ETP species. There is potential to enhance release procedures associated with dolphin and turtles through a fleet-wide code of conduct. Based on outcomes of observer programmes (see below) management measures should be developed to limit interactions with protected shark species.			
2.3.3	ETP spp. Information		✓		Interviews DGCF, Research Institute, Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al*, 2009
Explanatory Statement		Data on presence and distribution of ETP species is available. However, data specific to purse seine interaction with ETP species is lacking. In particular observer data to monitor shark bycatch in Indonesian fisheries is rare and effort should be focused to address this issue across the fleet.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Habitat impacts from this surface pelagic fishery are highly likely to be minimal. Lost gear is rare, although the occasional FAD is lost.			
2.4.2	Habitat Management			✓	Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Due to minimal impact, management strategies are not necessary			
2.4.3	Habitat Information		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		A Community Based Bathymetric Survey is currently in operation for Aceh Province through the voluntary use of sonar and GPS to map bathymetry and habitats. While significant areas have been monitored, the survey coverage is dependent on fishing vessels and therefore is not complete. This provides an excellent example of community based research to map habitat resources.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Interviews DGCF, Research Institute, Fishbase
Explanatory Statement		The fishery catches a wide range of species including high rates of			

PI	Title	Weak	Intermediate	Good	Reference
		juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is no ecosystem modeling to predict impacts of removal at current rates.			
2.5.2	Ecosystem Management		✓		Interviews DGCF, Research Institute
Explanatory Statement		No specific ecosystem management measures are undertaken at national level. However, there are closed areas for habitat protection and turtle management measures, although the latter could definitely be improved. Current levels of removals of small pelagic species are not considered to be heavily over exploited; furthermore most small pelagic species have a short population doubling time. Despite this, management of the indirect effect of removing target and retained species from the food web requires management measures, which would also be applicable for 2.1.2 retained species.			
2.5.3	Ecosystem Information		✓		Interviews DGCF, Research Institute
Explanatory Statement		Total removals are not well known for all Provinces within the BOBLME area, and those provided may be underestimated for the smaller vessels. There is little information on the ecological impacts of this fishery and ecosystem modeling has not been undertaken.			

2.2.2 Unit of Assessment: Bottom otter trawl

PI	Title	Weak	Intermediate	Good	Reference
Retained species					
2.1.1	Retained spp. Status	✓			Indonesian Research Organization, Hutomo *et al* 2009, Fishbase
Explanatory Statement		The bottom otter trawls are predominately targeting shrimps and demersal fish. Indian mackerel are taken as bycatch when the nets are hauled through the water column. The demersal fish species associated with this fishery are unknown. As reported by Hutomo *et al* (2009) the Indonesian Research Organization classifies the demersal fish and shrimp stocks to be over exploited in the Malacca Straight and Andaman and fully exploited in West Sumatra and Indian Ocean (see Table 4).			
2.1.2	Retained spp. management	✓			Interviews DGCF, FTDC, Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		There is no effective management of the bottom otter trawl fishery. The minimum mesh size of 1 inch is not appropriate to control the volume or size of fish landed and juveniles are expected to be landed in high proportions to enter the fish supplement and fish oil trade. The			

PI	Title	Weak	Intermediate	Good	Reference
		effect on recruitment for these small pelagic species due to high juvenile catch rates is unknown. There are no other controls over the size of fish landed or the volumes landed. A mesh size of 4 inches is used for nets deployed around Sabang Island as part of a voluntary agreement. This is to protect spawning areas and is in response to Coral Cay Conservation project in the area. While this is commendable it is unknown the extent of compliance or whether any positive effects have been measurable.			
2.1.3	Retained spp. Information		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Landing statistics have been provided to indicate landings by species and total landings by gear type for Aceh Province. However, data is not available for species landed by gear types or area. It is also unknown what level of data is available for other Provincial areas or whether data collection can continue in Aceh Province due to lack of resources.			
Discard species					
2.2.1	Discard spp. Status			✓	Interviews Panglima Laot
Explanatory Statement		Discards from this fishery are understood to be non-existent.			
2.2.2	Discard spp. Management			✓	Interviews DGCF, FTDC Provincial Marine and Fisheries Agency
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimization management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discard spp. Information		✓		Interviews DGCF, Research Institute
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. This fishery would benefit from an observer programme to verify this low level/ negligible impact.			
ETP species					
2.3.1	ETP spp. Status		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Demersal trawl gear in this area is likely to incidentally catch turtles. While the main disturbance and threat to turtles is likely to be from impacts occurring at nesting sites, the bycatch of turtles in shrimp trawls is reported to be high. An average of 11 sea turtles per shrimp vessel (Sorong based fleet) was revealed for 2005 and 6.5 turtles were caught on average as by-catch in 2006. Shrimp vessel crew confirm these numbers and admitted that, on average, 2-20 sea turtles were incidentally caught during the trawl			

PI	Title	Weak	Intermediate	Good	Reference
		operations. Overall the risk of the bottom otter trawl fishery is of intermediate concern, based on turtle interactions.			
2.3.2	ETP spp. Management	✓			Interviews DGCF, Research Institute, Provincial Marine and Fisheries Agency and Panglima Laot Zainudin *et al* 2007
Explanatory Statement		For the shrimp trawls, it appears that application of the legally required Turtle Excluder Devices (TED), By-catch Excluder Devices (BED), and Juvenile and Turtle Excluder Devices (JTED) is not well enforced. It is reported that when observers are onboard the devices are deployed with the result of zero turtle bycatch, but when not onboard bycatch is again significant. The additional income that crew get as bonus from capturing demersal fish is the main reason for not applying the TEDs in shallow waters. No other management measures are in place to protect ETP species.			
2.3.3	ETP spp. Information		✓		Interviews DGCF, Research Institute, Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al*, 2009
Explanatory Statement		Data on the presence and distribution of ETP species is available. However, data specific to demersal trawl interaction with ETP species is lacking. In particular observer data to monitor turtle bycatch would be beneficial to establish the true extent of status and required management measures.			
Habitats					
2.4.1	Habitat Status (SICA only)	✓			Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Habitat impacts from this bottom otter trawl fishery are likely to be significant.			
2.4.2	Habitat Management		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Strategies are in place to manage the habitat impact through closed areas to protect coral reefs. However the extent and spatial distribution of protected areas is unknown, as is the level of compliance for the demersal trawl fleet to abstain from fishing within these areas.			
2.4.3	Habitat Information		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al* 2009

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		A Community Based Bathymetric Survey is currently in operation for Aceh Province through the voluntary use of sonar and GPS to map bathymetry and habitats. While significant areas have been monitored, the survey coverage is dependent on fishing vessels and therefore is not complete. This provides an excellent example of community based research to map habitat resources. Coral reef distribution and species abundance is also known and mapped for Indonesia. The highest levels of coral diversity are found in central and eastern Indonesia. Of note, corals are known to grow better in locations quite far from Sumatra mainland (Hutomo *et al*, 2009).			
Ecosystems					
2.5.1	Ecosystem Status	✓			Interviews DGCF, Research Institute, Fishbase
Explanatory Statement		The fishery catches a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is not ecosystem modeling to predict impacts of removal at current rates. Demersal trawling gear also indiscriminately removes of a wide range of species and is not as targeted as other gears. The fishery therefore scores poorly for ecosystem status.			
2.5.2	Ecosystem Management	✓			Interviews DGCF, Research Institute
Explanatory Statement		No ecosystem management measures are undertaken at national level. Due to the higher degree of indirect effects associated with habitat impacts the fishery scores worse than other gear types.			
2.5.3	Ecosystem Information		✓		Interviews DGCF, Research Institute
Explanatory Statement		Total removals are not well known for all Provinces within the BOBLME area, and those provided may be underestimated for the smaller vessels. There is little information on the ecological impacts of the removal of target and retained species by this fishery and ecosystem modeling has not been undertaken. Despite this the general structure of the food web, associated trophic levels and key elements of the ecosystem are understood. Sufficient information on the overall impact of trawling gear on the wider ecosystem can be inferred and is sufficient to allow appropriate management measures to be implemented.			

2.2.3 Unit of Assessment: Gill net

PI	Title	Weak	Intermediate	Good	Reference
Retained species					

PI	Title	Weak	Intermediate	Good	Reference
2.1.1	Retained spp. Status	✓			Indonesian Research Organization, Hutomo *et al* 2009, Fishbase
Explanatory Statement		The coastal gill net fisheries are predominately targeting demersal fish with small proportional of Indian mackerel and other small pelagic species taken as bycatch. The demersal fish species associated with this fishery are unknown. As reported by Hutomo *et al* (2009) the Indonesian Research Organization classifies the demersal fish to be over exploited in the Malacca Straight and Andaman and fully exploited in West Sumatra and Indian Ocean (see Table 4).			
2.1.2	Retained spp. management	✓			Interviews DGCF, FTDC, Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		As a mixed fishery there is no specific management in the gill net fishery to limit capture of retained fish species. The mesh sizes in use are reported to range from 1-8 inches. The small mesh size of some gill nets suggests a high bycatch of juvenile fish which may affect recruitment for these species.			
2.1.3	Retained spp. Information	✓			Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Landing statistics have been provided to indicate landings by species and total landings by gear type for Aceh Province. However, data is not available for species landed by gear types or area. It is also unknown what level of data is available for other Provincial areas or whether data collection can continue in Aceh Province due to lack of resources. However much of the gill net fleet is made up of smaller vessels that operate from smaller ports where landings data collection is less rigorous.			
Discard species					
2.2.1	Discard spp. Status			✓	Interviews Panglima Laot
Explanatory Statement		Discards from this fishery are understood to be non-existent.			
2.2.2	Discard spp. Management			✓	Interviews DGCF, FTDC Provincial Marine and Fisheries Agency
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimization management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discard spp. Information		✓		Interviews DGCF, Research Institute
Explanatory Statement		No formal assessment of discard rates and their nature have been			

PI	Title	Weak	Intermediate	Good	Reference
		carried out, mainly due to the very low level involved. This fishery would benefit from an observer programme to verify this low level/ negligible impact.			
ETP species					
2.3.1	ETP spp. Status	✓			Interviews Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al*. 2009
Explanatory Statement		Interaction of gill nets with dugong is considered to be a major threat to this species (Hutomo *et al*. 2009). Bycatch of turtles is also likely to be significant and interactions with dolphin and shark species are inevitable. Gill nets with a larger mesh size are likely to have higher mortality rates, compared to those with smaller mesh sizes of 1 inch. Fisheries with a longer soak time will also have more significant interaction. Entanglement of turtles with lines and surface marker buoys may also occur as a result of turtles to mistaking floats for jellyfish and becoming entangled.			
2.3.2	ETP spp. Management	✓			Interviews DGCF, Research Institute, Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		There are no known management procedures. There are closed areas for coral reef protection, but it is unknown if these are complete no-take zones for all gears.			
2.3.3	ETP spp. Information		✓		Interviews DGCF, Research Institute, Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al*, 2009
Explanatory Statement		Data on presence and distribution of ETP species is available. However, data specific to gill net interactions with ETP species is lacking. In particular observer data to monitor turtle, shark, dugong and dolphin bycatch would be beneficial to establish true extent of status and required management measures.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Interviews Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		Habitat impacts as a result of the gear are considered minimal. The interaction of bottom set gill nets is limited to the weights and bottom line touching the seabed. However, lost nets do have the potential to impact coral reefs, but rates of loss are not thought to be a major issue (although are known).			
2.4.2	Habitat		✓		Interviews Provincial Marine and

PI	Title	Weak	Intermediate	Good	Reference
	Management				Fisheries Agency and Panglima Laot
Explanatory Statement		Strategies are in place to manage the habitat impact through closed areas to protect coral reefs. However the extent and spatial distribution of protected areas is unknown, as is the extent to which gill netters are excluded. No management structure exists to control the potential loss of gear e.g. due to rigging and gear failure. Nor is there a code of practice for gear retrieval or reporting of lost gear incidents.			
2.4.3	Habitat Information		✓		Interviews Provincial Marine and Fisheries Agency and Panglima Laot Hutomo *et al* 2009
Explanatory Statement		A Community Based Bathymetric Survey is currently in operation for Aceh Province through the voluntary use of sonar and GPS to map bathymetry and habitats. While significant areas have been monitored, the survey coverage is dependent on fishing vessels and therefore is not complete. This provides an excellent example of community based research to map habitat resources. Coral reef distribution and species abundance is also known and mapped for Indonesia. The highest levels of coral diversity are found in central and eastern Indonesia. Of note, corals are known to grow better in locations quite far from Sumatra mainland (Hutomo *et al*, 2009). The extent of lost gear incidents is unknown.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Interviews DGCF, Research Institute, Fishbase
Explanatory Statement		The fishery catches a wide range of species including high rates of juveniles in gill nets of smaller mesh sizes (1 inch), which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is no ecosystem modeling to predict impacts of removal at current rates.			
2.5.2	Ecosystem Management		✓		Interviews DGCF, Research Institute
Explanatory Statement		No ecosystem management measures are undertaken at national level.			
2.5.3	Ecosystem Information		✓		Interviews DGCF, Research Institute
Explanatory Statement		Total removals are not well known for all Provinces within the BOBLME area, and those provided may be underestimated for the smaller vessels, that are more likely to be deploying gill nets. There is little information on the ecological impacts of this fishery and ecosystem modeling has not been undertaken.			

2.2.4 Key Weaknesses with Current P2 Performance

Key problems across all gear types relate to the status and management of retained species. The current mesh size for purse seine and trawl gear (and some gill nets) is 1 mesh which results in high catch rates of juveniles. This is likely to have implications for recruitment and is likely to lead to growth overfishing and possibly ecosystem overfishing.

Landings data is not collected at a sufficient level to determine the total removals at species and gear levels and underreporting is expected in the smaller vessels.

The lack of discarding within these fisheries is considered a key strength; however this is primarily due to the landing of all fish including juveniles which itself is due to a lack of retained species management. Any measures introduced to manage retained species (such as TACs) should ensure that the negligible discard rate is maintained.

Little is known about the extent of interaction with ETP species and no measures exist to manage this at a fishery level.

Habitat impacts are predominately by the trawling fleet, although lost gear from the gill net fleet may also damage corals.

There is little information on the ecological role of Indian mackerel, its response to natural fluctuations and the impact of its removal from the ecosystem. Ecosystem modeling has not been undertaken.

2.2.5 Key Recommendations to Address P2 Performance Weaknesses

Key recommendations from the above assessment and key findings are:

- Develop management of retained species through more selective fishing gear e.g. introduction of larger mesh sizes which would allow juveniles to escape;
- Ensure consistent and robust data collation of fishery landing statistics at all fleet levels;
- Establish a program to identify and prioritize key areas to be designated as marine reserves to protect fish spawning areas, ETP species and habitat protection (coral and seagrass). This should include seasonally closed areas, areas restricted to certain gear types and complete closures;
- Establish a program for on-board observers to monitor and report on interactions with ETP species for all gear types. Use this information to shape any necessary measures to manage unacceptable interactions;
- Substantiate current release practices through a code of conduct for ETP interactions including techniques to releases animals and reporting templates to record frequency and location of interactions. A guide to fishermen on how to identify ETP species, particularly sharks, would also be helpful;
- Establish ecosystem based management through the development of ecosystem criteria for management of small pelagic fisheries, and the consideration of species interactions (e.g. predator – prey) in management; and
- Improve participation in international conventions to ensure improved management practices adhering to the Precautionary Principle and Ecosystem Based Fisheries Management.

2.3 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Governance and policy</td></tr>
<tr><td>3.1.1</td><td>Legal Framework</td><td></td><td>✓</td><td></td><td>Interviews DGCF, Provincial Marine and Fisheries Agency and Panglima Laot; Banks et al, 2010, FAO, 2010, FAO, 2000</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The institutional basis for fisheries management operates on a decentralized scheme consisting of three pillars: Ministry of Marine Affairs and Fisheries (MMAF) in Jakarta, Dinas Perikanan Provinsi (DKP), in 33 Provinces and 250 or more DKD, District administrations.

The Ministry, in the devolution of authority to the provinces and districts, is required to assume a facilitation and coordination role to guide these authorities in the management of their respective jurisdictions, consistent with national laws. The Ministry then focuses on implementation of these policies, through fisheries legislation for the offshore fisheries, i.e. vessels fishing outside 12 nautical miles or over 30 GTs.

The current national core fisheries laws are enshrined in Law (UU) No. 25/2004 concerning Planning System for National Development, UU No. 31/2004 concerning Fisheries and the Presidential regulation No. 7/2005 concerning the National Development Plan for medium phase (RPJMN) during year of 2004-2009, and modified by Act No. 45/2010.

In relation to this performance indicator the following queries remain outstanding:
How capable is the legal framework of delivering sustainable fisheries in accordance with Principles 1 and 2?
To what extent does it observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood? e.g. implicitly, is it required to do so in law?
Does it incorporate an appropriate dispute resolution framework, and how transparent is any such mechanism? e.g. Panglima Laot</td></tr>
<tr><td>3.1.2</td><td>Consultation</td><td></td><td></td><td>✓</td><td>Interviews DGCF, Provincial Marine and Fisheries Agency and Panglima Laot;</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The decentralization which began in 2001 gave key administrative responsibilities to Provinces and Districts. Consultation and communication at Provincial and District levels are well established. Within Aceh Province there are approximately 193 Panglima Laot, which are typically located at an estuary or a harbor.
Panglima Laot is a fishermen’s institution which has played a dominant role in governing the fishing industry in Aceh for over four centuries. The traditional institution is composed of a loose network of localized fishermen associations that follow a strict set of rules and regulations. The term "Panglima Laot" is both the name of the institution as well as the title of the elder fishermen who leads the organization.
The Panglima Loat communicate changes in regulations to the fishing industry. They have regular weekly meetings and provide an important framework for regular consultation between Government and fishermen.</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
		In relation to this performance indicator the following query remains outstanding: • To what extent are the roles and responsibilities of organizations and individuals who are involved in the management process clear, understood and/or implicitly/explicitly defined, for/by all relevant parties?			
3.1.3	Long-term Objectives		✓		Interviews DGCF, Provincial Marine and Fisheries Agency and Panglima Laot; Banks *et al*, 2010
Explanatory Statement		Indonesia's domestic and international fisheries policy objectives are set by a Fisheries Master Plan, produced every 5 years. The current version is due to expire in 2014. The political emphasis on the plan is to promote growth in aquaculture, as well as through export promotion. It is not clear from the Master Plan, how such a policy balances with the need for food security, and the drive to develop fisheries, to fuel the initiative. In relation to this performance indicator the following query remains outstanding: • Can the Master Plan be provided to allow us to quote from policy to show any reference or use of the words: long-term, sustainability and the precautionary approach?			
3.1.4	Incentives	✓			Interviews DGCF, Provincial Marine and Fisheries Agency and Panglima Laot
Explanatory Statement		No incentives to promote sustainable fishing (e.g. rights based mechanisms, subsidies for environmentally-friendly technologies and gear selectivity) are thought to be in place. Disincentives include fuel subsides and provision of many cheap/free inputs following the tsunami without proper control and consideration of their impacts.			
Fishery specific management					
3.2.1	Fishery Objectives	✓			Banks *et al* 2010
Explanatory Statement		Indonesia has had a requirement, as part of its National Law 31/2004 to implement fishery specific management plans. MMAF has identified 44 management units in 11 Fishery management areas. Each unit divided into demersal, shrimp, small pelagic and tunas. Currently three test cases are being explored by MMAF for implementation via management groups that are being set up for each case study. However, at the present time however there is no Indian mackerel specific management plan, nor one covering all small pelagic species.			
3.2.2	Decision making processes	✓			Interviews DGCF, Provincial Marine and Fisheries Agency. Banks *et al* 2010
Explanatory Statement		The structures for supporting decisions making processes appear to be in place, but these do not result in measures and strategies to achieve fishery specific objectives and no management plans have been implemented. No processes currently exist to link scientific outputs into management decision-making. Furthermore decision-making process affecting			

PI	Title	Weak	Intermediate	Good	Reference
		management of Indian mackerel specifically, and small pelagics more generally, are weak or nonexistent.			
3.2.3	Compliance & Enforcement		✓		Banks *et al* 2010, Panglima Laot, 2008
Explanatory Statement		The Directorate General for Marine Affairs Resource Controlling and Fisheries Surveillance is the central coordinating body for civil investigation compliance in Indonesia. Separate responsibilities are allocated to the Indonesian Navy and Marine Police. Port offices issue fishing permits for all vessels over 5 GT, and as such have extended their MCS role to cover boats licensed by the Provinces. The Directorate of Fisheries Resources Directorate General of Capture Fisheries and The Directorate General for Marine Affairs Resource Controlling and Fisheries Surveillance share responsibility for catch certificate, recording / monitoring, and reporting respectively. Within Aceh Province, the Panglima Laot are responsible for assigning parking places in the river, arbitrating disputes, determining damages should one fishermen's boat damage another, communicating changes in fishing regulations, organizing rescues as well as maintaining general order. Should a fisherman violate the code of conduct, the Panglima Laot has the authority to ground the boat for a week at a time, if the fisherman were to continue to disobey the rules they can be banished from the Panglima Laot. At a Central Government level, within Indonesian EEZ waters there are reported to be considerable levels of IUU by boats largely from Thailand, Philippines and Malaysia. In relation to this performance indicator the following query remains outstanding: • What sort of evidence is there to determine whether fishers are compliant, and how compliant are they thought to be? i.e. what sort of records are kept.			

PI	Title	Weak	Intermediate	Good	Reference
3.2.4	Research Plan		✓		Banks *et al*, 2010
Explanatory Statement		Indonesia's main fisheries scientific organization is the Marine & Fisheries Research Organization (BRKP). BRKP is responsible for the coordination of sub institutes including the Marine, Open waters, Conservation & stock enhancement (BRPL), Fisheries Technology and Research Centre for Social economics. Currently only a small number of species-specific fisheries research plans exist in Indonesia. Targeted assistance is required within MMAF and the decentralized organizations to support the capacity to develop and implement further fishery-specific research plans. Scope exists to develop fishery specific plans for a number of species groupings, including tuna (regional), small pelagics, shrimp and demersal species and possibly other small scale species. There are no specific Indian mackerel or small pelagic research plans. Such plans would be required to address the information needs of any future management plan. Furthermore, data and information resulting from any future research plan should be provided on a regular basis to ensure appropriate adaptation of any future management plan. The intermediate score is considered appropriate based on the structure and ability within the current research institute. Further support is necessary both in terms of financial funding for research assessments to take place and capacity building to develop consistently robust research plans and assessment methodologies.			
3.2.5	Performance Evaluation		✓		Banks *et al*, 2010
Explanatory Statement		There are no specific Indian mackerel or small pelagic management plans and therefore no plans to evaluate. MMAF do however provide a guide for consistent implementation according to general fisheries legislation and implementation of this is checked, National to Province, and Province to District, through annual audit processes.			

2.3.1 Key Weaknesses with Current P3 Performance

Key weaknesses are the lack of specific management plans and control measures in relation to fisheries for small pelagic species. While it is stated that TACs are set, it is unclear for which species these are applicable or which fleets comply. There is no evidence of implementation and monitoring of TACs at the Provincial level.

Open access remains, particularly for artisanal and coastal fishing sectors and there are reported to be considerable levels of IUU by boats largely from Thailand, Philippines and Malaysia.

Due to the geographical extent of Indonesia, spanning several sea areas and regional administrative areas, there has been devolution of some fisheries management and monitoring to state level. This makes it difficult to re-aggregate these aspects at a national level to ensure consistency in their application.

2.3.2 Key Recommendations to Address P3 Performance Weaknesses

Specific recommendations for improvement across Indonesian fisheries have been reviewed in detail by Banks *et al* (2010). Those of key relevance for Indian mackerel include:

- Setting and implementing a national management plan for small pelagics
- Improving data collection, collation and cross checking systems and update fishery statistics system;
- Properly review the assessment that have been undertaken for small pelagic resources;
- Design a comprehensive plan for future assessments to be undertaken on a regular basis;
- Clearly define the respective roles of the research institutions involved in stock assessments;
- Improve funding for scientific research and monitoring, to improve coverage and quality of current information collection systems and strengthen scientific input into decision making
- Establish processes to link scientific outputs into management decision-making

2.4 SUMMARY – INDIAN MACKEREL

The table below provides a summary of the performance for Indian mackerel in Indonesia

Table 5: Summary performance table for Indian Mackerel in Indonesia

Unit of Assessment	Principle 1: Stock status						
	Outcome			*Harvest strategy*			
Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding if necessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment
Purse seine	0	0	n/a	0	0	1	0
Bottom otter trawl	0	0	n/a	0	0	1	0
Gill nets	2	0	n/a	0	0	1	0

Unit of Assessment	Principle 2: Ecosystem impacts														
	Retained			*Discards*			*ETP*			*Habitat*			*Ecosystem*		
Gear	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discards status	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring
Purse seine	1	0	1	2	2	1	1	0	1	2	2	1	1	1	1
Bottom otter trawl	0	0	1	2	2	1	1	0	1	0	1	1	0	0	1
Gill nets	0	0	0	2	2	1	0	0	1	2	1	1	1	1	1

Unit of Assessment	Principle 3: Governance & Management								
	Governance & Policy				*Fishery specific mang*				
Gear	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
Purse seine	1	2	1	0	0	0	1	1	1
Bottom otter trawl	1	2	1	0	0	0	1	1	1
Gill nets	1	2	1	0	0	0	1	1	1

Appendix A: References

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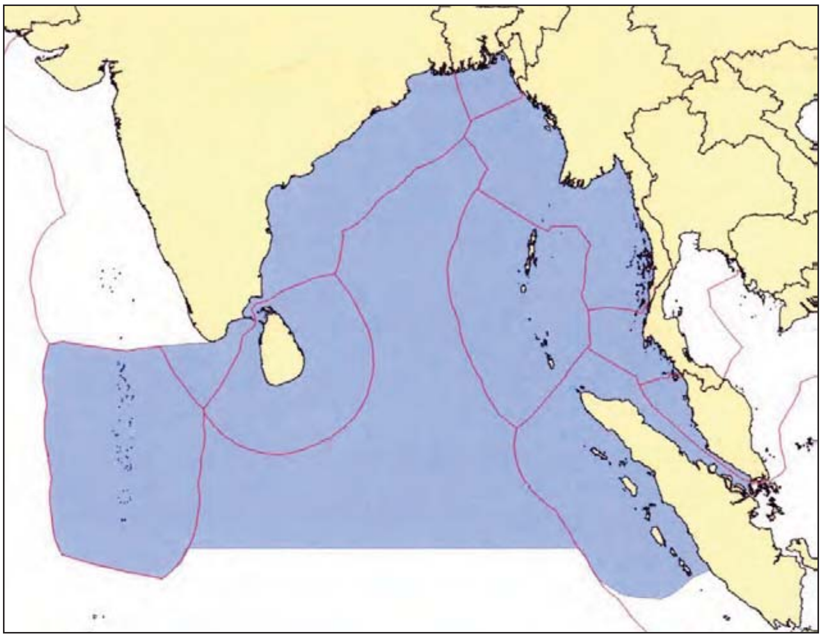
Appendix F: Country Report – Malaysia

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries



Country Report: Malaysia

Undertaken by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms

APFIC	Asia-Pacific Fisheries Commission
ASEAN	Association of Southeast Asian Nations
BOBLME	Bay of Bengal Large Marine Ecosystem
CBFM	Community Based Fisheries Management
CCRF	Code of Conduct for Responsible Fisheries
COFI	Committee on Fisheries
CPUE	Catch per Unit of Effort
DoFM	Department of Fisheries Malaysia
EAF(M)	Ecosystem Approach to Fisheries (Management)
EU	European Union
F	Fishing Mortality
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GT	Gross tonnage
IOTC	Indian Ocean Tuna Commission
IUU	Illegal, unreported and unregulated (fishing)
KG	Kilogrammes
m	Metres
MCS	Monitoring, Control and Surveillance
MEY	Maximum Economic Yield
mm	Millimetres
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
mt	Metric Tons
NGO	Non Governmental Organisation
nm	Nautical Miles
PSA	Productivity Susceptibility Analysis
RB	*Rastrelliger brachysoma*
RBF	Risk-Based Framework
RBFM	Rights Based Fisheries Management
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
RK	*Rastrelliger kanagurta*
SEAFDEC	The Southeast Asian Fisheries Development Center
TAC	Total Allowable Catch
TED	Turtle Exclusion Device
TURF	Territorial use rights in fisheries
UNDP	United Nations Development Programme

1 OVERVIEW

1.1 INTRODUCTION

The West Coast of Malaysia is part of the BOBLME region; from Perlis in the north bordering Thailand, to Selangor in the south of the Malacca Straits (Figure 1).

Figure 1 Malaysian States within the BOBLME area

Indian mackerel (*Rastrelliger* spp.) is one of the most important fisheries in Malaysia with 140,000 tonnes landed in 2008. This was mainly of *Rastrelliger brachysoma*, but landings of *Rastrelliger kanagurta* are also highly significant.

No information provided indicates the presence of a current hilsa shad fishery. Anecdotal information suggests hilsa used to be part of some river fisheries, but has been fished out. This report therefore does not contain an assessment of hilsa shad.

It is, however, worth briefly noting some aspects of Malaysian fisheries management as these may provide useful lessons for management of hilsa elsewhere in the BOBLME region. Some communities operate a community-based management system. For example in Sabah there is a 100 year old system used by the Tagal communities to manage Malaysian freshwater fisheries[1]. Each community along the river uses a red, yellow and green zoning system that protects spawning areas. The red zone is not for harvesting but for conservation, game fishing (catch and release) and "fish massage" (swimming with the fish) to attract tourists; in the yellow zone fishing is permitted for a limited period once or twice a

[1] More details on the Tagal system can be found within Tietze et al (2007) .

year; and the green zone is where fishing is permitted all year. Visitors pay for fishing rights and the earnings fund the river management. Regulation is by the community with locally determined fines for infringements.

1.2 PEOPLE MET

Name	Title and Organisation	Contact details	Location of meeting
Ahmad Adnan Nuruddin	Director, Capture Fisheries Division, Fisheries Research Institute	FRI KAmpung Aceh, 3200 Sitiawan, Perak Malaysia	Penang
Hjh. Mahyam Mohd. Isa	Chief, Marine Fishery Resources Development and Management Department, SEAFDEC	Taman Perikanan Chendering, 2180 Kuala Terengganu, Malaysia	Penang
Hj. Suhaili Bin Hj. Lee	Deputy Director General (Operations) Department of Fisheries. Malaysia (DoFM)	Ministry of Agriculture and Agro-based Industry, Level 6 Wisma Tani, Tower 4G2, Precinct 4, 62628, Putrajaya, Malaysia	Putrajaya
Mrs. Tan Geik Hong	Head of Fisheries Data Collection Department of Fisheries. Malaysia (DoFM)	Ministry of Agriculture and Agro-based Industry, Level 3 Wisma Tani, Tower 4G2, Precinct 4, 62628, Putrajaya, Malaysia	Putrajaya
Mr. Adrian F. Vijiarungam	Head of International Relations Department of Fisheries. Malaysia (DoFM)	Ministry of Agriculture and Agro-based Industry, Level 2 Wisma Tani, Tower 4G2, Precinct 4, 62628, Putrajaya, Malaysia	Putrajaya
Mr. Gulam Sawar bin Jan Mohammad	Head of Licencing Department of Fisheries. Malaysia (DoFM)	Ministry of Agriculture and Agro-based Industry, Level 1 Wisma Tani, Tower 4G2, Precinct 4, 62628, Putrajaya, Malaysia	Putrajaya
Mr. Ahmad Saktian bin Langgang	Head of Resource Management, Department of Fisheries. Malaysia (DoFM)	Ministry of Agriculture and Agro-based Industry, Level 1 Wisma Tani, Tower 4G2, Precinct 4, 62628, Putrajaya, Malaysia	Putrajaya

1.3 DESCRIPTION OF MAIN FLEETS AND GEARS

Malaysia's fishing fleet numbers approximately 40,959 vessels (Table 1), representing a 20% increase since 2000 (Department of Fisheries, Malaysia (DoFM)), the bulk of this increase coming from boats with outboard engines. Around 17,990 of all vessels are located on the west coast with 2,976 trawlers (16.5%), 326 purse seiners (1.8%) and 12,520 gill/drift nets (69.6%).

Table 1: Main vessels, gears and target species for Malaysian fleet, 2008

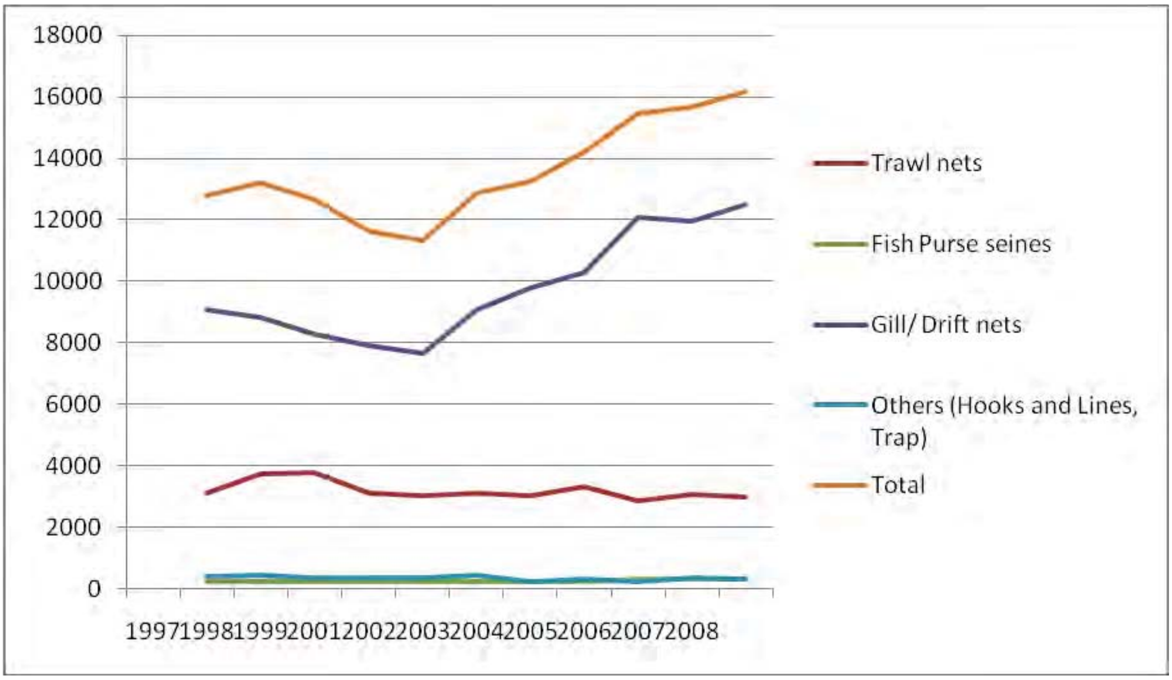
Gear	Main species	No. of Vessels	Sector
Purse seine	Indian mackerel, scad and other and tunas	1,133	Territorial/EEZ (B and C)
Drift / gill net	Mackerels, bream and tuna	24,160	Coastal (Zone A and B)
Trawl	Shrimp, squid and bream	6,090	Territorial (Zone B)
Hook and line	Bream and other finfish	4,478	Coastal (Zone A)
Traps	Finfish and crabs	1,473	Coastal (Zone A)
Others	Others	3,625	Others (Zone A)

Source: DoFM

The main approach to managing and regulating Malaysia's fisheries is the establishment of fishing zones and licensing of gears and vessels. The DoFM employs a management zone system to provide for equitable allocation of resources and reduce conflict between fishing groups. The marine waters are divided into 4 zones; A, B, C and C2. The first 5 nautical miles from the shore is an exclusive fishing zone for fishermen using traditional fishing gears, known as Zone A. These vessels are only allowed to use 'non-destructive fishing methods' within this zone. There are approximately 12,520 boats fishing in this zone on the West coast of Malaysia.

Figure 2 shows the recent trends in vessel numbers on the West Coast of Peninsula Malaysia. A longer-run time series, along with estimates of unlicensed vessels operating is presented in Annex 2. The large increase in numbers seen in the last 5 years has occurred in the gill/drift net fisheries, which may in part be a consequence of efforts to reduce capacity in the trawl fishery. There was also a 34% increase in numbers of purse seine vessels between 2001 and 2008 reaching a total of 326.

Figure 2: Trend in licensed vessels on the West coast of Malaysia



Source: DoFM

The licensing system in Malaysia is for vessels and gears. The licenses for vessels include details of name of owner and number of crews onboard, vessel tonnage, engine- power, allowed gears. The corresponding license for gears detail the type of gear and allowed fishing zone (Hiew 2008). The licenses stipulate that any intended changes to the details in the licenses must be notified to the DoFM. The DoFM is required to perform annual checks to ensure that the licenses are still valid. This system enables DoFM to keep a record of sea-going vessels and corresponding gears and to prevent fishermen from changing the configuration of their vessels without prior approval from DoFM. As part of the licensing system, DoFM prevents illegal, unregulated and unreported (IUU) fishing through colour-coding and registration number for vessels. A coloured stripe on the hull establishes what region a vessel is licenced to fish in and it cannot fish in other regions without permission from DoFM.

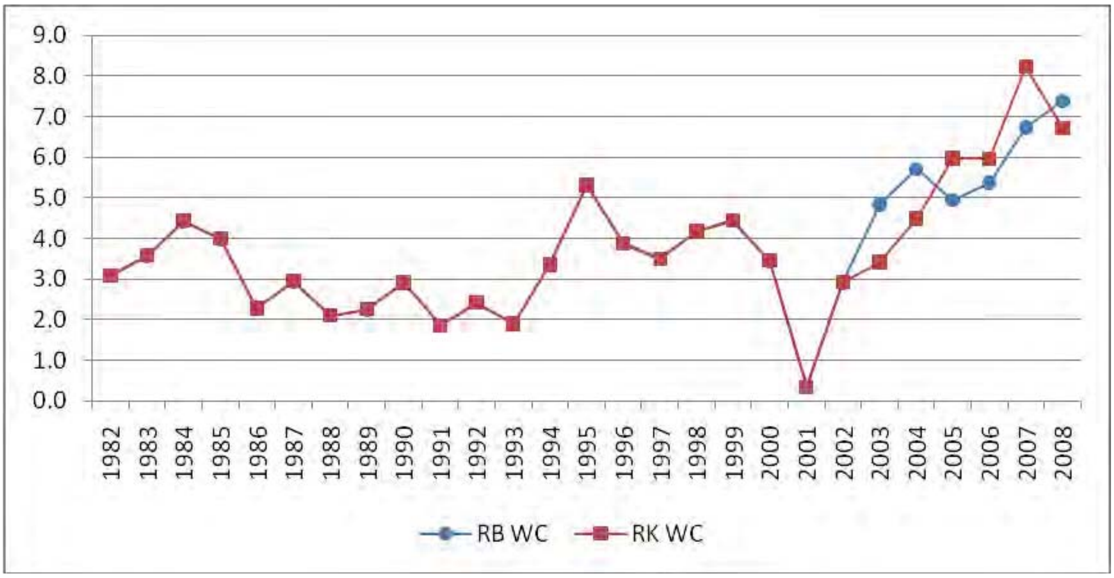
1.4 CURRENT EFFORT, CATCHES (VOLUME & VALUE) AND SOCIO-ECONOMIC IMPORTANCE

The most important commercial species harvested, by value are Indian mackerel, shrimp, threadfin bream, tuna and squid. The pelagic Indian mackerel (*Rastrelliger* spp.) has always been the most dominant group, with West Coast landings of 139,601 tonnes (mainly of *Rastrelliger brachysoma [RB]*) in 2008.

The West Coast (within the BOBLME region) accounted for 42% of *Rastrelliger kanagurta* (RK) landings in 2008, which amounted to 20,540 t, about one sixth (17%) of total RB landings, but RK commands a higher price than RB. The trends in west coast landings for the two species are presented in Figure 3.

Table 2 presents the landings of RK by gear type and region in 2008. Landings of RK come mostly from the purse seiners (56% of west coast landings), trawlers (42%) and only a very small amount (1%) from drift/gill netters. This is due to RK being a more offshore resource than RB, where nearly half of total landings come from inshore netters.

Figure 3: Landing trend of *R. brachysoma* and *R. kanagurta* in West Coast 1982-2008



Source: DoFM

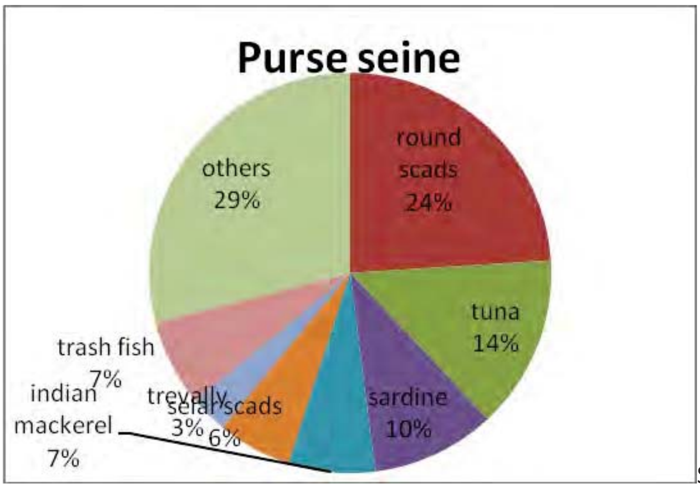
Table 2 Landings of *R.brachysoma* and *R. kanagurta* by region & main gears (tonnes), 2008

Gear	West Coast		East Coast		Sarawak		Sabah		Labuan	
Species	RB	RK	RB	RK	RB	RK	RB	RK	RB	RK
Trawl nets	19,678	8,733	197	1,521	158	2,335	-	708	266	360
Purse seines	48,394	11,526	1	6,401	24	477	-	6,816	4	21
Gill/Drift nets	50,785	281	2,114	6,886	32	284	-	138	12	44
Others (Hook Lines, Traps)	203	-	-	502	1	2	-	1,409	3	2
Total	**119,060**	**20,540**	**2,311**	**15,311**	**216**	**3,099**	**-**	**9,072**	**285**	**428**

Source: DoFM

The catch profile in the purse seine fishery is presented in Figure 4.

Figure 4 Catch profile of Malaysian purse seine fleet



Source: DoFM

Other purse seine and gill net catches include scad (80,000 t) and tunas and tuna-like species (50,000 t) (*Thunnus* spp., *Euthynnus affinis, Auxis thazard, Katsuwonus pelamis*). There is also a small purse seine anchovy fishery, catching around 20,000 t per annum (*Stolephorus* spp.). Ox-eye scad (*Selar boop*s), hard tail scad (*Megalaspis cordyla*), lizard fish (*Saurida* spp./*Trachinocephalus* spp.) and jewfish (*Pennahia* spp./*Johnius* spp.) are other important fish groups with landings over 20,000 tonnes.

Trawl fisheries provide the most significant economic contribution with shrimps (70,000t), threadfin bream (38,000t) and squid (60,000t), making up the most significant quantities caught by this sector. Trash fish makes up some 40% of the landings volume from trawlers. Threadfin bream and other finfish are also caught by trap, as well as by hook and line.

Most of the fishing operation for *R. brachysoma* and *R. kanagurta* are in the fishing zone B (5-12 n.m) and C (12-30 n.m). According to Hadil and Richard (1991), *R. kanagurta* are more abundant offshore.

Most *R. kanagurata* is caught offshore in zone C, while *R. brachysoma* is found inshore. Only a very small tonnage of RK is captured by the inshore gillnet fishery. The increasing use of lights in the purse seine fishery on both the mother vessel and skiffs means that several species are attracted and often captured together. They are then sorted as RK commands a higher market price to RB. A significant proportion of RK is also caught by trawls. Another gear that is thought to capture juvenile RK is the anchovy purse seine fleet that is permitted to fish in zone A. All of these methods capture several species and may not target RK specifically.

Zones B and C are within the coastal waters of 30 nm, while zone C2 is for deep-sea fishing. Vessels from the closer zones are permitted to fish in the further zones but not the other way around. Any vessels found encroaching into a closer zone are liable to be fined. The only exception in Zone A is the allowance for 130 commercial anchovy purse-seiners to operate, due to the presence of those particular resources in the area. Inshore fisheries (A & B zones) account for 1,078,752 tonnes, (US$ 1.622m), and deep-sea fisheries (C and C 2) for 315,779 tonnes , (US$ 0.408m).

The DoFM also established a Fisheries Prohibited Area (FPA) to protect coastal resources such as in Pulau Talang-talang and Pulau Satang, Sarawak and Tanjung Tuan and Pulau Besar, Malacca. The protected area differs between 1 to 3 nm according to sites. Fishermen in the region of Pulau Langkawi are proposing a closed area to protect spawning small pelagic including RK. Spawning of R. kanagurta is believed to be in February and March.

It is believed that the stock of RK straddles between Thailand and Malaysian waters with both fleets targeting the stock. The 2006 genetic research established that there were groups of *R. kanagurta* that were significantly differentiated in terms of morphology suggesting there is limited mixing north to south along the west coast of Malaysia. Fishermen in the state adjacent to Pulau Langkawi believe that it is an important spawning and nursery area that should be protected.

1.5 ENVIRONMENT

Protected areas have long been established in Malaysia (beginning with the Chior Wildlife Reserve in 1903) and since then, the number of protected areas has grown with some established and managed by the Federal government, while others are administered by the individual states (NRE, 2008). A network of Marine Parks is now well established and based around the nation's 42 islands extending 2 nautical miles from low water, and is overseen by the Department of Marine Parks within the Ministry of Natural Resources and Environment.

Knowledge of coral cover is good for a number of these areas with Park status (see Table 3, but less comprehensive information (and protection) is evident elsewhere.

Table 3: Coral cover in Kedah state

Location	% coral cover in coastal waters
Pulau Kaca	24.0
Pulau Lembu	14.0
Pulau Payar	34.5
Pulau Segantang	8.0

Source, Department of Marine Park Malaysia

Coral reef types in Malaysia are mostly shallow fringing reefs adjacent to the offshore islands (Zakariah *et al*. 2007). The rest are small patch reefs, atolls and barrier reefs. Over 85% of the coral reefs in Malaysia are considered to be threatened (Burke *et al* 2002). On the west coast of Peninsular Malaysia sedimentation is considered to be the most significant threat to corals, followed by fishing intensity, fishing damage and population pressure / coastal development; while coral mining, tourist activities and coral bleaching are of least threat to the coral reefs in this area (Husomo *et al,* 2009).

A Marine Parks project is currently being undertaken by the United Nations Development Programme (UNDP), and funded by the Global Environment Facility (GEF) together with the Government of Malaysia. The goal is to "ensure the conservation and sustainable use of marine biodiversity in Malaysia and sustainable island development". Focusing on the East coast peninsula of Malaysia but with a number of national strategic actions, the Department of Marine Park Malaysia (DMPM) under the Ministry of Natural Resources and Environment (NRE) is responsible for implementing the project between 2007-2012.

Four species of turtles are recorded in Malaysian waters: green turtle *Chelonia mydas,* hawksbill turtle *Eretmochelys imbricate,* leatherback turtle *Dermochelys coriacea* and olive ridley turtle *Lepidochelys olivacea*.

Table 4 presents the number of turtle landings recorded from 1991 to 2006 in Malaysian State that border the Bay of Bengal area. Landings do not appear to have declined especially for hawksbill and green turtles which make up the majority of landings (61 % and 37% respectively). Chan (2007) reports that despite 40 years of concerted conservation efforts, most turtle populations have not yet recovered.

The survival of marine turtles in Malaysia is threatened by habitat destruction (pollution and negative changes to their habitats), accidental drowning in fishing gear in terrestrial waters and high seas and illegal harvesting for their carapace and meat usually by foreign fishing vessels (WWF, 2009).

Under the Malaysian Constitution, turtles fall under the jurisdiction of the 13 individual states (Zulkifli Talib *et. Al,* 2004). In Peninsular Malaysia, Perlis and Selangor do not have marine turtle related legislation. To decrease the rate of decline the Malaysian Government has intensified efforts to protect nesting beaches by declaring them as turtle sanctuaries, regulated (and in some areas prohibited) the collection and sale of turtle eggs and adopted a regional cooperation strategy. The Malaysian National Plan of Action for Conservation and Management of Sea Turtles was developed in 2008 to strengthen conservation measures and management of sea turtles. Key priorities include a national ban on consumption and commercial sale of turtle eggs and other products, and enhancing public awareness and facilitate participation of local communities in conservation programmes (WWF, 2009). However, illegal collection of turtle eggs and incidental and illegal capture by fishing boats remain issues of concern, especially where enforcement and surveillance are weak.

Table 4: Turtle Landings from 1991-2006 per Malaysian State that borders Bay of Bengal

Turtle	State	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	TOTAL
Hawksbill	Melaka	306	269	203	233	255	297	241	222	241	159	205	272	205	285	301	379	4912
	Johor	63	69	94	10	0	45	108	43	15	15	33	88	57	105	55	39	
Green	Melaka	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2996
	Johor	0	5	15	0	0	0	100	6	0	1	6	3	4	16	25	61	
	Perak	67	102	211	197	197	144	128	132	202	105	208	123	147	101	80	74	
	Penang	0	0	0	0	30	13	4	0	0	0	63	39	47	59	39	71	
	Kedah	50	46	60	0	0	0	0	0	0	0	0	0	0	0	0	0	
Olive Riley	Johor	0	0	9	0	0	0	0	1	0	0	0	13	3	10	13	2	82
	Kedah	0	5	22	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Penang	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	
Leatherback	Johor	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	0	10
TOTAL		486	511	614	440	482	507	584	404	458	280	516	539	463	576	514	626	8000

Source: CREP, 2009

Dugongs occur in the coastal waters of Malaysia, in particular in areas with large tract seagrass, mangrove and coral reef (Tan *et al*, 2007). Sightings are reported in the Johor Marine Parks and there is strong evidence that dugongs are resident in the Johor-Singapore region (Marsh, 2002). The threats to dugongs include the loss of seagrass habitats (which are currently not protected), consumption by local communities, incidental catch by fisheries and death or injury by boat propellers.

Little is known about the occurrence and status of whales and dolphins in the coastal waters of Malaysia, primarily due to a lack of interest to conduct scientific research on these marine mammals (Jaaman, 2007, 2008, 2009). All cetaceans are protected by laws in Malaysia. However, small cetaceans continue to be threatened by incidental capture in fisheries, declining fisheries resources, habitat loss and degradation, pollution, heavy vessel traffic and coastal industrial development.

Other protected species include the sawfish (though now mostly extinct in Malaysian waters), the humphead wrasse and sea cucumbers.

1.6 RISK ASSESSMENT

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) in order to determine the overall risk to the stock. More detail on the PSA for Indian mackerel is provided in the main report. A summary of the PSA for Indian mackerel is provided in Table 5.

Table 5: Productivity Susceptibility Analysis for Indian Mackerel

Species	Gear	PSA															
		Productivity								Susceptibility					PSA Scores		
		Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Indian Mackerel	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Gill nets	1	1	1	1	1	1	2	1.14	1	2	3	3	1.43	1.83	Low	>80

Source: Poseidon

Based on the PSA assessment Indian mackerel is shown to be highly productive with a minimum population doubling time less than 15 months (Fishbase, 2010).

Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets. Vessels deploying these gears are likely to overlap > 30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. Due to the mesh sizes of these gears, they have a low selectivity in that most fish encountered will be captured. From a stock status perspective both purse seine and trawl fisheries are considered to be high risk to Indian mackerel.

The gillnet fishery however, is predominately carried out in the coastal areas and so has a lower risk score based on availability and encounterability attributes. While selectivity scores poorly due to the small mesh sizes compared to the fish length, overall the impact of this small scale fishery on the stock is considered low risk.

A PSA has also been undertaken for other species that are likely to be captured in conjunction with the small pelagic fishery, including Indo Pacific mackerel and tuna species. These results are presented in Table 6.

Table 6: Productivity Susceptibility Analysis for other retained species

Species	Gear	PSA															
		Productivity								Susceptibility					PSA Scores		
		Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Indo-pacific mackerel	Purse seine	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Btm Otter trawl	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Gill nets	1	1	1	1	1	1	1	1.00	1	2	3	3	1.43	1.74	Low	>80
Skipjack tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Longtail tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Frigate tuna	Purse seine	1	1	2	1	1	1	3	1.43	3	3	3	3	3.00	3.32	High	<60
Bigeye tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Bullet tuna	Purse seine	2	2	2	2	1	1	3	1.86	3	3	3	3	3.00	3.53	High	<60
Eastern little tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Yellowfin tuna	Purse seine	2	1	2	2	2	1	3	1.86	3	3	3	3	3.00	3.53	High	<60

Source: Poseidon

The above assessment is used for data deficient fisheries. However, a number of parameters for Malaysian Populations of *R. kanagurta* have been calculated. These are presented in Table 7, and show that the West Coast areas suggest a higher exploitation level compared to the east coast, however growth and length are higher (as is length at first maturity shown in Table 8). These indicate that West Coast populations may be deemed to be in a more robust state compared to East Coast stocks in some aspects, but this may not continue with the comparatively higher exploitation ratios.

Table 7 Population parameters of *R. kanagurta* in Malaysia

Area	Parameters					
	K	L∞	Z	M	F	E
	Growth	*Maximum length*	*Total mortality*	*Natural mortality*	*Fishing mortality*	*Exploitation ratio (f/z)*
Perlis (WC)	1.19	29.7	6.9	1.97	4.93	0.71
Penang (WC)	1.21	29	8.14	2.01	6.13	0.75
Tok Bali (EC)	1.1	27.56	4.79	1.87	2.90	0.61
Kuantan (EC)	1.0	27.60	3.73	1.86	1.87	0.50
Kuching	1.0	27.69	4.41	1.86	2.55	0.58
Kota Kinabalu	1.0	29.8	3.49	1.23	2.26	
Kudat	1.01	25.3	4.4	1.01	3.39	
Kunak	0.67	29.9	2.48	0.74	1.74	

Source: DoFM

Spawning seasons differ between sea areas. SEAFDEC research surveys in 2007 identified that the spawning season of *R. kanagurta* in the northern part of West Coast Peninsular of Malaysia occurred in March to April. The spawning season of *R. kanagurta* occurred twice a year in the South China Sea area. In the northern part of East Coast Peninsular of Malaysia, the spawning season occurred in March to May, and October to November, while in the southern part spawning occurred from April to August. In Sarawak, spawning occurred from January to April, and November to December.

Table 8: Length at first maturity for *R. kanagurta* by Malaysian sub-region

Species / sub-area	Total length at first maturity (mm)	
	Female	Male
Penang (West Coast)	206	
Tok Bali (East Coast)	186	189
Kuantan (East Coast)	165	190
Kuching, Sarawak	184	194

Source: DoFM

2 FISHERIES ASSESSMENTS – INDIAN MACKEREL

For the purpose of this assessment, the main 'units of assessment' are defined as follows:

1. **Purse seine vessels with 1 inch (25mm) mesh size** targeting small pelagic with Indian mackerel as one of these target species and those targeting tunas that catch Indian mackerel as a bycatch species.
2. **Bottom otter trawl fishery with 1 inch (25mm) mesh size** targeting shrimp and demersal fish and landing Indian mackerel as a bycatch species.
3. **Set gillnet fishery with mesh sizes ranging from 1 inch (25mm) upwards** targeting demersal fish and landing Indian mackerel as a bycatch species.

2.1 STOCK STATUS

2.1.1 Purse seine, Trawl fishery and Gillnets

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp status	✓			DoFM statistics, 2008 Hassan et al, 2006 in Ahmed, 2009
Explanatory Statement		Researchers believe CPUE is increasing and the status of the Indian Mackerel resource is therefore deemed to be good and not a priority for management. However, population parameters derived from a scientific survey conducted in 2006 showed high exploitation levels for West Coast stocks. The survey also estimated that the west coast peninsula of Malaysia, an area totaling nearly 28,000km^2, supported a pelagic resource of 210,000t (Hassan et al, 2006). This estimate is 23.8% lower than that estimated in the previous survey conducted in 1998. When compared to biomass estimates, landings of Rastrelliger sp. represent two thirds of the most recent estimate of total biomass. Although these species are highly fecund, the stock may be being overfished and a more recent assessment is required.			
1.1.2	Reference points	✓			DoFM questionnaire response
Explanatory Statement		Several RK population parameters are presented, but no reference points are set. A total pelagic biomass was estimated at 210,000t, suggesting west coast landings (140,000 t) of RK & mainly RB would give a high F value.			
1.1.3	Stock rebuilding	✓			FRI, DoFM interview
Explanatory Statement		No stock rebuilding strategy			
Harvest strategy					

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td>1.2.1</td><td>Harvest Strategy</td><td>✓</td><td></td><td></td><td>Fisheries master plan.</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Master plan gives objective as:
To meet fish production target of 1.83 million tones a year through the increment of deep sea fisheries to 380,000 tonnes, aquaculture to 508,000 tonnes, and maintaining coastal fisheries production to 938,000 tonnes
There is no harvest strategy for the RK and RB fishery, only an input control with some attempt to reduce capacity in zone B through an exit strategy for trawlers.</td></tr>
<tr><td>1.2.2</td><td>Harvest control rules and tools</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are no harvest control rules in place</td></tr>
<tr><td>1.2.3</td><td>Information / monitoring</td><td></td><td>✓</td><td></td><td>DoFM</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Good levels of reporting and fisheries-dependent information have been developed, but these are yet to directly feed into a harvest strategy. There are only sporadic (5 years +) resource surveys, and not on a regular basis.</td></tr>
<tr><td>1.2.4</td><td>Stock Assessment</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Several RK population parameters are presented based on a single 2006 survey and no reference points are set. Therefore while information is available, adequate regular stock assessment is not possible.</td></tr>
</table>

2.1.2 Key Weaknesses with Current P1 Performance

Information is primarily based on ad hoc research on pelagic resources rather than on regular assessment that can present trends in resource and consider these in relation to exploitation levels. There are no reference points or harvest control rules (e.g. output limits based on stock status).

2.1.3 Key Recommendations to Address P1 Performance Weaknesses

- Survey of pelagic resources including determination of biomass and identification of key spawning and nursery areas for the stock;
- Genetic research into Indian mackerel to explore stock and sub-stock relationships; and
- Identification of a catch profile of anchovy purse seiners – to see if this includes juvenile Indian mackerel.

2.2 ECOSYSTEM IMPACTS

2.2.1 Purse seine

PI	Title	Weak	Intermediate	Good	Reference
Other retained species					
2.1.1	Retained spp Status		✓		DoFM, IOTC.
Explanatory Statement		The main retained species are known, as RK is primarily captured offshore, the interaction with coastal fisheries including demersal fisheries is less than for example RB. Tuna may be captured when targeting shoals of small pelagic (making up 7% of seine catch). These are managed by the IOTC of which Malaysia is a signatory, and measures are in place. Overall therefore it is expected that the RK purse seine fishery is not hindering recovery of main retained species. See Table 6 for assessment of retained species.			
2.1.2	Retained spp management	✓			Fisheries statistics, 2008 (DoFM)
Explanatory Statement		Main retained species are small pelagic, which are not estimated by DoFM but deemed not to require additional measures. There is some limited management of retained species e.g. IOTC management of tuna.			
2.1.3	Retained spp Information			✓	Fisheries statistics, 2008 (DoFM)
Explanatory Statement		There is a detailed profile of the amount of retained species collected regularly for annual statistics. This is presented by gear type and therefore a full catch profile for each gear can be established.			
Discards					
2.2.1	Discarded spp Status			✓	
Explanatory Statement		No reported discarding of by-catch. All landed as ‘trash fish’.			
2.2.2	Discarded spp Management			✓	
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discarded spp Information		✓		
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. This fishery would thus benefit from an observer programme to verify this low level/ negligible impact.			

PI	Title	Weak	Intermediate	Good	Reference
ETP species					
2.3.1	ETP spp Status	✓			DoFM pers com
Explanatory Statement		Need more research on status of ETP species (turtle, dugong, marine mammals, sawfish, etc.) in Malaysian waters as current information on status is anecdotal. However indications are that species such as sawfish are close to extinct in Malaysian waters and turtle populations are still heavily depleted.			
2.3.2	ETP spp Management		✓		DoFM pers comm
Explanatory Statement		Regulation for protection of ETP species (turtle, dugong, marine mammals, sawfish, etc.) are in place and said to be applied. These include not permitting drift net >10 inches, and introduction of circle hooks in longline fishery to reduce turtle bycatch. However compliance and enforcement levels are unknown. Interactions with ETP species in the fishery are reported to be low and therefore no measures specific to the purse seine fishery are utilised. But evidence of this low level interaction are not available. Leatherback eggs are banned from sale and consumption in Terengganu, but there is evidence of collection continuing in this area (WWF, 2009). Eggs of other species are not banned in Peninsular Malaysia. Instead, egg collection is regulated by licensing systems. In contrast, sale and consumption of eggs of all marine turtle species are banned in Sabah and Sarawak (WWF, 2009).			
2.3.3	ETP spp Information		✓		WWF Malaysia DoFM
Explanatory Statement		There has been some significant research work, but often associated with marine parks. Ad hoc work has been completed by WWF e.g. on turtles. Several awareness-raising initiatives (posters, outreach) by DoFM but this is to inform the general population rather than monitor ETP status. There is no regular monitoring and collection of information on ETP interactions.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	UNEP/SCS National Report - Malaysia WWF Malaysia
Explanatory Statement		Extent and status of key habitats such as mangrove (109,000ha on west coast peninsula with 84,000ha recorded as mangrove reserve) and coral reefs is generally well known. Impact of purse seining on these critical habitats is expected to be minimal. *(www.wwfmalaysia.org/features/spaces/coral.htm)*			
2.4.2	Habitat			✓	UNEP/SCS National Report –

PI	Title	Weak	Intermediate	Good	Reference
	Management				Malaysia DoFM pers com
Explanatory Statement		Key habitats such as mangroves and coral reefs are managed as reserves and marine parks respectively. The purse seine fishery is not thought to significantly impact on these key habitats.			
2.4.3	Habitat Information			✓	UNEP/SCS National Report – Malaysia
Explanatory Statement		The extent and the vulnerability of the habitats and the extent of the fishery is known, and interaction with critical habitats minimal, and therefore the risk of impact is thought to be low for the purse seine fishery.			
Ecosystems					
2.5.1	Ecosystem Status		✓		
Explanatory Statement		The resource is dispersed across the Malaysian EEZ and associated with deeper waters of zones B & C. The fishery catches a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is not ecosystem modelling to predict impacts of removal at current rates. Certain resources are depleted, but the key elements to ecosystem structure are probably intact and the fishery in its current form is unlikely to cause serious or irreversible harm.			
2.5.2	Ecosystem Management		✓		
Explanatory Statement		There are licensing and management measures to reduce the impact of the fishery on the ecosystem. But the small mesh size (25mm despite regulations requiring 38mm) used means that a number of trophic levels are captured. This is further influenced by the increasing use of lights to aggregate fish, which results in a more heterogenous catch than through use of sonar alone.			
2.5.3	Ecosystem Information		✓		West Coast of Peninsular Malaysia: Acoustic, Fishery Oceanography and Bottom Substrate Surveys. Ahmad et al, eds, 2009
Explanatory Statement		The ecosystem has been studied over many years at a variety of levels and using a variety of techniques. However significant gaps remain to establish the scale and extent of connections of Malaysian resources to the BOBLME, and of the impacts of the purse seine fishery on ecosystems.			

2.2.2 Trawl fishery

PI	Title	Weak	Intermediate	Good	Reference
Retained species					
2.1.1	Retained spp Status	✓			DoFM, IOTC.
Explanatory Statement		The main retained species are known but their status is not. See Table 6 for risk assessment of other retained species. As RK is primarily captured offshore, the interaction with coastal fisheries including demersal fisheries is less than for example in the RB fishery. However status of many offshore resources is thought to be depleted.			
2.1.2	Retained spp management	✓			Fisheries statistics, 2008 (DoFM)
Explanatory Statement		Trawlers catch a wide range of fish and crustacean species as well as a high proportion of trashfish. There is no effective management of the bottom otter trawl fishery to reduce retained bycatch. The minimum mesh size of 1 inch is not appropriate to control the volume or size of fish landed and juveniles are expected to be landed in high proportions to enter the fish supplement and fish oil trade. The effect on recruitment for these small pelagic species due to high juvenile catch rates is unknown. There are no other controls over the size of fish landed or the volumes landed.			
2.1.3	Retained spp Information			✓	Fisheries statistics, 2008 (DoFM)
Explanatory Statement		There are detailed data on the amount of retained species collected regularly for annual statistics.			
Discards					
2.2.1	Discarded spp Status			✓	
Explanatory Statement		No reported discarding of by-catch. All landed as 'trash fish'.			
2.2.2	Discarded spp Management			✓	
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discarded spp Information		✓		

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		No formal assessment of discard rates and their nature has been carried out, mainly due to the very low level involved. This fishery would thus benefit from an observer programme to verify this low level/ negligible impact.			
ETP species					
2.3. 1	ETP spp Status	✓			DoFM pers com WWF, 2009
Explanatory Statement		Need more research on status of ETP species (turtle, dugong, marine mammals, sawfish, etc.) in Malaysian waters as current information on status is anecdotal. However indications are that species such as sawfish are close to extinct in Malaysian waters and turtle populations are still heavily depleted.			
2.3. 2	ETP spp Manageme nt		✓		DoFM pers comm
Explanatory Statement		Regulation for protection of ETP species (turtle, dugong, marine mammals, sawfish, etc.) are in place and said to be applied. These include not permitting drift net >10 inches and introduction of circle hooks in longline fishery. However compliance and enforcement levels are unknown. The scale and extent of interactions with ETP species in the fishery are unknown. No reported use of TEDs in the trawl fishery. Leatherback eggs are banned from sale and consumption in Terengganu, but there is evidence of collection continuing in this area (WWF, 2009). Eggs of other species are not banned in Peninsular Malaysia. Instead, egg collection is regulated by licensing systems. In contrast, sale and consumption of eggs of all marine turtle species are banned in Sabah and Sarawak (WWF, 2009).			
2.3. 3	ETP spp Information			✓	WWF Malaysia DoFM
Explanatory Statement		There has been some significant research work, but often associated with marine parks. Ad hoc work has been completed by WWF e.g. on turtles. Several awareness-raising initiatives (posters, outreach) by DoFM but this is to inform the general population rather than monitor ETP status. There is no regular monitoring and collection of information on ETP interactions.			
Habitats					
2.4. 1	Habitat Status (SICA only)	✓			UNEP/SCS National Report - Malaysia WWF Malaysia
Explanatory Statement		Extent of interaction with vulnerable habitats is a significant issue in the trawl fishery with damage to seagrass and coral areas evident.			
2.4. 2	Habitat Manageme nt		✓		UNEP/SCS National Report – Malaysia FRI pers comm DoFM pers comm

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		Key habitats such as mangroves and coral reefs are managed as reserves and marine parks respectively. The zoned licencing prevents trawling within 5nm of the shore, but there is encroachment by trawlers into this zone (FRI, pers comm.). The trawl fishery has the potential to damage key habitats such as seagrass and coral reefs. Marine parks with no take zones have been introduced in certain areas. Artificial reefs have been used in places to demarcate protected areas and to deter trawling. However these are only in certain select areas rather than providing widespread protection of these habitats. Although there is no information on compliance levels, this additional protection combined with the zonal management and reduction in capacity should reduce negative impacts.			
2.4. 3	Habitat Information			✓	UNEP/SCS National Report – Malaysia *www.wwfmalaysia.org/features/spaces/coral.htm*
Explanatory Statement		Extent and status of key habitats such as mangrove (109,000ha on west coast peninsula with 84,000ha recorded as mangrove reserve) and coral reefs is generally well known. Regular survey of coral status within marine parks is undertaken.			
Ecosystems					
2.5. 1	Ecosystem Status	✓			
Explanatory Statement		The resource is dispersed across the Malaysian EEZ and associated with deeper waters of zones B & C. While the trophic level of most species caught is well understood, there is not ecosystem modelling to predict impacts of removal at current rates. As the trawl fishery removes both juvenile fish and crustaceans in an untargeted way, there is the potential to cause serious damage the ecosystem.			
2.5. 2	Ecosystem Manageme nt	✓			DoFM pers comm
Explanatory Statement		There are licensing and management measures to reduce the impact of the fishery on the ecosystem, but there does not appear to be ecosystem-based fisheries management and the small mesh size (25mm despite regulations requiring 38mm) used means that a number of trophic levels are captured.			
2.5. 3	Ecosystem Information		✓		Ahmad et al, eds, 2009
Explanatory Statement		The ecosystem has been studied over many years at a variety of levels and using a variety of techniques. However significant gaps remain to establish the scale and extent of connections of Malaysian resources to the BOBLME, and of the impacts of the purse seine fishery on ecosystems.			

2.2.3 Gillnet

PI	Title	Weak	Intermediate	Good	Reference

PI	Title	Weak	Intermediate	Good	Reference
Other Retained species					
2.1.1	Retained spp Status	✓			DoFM, IOTC.
Explanatory Statement		The main retained species are known (mainly demersal), but status is either not assessed or known to be depleted. A small proportion of RASTRELLIGER KANAGURTA (1% of total landings) is captured by the traditional inshore fishery using gillnet.			
2.1.2	Retained spp management	✓			Fisheries statistics, 2008 (DoFM)
Explanatory Statement		Limited management of gill net fisheries and no evidence of actions on improving selectivity.			
2.1.3	Retained spp Information			✓	Fisheries statistics, 2008 (DoFM)
Explanatory Statement		There are detailed data on the amount of retained species by gear type that are collected regularly for annual statistics.			
Discards					
2.2.1	Discarded spp Status			✓	
Explanatory Statement		No reported discarding of by-catch. All landed as 'trash fish'.			
2.2.2	Discarded spp Management			✓	
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discarded spp Information		✓		
Explanatory Statement		No formal assessment of discard rates and their nature has been carried out, mainly due to the very low level involved. This fishery would thus benefit from an observer programme to verify this low level/ negligible impact.			
ETP species					
2.3.1	ETP spp Status	✓			DoFM pers com WWF, 2009

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		Need more research on status of ETP species (turtle, dugong, marine mammals, sawfish, etc.) in Malaysian waters as current information on status is anecdotal. However indications are that species such as sawfish are close to extinct in Malaysian waters and turtle populations are still heavily depleted. Gillnet interactions with these and other ETP species are a significant threat.			
2.3. 2	ETP spp Management		✓		DoFM pers comm
Explanatory Statement		Regulation for protection of ETP species (turtle, dugong, marine mammals, sawfish, etc.) are in place and said to be applied. These include not permitting drift net >10 inches and introduction of circle hooks in longline fishery. However compliance and enforcement levels are unknown. Interactions with ETP species in the fishery are not known as is the extent to which measures are complied with and enforced. Leatherback eggs are banned from sale and consumption in Terengganu, but there is evidence of collection continuing in this area (WWF, 2009). Eggs of other species are not banned in Peninsular Malaysia. Instead, egg collection is regulated by licensing systems. In contrast, sale and consumption of eggs of all marine turtle species are banned in Sabah and Sarawak (WWF, 2009).			
2.3. 3	ETP spp Information		✓		WWF Malaysia DoFM
Explanatory Statement		There has been some significant research work, but often associated with marine parks. Ad hoc work has been completed by WWF e.g. on turtles. Several awareness-raising initiatives (posters, outreach) by DoFM but this is to inform the general population rather than monitor ETP status. There is no regular monitoring and collection of information on ETP interactions.			
Habitats					
2.4. 1	Habitat Status			✓	UNEP/SCS National Report - Malaysia WWF Malaysia: (*www.wwfmalaysia.org/features/spaces/coral.htm*)
Explanatory Statement		Extent of key habitats such as mangrove (109,000ha on west coast peninsula with 84,000ha recorded as mangrove reserve) and coral reefs is known. Habitat impacts as a result of the gear are considered minimal. The interaction of bottom set gill nets is limited to the weights and bottom line touching the seabed. However, lost nets do have the potential to impact coral reefs.			
2.4. 2	Habitat Management		✓		UNEP/SCS National Report – Malaysia DoFM pers com
Explanatory Statement		Key habitats such as mangroves and coral reefs are managed as reserves and marine parks respectively. However the management of interaction between the gillnet fishery and habitats is limited as the inshore fishery is not limited by spatial management measures.			

PI	Title	Weak	Intermediate	Good	Reference
2.4.3	Habitat Information		✓		UNEP/SCS National Report – Malaysia
Explanatory Statement		The extent and the vulnerability of the habitats and the extent of the fishery is known, interaction and the risk of impact is thought to be moderate for the gillnet fishery.			
Ecosystems					
2.5.1	Ecosystem Status		✓		
Explanatory Statement		The resource is dispersed across the Malaysian EEZ and associated with deeper waters of zones B & C. While the trophic level of most species caught is well understood, there is not ecosystem modelling to predict impacts of removal at current rates. As the gillnet fishery removes juvenile fish in an untargeted way, there is the potential to cause damage the ecosystem. The small-scale nature of the fishery may mean limited impact to the wider ecosystem, but could have localised effects.			
2.5.2	Ecosystem Management		✓		DoFM pers com
Explanatory Statement		There are licensing and management/regulatory measures, but these do not limit capacity in the inshore gillnet fishery. The small mesh size (25mm despite regulations requiring 38mm) used means that a number of trophic levels are captured.			
2.5.3	Ecosystem Information		✓		Ahmad et al, 2009
Explanatory Statement		The ecosystem has been studied over many years at a variety of levels and using a variety of techniques. However significant gaps remain to establish the scale and extent of connections of Malaysian resources to the BOBLME.			

2.2.4 Key Weaknesses with Current P2 Performance

Regulations have been developed to reduce fisheries impacts on species and habitats, but these are yet to be fully applied or enforced. In the case of increased mesh size this is due to political objections citing economic and social consequences of moving to 38mm. In the case of ETP species, the introduction of technical measures such as TEDs and JTEDs has not yet occurred, citing practicalities of managing grids with net drums. These have however been overcome in other countries. Instead education and awareness-raising is favoured, but the impact of these efforts is not known. Finally the level of fisheries information (retained species) is very good compared to the information on fisheries/ETP interactions with a reliance on anecdotal information.

2.2.5 Key Recommendations to Address P2 Performance Weaknesses

Key recommendations are:

- Complete a regulatory impact assessment of mesh size increases, and investigation of a phased approach and introduction in certain key fisheries;
- Explore the location and scale of seasonal and permanent marine protected areas for fisheries improvement & refugia (spawning & nursery areas) as well as habitat protection; and
- Develop strategy to roll-out technical measures reducing environmental impact of gear.

The above should ideally be based on multilateral and at a minimum bilateral agreements with neighbouring countries.

2.3 FISHERY MANAGEMENT FRAMEWORK

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Governance and policy</td></tr>
<tr><td>3.1.1</td><td>Legal Framework</td><td></td><td></td><td>✓</td><td>SEAFDEC, 1999
Fisheries Act, 1985, amended 1993</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The current Act is the Fisheries Act 1985, and the regulations made under the Act provide the legal framework for the management of fishery resources and aquaculture. Malaysia has an appropriate legal framework to implement fisheries management. This is supported through a strong deterrent mechanism within the laws, as well as a certified ISO 9000 approved, integrated licensing system that is one of the better systems in Asia.
The Federal Constitution of Malaysia clearly divides the law-making authority of the Federation into its legislative authority, judicial authority and executive authority. The separation of power also occurs both at federal and state levels. The fisheries system appears to recognize the rights of traditional fishers and there is a sound legal system to consider and resolve disputes in addition to supporting enforcement.</td></tr>
<tr><td>3.1.2</td><td>Consultation</td><td></td><td></td><td>✓</td><td>DoFM pers comm</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The roles and responsibilities of organisations and individuals who are involved in the management process are well defined and understood by all relevant parties and there are good levels of consultation.
Each district has a fisheries extension officer who meets with fishermen and their representatives on a regular basis. Any issues emerging get reported up to state level and on to national level. Key developments such as the fisheries master plan are put out for consultation ahead of finalisation.</td></tr>
<tr><td>3.1.3</td><td>Long-term Objectives</td><td></td><td>✓</td><td></td><td>DoFM pers comm.
Annual report, DoFM, 2008</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">A new marine management plan is being drafted for roll out in 2011. Details of this were unavailable, but it is suggested by DoFM that this will integrate management of environment, fisheries and other marine sectors.
At present, the current fisheries master plan does seeks production increases, but recognises that this should be from further development of offshore resources and not an increase in production for the coastal fishery.
Objectives:
• To meet fish production target of 1.83 million tones a year through the increment of deep sea fisheries to 380,000 tonnes, aquaculture to 508,000 tonnes, and maintaining coastal fisheries production to 938,000 tonnes
• To increase the export value of fish based products to RM 3.3 billion while controlling imports at RM 2.8 billion
• To achieve a minimum net income per head of RM 3,000 per</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
		month for fisheries entrepreneurs • To ensure that the income of fishermen exceeds poverty levels			
3.1.4	Incentives		✓		DoFM pers comm. Annual report, DoFM, 2008
Explanatory Statement		For the fishing fleet, , fuel subsidies continue, which are most critical to supporting the trawl fleet, which at the same time are part of the exit strategy to reduce capacity. There are also a number of initiatives to reduce impact on ETP species, but more could be done to incentivise take up of known measures such as TEDS and in implementation of increased mesh size to reduce capture of juveniles and low value species.			
Fishery specific management					
3.2.1	Fishery Objectives	✓			DoFM pers comm
Explanatory Statement		There are no fishery-specific management objectives for Indian mackerel. The fisheries do not operate on a targeted basis, only fishing in certain zones with certain methods.			
3.2.2	Decision making processes	✓			DoFM pers comm
Explanatory Statement		There are no fishery-specific decision-making process for Indian mackerel, largely because there is no fisheries-specific management beyond licensing and zonal management.			
3.2.3	Compliance & Enforcement		✓		DoFM pers comm
Explanatory Statement		The MCS system in Malaysia is reasonably comprehensive with a hull colour coding system that enables prompt establishment of a vessel's right to fish in a certain area. Enforcement of technical measures is however less advanced. There remains a disconnect between what is regulated and what is applied, e.g. the regulation for 38mm mesh not being enforced. Levels of compliance and suggested to be good, but no evidence provided.			
3.2.4	Research Plan	✓			FRI & DoFM pers comm
Explanatory Statement		The limited resources for research are applied on a priority basis, which in this instance is the demersal fish and shellfish resource, not the pelagic resource. There is a reliance on externally supported ad hoc surveys, including occasional use of the SEAFDEC research vessel. As fishery-specific management objectives do not exist, research cannot be properly targeted.			
3.2.5	Performance Evaluation		✓		DoFM, pers comm
Explanatory Statement		There is an impressive system of stakeholder extension services to regularly consult with fisheries interests and communities. This is further enhanced by initiatives such as 'meet the client' days. However as the overall management system is underdeveloped in terms of fishery-specific objectives and associated targets, there is no opportunity to evaluate against performance.			

2.3.1 Key Weaknesses with Current P3 Performance

Malaysia has an extensive and detailed legislative framework for fisheries management, but certain aspects are not applied in practice. As stocks are shared, there is a reluctance to apply more stringent management measures than neighbouring countries.

Consultation levels via the extension officer network are good, but this stops short of localised and community-based fisheries management (CBFM). Decision-making remains highly centralised, resulting in general policies that may not meet the differing circumstances found around the Malaysian coast. There are riverine examples where CBFM is in place, such as Tagal and there is a fishing community programme which now has 87 communities in place. At present projects relate to fishermen's training and technical support, but DoFM state they are looking to move towards CBFM.

DoFM's priority is to address excessive effort in fleets targeting demersal stocks. Efforts such as the exit strategy (decommissioning) to remove zone B vessels[2] are being taken to address excess capacity in the trawl fleet targeting demersal stocks.

Fisheries-specific policies e.g. for small pelagics are lacking. Small pelagics are not currently viewed as a priority. Demersal fisheries are the current priority and fleet overcapacity is being addressed to an extent. The focus is on capacity reduction through reducing total number of vessels. Other effort management measures such as technical measures (mesh size increases) are not being implemented at present.

2.3.2 Key Recommendations to Address P3 Performance Weaknesses

Key recommendations are:

- Develop and implement a national management plan for small pelagics (i.e. before it becomes a reaction to major problems in the fishery);
- Design a comprehensive research plan as part of small pelagic management;
- Introduce evidence-based decision-making, supported by more regular resource assessment for small pelagic; and
- Explore multi-lateral agreements on implementation of technical measures (mesh size, use of light, placement & use of FADs, etc.);
- Develop co-operative management plans for shared stocks of small pelagics;
- Expand successful experiences of community-based fisheries management for coastal fishers.
- Review Marine Management Plan in the context of fisheries management and specific fishery management plans to ensure compatibility.

[2] 160 from state of Kadah removed to date. A proportion have moved into zone A, others have invested in zone C vessels or have taken up fish farming.

2.4 SUMMARY – INDIAN MACKEREL

The table below provides a summary of the performance for Indian mackerel in Malaysia. In terms of stock, some information including estimated population parameters is given but this is now some years old and more significantly has not informed a harvest strategy. The recording of landings is comprehensive and as no discarding occurs is assumed to effectively relate to total catch. However more extensive investigation of by-catch and ETP interactions is needed. Zonal management in Malaysia is relatively advanced as is the well-established network of marine parks. However there remain shortcomings in the implementation of management measures.

Table 9: Summary performance table for Indian Mackerel in Malaysia

Malaysia																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts															Principle 3: Governance & Management								
		Outcome			*Harvest strategy*				*Retained*			*Bycatch*			*ETP*			*Habitat*			*Ecosystem*			*Governance & Policy*				*Fishery specific man.*				
Spp	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding if necessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discards status	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
I. mackerel	Purse seine	0	0	n/a	0	0	1	0	1	0	2	2	2	1	0	1	1	2	2	2	1	1	1	2	2	2	1	0	0	1	0	1
I. mackerel	Btm otter trawl	0	0	n/a	0	0	1	0	0	0	2	2	2	1	0	1	2	0	1	2	0	0	1	2	2	2	1	0	0	1	0	1
I. mackerel	Gill nets	0	0	n/a	0	0	1	0	0	0	2	2	2	1	0	1	1	2	2	1	1	1	1	2	2	2	1	0	0	1	0	1

Appendix A: References

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Appendix B: Number of vessels by fishery in Malaysia

Table 10: No. of fishing vessels licensed & estimated to be operating on the W. Coast

Year	Trawl		All Seines		F. Purseseine		Drift Net		Other Gear		Total	
	Lcnsd	Oprt	Lcnsd	Oprt	Lcnsd	Oprt	Lcnsd	Oprt	Lcnsd	Oprt	Lcnsd	Oprt
1967	180	899	1478	1342			4163	3321	3592	4270	9413	9832
1968	264	1028	1527	1485			4564	3389	3228	3898	9583	9800
1969	367	1396	1694	1879			5240	3472	3303	4498	10604	11245
1970	599	2683	1754	1556			5551	3016	3992	4805	11896	12060
1971	2594	3252	1412	1460			5216	3244	3313	4267	12535	12223
1972	2846	4068	1473	1488			5319	3698	2847	3510	12485	12764
1973	2897	3267	1650	1446			6533	3530	2776	2949	13856	11192
1974	2928	3909	1814	1535			6236	4091	2957	2696	13935	12231
1975	2815	3873	2123	1687			6702	4359	3414	2701	15054	12620
1976	3039	4008	1354	1425			7475	5092	4481	2762	16349	13287
1977	3029	4195	1877	1204			8932	5951	6350	3113	20188	14463
1978	3321	4463	2004	1394	434	195	11012	6968	4646	2814	20983	15639
1979	3316	5112	1909	1542	366	236	12363	7878	4663	3380	22251	17912
1980	3347	5265	2028	1951	421	241	13260	8453	7735	4087	26370	19756
1981	3414	5266	1755	2081	411	301	13394	8525	8183	4751	26746	20623
1982	3365	5257	1726	2133	370	343	11647	8689	9418	5463	26156	21542
1983	3236	5166	929	2046	384	325	11283	9096	6485	5803	21933	22111
1984	3487	5255	1099	1167	390	361	11033	9694	4427	5361	20046	21477
1985	3281	5163	934	2047	364	377	10710	10417	5911	4878	20836	22505
1986	3281	4505	766	1449	329	251	9940	8430	2259	3061	16246	17445
1987	3336	4442	1090	1176	328	320	9371	8402	1745	3078	15542	17098
1988	3257	4547	1251	1105	305	318	8965	8660	1736	2665	15209	16977
1989	3331	4468	1308	1013	287	217	10713	8388	1985	2389	17337	16258
1990	3187	4106	1219	1004	266	202	10728	9446	1864	2143	16998	16699
1991	3224	4599	1196	1020	257	226	10465	9095	1774	2691	16659	17405
1992	3294	4185	1160	948	249	172	9723	9376	1700	2918	15877	17427
1993	3155	3939	1116	845	235	204	8518	10232	1517	3334	14306	18350
1994	3137	3951	1048	883	220	194	7818	10351	1434	3379	13437	18564
1995	3136	3933	1022	871	221	199	10826	10360	1514	3403	16498	18566
1996	3063	4032	934	843	217	189	9289	10716	1390	3713	14676	19304

Note : Lcnsd = licensed; Oprt = operating

Table 11: More recent trend in licensed vessel numbers

Year	Trawl nets	Fish Purse seines	Gill/ Drift nets	Others (Hooks & Lines, Trap)	Total
1997	3,107	221	9,087	484	12,899
1998	3,037	221	8,808	455	12,521
1999	3,091	247	8,267	355	11,960
2000	3,183	246	7787	463	11,679
2001	3,099	243	7,908	366	11,616
2002	3,047	253	7,676	356	11,332
2003	3,102	250	9,078	443	12,873
2004	3,015	230	9,775	232	13,252
2005	3,319	254	10,298	318	14,189
2006	2,867	302	12,081	229	15,479
2007	3,070	303	11,950	358	15,681
2008	2,978	326	12,520	333	16,157

Appendix G: Country Report – Maldives

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Tuna pole and line vessel. Source: Poseidon

Country Report: Maldives

Prepared by

Poseidon Aquatic Resource Management Ltd

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1 OVERVIEW

1.1 INTRODUCTION

Annex 2 of the terms of reference for this study state that: 'The geographic scope of this work are the Bay of Bengal sea areas of the Maldives, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia. Indian mackerel fisheries are present *in all these areas* [our emphasis] whilst the hilsa shad is restricted to India (West Bengal), Bangladesh, Myanmar and possibly Sri Lanka.'

However, under the section of the ToR outlining the project purpose of the BOBLME project, and the objective of sub-component 2.3 the text notes that: 'the subcomponent will support the following activities: (i) … (ii) development of sub-regional fishery management plan for Indian mackerel (Bangladesh, India, Indonesia, Malaysia, Myanmar, and Thailand) *i.e. excluding the Maldives* [our emphasis/addition]; (iii) development of sub-regional fishery management plan for Hilsa shad (Bangladesh, India, and Myanmar); iv) …'

A visit to the Maldives by the consultants confirmed that there is no regular/commercial fishery for Indian mackerel in the Maldives (although very occasional limited catches of Indian mackerel are made in the north of the atoll chain, mainly for subsistence use). As there are also no hilsa fisheries in the country, it was therefore agreed with the BOBLME coordination unit prior to travelling that no pre-assessment for Indian mackerel should be conducted in the Maldives, or indeed of any other species. The consultants' visit was thus used to discuss future support by the BOBLME project under sub-component 2.3, as well as policy issues being covered by the BOBLME project under sub-component 2.2.

Unlike the text in other Appendices, this Appendix thus provides text only in the form of recommendations with regards to future support by the BOBLME project under sub-component 2.3.

1.2 PEOPLE MET

Name	Title and Organisation	Contact details	Location of meeting
Mr. Ali Riwan	Bluepeace (NGO based in Male)	bluepeace.maldives@gmail.com	Male
Dr. Naseer	Permanent Secretary, Ministry of Fisheries and Agriculture	Abdulla.naseer@fishagri.gov.mv	Male
Hussain Sinan	Senior Research Officer, Ministry of Fisheries and Agriculture	Hussain.sinan@fishagri.gov.mv	Male
Shahaema A. Satter	Fisheries biologist, Marine Research Centre	sasatter@mrc.gov.mv	Male
Adam Manik	Director, Ministry of Fisheries and Agriculture	Adam.manik@fishagri.gov.mv	Male
Hassan Shakeel	Senior Biologist, Marine Research Centre	hshakeel@mrc.gov.mv	Male
Mohammed Zuhair	Director General, Environmental Protection Agency	Mohamed.zuhair@epa/gov.mv	Male
Dr. Shiham Adam	Director, Marine Research Centre	msadam@mrc.gov.mv	Male

2 CONCLUSIONS AND RECOMMENDATIONS

2.1 RECOMMENDATIONS FOR FURTHER ACTION

A number of possible areas of intervention by the BOBLME were suggested for support under sub-component 2.3 during the meetings held in the Maldives. These are presented below along with some observations about each potential activity.

1. Study on the role of small pelagics in tuna diets.

Such a study would be of interest to the Maldives given its high reliance on tuna species and the potential contribution of such diet studies to an understanding of the trophic relationships impacted by tuna fishing. Furthermore such a study might provide further information on movement and distribution patterns of small pelagic species in the Bay of Bengal.

Earlier studies in the region indicated skipjack tuna feed on Engraulids and variety of pelagic species including squid, crustaceans and the diurnally migrating Myctophid species. Myctophids are believed to occur in large concentrations in the Indian Ocean and trials have been proposed for catching them to use an alternative livebait source for the pole-and-line fishery.

Distribution and abundance of such species are poorly known in the Indian Ocean, and improved understanding would greatly facilitate tuna research and SEPODYM type simulation modelling.

Advocacy for this activity may be stretching the project sub-component intent, given its focus on assessments and management plans for Indian mackerel, hilsa and sharks, and fact that IOTC has a remit for management of tuna stocks.

2. Study into the extent of the Indian mackerel fishery in the Maldives

While it is widely believed that there is very little Indian mackerel present in Maldivian waters, it is also true that documented information to show that this is the case is very weak or non-existent, given that there is no dedicated Indian mackerel fishery, and no data collected on the species. A study could therefore focus on northern atolls (where limited and sporadic catches are believed to occur) in order to validate this assumption, and to obtain a 'participatory rural appraisal' of the actual extent of Indian mackerel. Information could be collected on trends in catches over time, seasonality, marketing of catch, and so on. Such a study would of course fit well under sub-component, but on the assumption that Indian mackerel catches are indeed very small, then this activity would have little practical benefit to the Maldives except for proving what is already believed.

3. Study on sharks

The Maldives now has in place regulations stipulating a total ban on shark fishing and export in/from its EEZ. There is therefore no need for any sort of additional shark management plan for the Maldives. However potential areas of interest for research could be the impact of the recent ban on shark fishing (and trade) on regional stocks, and interactions with shark populations in Sri Lanka (where shark fishing is permitted) e.g. to determine the role of large 'no-take areas' on shark conservation. It is believed that there are no baseline studies of shark populations in the Maldives or in the Indian Ocean. Such a study would greatly complement the existing monitoring efforts in the Maldives to validate (at some future time) whether shark populations have been rehabilitated or improved.

Sharks are not covered under the remit of the present study being completed by the consultants, but other imminent BOBLME activities under sub-component 2.3 will consider shark assessments.

4. A study on scads (e.g. *Decapterus* spp + *Selar curmnophthalmus*) and the extent to which they might be migratory and a regional stock.

Such a study is of potential interest in the Maldives because of the importance of scad as a bait fish for yellowfin tuna handline fishery and longline fishery A study of this nature would also fall broadly within the intentions of the sub-component and its focus on small pelagic species and sharks, which are all outside the remit of the IOTC. A potential drawback of such a study however is that scads in the Maldives are not thought to be a regional stock, and might also therefore just prove what is already believed. It addition, other recent work has also been completed on bait fisheries in the Maldives[1] and/or is still underway, dealing with a Bait Fisheries Management Framework, and with a Best Practice Guide and Code of Conduct.

[1] Under IDA Credit: 44270-MAL

Appendix H: Country Report – Myanmar

Assessments of the Indian mackerel (Rastrelliger kanagurta*)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Country Report: Myanmar

Undertaken by

Poseidon Aquatic Resource Management Ltd

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Acronyms

APFIC	Asia-Pacific Fisheries Commission
ASEAN	Association of Southeast Asian Nations
BOBLME	Bay of Bengal Large Marine Ecosystem
BRKP	Marine & Fisheries Research Organisation
CBFM	Community Based Fisheries Management
CCRF	Code of Conduct for Responsible Fisheries
COFI	Committee on Fisheries
COREMAP	Coral Reef Rehabilitation and Management Program
CPUE	Catch per Unit of Effort
DGCF	Directorate General of Capture Fisheries
DKP	Dinas Perikanan Provinsi
EAF(M)	Ecosystem Approach to Fisheries (Management)
EU	European Union
F	Fishing effort
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FTDC	Fishing Technology Development Centre
GT	Gross tonnage
IPOA	International Plan of Action
IUU	Illegal, unreported and unregulated (fishing)
KG	Kilogrammes
M	Metres
MCS	Monitoring, Control and Surveillance
MEY	Maximum Economic Yield
MM	Millimetres
MMAF	Ministry of Marine Affairs and Fisheries
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MT	Metric Tons
NGO	Non Governmental Organisation
PSA	Productivity Susceptibility Analysis
RBF	Risk-Based Framework
RBFM	Rights Based Fisheries Management
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
TAC	Total Allowable Catch
TED	Turtle Exclusion Device
TURF	Territorial use rights in fisheries

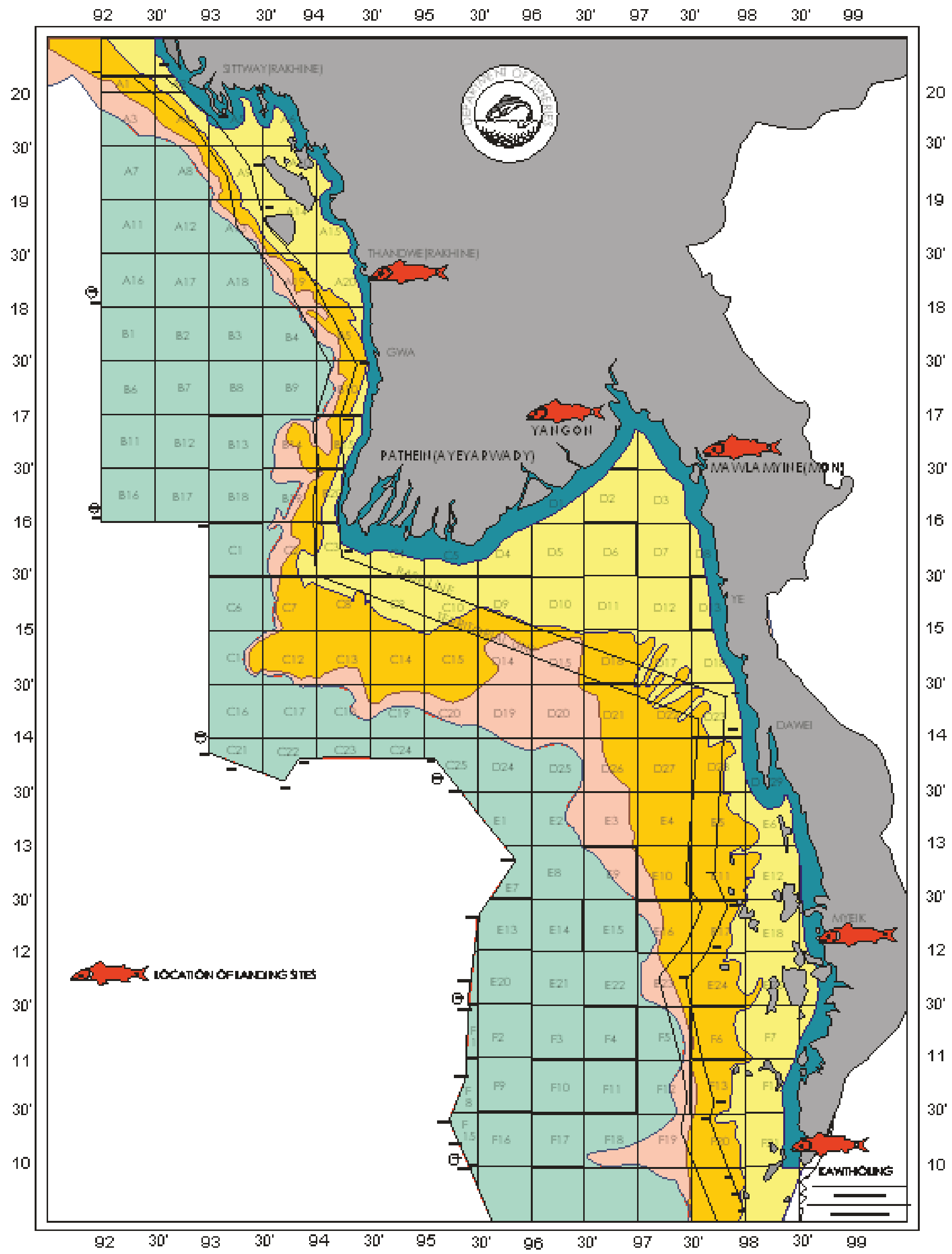
1 OVERVIEW

1.1 INTRODUCTION

Mainland Myanmar coastline stretches approximately 3,000 km along the Bay of Bengal and Andaman Sea, with several large estuaries and delta systems, as well as numerous offshore islands.

The main landing sites in Myanmar are around Yangon, at Pazuntaung Nyaungdan and Annawa, with a fish market at San Pya in Alone township. Other important landing sites along the coast include Thandwe, Mawlamyine, Myeik and Kawthoung (Figure 1).

Figure 1: Myanmar fishing grounds and landing sites



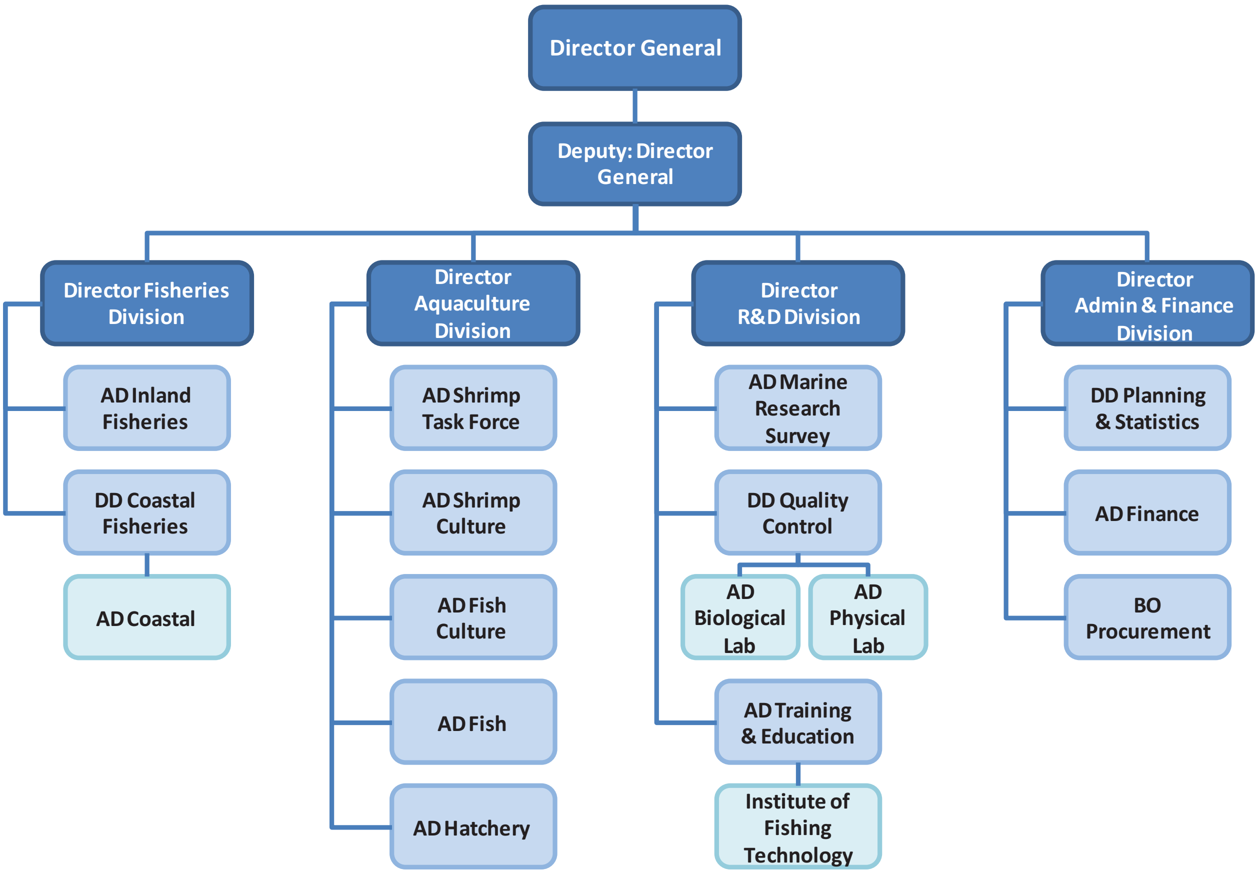
Source: FAO, 2009

Hilsa shad is the most important exported marine fish in terms of both volume and value representing 26% and 20% respectively of Myanmar marine fish exports (DoF, 2010). Section 2 presents an assessment for vessels targeting this species at sea, at estuary mouths and within rivers.

Indian mackerel landings constituted only 0.02% by volume of Myanmar exports, recorded over an annual period from 2008-2009. However landings data for domestically consumed fish are unknown and it is anticipated that total landings for both hilsa shad and Indian mackerel will be significantly higher. Furthermore, it is understood that historically landings of Indian mackerel have been more prominent and for this reason a brief assessment for this species has been undertaken and is presented in Section 3.

Management and development of fisheries resources in Myanmar waters is undertaken by the Department of Fisheries (DoF) of the Ministry of Livestock and Fisheries. The organisational structure of the DoF is shown in Figure 2.

Figure 2: Organisational chart of the Department of Fisheries of Myanmar



Source: FAO, 2009

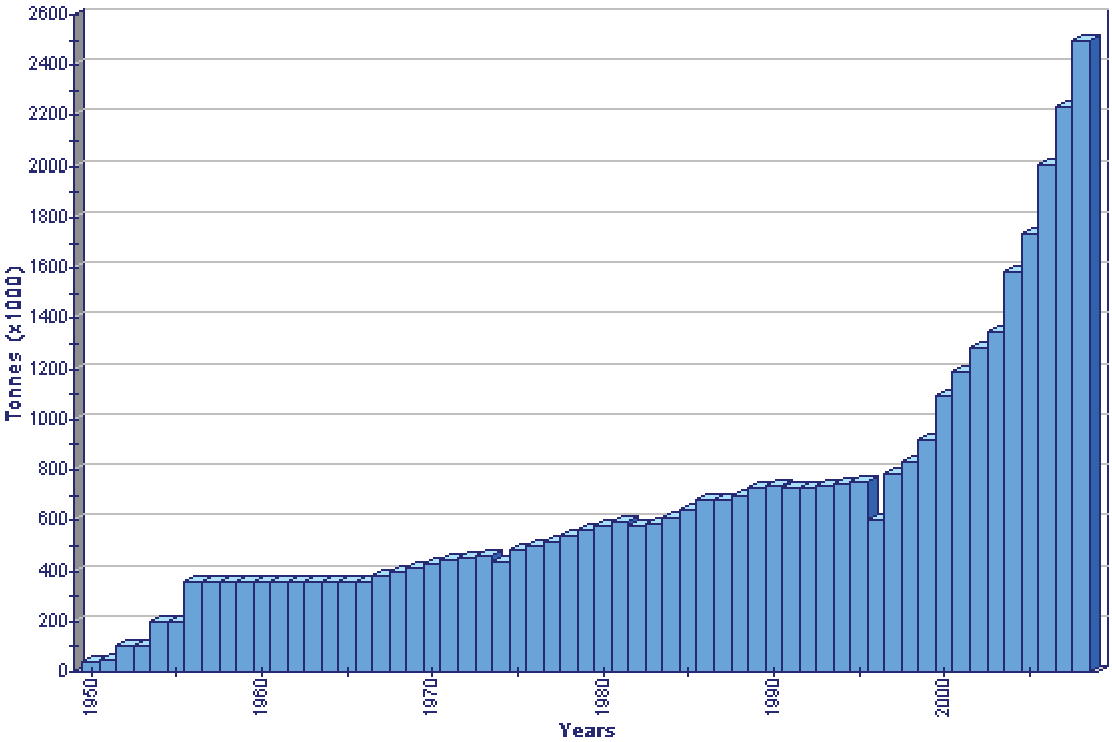
1.2 CURRENT EFFORT, CATCHES (VOLUME & VALUE) AND SOCIO-ECONOMIC IMPORTANCE

Total landings from Myanmar capture fisheries are presented in Figure 3 for period 1950-2008. Growth has increased fairly steadily from 1966 to 1999 with an average increase of 3% from year to year. Since 2000, recorded landings by volume have increased dramatically to approximately 2.5 million tonnes in 2008.

The most recent landing statists available present the exported quantities of marine capture fishery products from Myanmar (Table 1). Hilsa shad is the most economically important marine capture fishery product to be exported from Myanmar, representing 26% of the total volume and 20% of the total value.

Landing statistics of domestically consumed fisheries products are not available.

Figure 3: Myanmar capture fisheries production from 1950-2008



Source: FAO, 2009

Table 1: Exported marine fishery products from Myanmar for annual period from 2008-2009

Commodities	Tonnes	US$ million	Commodities	Tonnes	US$ million
Hilsa	12,606.661	$20.409	Queen fish	50.116	$0.050
White pomfret	4,372.703	$18.919	Dursky perch	22.887	$0.049
Rosy jew fish	5,232.055	$13.527	Hard tail scad	95.240	$0.049
Yellow croaker	5,063.189	$9.721	Lonf fin cavalla	47.250	$0.043
Ribbon fish	6,855.578	$8.502	Gloden fish	36.720	$0.033
Big eye croaker	4,127.447	$4.552	Climbing perch	38.464	$0.032
Sea eel	2,253.985	$3.858	NGA wine sein	32.996	$0.030
Toungue sole	2,636.866	$3.298	Sillago/trump whiting	5.774	$0.030
Black pomfret	1,321.885	$3.207	Pony fish	11.400	$0.028
Barramundi (fillet)	559.199	$2.040	Grouper	6.843	$0.024
Thread fin	372.696	$0.726	Sardine	10.576	$0.020
Threadfin bream	612.005	$0.592	Tooya	3.953	$0.013
Koral/barramundi	220.191	$0.571	Palatu / Indian mackerel	10.576	$0.008
Spanish mackerel	207.927	$0.499	Thread fin bream (fillet)	3.953	$0.007
White croaker	265.960	$0.358	Flat head fish (fillet)	4.827	$0.006
Milky white fish	213.149	$0.327	Nga myat kyee	6.680	$0.005
Long fin moyarro	198.640	$0.226	Wolf harring	5.200	$0.003
Big eye illisha	224.966	$0.203	Spotted sickel fish	3.260	$0.002
Chinese pomfret	23.520	$0.188	Nga yaung ma	1.492	$0.002
Lotia	154.660	$0.170	Marine cat fish	2.078	$0.002
Red snapper (fillet)	45.858	$1.280	Spotted croaker	0.514	$0.002
Puffer	5.998	$0.099	Mokkah	1.080	$0.001
Tapashi	36.423	$0.094	Black pomfret (fillet)	0.431	$0.001
Line silver grunt	48.940	$0.085	Round scad	1.400	$0.001
Golden travelle	47.827	$0.077	Long tail tuna	1.640	$0.001
Barracuda	33.814	$0.076	India halibut	0.118	$0.0002
Grouper (fillet)	8.090	$0.054	Chinese pomfret (fillet)	0.032	$0.0002
Red snapper	19.890	$0.052	White pomfret (fillet)	0.016	$0.0001
Total				**48,213.072**	**$93.000**

Source: Department of Fisheries, 2010

1.3 ENVIRONMENT

The diversity of Myanmar's coastal habitats includes large coral reefs, seagrass beds, mangroves, sandy beaches and mudflats.

The estimated coral reefs area of Myanmar is around 1,700 km2 with a range of 65-97 species and 31-67 genera reported by various surveys (as cited in Hutomo et al, 2009). Along the southern coast is a complex of offshore islands known as Myeik Archipelago where the majority of Myanmar's coral reefs are found. They are also known to be present around the chain of islands between Ayeyarwardy Delta and Andaman Islands, but these have been minimally surveyed. The coastal zone is considered to be in good ecological condition with no sign of coral depletion (CREP, 2008), although it is recognised that there is a lack of scientific data and surveys to confirm this. Furthermore, according to the Reef at Risk Analysis 56% of Myanmar's coral reefs are threatened, with overfishing forming the major threat, followed by destructive fishing practises, coastal development and sedimentation (Burke et al, 2002).

Seagrass beds of three species exist around Myanmar and are considered to be in healthy condition (Myanmar National report, 2008). Seagrass beds flourish mainly in the Myeik Archipelago and off Yanbye Island. Seabeds are most vulnerable to wastewater discharge from coastal industries, urban development and shrimp farms (Hutomo *et al*., 2009).

Myanmar has 4,100 km2 of mangrove areas along its coastline, which are being systematically preserved. Mangrove ecosystems are widespread in the northern Rakhine coastal zones, northern Tanintharyi coastal zones and the Ayeyarwady Delta. The latter represents an important and extended mangrove forest, included in the Delta Forest Division. Twenty four species of mangroves are confirmed in Myanmar (CREP, 2008). Mangroves are reported to have suffered dramatic decline due to conversion of areas into rice fields.

In relation to endangered species it is considered that the protection and law enforcement should be increased for dugongs, whale sharks and turtles. Four species of turtle have been recorded in Myanmar waters: green turtle *Chelonia mydas,* hawksbill turtle *Eretmochelys imbricate,* olive ridley turtle *Lepidochelys olivacea* and leatherback turtle *Dermochelys coriacea*. The latter is considered very rare in Myanmar waters. The Estuarine crocodile *Crocodylus porosus* and the river terrapin *Batagur baska* occur in the Ayeyarwady Delta, although the river terrapin's population has declined to possible extinction. Dugongs are rare and mostly found on the southern shelf of Rakhine coast and further north. Dugongs are considered to be at risk from intentional capture for meat, or incidental capture by fishing gear and death from destructive fishing practises.

1.4 PEOPLE MET

Consultation was undertaken from 11th-13th October 2010 in Yangon. The following people were met and consulted:

Name	Title and Organisation	Contact details	Location of meeting
U Mya Than Tun	Department of Fisheries National Coordinator, BOBLME Project	mttun@myanmar.com.mm	Yangon
U Khin Ko Lay	Director General Department of Fisheries	fisheries@myanmar.com.mm	Yangon
Khin Soe Tint	Fishery Officer	Kst1955@gmail.com	Yangon
Daw Win Win Le'	Deputy Fisheries Officer	dwinwinle@gmail.com	Yangon
Saw Aung Ye Htet Lwin	Aquaculture and Fisheries		Yangon
	Hilsa processor		Yangon
U Win Naing	Managing Director, Szyh Jetty, Shwe Zin Yaw Hein Manufacturing Co. Ltd	01-682187	Yangon

In additional to these meetings the consultants attended the 2-day National Stakeholder Workshop on Myeik Archipelago Management and Sustainable Use, held as part of the BOBLME project. Presentations at the workshop included:

- Critical habitats and protected areas: mangrove, coral reefs and seagrass beds;
- Ecosystem approach to fishery management: basic oceanography, fish larvae patterns and endangered species;
- Alternative livelihood development;
- Public awareness;
- Existing planning and management capacity for fisheries and tourism sector; and
- Fisheries licensing system in Myanmar.

2 FISHERIES ASSESSMENTS – HILSA SHAD

2.1 DESCRIPTION OF MAIN FLEETS AND GEARS

Hilsa shad (*T. ilisha*) is anadromous and capable of withstanding a wide range of salinity. Hilsa spends the majority of its life cycle in the marine environment and migrates inland through rivers to spawn. This species is targeted throughout its life cycle; at sea by purse seiners, in estuaries by gill nets and in rivers by stow nets. The main rivers in Myanmar inland fisheries are Ayeyarwaddy, Chindwin, Sittatung and Thanlwin, which extend from the eastern part of the Bay of Bengal to the Gulf of Moattama and along the eastern edge of the Andaman Sea.

Numbers of vessels involved in this fishery are unknown. A short description of each of the gear types is provided below.

Purse seine are mobile gear that consist of a large netting wall which is set by the vessel from the surface to surround aggregated fish, both from the sides and underneath, thus preventing them escaping from the bottom of the net. The netting wall holds its position in the water column due to a floatline running along the top length of the net, and a leadline along the bottom.

Gill nets are stationary gear consisting of a single netting wall kept more or less vertical by a float line and a weighted ground line. The net is generally set on the bottom when targeting demersal species and from the top when targeting pelagic species. The net is kept stationary by anchors on both ends and at intervals along the nets length. The mesh sizes of gill nets deployed by the Myanmar fleet are unknown, but expected to be between 1-2.5 inches.

Stow nets are stationary gear made from very fine netting, with mesh sizes typically 12mm. The nets are fixed to the benthos by anchors or stakes and placed according to the direction and strength of the current (FAO, 2010). The net endings, which are in a cone or pyramid shape (Figure 4), are usually hauled by hand while the body and stakes are left in position. As a consequence the gear can remain in the same location for a long period of time, with emptying of the conical ends on a regular basis.

Figure 4: Typical stow net configuration

Source: FAO, 2010

2.2 SCALE, INTENSITY AND CONSEQUENCES ANALYSIS

For the purpose of this assessment on hilsa shad, three main 'units of assessment' are defined as follows:

1. **Purse seine vessels with 1 inch mesh size** targeting small pelagic with Hilsa shad as one of the target species.
2. **Gill nets** at the river mouths and in estuaries
3. **Stow nets** operated within rivers.

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) – which is provided in detail for Hilsa shad in the main report – in order to determine the overall risk to the stock. A summary of the PSA for Hilsa shad is provided in Table 4.

Table 2: Productivity Susceptibility Analysis for Hilsa shad

	PSA															
	Productivity								Susceptibility					PSA Scores		
Gear	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Purse seine	1	1	1	1	1	1	1	1.0	2	3	2	3	1.88	2.13	Low	>80
Gill nets	1	1	1	1	1	1	1	1.0	3	3	3	3	3.00	3.16	Med	60-80
Stow nets	1	1	1	1	1	1	1	1.0	3	3	3	3	3.00	3.16	Med	60-80

Source: Poseidon

The productivity element of the risk assessment is discussed in the main report and shows hilsa to be a highly productive species.

Hilsa shad is highly susceptible to being caught by the gill nets and stow nets on account of them targeting the areas where hilsa are returning to spawn. The mesh sizes of these gears also reflect a low selectivity and therefore an overall medium risk to the hilsa stock status.

The purse seine gear, operated at sea, has a lower chance of catching hilsa and therefore a better availability score. Furthermore, the recent increase in mesh size to 2.5 inches allows a relatively better selectivity score, compared to the two static gear types. The overall risk of the purse seine fleet is therefore assessed as low to the hilsa stock status.

2.3 PRINCIPLE 1: STOCK STATUS

2.3.1 Unit of Assessment: Purse seine, gill nets and stow nets

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp status		✓		Fishbase, FAO fact sheets, Milton, 2010
Explanatory Statement		Hilsa shad has been assessed using the Risk Based Framework approach developed by the MSC. The purse seine fishery is considered to be of low risk to the stock status of hilsa, while the gill net and stow net fisheries are of medium risk. Limited data exists on the status of hilsa within Myanmar waters, although it is understood that Milton (2010) reports that hilsa in Myanmar is less susceptible to overfishing compared to Bangladesh fisheries. An overall intermediate score is therefore appropriate.			
1.1.2	Reference points (not if RBF)	✓			Milton, 2010
Explanatory Statement		Although various estimates of B_{MSY} have been calculated, mainly based on large length-frequency (L-F) analyses (Milton, 2010), no biomass-based reference points have been utilised for hilsa fisheries management in Myanmar. Given the complexities involved in measuring hilsa abundance, the current L-F based stock assessments are a realistic and practical approach given data limitations.			
1.1.3	Stock rebuilding				n/a
Explanatory Statement		Not expected to be rebuilding, and as RBF used to score 1.1.1 and 1.1.2 no score is given			
Harvest strategy					
1.2.1	Harvest Strategy	✓			
Explanatory Statement		There is no known harvest strategy in place for the fishery that combines monitoring, harvest control rules and management actions. One measure in place relates to minimum mesh size, however the level of compliance is unknown and this is not considered appropriate to manage the fishery.			

PI	Title	Weak	Intermediate	Good	Reference
1.2.2	Harvest control rules and tools	✓			
Explanatory Statement		There are no known harvest control rules and tools in place that specifically manage the removal of hilsa shad. Regulations stipulate a minimum mesh size of 1 inch for purse seine gear, although the extent of compliance is unknown.			
1.2.3	Information / monitoring	✓			Department of Fisheries, 2010
Explanatory Statement		There are currently no known logbook schemes in operation. Statistics are reported for exported volume and value of hilsa on an annual basis, however the quantity of hilsa landed for domestic consumption is unknown. There is no gear differentiation within landing statistics for hilsa shad. See also comments in 1.1.1 on information on stock status.			
1.2.4	Stock Assessment (not if RBF)	✓			n/a
Explanatory Statement		Using the Risk-Based Framework (RBF) this would normally be scored a default 'Intermediate' status. However given the lack information on which to base a stock assessment and the lack of 'management drivers' to demand an assessment of this stock, it is scored as 'weak'.			

2.3.2 Key Weaknesses with Current P1 Performance

There is a lack of knowledge on many aspects relating to the stock status of hilsa shad in Myanmar. The existence of genetically distinct stocks and associated boundaries within Myanmar and between Myanmar, Bangladesh and India are unknown. Accurate assessments of stock biomass are not available.

No recent reference points have been defined and there is no harvest strategy or harvest control rules and tools in place to manage the fishery, other than a minimum mesh size which (at the current size) is not appropriate to manage the stock, especially for gill net and stow net fisheries.

While detailed export figures are available, landings data (including both domestically consumed and exported figures) are not available at a species or gear level.

2.3.3 Key Recommendations to Address P1 Performance Weaknesses

Specific recommendations to address weaknesses highlighted above include:

- Support to planned and future genetic studies to determine hilsa shad stock units;
- Provide training and capacity building on stock assessment methodologies for small pelagic species;
- Undertake coordinated and complete stock assessments on a regular (annual) basis to determine stock status of hilsa shad and establish appropriate reference points;
- Collect data on landings by species for all vessel sizes and gear types. Ensure appropriate detail to allow analysis of catch/effort and size composition;
- Explore potential to introduce logbook scheme to vessels; and
- Develop appropriate harvest control rules (such as increase in mesh size for all gears targeting hilsa).

2.4 PRINCIPLE 2: ECOSYSTEM IMPACTS

2.4.1 Unit of Assessment: Purse seine

The assessment below has been combined for hilsa and Indian mackerel species, since they are landed by the same purse seine fishery.

PI	Title	Weak	Intermediate	Good	Reference
Retained species					
2.1.1	Retained spp Status		✓		Hutomo *et al* 2009, Fishbase
Explanatory Statement		It has not been possible to determine the retained species taken in the purse seine fishery since landings statistics are not presented by gear type. It is, however, understood that a number of small pelagic species are landed in the purse seine fishery including hilsa, Indian mackerel and Indo pacific mackerel. The former two species are assessed as target species elsewhere in this report. A PSA assessment indicates that the purse seine fishery is of low risk to Indo Pacific mackerel.			
2.1.2	Retained spp management		✓		Interviews DoF, Szyh Jetty
Explanatory Statement		There is seasonal closure for 3 months during May-July to protect spawning grounds. Four fishery blocks (as represented in Figure 1) are closed, although the locations of these blocks are not known. There is no other effective management of the small pelagic purse seine fishery. The minimum mesh size of 1 inch is not appropriate to control the volume or size of fish landed and juveniles are expected to be landed in high proportions to enter the fish supplement and fish oil trade. The effect on recruitment for these small pelagic species due to high juvenile catch rates is unknown. There are no other controls over the size of fish landed or the volumes landed.			
2.1.3	Retained spp Information	✓			Interviews DoF, Szyh Jetty
Explanatory Statement		Export data has been provided. However, no accurate landings data is available reporting both exported and domestically consumed volumes. It is not possible to determine catch composition for the purse seine fleet landing small pelagics.			
Discard species					
2.2.1	Discard spp Status			✓	Interviews DoF, Szyh Jetty
Explanatory Statement		Discards from this fishery are understood to be non-existent.			
2.2.2	Discard spp Management			✓	Interviews DoF, Szyh Jetty
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			

PI	Title	Weak	Intermediate	Good	Reference
2.2.3	Discard spp Information		✓		Interviews DoF, Szyh Jetty
Explanatory Statement	No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. This fishery would thus benefit from an observer programme to verify this low level/ negligible impact.				
ETP species					
2.3.1	ETP spp Status		✓		Interviews DoF, Szyh Jetty, Kirby, 2006
Explanatory Statement	Potential purse seine interaction with ETP species is likely to be limited to dolphins and turtles, both of which are released alive prior to hauling nets. A high survivability rate (>90%) is expected. A risk assessment in the Pacific Ocean (Kirby, 2006) indicates that sharks are the highest risk group in purse seines – at greatest risk are the low fecundity silky shark, short-finned mako, porbeagle, and oceanic whitetip rather than the more fecund blue sharks and hammerheads. These shark species are at more risk from the tuna fisheries than the small pelagic fisheries since they often trail schools of tuna for prey. Overall the risk of the small pelagic purse seine fishery is of intermediate concern, based primarily on shark interactions.				
2.3.2	ETP spp Management		✓		Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement	There are closed areas in inshore locations specifically to protect turtles when they are returning to breed. The locations of these areas are unknown. The Myeik Archipelago Islands have large areas closed to fishing, primarily to protect coral reef habitats, but this also acts to protect ETP species in this area. No management is known to reduce interactions with sharks.				
2.3.3	ETP spp Information		✓		Interviews DoF, Szyh Jetty, BOBLME workshop, Hutomo *et al*, 2009
Explanatory Statement	Data on presence and distribution of ETP species around the Myeik Archipelago Islands is well understood and protection of this area is regarded with high national importance. However, data for ETP species outside this area are limited, with the exception of turtle breeding areas which have informed closure of certain locations. Data on specific purse seine interactions with ETP species is lacking. In particular observer data to monitor shark bycatch in Myanmar fisheries is rare and effort should be focused to address this issue across the fleet.				

PI	Title	Weak	Intermediate	Good	Reference
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Interviews DoF, Szyh Jetty
Explanatory Statement		Habitat impacts from this surface pelagic fishery are highly likely to be minimal. Lost gear is rare, although the occasional FAD is lost.			
2.4.2	Habitat Management			✓	Interviews DoF, Szyh Jetty
Explanatory Statement		Due to minimal impact, management strategies are not necessary			
2.4.3	Habitat Information		✓		Interviews DoF, Szyh Jetty, BOBLME workshop, Hutomo *et al*, 2009
Explanatory Statement		As with ETP species, the extent and location of important habitats including coral reefs, seagrass beds and mangroves are well understood for the areas surrounding the Myeik Archipelago Islands. Information is generally lacking for other areas.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Interviews DoF, Fishbase
Explanatory Statement		The fishery catches a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is no ecosystem modelling to predict impacts of removal at current rates.			
2.5.2	Ecosystem Management		✓		Interviews DoF, Fishbase
Explanatory Statement		No specific ecosystem management measures are undertaken at national level. However, there are closed areas for habitat protection and turtle management measures. Current levels of removals of small pelagic species are not considered to be heavily over exploited; furthermore most small pelagic species have a short population doubling time. Despite this, management of the indirect effect of removing target and retained species from the food web requires management measures, which would also be applicable for 2.1.2 retained species.			
2.5.3	Ecosystem Information	✓			Interviews DoF, Fishbase
Explanatory Statement		Total removals are not well known for Myanmar fisheries. There is little information on the ecological impacts of this fishery and ecosystem modelling has not been undertaken.			

2.4.2 Unit of Assessment: Gill net and stow nets

There are no differences between the outcomes of the hilsa assessments for gill nets and stow nets and therefore they are reported together in the table below.

PI	Title	Weak	Intermediate	Good	Reference
Retained species					
2.1.1	Retained spp Status	✓			
Explanatory Statement		There is no information available to allow this performance indicator to be assessed. It is unknown what species are landed together with hilsa shad in the estuarine and river mouth environments.			
2.1.2	Retained spp management	✓			
Explanatory Statement		While the retained species are unknown, it is known that no specific measures exist to manage their capture. The gill net and stow net fisheries operate with small mesh sizes with low selectivity, therefore likely to be catching a number of juvenile fish.			
2.1.3	Retained spp Information	✓			
Explanatory Statement		No information has been provided on the volume of retained species landed by this hilsa fishery. Data for landings that are domestically consumed are not known to be collected. Data is not available at a gear level.			
Discard species					
2.2.1	Discard spp Status			✓	
Explanatory Statement		Discards from these fisheries are understood to be non-existent.			
2.2.2	Discard spp Management			✓	
Explanatory Statement		Discards from these fisheries are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discard spp Information		✓		
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. This fishery would benefit from an observer programme to verify this low level/ negligible impact.			

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">ETP species</td></tr>
<tr><td>2.3.1</td><td>ETP spp Status</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There is no information available to allow this performance indicator to be assessed. It is unknown what ETP species are present in the estuarine and riverine environments within Myanmar. It is anticipated that some species of river dolphin may exist, which could potentially interact with both gear types.</td></tr>
<tr><td>2.3.2</td><td>ETP spp Management</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are no known management procedures to manage interaction of these fisheries with ETP species</td></tr>
<tr><td>2.3.3</td><td>ETP spp Information</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There is no information available to allow this performance indicator to be scored. The levels of ETP species interactions with these gears are unknown.</td></tr>
<tr><td colspan="6">Habitats</td></tr>
<tr><td>2.4.1</td><td>Habitat Status (SICA only)</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Habitat impacts as a result of these gears are considered minimal. The interaction of bottom set gill nets is limited to the weights and bottom line touching the seabed. However, lost nets do have the potential to impact sensitive habitats, but rates of loss are not thought to be a major issue (although are unknown).

Stow nets tend to be fixed in position for a long period of time and therefore do not have a large footprint of habitat impact. Although operated in high tidal conditions, lost gears are considered highly unlikely.</td></tr>
<tr><td>2.4.2</td><td>Habitat Management</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are no known management measures to protect sensitive habitats, however it is anticipated that gear interactions are minimal.

No management structure exists to control the potential loss of gear e.g. due to rigging and gear failure. Nor is there a code of practise for gear retrieval or reporting of lost gear incidents.</td></tr>
<tr><td>2.4.3</td><td>Habitat Information</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">No information is available on the extent and distribution of habitats in the riverine and estuarine environments. The location of gear deployment is unknown.</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
		The extent of lost gear incidents is unknown.			
Ecosystems					
2.5.1	Ecosystem Status	✓			
Explanatory Statement		The fisheries are likely to catch a wide range of species including high rates of juveniles in gill nets and stow nets with small mesh sizes, which may be of concern to recruitment of these species. Other than the target species it is unknown what other species are removed from the ecosystem by this gear. The overall impact on the ecosystem is therefore difficult to determine. There is no ecosystem modelling to predict impacts within these estuarine and riverine environments.			
2.5.2	Ecosystem Management	✓			
Explanatory Statement		No ecosystem management measures are undertaken at national level.			
2.5.3	Ecosystem Information	✓			
Explanatory Statement		Total removals are not well known for Myanmar fisheries. There is little information on the ecological impacts of this fishery and ecosystem modelling has not been undertaken.			

2.4.3 Key Weaknesses with Current P2 Performance

Key problems across all gear types relate to the status and management of retained species. The current mesh size for purse seine, gill nets and stow nets results in high catch rates of juveniles. This is likely to have implications for recruitment and is likely to lead to growth overfishing and possibly ecosystem overfishing.

Landings data is not collected at a sufficient level to determine the total removals at species and gear levels and underreporting is expected due to lack of knowledge on levels landed for domestic consumption.

The lack of discarding within these fisheries is considered a key strength; however this is primarily due to the landing of all fish including juveniles which itself is due to a lack of retained species management. Any measures introduced to manage retained species (such as TACs) should ensure that the negligible discard rate is maintained.

Little is known about the extent of interaction with ETP species and no measures exist to manage this at each fishery level.

Habitat impacts are not considered to be of concern for all three gear types; however knowledge is not sufficient to inform potential management requirements for both the gill net and stow net fisheries.

There is little information on the ecological role of hilsa or the other species landed in these fisheries, their response to natural fluctuations and the impact of their removal from the ecosystem. Ecosystem modelling has not been undertaken for the marine, estuarine or freshwater ecosystems.

2.4.4 Key Recommendations to Address P2 Performance Weaknesses

Key recommendations from the above assessment and key findings are:

- Develop management of retained species through more selective fishing gear e.g. introduction of larger mesh sizes which would allow juveniles to escape (as is currently seen n trawling gear);
- Ensure consistent and robust data collation of fishery landing statistics at all fleet levels for domestic and export markets;
- Establish a program to identify and prioritize key areas to be designated as marine reserves to protect fish spawning areas, ETP species and habitat protection for estuarine and riverine environments;
- Establish a program for on-board observers to monitor and report on interactions with ETP species for all gear types. Use this information to shape any necessary measures to manage unacceptable interactions;
- Substantiate current release practices within the purse seine fleet through a code of conduct for ETP interactions including techniques to releases animals and reporting templates to record frequency and location of interactions. A guide to fishermen on how to identify ETP species, particularly sharks, would also be helpful;
- Establish ecosystem based management through the development of ecosystem criteria for management of small pelagic fisheries, and the consideration of species interactions (e.g. predator – prey) in management; and
- Improve participation in international conventions to ensure improved management practices adhering to the Precautionary Principle and Ecosystem Based Fisheries Management.

2.5 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

Limited information in relation to the legal and management framework of Myanmar fisheries has been provided. It has been requested that the Department of Fisheries provide further clarification on both fisheries laws and management, as well as provide comment on our current understanding on these specific points below.

PI	Title	Weak	Intermediate	Good	Reference
Governance and policy					
3.1.1	Legal Framework		✓		Interviews DoF, FAO, 2010.
Explanatory Statement		Management and development of fisheries resources is undertaken by the Department of Fishery (DoF) of the Ministry of Livestock and Fisheries. The structure of the DoF is presented in Figure 2. The DoF has established an appropriate legal framework and formulated and implemented various strategies for the sustainable development and management of marine fisheries. Fisheries management is pursued by licensing, prescribing exploitable species, designating environmental friendly fishing gears and methods, imposing closed areas and seasons.			
3.1.2	Consultation		✓		Interviews DoF
Explanatory Statement		Fishery officers from the DoF meet with stakeholders each week, however the extent of stakeholder influence is unclear.			
3.1.3	Long-term Objectives		✓		Interviews DoF Fisheries 2020 poster, DoF
Explanatory Statement		It is understood that there are long term objectives for the management of Myanmar's fisheries and their environmental sustainability with high level objectives are presented under Fisheries 2020. However, these objectives are not fishery-specific and we do not have evidence of actions being implemented to deliver these objectives. A copy of the management plan and more information on fisheries management is requested from the DoF.			
3.1.4	Incentives	✓			Interviews DoF
Explanatory Statement		No incentives to promote sustainable fishing (e.g. rights based mechanisms, subsidies for environmentally-friendly technologies and gear selectivity) are thought to be in place. Details of any fuel subsidies or other financial support measures provided to hilsa fishermen are requested from the DoF.			
Fishery specific management					
3.2.1	Fishery Objectives	✓			Interviews DoF
Explanatory Statement		There are no Indian mackerel or hilsa shad specific management plans, nor is there one covering all small pelagic species.			
3.2.2	Decision making processes	✓			Interviews DoF
Explanatory Statement		The structures for supporting decisions making processes appear to be in place, but these do not result in measures and strategies to achieve			

PI	Title	Weak	Intermediate	Good	Reference
		fishery specific objectives and no management plans have been implemented. No processes currently exist to link scientific outputs into management decision-making. Furthermore decision-making process affecting management of Indian mackerel specifically, and small pelagics more generally, are weak or nonexistent.			
3.2.3	Compliance & Enforcement		✓		Interviews DoF, FAO, 2010 Myanmar Marine Fisheries Law, 2007
Explanatory Statement		It is understood that the DoF have a programme for Monitoring, Control and Surveillance (MCS) of fisheries. An objective is for this programme to provide effective and efficient scientific data acquisition for resources evaluation and management of fisheries in Myanmar, although the extent to which this has been achieved is unknown. The MCS system provides a basis for effective monitoring and control of fisheries enforcement activities, to ensure that only authorized or licence-holding fishing vessels operate within the designated areas in the national EEZ. The was no evidence provided on the extent of inspections or infringements. The resources available to Myanmar fisheries for MCS suggests inspection of inshore fisheries such as hilsa does not occur and inspection of offshore fisheries (many under licence to foreign vessels) is limited. The maximum fine levels proposed in the 2007 Maritime law are noted to be very high in relation to average earnings for small scale fishermen, but for offshore vessel-owners these appear manageable levels such fines. The following queries remain outstanding in relation to this indicator: • Is there any information available on the extent of record keeping on inspections and infringements? • Are sanctions felt to be appropriate and sufficient to act as a deterrent? • What is the general view with regards to compliance in hilsa fisheries? • Are there particular times of the year, areas, or groups of fishermen that are known to be high risk?			
3.2.4	Research Plan	✓			Interviews DoF
Explanatory Statement		There are no specific Indian mackerel, hilsa shad or small pelagic research plans in place. Myanmar's ongoing involvement and cooperation in the SEAFDEC project titled "Tagging Program For Economically Important Pelagic Species in South China Sea And Andaman sea" is noted.			
3.2.5	Performance Evaluation	✓			Interviews DoF
Explanatory Statement		There are no specific Indian mackerel, hilsa shad or small pelagic management plans and therefore no plans to evaluate.			

2.5.1 Key Weaknesses with Current P3 Performance

A key weakness is the lack of resources that could be applied to the management and assessment of small pelagic species. This indicates that specific management plans and control measures would be difficult to implement even if developed.

2.5.2 Key Recommendations to Address P3 Performance Weaknesses

Specific recommendations for improvement across Myanmar small pelagic fisheries include:

- Setting and implementing a national management plan for small pelagic on a species by species or grouped basis as appropriate;
- Improving data collection at all scales, including fish landed for domestic consumption, for all gear types and recorded at species level;
- Design a comprehensive plan for stock assessments of small pelagic species to be undertaken on a regular basis;
- Improve funding for scientific research and monitoring, to improve coverage and quality of current information collection systems and strengthen scientific input into decision making;
- Improve funding for practical implementation of technical gear measures including Turtle Exclusion Devices and Juvenile Bycatch Excluder Devices.

2.6 SUMMARY – HILSA SHAD

The table below provides a summary of the performance for Hilsa shad in Myanmar

Table 3: Summary performance table for Hisla shad in Myanmar

Unit of Assessment	Principle 1: Stock status						
	Outcome			*Harvest strategy*			
Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment
Gill nets	1	0	n/a	0	0	0	0
Stow nets	1	0	n/a	0	0	0	0
Purse seine	1	0	n/a	0	0	0	0

Unit of Assessment	Principle 2: Ecosystem impacts														
	Retained			*Bycatch*			*ETP*			*Habitat*			*Ecosystem*		
Gear	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring
Gill nets	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
Stow nets	0	0	0	2	2	1	0	0	0	2	1	0	0	0	0
Purse seine	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0

Unit of Assessment	Principle 3: Governance & Management								
	Governance & Policy				*Fishery specific mang*				
Gear	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
Gill nets	1	1	1	0	0	0	1	0	0
Stow nets	1	1	1	0	0	0	1	0	0
Purse seine	1	1	1	0	0	0	1	0	0

3 FISHERIES ASSESSMENTS – INDIAN MACKEREL

3.1 DESCRIPTION OF MAIN FLEETS AND GEARS

For the purpose of this assessment on Indian mackerel, two main ‘units of assessment’ are defined as follows:

1. **Purse seine vessels with 1 inch mesh size** targeting small pelagic species with Indian mackerel landed as a minor bycatch species.
2. **Bottom otter trawl fishery with 1.5 inch mesh size** targeting shrimp and 2.5 inch mesh size targeting demersal fish and landing Indian mackerel as a minor bycatch species.

The two main types of purse seines nets employed in Myanmar waters are the fish purse seine, which is used to catch small pelagic species, and the anchovy purse seine, for anchovies in coastal waters, especially in the northern sector of Rakhine state. The anchovy purse seine is not known to land Indian mackerel and will not be assessed further.

In Myanmar, the purse seine nets are operated in a traditional manner, without fish aggregating devices (FADs). Catching efficiency of this gear has not improved through the years. There are no new fishing techniques to increase fishing pressure on stocks of small pelagic species. Most purse seiners have a skipper with expertise in seeking out fish schools relative to the “fish lures”, and at night, free-school scouting purse nets using lights. The purse seine fishery mainly harvests small mackerels and sardine species, such as Indo Pacific mackerel *Rastelliger brachysoma* and *Sardinella* spp. (FAO, 2010).

Otter bottom trawl nets are the main gear for demersal finfish and penaeid prawns. The trawl fisheries are of sizable scale in Myanmar and contributed more than 40% to marine landing in 2002–2003. The trawlers landed a large number of fish species. When demersal species were still the main catch, the trawl nets caught pelagic finfish, mainly the Indo-Pacific mackerel *R. brachysoma*. This resulted in the Indo-Pacific mackerel being caught mainly by bottom trawl nets.

Penaeid shrimps are important for trawlers operating in inshore waters, particularly on the coast of Rakhine. The rapid development and concentration of the trawl fishery within coastal waters has result in the current intensive exploitation of the coastal demersal finfish and penaeid shrimp resources (FAO, 2010).

3.2 SCALE, INTENSITY AND CONSEQUENCES ANALYSIS

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) – which is provided in detail for Indian mackerel in the main report – in order to determine the overall risk to the stock. A summary of the PSA for Indian mackerel is provided in Table 4.

Table 4: Productivity Susceptibility Analysis for Indian Mackerel

Gear	PSA															
	Productivity								Susceptibility					PSA Scores		
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60

Source: Poseidon

Based on the PSA assessment, Indian mackerel is shown to be highly productive with a minimum population doubling time less than 15 months (Fishbase, 2010).

Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets. Vessels deploying these gears and operating throughout the Bay of Bengal area are likely to overlap > 30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. Due to the mesh sizes of these gears, they have a low selectivity in that most fish encountered will be captured. From a stock status perspective both purse seine and trawl fisheries are considered to be high risk to Indian mackerel.

A PSA has also been undertaken for Indo-Pacific mackerel and is presented in Table 5.

Table 5: Productivity Susceptibility Analysis for Indo-Pacific mackerel

Gear	PSA															
	Productivity								Susceptibility					PSA Scores		
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Purse seine	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
Btm Otter trawl	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80

Source: Poseidon

3.3 PRINCIPLE 1: STOCK STATUS

3.3.1 Unit of Assessment: Purse seine and bottom otter trawl fisheries

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp status	✓			Fishbase, FAO fact sheets, Hutomo *et al* (2009)
Explanatory Statement		Indian mackerel *Rastrelliger kanagurta* has been assessed using the RBF PSA methodology. The species has a high productivity, with a maximum age of 4-5 years and an estimated population doubling time of 15 months. They are pelagic broadcast spawners and have a trophic level of 3.16. While this species scores well under productivity attributes, it does not under selectivity. It is likely to be fished over most of its geographic and depth range. Being a neritic species with common distribution from 20-90m depth, it is likely to have high encounterability with fisheries. It is recognised that Myanmar has participated in the regional tagging project of Indian mackerel, run by SEAFDEC. This study is ongoing and the present levels of returns have not allowed assessment of Indian mackerel population dynamics. While the increase in mesh size for the demersal trawling fleet from 1 inch to 1.5 inches for prawn fishery and 2.5 inches for the demersal finfish fishery is commendable, it is still considered likely that juveniles will be landed by the fishery (note that average size of maturity for females is 19cm, or 7.5 inches).			
1.1.2	Reference points (not if RBF)	✓			n/a
Explanatory Statement		Due to the lack of stock assessment, there are no limit or target reference points for stock management and Bmsy (the biomass at which Maximum Sustainable Yield, is achieved) is unknown.			
1.1.3	Stock rebuilding				n/a
Explanatory Statement		Not expected to be rebuilding, and as RBF used to score 1.1.1 and 1.1.2 no score is given			
Harvest strategy					
1.2.1	Harvest Strategy	✓			Interviews DoF, Szyh Jetty
Explanatory Statement		There is no harvest strategy in place for the fishery that combines monitoring, harvest control rules and management actions. One measure in place relates to minimum mesh size of 1 inch for purse seine and 1.5-2.5 inch for demersal trawl, however this is not considered appropriate to manage the fishery.			

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td>1.2.2</td><td>Harvest control rules and tools</td><td>✓</td><td></td><td></td><td>Interviews DoF, Szyh Jetty</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">There are no harvest control rules and tools in place that specifically manage the removal of Indian mackerel.</td></tr>
<tr><td>1.2.3</td><td>Information / monitoring</td><td></td><td>✓</td><td></td><td>Interviews DGCF, FTDC, Research Institute</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Logbooks are believed to be in operation for the demesal trawling fleet, but it is unknown if logbooks are maintained for the purse seine fishery.

There is no gear differentiation within landing statistics for Indian mackerel

See also comments in 1.1.1 on information on stock status.</td></tr>
<tr><td>1.2.4</td><td>Stock Assessment (not if RBF)</td><td>✓</td><td></td><td></td><td>n/a</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Using the Risk-Based Framework (RBF) this would normally be scored a default ‘Intermediate’ status. However given the lack information on which to base a stock assessment and the lack of ‘management drivers’ to demand an assessment of this stock, it is scored as ‘weak’.</td></tr>
</table>

3.3.2 Key Weaknesses with Current P1 Performance

There is a lack of knowledge on many aspects relating to the stock status of Indian mackerel in Myanmar. The existence of genetically distinct stocks and associated boundaries are unknown. Accurate and complete assessments of stock biomass are not available.

No recent reference points have been defined and there is no harvest strategy or harvest control rules and tools in place to manage the fishery, other than a minimum mesh size which is not appropriate to manage the Indian mackerel stock for all gear types. It is however noted that the mesh size for the demersal trawling fleet targeting finfish was recently increased to 2.5 inches.

Landing statistics are not provided in sufficient detail and do not allow catch per unit effort to be calculated.

3.3.3 Key Recommendations to Address P1 Performance Weaknesses

Specific recommendations to address weaknesses highlighted above include:

- Support to planned and future genetic studies to determine Indian mackerel stock units;
- Provide training and capacity building on stock assessment methodologies for small pelagic species;
- Undertake coordinated and complete stock assessments on a regular (annual) basis to determine stock status of Indian mackerel and establish appropriate reference points;
- Collect data on landings by species for all vessel sizes and gear types. Ensure appropriate detail to allow analysis of catch/effort and size composition; and
- Develop appropriate harvest control rules.

3.4 PRINCIPLE 2: ECOSYSTEM IMPACTS

3.4.1 Unit of Assessment: Purse seine

It is understood that Indian mackerel is landed by the same fleet of purse seiners that target hilsa shad. The Principle 2: Ecosystem Impacts assessment undertaken for hilsa is therefore applicable for this Indian mackerel fishery and will not be repeated here. This assessment is presented in Section 2.4.1: Unit of Assessment Purse Seine.

3.4.2 Unit of Assessment: Bottom otter trawl

<table>
<tr><th>PI</th><th>Title</th><th>Weak</th><th>Intermediate</th><th>Good</th><th>Reference</th></tr>
<tr><td colspan="6">Retained species</td></tr>
<tr><td>2.1.1</td><td>Retained spp Status</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The bottom otter trawls are predominately targeting shrimps and demersal fish. Indian mackerel are taken as bycatch when the nets are hauled through the water column.

The demersal fish species associated with this fishery are unknown.

The current status of shrimp fisheries is also unknown.</td></tr>
<tr><td>2.1.2</td><td>Retained spp management</td><td></td><td>✓</td><td></td><td>Interviews DoF, Szyh Jetty</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">The minimum mesh size for demersal trawling fleet was recently increased under a Regulation introduced on 1st September 2010. This increased prawn trawl nets to 1.5 inch mesh size and finfish trawl nets to 2.5 inches. Due to the timescale of this introduction it is currently too early to tell if the numbers of juvenile fish landed is decreasing.

There are no other controls over the size of fish landed or the volumes landed.

There is seasonal closure for 3 months during May-July to protect spawning grounds. Four fishery blocks (as represented in Figure 1) are closed, although the locations of these blocks are not known.</td></tr>
<tr><td>2.1.3</td><td>Retained spp Information</td><td></td><td>✓</td><td></td><td>Interviews DoF, Szyh Jetty</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">It is understood that logbook schemes are in place for demersal trawling fleet. Data from these logbooks have not been available for assessment. It is unknown if all vessel size complete logbook are to what extent landings for local consumption are recorded.</td></tr>
<tr><td colspan="6">Discard species</td></tr>
<tr><td>2.2.1</td><td>Discard spp Status</td><td></td><td></td><td>✓</td><td>Interviews DoF, Szyh Jetty</td></tr>
<tr><td colspan="2">Explanatory Statement</td><td colspan="4">Discards from this fishery are understood to be non-existent.</td></tr>
</table>

PI	Title	Weak	Intermediate	Good	Reference
2.2.2	Discard spp Management			✓	Interviews DoF, Szyh Jetty
Explanatory Statement		Discards from this fishery are understood to be non-existent. As a result no bycatch minimisation management is currently required. It is recommended that any further management implemented to address retained species should ensure that discards continue to be minimal.			
2.2.3	Discard spp Information		✓		Interviews DoF, Szyh Jetty
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. This fishery would benefit from an observer programme to verify this low level/ negligible impact.			
ETP species					
2.3.1	ETP spp Status	✓			Interviews DoF, Szyh Jetty
Explanatory Statement		Demersal trawl gear in this area is likely to incidentally catch turtles. While the main disturbance and threat to turtles is likely to be from impacts occurring at nesting sites, the bycatch of turtles in shrimp trawls is likely to be high.			
2.3.2	ETP spp Management		✓		Interviews DoF, Szyh Jetty
Explanatory Statement		Area C4 is closed for the entire year in order to protect turtle nesting sites. This area is known to be an important stretch of water for transiting green turtles. The Myeik Archipelago Islands have large areas closed to fishing, primarily to protect coral reef habitats, but this also acts to protect ETP species in this area. Turtle Excluder Devices (TED) have been trialled by the Fisheries Technology Department, however they are not mandatorily or voluntarily implemented within demersal trawling fleet.			
2.3.3	ETP spp Information		✓		Interviews DoF, Szyh Jetty
Explanatory Statement		Data on the presence and distribution of ETP species is available for the areas surrounding the Myeik Archipelago Islands. However, data outside this area could be improved; furthermore data specific to demersal trawl interaction with ETP species is lacking. In particular observer data to monitor turtle bycatch would be beneficial to establish the true extent of status and required management measures.			

PI	Title	Weak	Intermediate	Good	Reference
Habitats					
2.4.1	Habitat Status (SICA only)	✓			Interviews DoF, Szyh Jetty
Explanatory Statement		Habitat impacts from this bottom otter trawl fishery are likely to be significant.			
2.4.2	Habitat Management		✓		Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement		Strategies are in place to manage the habitat impact through closed areas to protect coral reefs around the Myeik Archipelago Islands. However the extent and spatial distribution of corals outside this area is less understood and no other management measures exist to protect their presence.			
2.4.3	Habitat Information		✓		Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement		As with ETP species, the extent and location of important habitats including coral reefs, seagrass beds and mangroves are well understood for the areas surrounding the Myeik Archipelago Islands. Information is generally lacking for other areas.			
Ecosystems					
2.5.1	Ecosystem Status	✓			Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement		The fishery catches a wide range of species including high rates of juveniles, which may be of concern to recruitment of these species. While the trophic level of most species caught is well understood, there is not ecosystem modelling to predict impacts of removal at current rates. Demersal trawling gear also indiscriminately removes of a wide range of species and is not as targeted as other gears. The fishery therefore scores poorly for ecosystem status.			
2.5.2	Ecosystem Management	✓			Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement		No ecosystem management measures are undertaken at national level. Due to the higher degree of indirect effects associated with habitat impacts the fishery scores worse than other gear types.			
2.5.3	Ecosystem Information	✓	✓		Interviews DoF, Szyh Jetty, BOBLME workshop
Explanatory Statement		Total removals are not well known for Myanmar fisheries. There is little information on the ecological impacts of this fishery and ecosystem modelling has not been undertaken.			

3.4.3 Key Weaknesses with Current P2 Performance

Key weaknesses are largely consistent with those presented under hilsa P2 assessment for the small pelagic purse seine fishery, presented in Section 2.4.3. In addition to these, the major weakness for the trawl gear is associated with habitat and ETP interactions.

3.4.4 Key Recommendations to Address P2 Performance Weaknesses

Key recommendations over and above those presented in Section 2.4.4 and specific to the demersal trawl fleet include:

- Introduction of TEDs to the trawl fleet, prioritizing those of most impact to turtles i.e. those in coastal locations and targeting shrimp; and
- Improve knowledge on habitat status with particular focus on coral reef systems with the view of establishing further closed areas to trawl fisheries.

3.5 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

The management framework, key weaknesses and recommendations for the Indian mackerel fishery are consistent with those presented for hilsa shad in Section 2.5.

For Indian Mackerel the capacity problems identified are exacerbated by the offshore fishery mainly involving foreign vessels under license that are not always landing catches back into Myanmar.

3.6 SUMMARY – INDIAN MACKEREL

The table below provides a summary of the performance for Indian mackerel in Myanmar

Table 6: Summary performance table for Indian Mackerel in Myanmar

Unit of Assessment	Principle 1: Stock status							Principle 2: Ecosystem impacts															Principle 3: Governance & Management								
	Outcome			*Harvest strategy*				*Retained*			*Bycatch*			*ETP*			*Habitat*			*Ecosystem*			*Governance & Policy*				*Fishery specific mang*				
Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
Purse seine	0	0	n/a	0	0	1	0	1	1	0	2	2	1	1	1	1	2	2	1	1	1	0	1	1	1	0	0	0	1	0	0
Btm otter trawl	0	0	n/a	0	0	1	0	0	1	1	2	2	1	0	1	1	0	1	1	0	0	0	1	1	1	0	0	0	1	0	0

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Appendix I: Country Report – Sri Lanka

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Beach seine net being hauled at Beruwela. Source: Ms. Deishini Herath

Country Report: Sri Lanka

Prepared by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms

BOBLME	Bay of Bengal Large Marine Ecosystem
CIDA	Canadian International Development Agency
CPUE	Catch Per Unit of Effort
CZMP	Coastal Zone Management Plan
DARD	Department of Fisheries and Aquatic Resources
FAO	Food and Agriculture Organisation (of the United Nations)
MARD	Ministry of Fisheries and Aquatic Resources
MTRB	Motorized traditional boats
NARA	National Aquatic Resources Research and Development Agency
NTRB	Non-motorized traditional boats
OFRP	Fibreglass reinforced plastic boats
PSA	Productivity and Susceptibility Analysis
RBF	Risk Based Framework
SICA	Scale, Intensity and Consequences Analysis

1 OVERVIEW

The island of Sri Lanka (Figure 1) is located in the Indian Ocean to the southeast of India. Its area is approximately 65,610km^2 with a coastline of about 1,620km (Joseph, undated). Sri Lanka and the southern tip of India share the same continental shelf and are separated by a shallow sea, the Palk Strait, which is barely 30m deep. However, the shelf ends more abruptly in the south and east of Sri Lanka, averaging 22.5 km in width and rarely extending beyond 40 km. Within the shelf area, estimated to cover about 30,000km^2, the mean water depth is about 75m, but the depth drops abruptly to 900m within 3km and 1,800m within about 15 km of the shelf's edge. Beyond this there is a steep descent of over 5,500m to the depths of the Indian Ocean (Madduma Bandara, 1989).

Figure 1: Map of Sri Lanka

1.1 DESCRIPTION OF MAIN FLEETS AND GEARS

Although the Indian mackerel is a popular fish in Sri Lanka, it is not a major target fishery and is mainly landed as a minor bycatch from fisheries targeting other small pelagic species, primarily the spotted sardinella (*Amblygaster sirm*). Three main gears are used to catch Indian mackerel in Sri Lanka, as shown below in Table 1.

Table 1: Gears used in Sir Lanka to catch Indian mackerel

Gear	Locations & seasons	Fleet characteristics	Other factors
Small mesh gillnet (2.5 – 3 cm mesh)	NW: June – Oct W: Jan-mar & Aug-Dec S: June - Nov	15-30 hp vessels – out-board engine fibreglass reinforced plastic boats (OFRP); motorized traditional Boats ((MTRB); & non-motorized traditional boats (NTRB). 2-3 crew	10-30m water depth. Use 15 – 20 panels 1,500 meshes in length 120 and 330 – 120 meshes in depth
Small mesh gillnet (4-4.5 cm mesh)	NW: July to Sep in NW		
Beach seine (< 1 cm mesh)	Entire coast, at specific traditional beach locations	Shore-based, except to tow out net with a beach seine craft (NBSB). 20 persons	Up to 1,000m long. Shallow, inshore waters <10m deep.

The small mesh gillnet fishery is the most important, although mainly targets sardinallas and other smaller pelagic species. The slightly larger (but still small) mesh (4-4.5 cm) used at specific periods of the year is more focused on Indian mackerel and other slightly larger small pelagic species such as the *Decapterus* scads.

Gillnet fisheries are coastal in nature operating mainly over the wider shallow continental shelf in the north of the country, operating out to 25 km offshore in motorised boats and 2 km in un-motorised vessels. The different sized mesh nets are used by the same vessels, with a switch to the larger mesh nets for small periods of the year when the Indian mackerel is more targeted. As such, for the purpose of this assessment, small-mesh gillnets are considered as one ‘unit of assessment’. Gillnets are set on the surface, usually early in the morning and occasionally overnight. The catches from a sample of motorised fibreglass, mortised traditional and non-motorised traditional gillnet vessels for 2008 & 2009 at selected locations is provided in Table 2, and shows that Indian mackerel represents only around 2-3% of the total catch by these vessels.

Table 2: Species composition of small-mesh gillnet catches (2008 & 2009)

A. 2008

Species	OTRP		MTRB		NTRB		All boats	
	Kg/yr	%	Kg/yr	%	Kg/yr	%	Kg/yr	%
Amblygaster sirm	41,059	46%	5,462	54%	139	3%	**46,660**	**45%**
Sardinella gibbosa	7,895	9%	2,115	21%	14	0%	**10,024**	**10%**
Ariidae	5,716	6%	-	0%	1	0%	**5,717**	**6%**
Sardinella albella	3,722	4%	35	0%	975	23%	**4,731**	**5%**
Carangidae	3,411	4%	11	0%	206	5%	**3,628**	**3%**
Sardinella longiceps	1,778	2%	1,142	11%	567	13%	**3,487**	**3%**
Amblygaster clupeoides	3,196	4%	1	0%	1	0%	**3,198**	**3%**
Other rockfish	2,977	3%	14	0%	48	1%	**3,038**	**3%**
Rastrelliger kanagurta	2,357	3%	317	3%	31	1%	**2,705**	**3%**
Stolephorus heterolobus	2,491	3%	-	0%	16	0%	**2,508**	**2%**
Selar crumenophthalmus	1,726	2%	60	1%	409	9%	**2,195**	**2%**
Pellona ditchela	1,357	2%	13	0%	346	8%	**1,717**	**2%**
Auxis thazard	1,277	1%	-	0%	-	0%	**1,277**	**1%**
Other small pelagics	1,040	1%	5	0%	64	1%	**1,109**	**1%**
Stolephorus bataviensis	1,085	1%	-	0%	13	0%	**1,098**	**1%**
Decapterus russelli	815	1%	96	1%	15	0%	**926**	**1%**
Gazza minuta	492	1%	1	0%	275	6%	**768**	**1%**
Chirocentrus dorab	558	1%	15	0%	185	4%	**758**	**1%**
Exocoetidae	746	1%	-	0%	-	0%	**746**	**1%**
Dussumieria acuta	487	1%	115	1%	73	2%	**674**	**1%**
Auxis rochei	617	1%	-	0%	-	0%	**617**	**1%**
Other species	4,508	5%	719	7%	948	22%	**6,175**	**6%**
TOTAL	**89,309**	**100%**	**10,119**	**100%**	**4,325**	**100%**	**103,754**	**100%**

B. 2009

Species	OTRP		MTRB		NTRB		All boats	
	Kg/yr	%	Kg/yr	%	Kg/yr	%	Kg/yr	%
Amblygaster sirm	40,066	43%	4,718	63%	198	4%	**44,982**	**43%**
Sardinela longiceps	4,466	5%	603	8%	975	19%	**6,044**	**6%**
Stolephorus heterolobus	4,561	5%	10	0%	58	1%	**4,629**	**4%**
Carangidae	3,590	4%	28	0%	153	3%	**3,771**	**4%**
Sardinella gibbosa	2,036	2%	1,460	19%	156	3%	**3,652**	**3%**
Sardinella albella	2,567	3%	39	1%	750	15%	**3,356**	**3%**
Auxis thazard	2,950	3%	-	0%	-	0%	**2,950**	**3%**
Amblygaster clupeoides	2,919	3%	-	0%	-	0%	**2,919**	**3%**
Other rockfish	2,749	3%	-	0%	22	0%	**2,770**	**3%**
Sardinella sindensis	2,464	3%	44	1%	213	4%	**2,721**	**3%**
Ariidae	2,544	3%	1	0%	3	0%	**2,547**	**2%**
Selar crumenophthalmus	1,630	2%	-	0%	514	10%	**2,144**	**2%**
Decapterus russelli	1,676	2%	2	0%	5	0%	**1,683**	**2%**
Euthynnus affinis	1,613	2%	5	0%	-	0%	**1,618**	**2%**
Auxis rochei	1,617	2%	-	0%	-	0%	**1,617**	**2%**
Other small pelagics	1,359	1%	-	0%	75	1%	**1,434**	**1%**
Exocoetidae	1,382	1%	-	0%	-	0%	**1,382**	**1%**
Chirocentrus dorab	1,185	1%	13	0%	179	4%	**1,377**	**1%**
Stolephorus bataviensis	1,344	1%	-	0%	-	0%	**1,344**	**1%**
Rastrelliger kanagurta	1,102	1%	66	1%	65	1%	**1,234**	**1%**
Other species	9,012	10%	512	7%	1,713	34%	**11,237**	**11%**
Total	**92,830**	**100%**	**7,500**	**100%**	**5,077**	**100%**	**105,407**	**100%**

Source: NARA internal records (Small Pelagic Survey)

Figure 2: Small mesh gillnet vessels in Negombo - sorting the catch

Source: Poseidon

The beach seine fishery is a very small-mesh traditional fishing method in designated zones of the sub-littoral zone. This gear is up to a kilometre in length, and is towed by a boat around the shore line in shallow sub-tidal waters down to around 10 m. It consists of a small mesh (< 1cm) encircling net with an additional cod end. Typically, two hauls a day are made in the peak season (one in the morning and one in the evening), with Sundays considered a day of rest. The net is used on sandy or muddy substrates, and has a large number of small (*c*. 1 kg) weights to keep the footrope on the bottom. Catches average around 100 – 300 kg per haul, mostly of sardines (*Sardinella* spp.), anchovies (*Stolephorus* spp.) and silver bellies (*Leiognathus* spp.) – see Table 3.

Table 3: Species composition of beach seine catches

Species	NW 1992 to 1994			Southern 1995 - 97		
	Kg / operation	%	rank	Kg / operation	%	rank
Sardinella gibbosa	74.56	27.5	1	0.62	0.4	11
S. albella	37.42	13.8	2	7.09	4.5	6
Amblygaster sirm	35.54	13.1	3	8.7	5.5	5
Leiognathus sp	21.05	7.7	4	18.22	11.5	2
Carangids	19.65	7.2	5	15.13	9.5	3
Rastrelliger kanagurta	***19.49***	***7.2***	***6***	***4.61***	***2.9***	***7***
Stolephorus sp	13.09	4.8	7	49.27	31.7	1
Sphyreana sp	2.77	1	8	4.14	2.6	8
Chirocentrus sp	2.51	.9	9	1.47	.9	10
Dussumieria accuta	2.12	.7	10	0.56	.4	12
Pellona sp	1.33	.4	11	2.74	1.7	9
Trichurus so.	1.11	.4	12	13.46	8.5	4

Source: Fernando (2001)

1.2 CURRENT EFFORT, CATCHES AND SOCIO-ECONOMIC IMPORTANCE

Current effort levels in the mixed small-mesh gillnet pelagic fishery are not known. However, fleet numbers for the main vessels catching small pelagic species are shown in Table 4 and indicate very significant increases in recent years. Much of the increase has been fuelled by donations of boats following the tsunami at the end of 2004. Of course many of these vessels may use gear not catching small pelagics, rather than the small-mesh gill nets which do, but Table 4 provides a strong indication that effort levels on small pelagics have been increasing significantly in recent years. There were also 975 beach seine operations in the country in 2009.

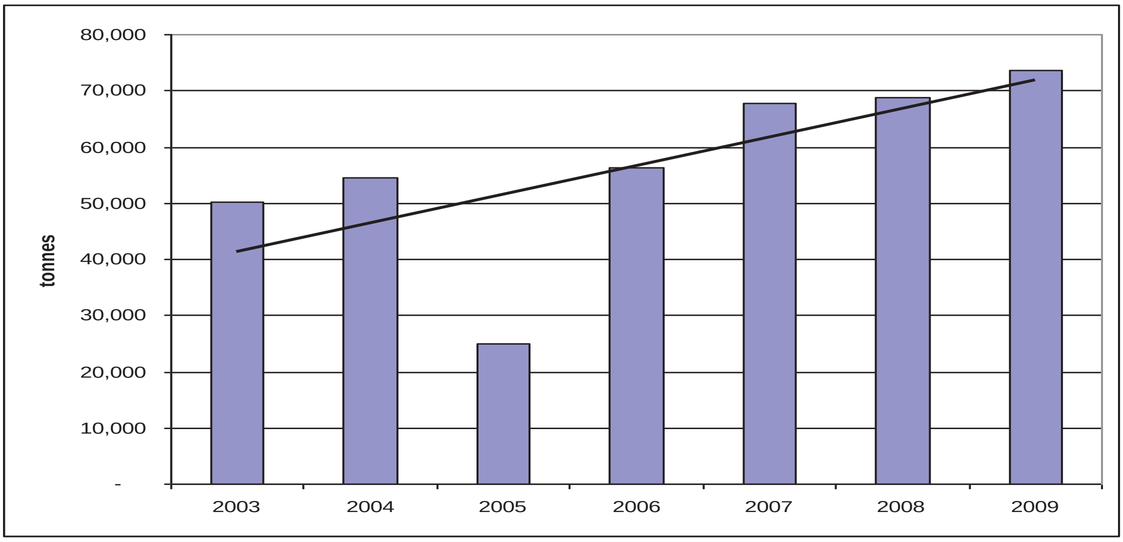
Table 4: No. of vessels potentially using small-mesh gillnets to target small pelagic species

Year	Outboard FRP	Outboard traditional	Non-motorised traditional
2000	8,690	1,205	15,100
2001	8,744	640	15,200
2002	9,033	776	15,600
2003	11,020	618	15,040
2004	11,559	674	15,260
2005	11,010	1,660	14,739
2006	13,860	1,842	16,347
2007	15,200	1,680	16,640
2008	15,847	1,959	17,178
2009	17,193	2,126	18,243

Source: Sri Lankan fisheries statistics, 2009

The supposition about rising effort levels is supported by national catch levels of small pelagic species shown in Figure 3 overleaf, which demonstrates an increase of 40% in landed volumes over the last 7 years. Landed volumes are not recorded by species, but the data collected by NARA shows that Indian mackerel contributed just 2.61% of total small pelagic catches in 2008 and 1.17% of small pelagic catches in 2009. Applying these percentages to the total volumes of landed small pelagics, we can estimate that Indian mackerel catches in Sri Lanka were around 1,796 tonnes in 2008 and 862 tonnes in 2009.

Figure 3: Landings of small pelagic species 2003 to 2009 (tonnes)



Source: Sri Lankan fisheries statistics, 2009

Market prices are tracked on a regular basis for *Sardinella* in the Colombo wholesale market, and assuming similar prices for all small pelagics of Rs/kg 98.75 in 2009, landed values of small pelagics in 2009 can be approximated at around Rs 7.3 billion / $63.7 million, and a landed value of Indian mackerel in 2009 at around Rs 86 million / $758,816.

Table 5: Small pelagic landings by district (tonnes, 2009)

District	Shore seine / small pelagic	District	Shore seine / small pelagic
Puttulam	5,840	Kalmunai	7,190
Chilaw	6,980	Batticaloa	15,020
Negombo	11,040	Trincomolee	9,760
Colombo	220	Mallaithivu	-
Kalutara	3,670	Kilinochi	-
Galle	4,860	Jaffna	1,910
Matara	4,290	Mannar	710
Tangalla	4,140	**Total**	**73,630**

Source: Sri Lankan fisheries statistics, 2009

The socio-economic importance of small pelagic species is thought to be very considerable, given their low cost to consumers meaning that they are one of the most affordable forms of seafood, with a very high nutritional value and being rich in micro-nutrients. While exact figures are not known, small pelagic species contribute very significantly to the total fishing population in the country of around 165,000 people. However, given the very low estimated volumes of Indian mackerel landed in Sri Lanka, its socio-economic importance can be considered as minor. As shown in Table 5, Negombo and Batticaloa are the two districts contributing the greatest proportions of total small pelagic catch to national figures. There has been little work completed on the socio-economic importance of small pelagic fisheries, especially in the North and East of the country, and this remains a major research gap.

1.3 ENVIRONMENT

Sri Lanka has a tropical climate with an annual weather cycle divided into two main periods:

- the south-west monsoon, from May to August, which brings rains to the southern and western coastal regions. The dry season in these regions is from December to March;
- the north-east monsoon, from October to January, which brings rain to the north and east of the island. This is weaker and shorter-lived than the southwest monsoon.

The large-scale oceanic currents around Sri Lanka undergo complete seasonal reversals. Currents to the east of the island are strongest during the north-east monsoon (November-March), and follow a gyre which changes from clockwise to anti-clockwise and back again during the course of the year. Currents to the south of the island flow eastwards from about May to about October, and westwards for the remainder of the year. In general the currents off the east coast are stronger than those off the west coast, while those off the southern coast are among the strongest of all (De Bruin, Russell and Bogusch, 1994).

Sri Lanka has four National Parks adjoining coastal waters and a total of 17 other protected areas designated as marine sanctuaries (draft CZMP, 2003).

The incidental catching of marine mammals became a major environmental issue in Sri Lanka in the 1980's, and a number of investigations conducted during the 1980's and 1990's provided estimates of dolphins killed, ranging from 8,000 to nearly 50,000 per annum, mostly by the large-mesh tuna-directed fisheries. The highest estimate of 49,863 made by Leatherwood and Reeves (1989) was later revised to 8,042-11,821 by the same authors, admitting to an error in the original calculations. Five species of dolphins - the Spinner, Striped, Bottlenose, Risso's and Spotted dolphin are the most common among the dolphin by-catch. Among the smaller whales, the Pygmy killer whale, the False Killer whale and the Dwarf Sperm whale have been reported in most studies.

Of the seven species of marine turtles found in the world, five are reported from around the seas off Sri Lanka and all five species are also reported to come ashore for nesting. These species – the Olive Ridley (*Lepidochelys olivacea*), the green turtle (*Chelonia mydas*), the leatherback turtle (*Dermochelys coriacea*), the loggerhead turtle (*Caretta caretta*) and the hawksbill turtle (*Eretmochelys imbricata*) are also listed as either endangered or vulnerable in the IUCN Red List. An amendment to the Fauna and Flora Protection Ordinance in 1972 has provided legal protection to all species of marine turtles in Sri Lanka. However, marine turtles continue to be exploited by coastal communities for their eggs, meat and carapace.

There are also some important coral reef areas at various locations around the Sri Lankan coastline.

1.4 SCALE, INTENSITY AND CONSEQUENCES ANALYSIS (SICA)

A first step in a 'Risk Based Framework' for assessing data-poor fisheries is to determine the scale and intensity of the fishery. This is then used with the 'Productivity / Susceptibility Analysis' (PSA) – which is provided for Indian mackerel in the main report – in order to determine the overall risk to the stock.

Figure 4: Productivity / Susceptibility Analysis (inc. SICA)

Gear	PSA															
	Productivity								Susceptibility					PSA Scores		
	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Gill nets (< 9 cm)	1	1	1	1	1	1	2	1.14	2	2	3	3	1.88	2.20	Low	>80
Beach seine	1	1	1	1	1	1	2	1.14	1	3	3	3	1.65	2.01	Low	>80

The table above shows that the Indian mackerel is highly productive. However the fishery scores poorly in terms of all the elements of susceptibility, mainly due to the small mesh sizes of both the beach seine (PSA score 2.01) and gill net (2.20), as well as the high (beach seine) and medium (gill net) level of encounterability of the gear in the water column. However, because of the species' high productivity and low availability of the stock to the fishery (it only operates in the coastal fringes of the stock), this stock is considered low risk overall.

1.5 PEOPLE MET

Name	Title & Organisation	Contact details	Location of meeting
Dr. Hiran W. Jayawardene	Chairman, NARA	chairman@nara.ac.lk	NARA, Colombo
Mrs. Nilmini Diybedanage	Director General, NARA	dg@nara.ac.lk	NARA, Colombo
Mr. Indra Ranasinghe	MFAR	0718724161 iranapiu@yahoo.com	NARA, Colombo
Mr. J. Jayasooriya	Statistician, MFAR	2381367, b.jayasooriya@yahoo.com	NARA, Colombo
Ms. Kalyani Hewapathirana	DFAR	2470439, kalhewa2009@yahoo.com	NARA, Colombo
Dr. Champa Amarasiri	FAO	Champa.amarasiro@fao.org	NARA, Colombo
Mr. K Silva	Min. of Envt. & Natural Resources		NARA, Colombo
Dr. Rekha Maldenniya	Head, Marine Biological Resource Div., NARA	rekhamaldeniya@gmail.com	NARA, Colombo
Mr. S. Azmy	NARA	azmyahmed@yahoo.com	NARA, Colombo
Mr. P Jayasinghe	Research Officer, NARA	Prabath_jayasinghe@yahoo.com	NARA, Colombo
Ms. D. Herath	NARA	deishini.herath@yahoo.com	NARA, Colombo
A.A. Abeysinghe	Fisheries Resources, MRAD	vrdfar@gmail.com	MARD, Colombo
S.O. Premawardana	Fisheries Inspector, MARD	rrdfar@gmail.com	MARD, Colombo
Amidha Abayasiri	Legal assistant, MARD	amidhaabeysiri@yahoo.com	MARD, Colombo
A.J.P.C Wijegoonaboaraan	Deputy Director, MARD		MARD, Colombo
A.H.B. Edinweera	Socio-economist, MARD	ahsediriweera@fisheries.gov.lk	MARD, Colombo
Patrick Evans	FAO	Patrick.evans@fao.org	Colombo
Gill net fishermen: various individual fishermen			Negombo
Beach seine fishermen: various individual fishermen			Negombo

2 FISHERIES ASSESSMENTS – INDIAN MACKEREL

For the purpose of this assessment, two main 'units of assessment' are defined as follows:

1. **Small mesh gillnet fishery** (mesh size 2-4.5cm / 1-2.5 inches), used by fibreglass reinforced plastic boats (OFRP), motorized traditional Boats ((MTRB), & non-motorized traditional boats (NTRB) throughout Sri Lanka; and
2. **Beach seines** (mesh size <1cm) throughout Sri Lanka.

2.1 PRINCIPLE 1: STOCK STATUS

2.1.1 Assessment

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp. status			✓	Interviews NARA/Ministry. Sanders & Dayaratne (1999)
Explanatory Statement		There is no recent formal stock assessment or information on which to determine whether the stock is at a level which maintains high productivity and has a low productivity of recruitment overfishing[1]. So this PI is scored using the RBF. Using the RBF, the fishery scores very highly for productivity (1.14, see main report). However it scores poorly in terms of all the elements of susceptibility, mainly due to the small mesh sizes of both the beach seine (PSA score 2.01) and gill net (2.20). However, because of the low availability of the stock to the fishery (it only operates in the coastal fringes of the stock), this stock is considered low risk overall.			
1.1.2	Reference points (not if RBF)	✓			n/a
Explanatory Statement		There are no limit or target reference points due to the lack of stock assessment so scored under RFB (see above)			
1.1.3	Stock rebuilding				n/a
Explanatory Statement		Not expected to be rebuilding, and as RBF used to score 1.1.1 and 1.1.2 no score is given			
Harvest strategy					
1.2.1	Harvest Strategy	✓			Interviews NARA/Ministry
Explanatory Statement		There is no harvest strategy for any small pelagics, either for gillnets or beach seines. There are no input management measures, output management measures, or technical management measures at all. Some research is ongoing on the impact of night fishing by gillnets			

[1] In 1999 Sanders and Dayaratne suggested that the MSY for Indian mackerel might be in the order of 770 tonnes per year.

PI	Title	Weak	Intermediate	Good	Reference
		(important for spawning) and such fishing may be regulated in the future. No information is available on locations of key spawning grounds, nursery areas, etc on which to base a harvest strategy.			
1.2.2	Harvest control rules and tools	✓			Interviews NARA/Ministry
Explanatory Statement		There are no harvest control rules and tools in place at all. Boats must be registered and licensed but there are no restrictions in terms of numbers. Some gear and time restrictions are in place but these are very localised in some areas and motivated by a desire to reduce user conflict.			
1.2.3	Information / monitoring	✓			Interviews NARA/Ministry
Explanatory Statement		A little bit of work has been done on stock structure e.g. length frequency, but nothing is known on biomass levels (since the *Fridtjof Nansen* surveys in the 1980's), migration, etc. More on is known on general stock productivity. Fleet composition is well known. For small scale landing sites data collection is not considered to be very reliable, and data for individual small pelagic species are not recorded separately by the Ministry. Each fisheries inspector division is responsible for recording landings data, based on estimates provided by fishing cooperatives/organisations. Improvements are however underway with training being provided by the Statistics Department to fisheries inspectors on species identification and verification cross-checks.			
1.2.4	Stock Assessment	✓			n/a
Explanatory Statement		Using the Risk-Based Framework (RBF) this would normally be scored a default 'Intermediate' status. However given the lack information on which to base a stock assessment and the lack of 'management drivers' to demand an assessment of this stock, it is scored as 'weak'.			

2.1.2 Key Weaknesses with Current P1 Performance

It is assumed that there is one stock of Indian mackerel in Sri Lankan waters, although this is far from certain as genetic tests have not been carried out (Dayaratne, 1998) and the presence of localised sub-populations should not be ruled out.

Key weaknesses with respect to the assessment of stock status relate to:

- A lack of knowledge of stock biomass (unexploited or current levels), and therefore no way to determine any target reference points
- A complete lack of any sort of control over effort/inputs, outputs/volumes, or the use of specific gears (i.e. no minimum mesh size)
- Insufficient disaggregation of information collected and recorded on small pelagic species

2.1.3 Key Recommendations to Address P1 Performance Weaknesses

Specific recommendations to address weaknesses highlighted above, some of which could fall under future support by the BOBLME project include:

- Expand catch monitoring of small pelagics by NARA to include landing sites in North and North East;
- NARA to establish a small-pelagic database (similar to the one maintained for large pelagics and used to provided data on tuna and tuna-like species to IOTC);
- Ministry to break down small pelagic catch reporting to provide information on key small pelagic species, and to continue training of inspectors in species identification and data cross-checking;
- Preparation of a small pelagic management plan (see below in Section 2.3.3). Note that a recent CIDA/FAO project (completed in 2010) worked to prepare management plans for some inshore species (e.g. lobster, ornamental fish) so there is some institutional capacity present in Sri Lanka, both within NARA and the Ministry, that could be used and further strengthened;
- A genetic study to be completed to determine whether Indian mackerel found in Sri Lanka is one stock, and whether stocks are shared with India;
- A study on Indian mackerel migration and other small pelagics – both horizontal (e.g. along coast or into other national waters), and vertical (between inshore shallow waters and offshore deeper waters);
- Training provided to NARA staff on stock assessment methodologies for small pelagic species.

Figure 5: Small pelagic fishermen in Negombo

Source: Poseidon

2.2 PRINCIPLE 2: ECOSYSTEM IMPACTS

2.2.1 Unit of Assessment A: Small-mesh gillnets

PI	Title	Weak	Intermediate	Good	Reference
Other retained species					
2.1.1	Other retained spp. status		✓		Dayaratne (1997); Sanders & Dayaratne (1999)
Explanatory Statement		The stock status of none of the main bycatch species are known, although yield estimates for all the small pelagic species were made in 1998. More work has been done on *Amblygaster sirm* as the main catch (*c.* 45%), where CPUE's are known to be declining. Even in the case of *A. sirm* where there are some data, this is insufficient to demonstrate recruitment impairment with current catches. In 1999 Sanders and Dayaratne suggested there was room for a modest improvement in these fisheries, but the fishery has expanded considerably since then and revised stock assessments are now urgently needed.			
2.1.2	Other retained spp. management	✓			Interviews NARA/Ministry
Explanatory Statement		There is no effective management of the small pelagic gillnet fishery. There are no minimum mesh sizes, harvest strategy or harvest control rules. As a result there are no controls over the size of fish being caught, nor the volumes involved. The smaller mesh sizes in particular have very high catch rates of juvenile fish with an unknown effect upon recruitment.			
2.1.3	Other retained spp. Information		✓		Interviews NARA/Ministry
Explanatory Statement		NARA has been collecting samples of small pelagic catches since 2000. These detail catch (to species level) as well as gear, fishing location and vessel type data, but takes places at selected landing sites, and is not national in coverage. There is also some limited length-frequency data collection. See also comments above in 1.2.3 on Ministry data collection of small pelagic landings.			
Discard species					
2.2.1	Discard spp. Status			✓	Fishermen interviews
Explanatory Statement		Discards from this fishery are almost non-existent, limited to occasional puffer fish and jellyfish. The status of these species is unknown, but there is likely to be a degree of post-discard survival.			
2.2.2	Discard spp. Management			✓	Interviews NARA/Ministry
Explanatory Statement		There is no management of discards due to the very low volume			

PI	Title	Weak	Intermediate	Good	Reference
		involved, which constitutes a de facto partial strategy e.g. no discarding.			
2.2.3	Discard spp. Information		✓		Interviews NARA/Ministry
Explanatory Statement		No formal assessment of discard rates and nature have been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
ETP species					
2.3.1	ETP spp. Status			✓	Fishermen interviews; Kapurusinghe and Cooray, 2002
Explanatory Statement		Due to the small mesh nature of this fishery and its short soak time (<2 hours), this fishery does not interact with any ETP species. It is understood that there is the very occasional sea turtle that gets entangled in the top floats, but these are released alive.			
2.3.2	ETP spp. Management			✓	Interviews NARA/Ministry; Kapurusinghe and Cooray, 2002
Explanatory Statement		There is no management of discards due to the very low volume involved, which constitutes a de facto partial strategy e.g. no ETP interactions. There are strong regulatory controls preventing the catch of ETP species. A code of conduct to formalise release procedures may be necessary.			
2.3.3	ETP spp. Information		✓		Interviews NARA/Ministry; Kapurusinghe and Cooray, 2002
Explanatory Statement		No formal assessment of the rate and nature of ETP interactions has been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Fishermen interviews. Interviews NARA/Ministry
Explanatory Statement		This is purely a surface fishery with a very limited interaction with the substrate. There may be the occasional contact when fishing in shallow waters, but this is intermittent and temporary. Bottom trawling for small pelagics is banned.			
2.4.2	Habitat Management		✓		Interviews NARA/Ministry
Explanatory Statement		There is no management of habitat interactions in this fishery as these are rare, temporary and low impact. However further spatial management may be appropriate to ensure that larger nets do not touch the bottom and to minimise gear conflicts and thus minimise gear loss. There is however a regulatory ban on the use of gill nets in			

PI	Title	Weak	Intermediate	Good	Reference
		coral reef areas.			
2.4.3	Habitat Information		✓		Interviews NARA/Ministry
Explanatory Statement		Outside of the coral reef areas there is little information on the nature of marine habitats and their spatial distribution. Given the shallow nature of the fishing areas, this knowledge could be improved and any necessary spatial measures e.g. closure of shallow, rocky substrates, be considered.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Haputhantri et al, 2008.
Explanatory Statement		This fishery has no minimum mesh size and thus has a high potential to disrupt recruitment, esp. give the current rate of (uncontrolled) expansion. It catches a wide variety of pelagic and epi-pelagic species at a number of trophic levels (e.g. from planktivorous scobrids to piscivorous barracuda and carangids).			
2.5.2	Ecosystem Management		✓		Interviews NARA/Ministry
Explanatory Statement		There is a total lack of control over this fishery in terms of catch selectivity and effort. Given its focus on a wide range of both prey and predator species this is of concern, although any ecosystem impact is yet to be proven.			
2.5.3	Ecosystem Information		✓		Haputhantri et al, 2008
Explanatory Statement		There is little information on the ecological impact of this fishery, although preliminary EcoPath modelling has been conducted and has focused upon the impacts of the coastal small-mesh gillnet fishery Further information on the role of small pelagics in general, and key species such as *Amblygaster* in particular, would appear warranted.			

2.2.2 Unit of Assessment B: Beach seines

PI	Title	Weak	Intermediate	Good	Reference
Retained species					
2.1.1	Retained spp. status		✓		Dayaratne (1997); Sanders & Dayaratne (1999)
Explanatory Statement		This gear has no selectivity and thus has a wide range of catch in terms of both species numbers and sizes. The stock status of all the main retained bycatch species are unknown, although yield estimates for all the small pelagic species were made in 1998. More work has been done on *Amblygaster sirm* as an important catch component, where CPUE's are known to be declining. Even in the case of *A. sirm* where there are some data, this is insufficient to demonstrate recruitment			

PI	Title	Weak	Intermediate	Good	Reference
		impairment with current catches. In 1999 Sanders and Dayaratne suggested there was room for a modest improvement in these fisheries, but the fishery has expanded considerable since then and revised stock assessments are now urgently needed.			
2.1.2	Retained spp. management	✓			Interviews NARA/Ministry
Explanatory Statement		There is no effective management of the beach seine fishery apart from a restriction on seining sites, based on long-established traditional rights. There are no minimum mesh sizes, harvest strategy or harvest control rules. As a result there are no controls over the size of fish being caught, nor the volumes involved. This gear has very high catch rates of juvenile fish with an unknown effect upon recruitment.			
2.1.3	Retained spp. Information		✓		Interviews NARA/Ministry
Explanatory Statement		NARA has been collecting samples of small pelagic catches since 2000. These detail catch (to species level) as well as gear, fishing location and vessel type data. There is some limited length-frequency data collection.			
Discard species					
2.2.1	Discard spp. Status			✓	Fishermen interviews
Explanatory Statement		Discards from this fishery are almost non-existent as everything is utilised for either human consumption or reduction into fishmeal – discards are therefore limited to the occasional jellyfish.			
2.2.2	Discard spp. Management			✓	Interviews NARA/Ministry
Explanatory Statement		There is no management of discards due to the very low volume involved, which constitutes a de facto partial strategy e.g. no discarding.			
2.2.3	Discard spp. Information		✓		Interviews NARA/Ministry
Explanatory Statement		No formal assessment of discard rates and their nature have been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
ETP species					
2.3.1	ETP spp. Status			✓	Fishermen interviews
Explanatory Statement		Due to the inshore nature of this fishery, this fishery does not interact with any ETP species. It is understood that there is the very occasional sea turtle that gets trapped in the seine, but these are released alive with no mortality due to the very short time the net is in the water, and			

PI	Title	Weak	Intermediate	Good	Reference
		regulations which prevent the catching of turtles.			
2.3.2	ETP spp. Management			✓	Interviews NARA/Ministry
Explanatory Statement		There is no management of discards due to the very low volume involved, which constitutes a de facto partial strategy e.g. no ETP interactions. There are strong regulatory controls preventing the catch of ETP species. A code of conduct to formalise release procedures may be necessary.			
2.3.3	ETP spp. Information		✓		Interviews NARA/Ministry
Explanatory Statement		No formal assessment of the rate and nature of ETP interactions has been carried out, mainly due to the very low level involved. An observer programme is necessary to verify these very low rates and to develop a risk-based sampling programme.			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	Fishermen interviews
Explanatory Statement		This fishery is undertaken entirely in sandy / muddy habitats without any complex rocks or coral (which would render the gear unusable). There areas are highly dynamic (much of it is within or near to the surf zone) and thus it likely to cause little or very short-lived changes to the habitat. It should be noted that beach seine sites have remained fixed for many years at traditional locations and are not used in sensitive habitat areas.			
2.4.2	Habitat Management			✓	Interviews NARA/Ministry
Explanatory Statement		There is no management of habitat interactions in this fishery as these are rare, temporary and low impact. The one exception is that there is a legal prohibition to operate in coral reef areas in order to protect this important habitat.			
2.4.3	Habitat Information		✓		Interviews NARA/Ministry
Explanatory Statement		Outside of the coral reef areas there is little information on the nature of marine habitats and their spatial distribution.			
Ecosystems					
2.5.1	Ecosystem Status		✓		Haputhantri et al, 2008
Explanatory Statement		This fishery has no minimum mesh size and thus has a high potential to disrupt recruitment. It catches a wide variety of pelagic and epi-pelagic species at a number of trophic levels (e.g. from planktivorous scobrids to piscivorous barracuda and carangids).			

PI	Title	Weak	Intermediate	Good	Reference
2.5.2	Ecosystem Management		✓		Interviews NARA/Ministry
Explanatory Statement		There is a total lack of control over this fishery in terms of catch selectivity. Given its focus on a wide range of both prey and predator species this is of concern, although any ecosystem impact is yet to be proven.			
2.5.3	Ecosystem Information		✓		Haputhantri et al, 2008
Explanatory Statement		There is little information on the ecological impact of this fishery, although preliminary EcoPath modelling has been conducted and have focused upon the impacts of the coastal small-mesh gillnet fishery Further information on the role of small pelagics in general, and key species such as Amblygaster, would appear warranted.			

Figure 6: Beach seine, Beruwela

Source: Deishini Herath, NARA

2.2.3 Key Weaknesses with Current P2 Performance

Both the small mesh gill net fishery and the beach seine fishery perform relatively well in terms of the impacts on discard, habitats, and ETP species. Due to the minimal reported interactions with ETPs, and habitats, and zero discards, there is therefore no specific management of such issues, which is quite understandable. However, some specific research/observation should be carried out to provide information to verify/document the lack of impacts.

The key area of weakness remains the lack of information and management of retained species (actually the target catch in this case).

2.2.4 Key Recommendations to Address P2 Performance Weaknesses

Specific recommendations to address the weaknesses highlighted above are those outlined in section 2.1.3 above, and some specific observation/monitoring of discard, habitat and ETP interactions/impacts to document and provide an empirical basis for the assumption and widely stated view that there are few issues of concern.

2.3 PRINCIPLE 3: FISHERY MANAGEMENT FRAMEWORK

2.3.1 Assessment

PI	Title	Weak	Intermediate	Good	Reference
Governance and policy					
3.1.1	Legal Framework		✓		Stakeholder meetings; MFAR, 1996; MFAR, 2004 and subsidiary regulations; NARA/Ministry interviews.
Explanatory Statement		Fisheries Ordinance 1940 contains detailed provisions to deal with disputes. Sections 20 and 20A, provide regulations to appoint a Committee of Inquiry or a Commissioner to deal with fishing disputes. Many area-specific regulations have resulted from this process. Legal and customary rights are also strongly provided for in policy, legislation and in the management system more generally e.g. on beach seining by traditional operators/communities, reference to protecting the rights of traditional fishers in coastal fisheries in the policy. Fisheries legislation provides for the codification of many community management rules through local by-laws and regulations, and the provision for management by fisheries committees. The Fisheries Act is under revision to strengthen it further with regards to coherence with international obligations, increased sanctions, and even wider stakeholder involvement. However, there is no legal framework or regulations covering gillnet fisheries, with the exception of a prohibition to operate in coral reef areas.			
3.1.2	Consultation, roles and responsibilities			✓	NARA/Ministry interviews. Macfadyen, G., Cacaud, P., & Kuemlangan, B. (2005).
Explanatory Statement		Roles and responsibilities in the management process are defined in law with respect to the functions of NARA, the Ministry, and the Department of Fisheries & Aquatic Resources (DFAR). General principles of participation are included in fisheries policy, and there is a Constitutional provision for decentralisation. Co-management is also fostered by important non-fisheries legislation relating to coastal conservation. Fishermen's cooperative societies can provide the necessary focus within a community on which a management system could be based. The number of cooperative societies, their membership and financial resources (both internally generated and loans) have greatly increased in recent years. A co-management division in DFAR supporting consultation processes does not yet explicitly address small-pelagic issues, but could do so, although remains rather weak in terms of institutional capacity. The Coast Conservation Act, 1981 (makes provisions for the identification of special coastal areas needing management (under Special Area Management process) and the establishment of management committees with the participation of all stakeholders, including fishers.			

PI	Title	Weak	Intermediate	Good	Reference
3.1.3	Long-term Objectives		✓		NARA/Ministry interviews. MAFR, 2004; MAFR, 2006a
Explanatory Statement		Policy refers to current and future generations, implying long-term objectives. The policy also requires that a 'precautionary approach is followed in the management of marine resources'. Of concern is a strong emphasis in policy on production increases, but the 10yr development framework explicitly recognises that 'though there appears to be scope for increasing production in the coastal sub-sector, in view of the uncertain resource picture it is necessary to adopt a "precautionary approach" in aiming at production increases.' Other policy content requires promoting the principles of responsible fisheries, stock assessments, cooperation with regional fishery management organisations and international conventions.			
3.1.4	Incentives		✓		NARA/Ministry interviews. Fishermen interviews
Explanatory Statement		Fisheries sector subsidies are not in place in Sri Lanka, having been phased out in recent years. There is no direct or indirect support for the catching sector towards fuel costs, vessel construction, or other subsidies typically thought to contribute to over-capacity in fishing fleets. However there is also no use of positive incentives to provide a stimulus for greater sustainability.			
Fishery specific management					
3.2.1	Fishery Objectives	✓			NARA/Ministry interviews. MAFR, 2006b
Explanatory Statement		There are currently no objectives at all relating specifically to either small pelagic fisheries or Indian mackerel in particular. Objectives consistent with sustainability are not even implicit given that there are no management regulations at all aimed at regulating effort or catches in the small pelagic fishery. There are not even any minimum mesh sizes in operation.			
3.2.2	Decision making processes	✓			NARA/Ministry interviews
Explanatory Statement		There is no fishery-specific management system for small pelagic fisheries in Sri Lanka, or for Indian mackerel in particular, and no decision making processes and strategies to achieve any objectives.			
3.2.3	Compliance & Enforcement	✓			NARA/Ministry interviews
Explanatory Statement		It could be argued that since there are no management measures imposed on small pelagic fisheries, there is no need for any control and enforcement or full compliance with regulations. However, enforcement more generally in Sri Lanka of fisheries regulations is considered to be very weak. This is in part due to the historical focus of the Coastguard on security issues rather than fisheries enforcement, and in part due to the fact that fisheries inspectors serve a dual function with regards to both land-based enforcement activities, and data collection and service			

PI	Title	Weak	Intermediate	Good	Reference
		provision to the fishing community. Budgets for enforcement activities are not sufficient. More active engagement of the Coastguard in fisheries issues might be expected to improve following the end of the war. However enforcement activities in general would be much improved if a documented risk-based MCS plan was prepared annually focussing on locations, seasons, and stakeholders felt to be of special concern in terms of compliance. Such a plan could also help to articulate roles and responsibilities of those engaged in enforcement activities.			
3.2.4	Research Plan		✓		NARA/Ministry interviews
Explanatory Statement		Some research on small pelagic species is completed by NARA in the form of ongoing data collection on small pelagic species, and some specific studies have been completed over the years, but none very recently. The NARA collection programme generates information on catches, and CPUE, by fishing gear and area. NARA also formulates annual budgets which in effect articulate its focus on different activities for the coming year. However little other research takes place on small-pelagic species, and there is no defined small pelagic research plan. Considerable gaps in knowledge remain with respect to small pelagic species in general, and to Indian mackerel in particular, with no clear plan specified to address them.			
3.2.5	Performance Evaluation	✓			NARA/Ministry interviews
Explanatory Statement		Again, it could be argued that there is no need for a system of monitoring and evaluating the performance of the small pelagic management system since there is no system in place. But there is no mechanism, either internal or external, in place to evaluate and determine whether a management system for small pelagic species is necessary.			

2.3.2 Key Weaknesses with Current P3 Performance

The *overarching* governance and policy framework, in terms of the legal framework, provision for the protection of community rights, stakeholder participation, etc is generally quite strong in Sri Lanka, and provides ample opportunity and an enabling framework for successful *fisheries-specific management*.

However fishery-specific management is totally lacking in the country, both for small pelagic species in general, and for Indian mackerel in particular. This is rather surprising given the high socio-economic importance of small pelagic fisheries in terms of both livelihoods and food security. In addition, even in the event that such a framework was in place in terms of research and consultative processes informing the specification of management decisions and rules, concerns would still certainly remain over fisheries control and enforcement.

2.3.3 Key Recommendations to Address P3 Performance Weaknesses

The co-management division in the Ministry of Fisheries and Aquatic Resources provides a potential institutional mechanism to specify and monitor a fisheries-specific management system, based on a small-scale fisheries management plan.

Such a plan could be informed by a study of the socio-economic importance of small pelagics, particularly in the North and North East of the country now that the civil war has finished. The plan could include information and requirements with regard to the following:

- An overall vision and objectives;
- The species to be covered by the plan;
- The current status of stocks;
- The extent to which scientific information is available on which to base the management plan, and the extent to which the plan will have to rely on a risk-based framework and the precautionary approach;
- The stakeholders involved in the fishery (who they are, where they are, what their interests are);
- Information on the socio-economic/financial status/importance of the fishery;
- Any relevant cooperation and coherence with India (Tamil Nadu state in particular) on issues related to shared stocks;
- Specific management measures agreed by stakeholders (and informed by local knowledge) related to target catches, as well as to retained bycatch, discards, habitats, and ecosystems; and
- Compliance and enforcement mechanisms (formal and self-regulatory).

2.4 SUMMARY – INDIAN MACKEREL

The table below provides a summary of the performance for Indian mackerel in Sri Lanka

Table 6: Summary performance table for Indian Mackerel in Sri Lanka

Sri Lanka																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts															Principle 3: Governance & Management								
		Outcome			*Harvest strategy*				*Retained*			*Bycatch*			*ETP*			*Habitat*			*Ecosystem*			*Governance & Policy*				*Fishery specific mang*				
Spp	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding ifnecessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Retained status	2.1.2. Retained management	2.2.3. Retained info / monitoring	2.2.1. Discardsstatus	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	3.1.2. Consultation, roles & responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	3.2.5. Management performance evaluation
I. mackerel	Small mesh gillnet	2	0	*	0	0	0	0	1	0	1	2	2	1	2	2	1	2	1	1	1	1	1	1	2	1	1	0	0	0	1	0
I. mackerel	Beach seine	2	0	*	0	0	0	0	1	0	1	2	2	1	2	2	1	2	2	1	1	1	1	1	2	1	1	0	0	0	1	0

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Appendix J: Country Report – Thailand

Eight countries, connected by one ecosystem, working together to secure its future.

Assessments of the Indian mackerel (*Rastrelliger kanagurta)* and the Hilsa shad (*Tenualosa ilisha*) fisheries in the BOBLME countries

Country Report: Thailand

Undertaken by

Poseidon Aquatic Resource Management Ltd

711-REG

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Acronyms

APFIC	Asia-Pacific Fisheries Commission
ASEAN	Association of Southeast Asian Nations
ASRI	Andaman Sea Research Institute
BOBLME	Bay of Bengal Large Marine Ecosystem
CBFM	Community Based Fisheries Management
CCRF	Code of Conduct for Responsible Fisheries
CHARM	Coastal Habitats and Aquatic Resource Management (Project)
COFI	Committee on Fisheries
CPUE	Catch per Unit of Effort
CREP	Coastal Resources and Environmental Profile
DoF	Department of Fisheries
EAF(M)	Ecosystem Approach to Fisheries (Management)
EU	European Union
F	Fishing effort
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
GT	Gross tonnage
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action
IUU	Illegal, unreported and unregulated (fishing)
KG	Kilogrammes
M	Metres
MCS	Monitoring, Control and Surveillance
MEY	Maximum Economic Yield
MFRDB	Marine Fisheries Research and Development Bureau
MM	Millimeters
MoF	Ministry of Fisheries
MoNRE	Ministry of Natural Resources and the Environment
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MT	Metric Tons
NGO	Non Governmental Organization
RBFM	Rights Based Fisheries Management
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
TAC	Total Allowable Catch
TED	Turtle Exclusion Device
TURF	Territorial use rights in fisheries
UNEP	United Nations Environment Program

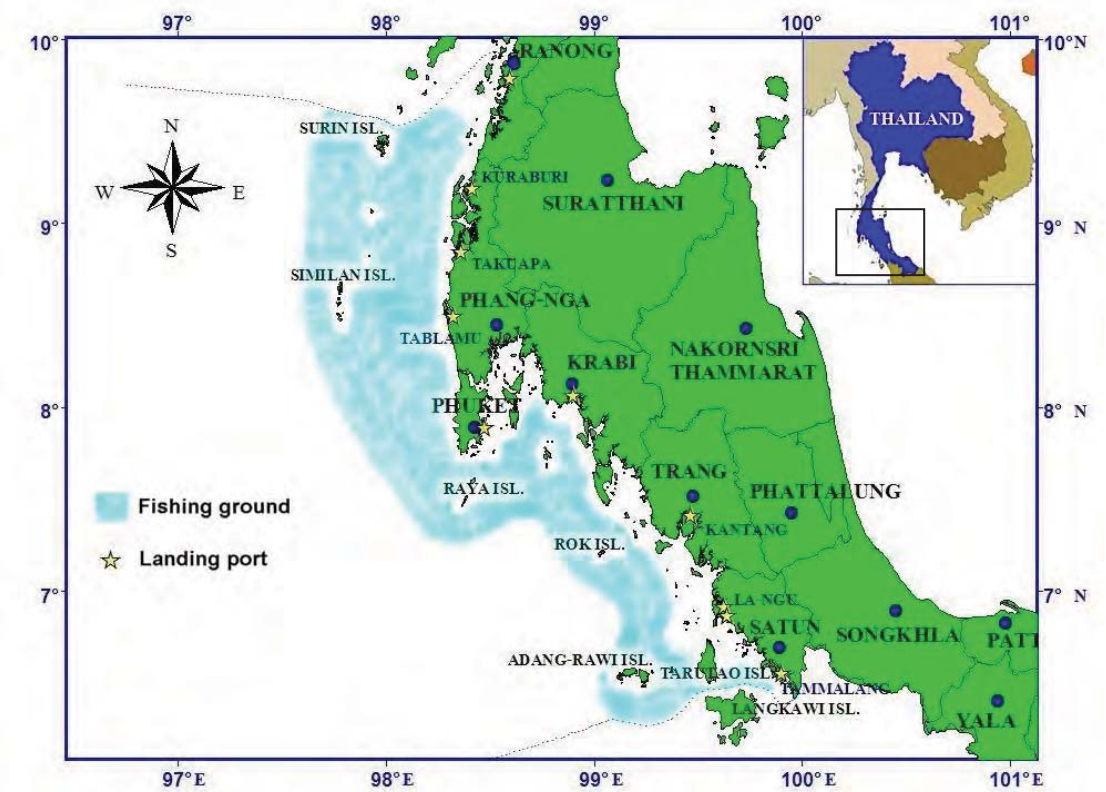
1 OVERVIEW

1.1 INTRODUCTION

Thailand is one of the world's leading marine capture fisheries producers, harvesting 2,457,184t of fish in 2008, valued at US$2.25 billion, with 40% being taken by Thailand's fleet fishing outside its EEZ. Thailand's offshore freezer trawler and purse seiner fleet fish in international waters and in the EEZs of other Bay of Bengal states.

Thailand's Andaman Sea coast is adjacent to the Bay of Bengal (Figure 1). The country's fishing fleet and landings are divided between here and the Gulf of Thailand. Ranong is a hub for landings by fleets fishing in the Andaman Sea and in Myanmar, with the port also receiving many transhipments from other Bay of Bengal states. Approximately a third of the catch from within Thailand's EEZ is from the Andaman Sea area. By volume, the main species harvested include threadfin bream, Indo-Pacific mackerel, coastal tunas, bigeye, snapper, squids, sardines, round scads and anchovies.

Figure 1 Area of Thailand within the BOBLME area



Indian mackerel (*Rastrelliger kanagurta)* is the one of major target species of marine fisheries along the Andaman Sea coast of Thailand. Purse seine is the main fishing gear used, with demersal trawl and other gears also catching a small proportion of the total catch of this species.

Interviewees suggest hilsa shad was previously an important fishery, but that this species was fished out some years ago. The MoF does however report that new small scale hilsa fisheries (catching hilsa using gill nets between October and February) have been identified since 2006 and contribute a total of approximately 17 tonnes per annum in the following areas:

1. Panga Bay (100 families, 1 vessel per family, 50kg per community per day therefore estimate 7.5t caught)
2. Cape Lamb Sac (70 families, 5.25t)
3. Ko Hang and Ko Pu islands (60 families, 4.5t)

Further information on these fisheries is not available. Therefore this report focuses on Indian Mackerel, but the above indicates that hilsha-related work is also of relevance to Thailand.

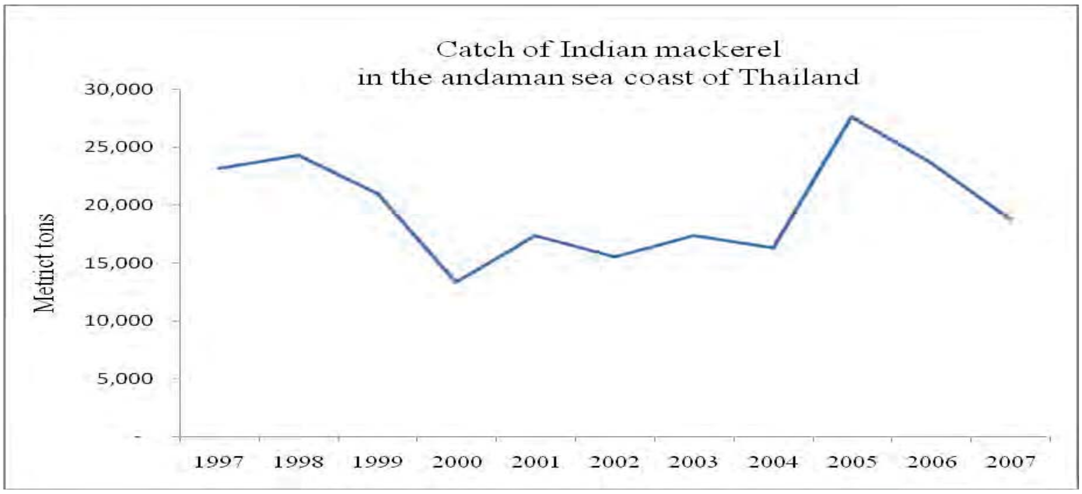
1.2 PEOPLE MET

Name	Title and Organization	Contact details	Location of meeting
Praulia Chantawong	Head of Andaman Sea Research Institute (ASRI)	nootmorn@yahoo.com	Phuket
Professor Wannakiat Thubthimsang	Director of Phuket Marine Biological Center		Phuket
San Srinand	Director of Marine Research and Fishery Conservation		Bangkok
Lt. Apichat Somrith	Captain of Fishery Patrol Vessel	081-9443250	Bangkok

1.3 MAIN FLEETS AND GEARS, CURRENT EFFORT, CATCHES (VOLUME & VALUE) AND SOCIO-ECONOMIC IMPORTANCE

The total catch of Indian Mackerel in the Andaman Sea has averaged around 20,000t per annum over the past 10 years, but as Figure 2 indicates, the total has fluctuated, and since a peak of nearly 28,000t in 2005, landings have declined.

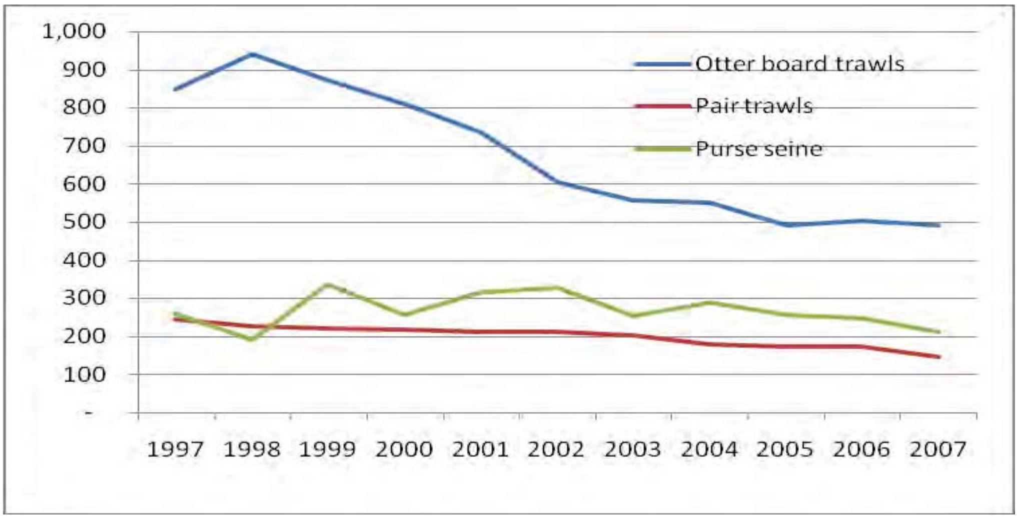
Figure 2 Total catch of Indian Mackerel in the Andaman Sea 1997-2007



Source: ASRI

Around 74% of this catch was from the purse seine fleet, with 25% from trawlers and 1% coming from other gears. The number of vessels has been declining in recent years.

Figure 3 Number of fishing vessels registered in Andaman Sea by main gear type



Source: ASRI

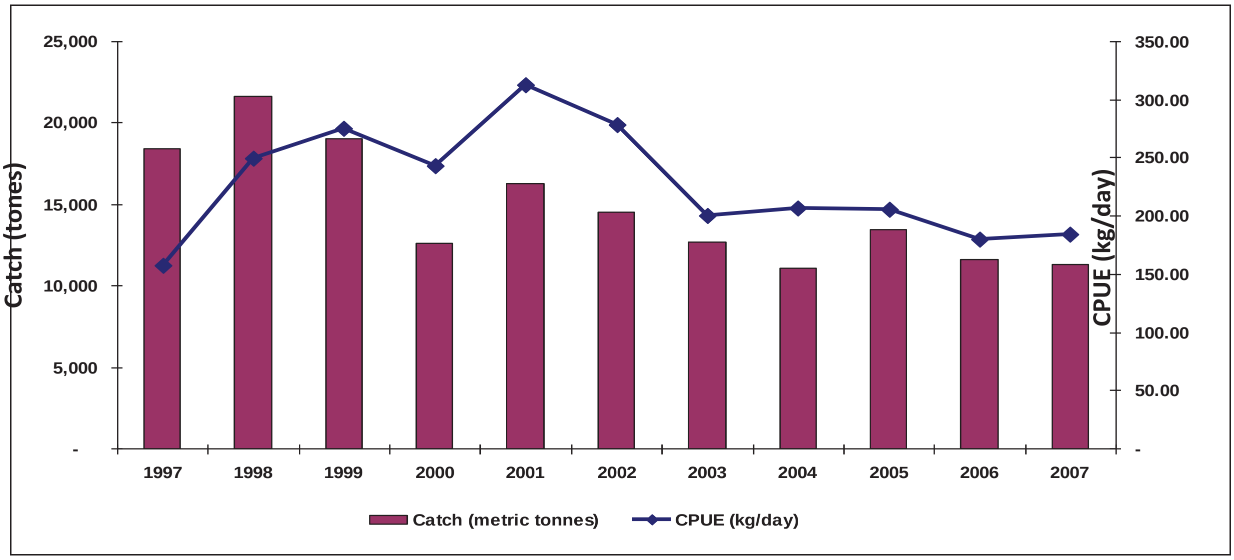
Fisheries statistics suggest between 1997 and 2007, the number of purse seiners registered on the western coast of Thailand grew from 192 in 1998 to 337 in 2002, before dropping to 212 vessels by 2007. The ASRI study of 2007 identified that there were 415 purse seiners fishing in the Andaman Sea, with the seasonal movement of vessels from the Gulf of Thailand almost doubling the fleet of vessels registered on the West Coast in 2007 (DOF, 2009).

The purse seiners use a net length 700-1,300m, depth 80-140m with mesh size 25mm operated with 1-3 day/trip, about 24 day/month. The vessels range in length from 14 to 27m and use engines of 250 to 300hp. Purse seine fisheries operate throughout the year, with high activity in the northeast monsoon season period (October-March), at a depth of between 40-100m and generally on substrate sandy-clay sea bed along Andaman Sea Coast.

For Indian mackerel and sardine, the fishing grounds are mainly located within the depth range of 30-70m (Chantawong, 2008). The main landing ports of Indian mackerel in Thailand are Ranong, Phang-nga, Phuket, Krabi, Trang and Satun.

Indian mackerel represented 15.53% of total purse seine catch in 2007, with CPUE estimated at 467.57 kg/day. The annual production and CPUE for the Indian mackerel purse seine fishery peaked at 21,654 tonnes in 1998, and has since declined along with the overall catch (Figure 4).

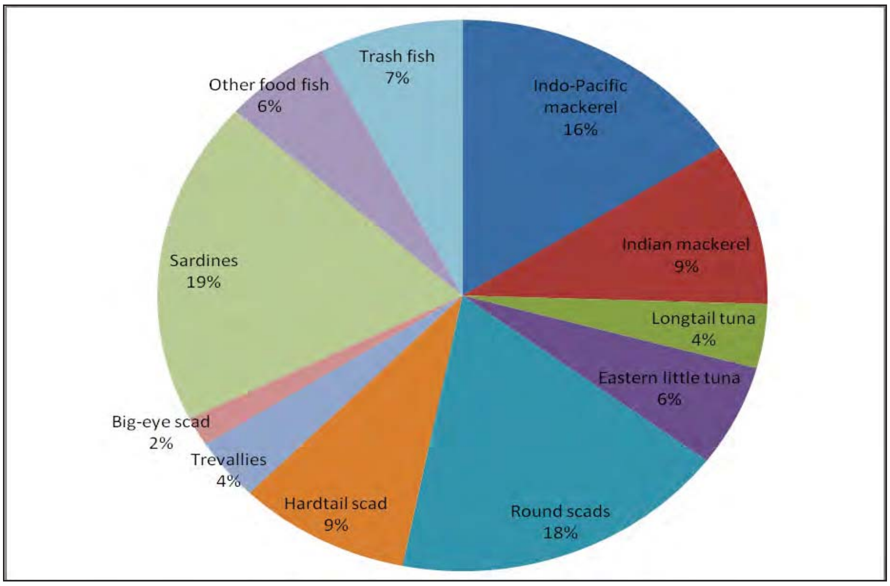
Figure 4 Annual variation of catch and CPUE of Indian Mackerel in the Andaman Sea purse seine fleet 1997-2007



Source:ASRI

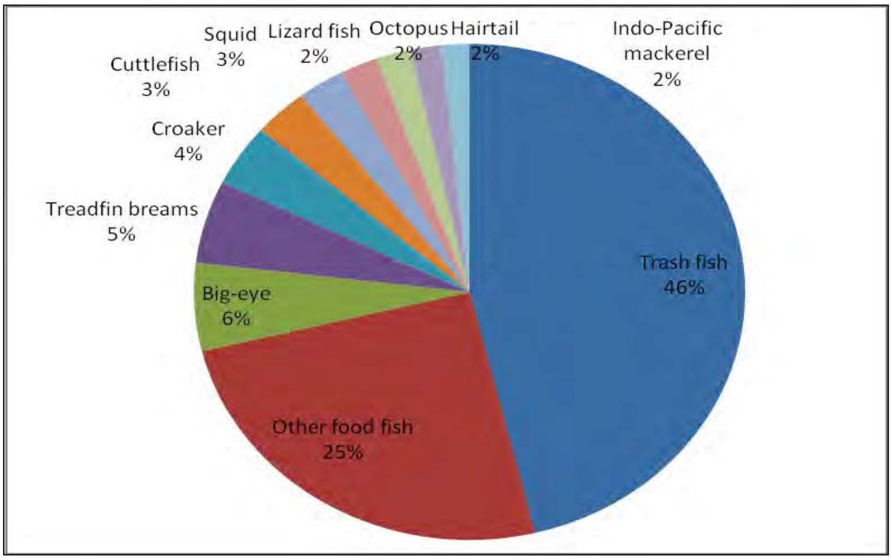
Figure 5 and Figure 6 show that the catch from trawlers and purse seiners consists of a wide variety of species. Trawl catches in particular are made up of very many species (over 50 species recorded) with many, including Indian Mackerel, making up less than 1% of the catch. Figure 6 presents only species that account for more than 1% of the catch.

Figure 5 Average catch profile for purse seiners in the Andaman Sea (1997-2007)



Source:ASRI

Figure 6 Average catch profile for trawlers in the Andaman Sea (1997-2007)

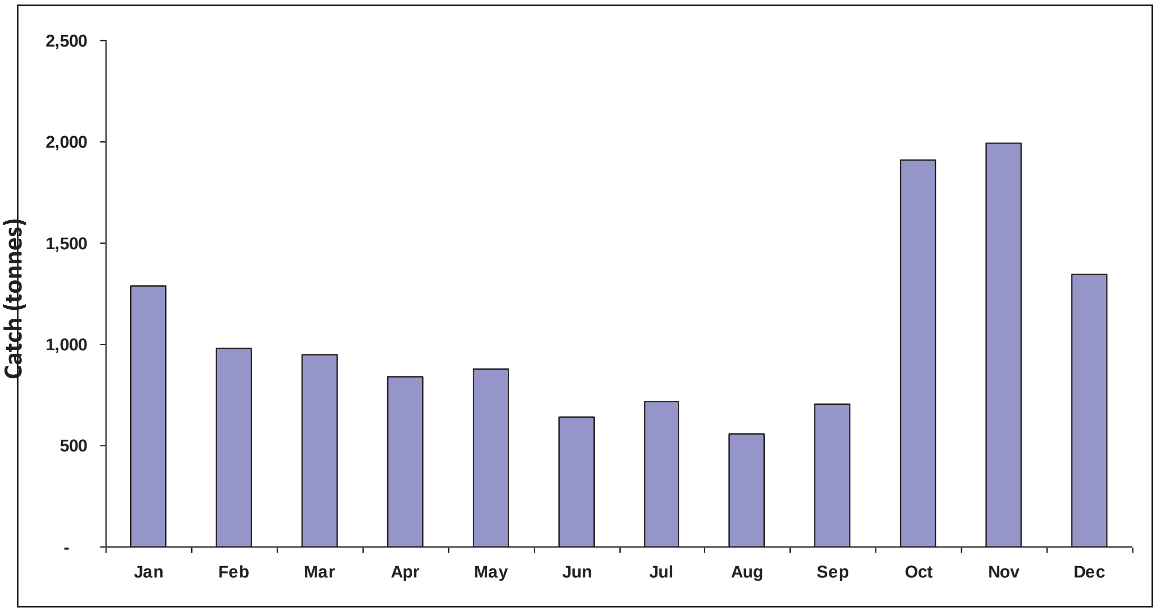


Source: ASRI

Monthly production fluctuates and shows high values of catch during early Northeast monsoon season (October-December 1,910, 1,993 and 1,343 tonnes respectively per month), while during the Southwest monsoon season, the catch shows lower values (Figure 7).

Indian mackerel along the Andaman Sea coast spawns in 2 main spawning phases: during December-March and during August-September. The average size at first maturity of males and females were 17.83 and 18.92 cm (smallest size were 16.30 and 16.20 cm) respectively, while sex ratio of male:female was 1:1.31 (Krajangdara *et al*., 2007.)

Figure 7 Seasonality of Indian mackerel catches by purse seine in the Andaman Sea



Source:ASRI

In 1998 Chullasorn (reported in Chantawong, 1998) reviewed landings data between 1984-1995 for key pelagic resources and identified average catch levels exceeded MSY estimates for all these resources (Table 1).

Table 1 Catches, Maximum Sustainable Yield (MSY) and optimum effort (F_{opt}) of important pelagic species along the Andaman Sea

Species	Catch from 1984 to 1995 (mt)	Average Catch (mt)	MSY (mt)	Catch as % of MSY	F_{opt} (days)
Indo-Pacific mackerel	12,044 – 66,833	30,553	23,765	129%	70,059
Round scads	2,464 – 35,994	17,046	15,728	108%	74,680
Small tunas	4,695 – 12,611	14,982	8,651	173%	71,104
Sardines	19,874 – 54,849	31,945	31,641	101%	42,119
Pelagic fish	56,474 – 286,509	154,566	136,602	113%	79,591

Source: (Chullasorn, 1998)

More recently a “Length Based Thompson and Bell Analysis” was applied by Sumontha *et al* (2010) to the available catch and relative effort for Indian mackerel. The maximum sustainable yield (MSY) for Indian Mackerel was 12,999 tonnes at the F-factor of 0.7 and the maximum sustainable economics yield (MEY) was 565.78 million baht at the F-factor of 0.4. In 2007, the catch and value of the Indian mackerel were 12,805 tonnes and 433 million baht which over 30% of the MSY and over 60% of the MEY (Sumontha *et al*., 2010).

1.4 ENVIRONMENT

The state of Thailand's environment is reported in ASEAN's Fourth State of Environment Report, 2009. Thailand's mangrove areas reduced from 280,000ha to 240,000ha between 1980 and 2005.

A comprehensive survey of coral reefs at 169 sites in the Andaman Sea was undertaken from 1995 to 1998 to assess reef health using an indicator of the ratio of live and dead coral cover (CREP, 2008). In this assessment 5% of coral reefs where in excellent condition, 12% good, the majority (33%) fair, 27% poor and 23% in very poor condition. Hutomo *et al* (2009) report that most of the coral reefs in the Andaman Sea have degraded to poor or very poor condition due to natural causes, such as storms that severely damaged the Adang-Rawi Islands in 1986, the crown-of-thorn starfish epidemic in several areas and the 2004 Tsunami. Coral bleaching has also been reported during 1984-1986 due to sea temperature rise as a result of global warming. Human impacts are mainly from mining related sedimentation and harmful tourism activities, but also destructive fishing such as blasting, impact of lost nets and fish traps.

Thailand waters support a diverse community of seagrass beds with about 12 species and 7 genera. The Department of Marine and Coastal Resources conducted a survey and assessment of seagrass beds in 2008. In the Andaman Sea, the most abundant seagrass beds are in Nai Yang National Park, Phuket Province and within the National Park, they are not disturbed by human activities. However, sedimentation from mining activities does occur within Phuket Province which could impact seagrass beds. It is also noted that fisheries in the seagrass beds zone in Krabi Province include shrimp trawl fisheries. The seagrass beds are in very coastal shallow locations and so any interaction will be from small boats.

Associated with the seagrass beds are Dugong *Dugong dugon* populations. Recent estimates of dugong numbers in the Andaman Sea totaled 200, with 150 of these found in Trang Province (CREP, 2009). Major threats include incidental capture by fishing gear, predominately set and drift gill nets.

Five species of turtle are reported within Thai waters: : green turtle *Chelonia mydas,* hawksbill turtle *Eretmochelys imbricate,* leatherback turtle *Dermochelys coriacea*, loggerhead turtle *Caretta caretta* and olive ridley turtle *Lepidochelys olivacea*. The species distribution around Thailand is broadly understood, with highest frequency of recordings around Phuket Province. The numbers of eggs and nesting sites have drastically declined over the past decade with main threats listed as habitat destruction and collection, sale and consumption of turtle eggs. From 2000 to 2006 annual surveys of nesting sites found over 400 turtle nests on Taimuang Beach, Lampi-Taiuang National Park and Phang-Nga Province. However, the number has since declined to 10-40 sea turtle nests. This decrease has led to a number of efforts to protect the habitat in several ways including zoning in marine parks, rehabilitation and enforcement of laws including the Fishery Act 1947 and Wildlife Preservation and Protection Act 1960. The effectiveness of these measures and levels of compliance and enforcement are unknown.

Whale sharks became protected on 28th march 2000 and hunting or killing is strictly prohibited. In the Andaman Sea the whale shark can be found at the Richelieu Rock in Phang Nga Province and at the Purple Rock and Red Rock in Krabi Province. At present the number of whale sharks is considered to be low. Other protected species within the Andaman Sea include many species of whales and dolphins.

Thailand established 23 Marine Protected Areas (MPAs), part of a 56% increase in the sea area covered by MPAs since 1995 (ASEAN, 2009). However the extent to which resources are protected in law and effectively managed in those MPAs is unknown.

ASEAN notes that "Some of the reasons for the slow progress in managing the coastal and marine environment are the lack of irrefutable and clear information about the nature and extent of the problems affecting the coastal and marine environments; legal and institutional complexities; non-involvement of local communities; and weak multi-sectoral cooperation" (ASEAN, 2009).

Significant causes of marine and coastal resources deteriorations are destruction of breeding grounds and natural buffer zone, use of natural resources beyond carrying capacity, accumulation of solid wastes on beaches and intrusion of coastal developments. Concerned agencies have implemented several projects and activities in an attempt to solve these problems. Those projects and activities include: rehabilitation of mangrove forests; survey the status and locate conservation and use zones of coral reef resources; survey and provide protected areas for sea-grass and manatees (MONE, 2005).

The Policy and Strategy of the Ministry of Natural Resources and the Environment (MONRE) received Cabinet approval on 18 March. It vision is to:

"Return the natural environment to the Thai society and work towards the inclusion of natural resources and the environment in the national agenda as they provide the basis for social and economic development. Support proactive integration of the administrative management of natural resources, environmental protection, and biological diversity, based on the principles of public participation and good governance." A number of approaches and actions are identified in order to deliver this vision.

1.5 RISK ASSESSMENT

A number of population parameters have been estimated for Indian Mackerel in the Andaman Sea. While there is a good level of stock information compared to other areas in the BOBLME region, these estimates are based on a limited data set that is five years old. Therefore it is useful to consider a risk assessment to consider the scale and intensity of the fishery in relation to the target species. This is presented in a 'Productivity / Susceptibility Analysis' (PSA) in order to determine the overall risk to the stock from fishing. More detail on the PSA for Indian mackerel is provided in the main report. A summary of the PSA for Indian mackerel is provided in Table 2.

Table 2: Productivity Susceptibility Analysis for Indian Mackerel

Species	Gear	PSA															
		Productivity								Susceptibility					PSA Scores		
		Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (Fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Indian Mackerel	Purse seine	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Btm Otter trawl	1	1	1	1	1	1	2	1.14	3	3	3	3	3.00	3.21	High	<60
	Gill nets	1	1	1	1	1	1	2	1.14	1	2	3	3	1.43	1.83	Low	>80

Source: Poseidon

Based on the PSA assessment, Indian mackerel is shown to be highly productive with a minimum population doubling time less than 15 months (Fishbase, 2010).

Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets. Vessels deploying these gears are likely to overlap >30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. Due to the mesh sizes of these gears, they have a low selectivity in that most fish encountered will be captured. From a stock status perspective, both purse seine and trawl fisheries are considered to be high risk to Indian mackerel.

The gillnet fishery however, is predominately carried out in the coastal areas and so has a lower risk score based on availability and encounterability attributes. While selectivity scores poorly due to the small mesh sizes compared to the fish length, overall the impact of this small scale fishery on the stock is considered low risk.

A PSA has also been undertaken for other species that are likely to be captured in conjunction with the small pelagic fishery, including Indo Pacific mackerel and tuna species. These results are presented in Table 3.

Table 3: Productivity Susceptibility Analysis for other retained species

Species	Gear	PSA															
		Productivity								Susceptibility					PSA Scores		
		Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (Fishbase)	Total Productivity	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	Risk Category	MSC score
Indo-pacific mackerel	Purse seine	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Btm Otter trawl	1	1	1	1	1	1	1	1.00	3	3	3	3	3.00	3.16	Med	60-80
	Gill nets	1	1	1	1	1	1	1	1.00	1	2	3	3	1.43	1.74	Low	>80
Skipjack tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Longtail tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Frigate tuna	Purse seine	1	1	2	1	1	1	3	1.43	3	3	3	3	3.00	3.32	High	<60
Bigeye tuna	Purse seine	2	2	2	2	2	1	3	2.00	2	3	3	3	2.33	3.07	Med	60-80
Bullet tuna	Purse seine	2	2	2	2	1	1	3	1.86	3	3	3	3	3.00	3.53	High	<60
Eastern little tuna	Purse seine	2	2	2	2	2	1	3	2.00	3	3	3	3	3.00	3.61	High	<60
Yellowfin tuna	Purse seine	2	1	2	2	2	1	3	1.86	3	3	3	3	3.00	3.53	High	<60

Source: Poseidon

2 FISHERIES ASSESSMENTS – INDIAN MACKEREL

For the purpose of this assessment, two 'units of assessment' are identified as follows:

- Purse seine vessels targeting small pelagic species within Thailand EEZ waters with nets of mesh size 1 inch.
- Bottom otter trawl vessels targeting demersal finfish and shrimps, taking Indian mackerel as a bycatch, operating within Thailand EEX waters with nets of mesh size 1 inch.

2.1 PRINCIPLE 1: STOCK STATUS

2.1.1 Purse seine and Trawl fishery

PI	Title	Weak	Intermediate	Good	Reference
Outcome					
1.1.1	Target spp. status	✓			ASRI, pers. comm. BOBLME Stock assessment workshop, 2010 N. Theranantakul Pers. Com.
Explanatory Statement		2007 catch (12,805 t) is less than that indicated for MSY (12,999 t) however declining trend in catches over the last 10 years and estimates suggest that catch is 30% over MSY (60% over MEY). It is not known whether the stock is a single stock or there are separate stocks that Thailand shares with Malaysia and Myanmar. Genetic studies are needed to determine this.			
1.1.2	Reference points (not if RBF)	✓			
Explanatory Statement		No target reference points - SSB is not quoted anywhere and appears to be unknown. Thompson and Bell analysis has been used to estimate MSY and MEY, but these are not set as limit or target reference points in management of the stock.			
1.1.3	Stock rebuilding	✓			
Explanatory Statement		No stock rebuilding strategies identified			
Harvest strategy					
1.2.1	Harvest Strategy	✓			
Explanatory Statement		Management is effort-based (relating to vessels rather than specific stocks) – spatial and temporal closures are used to shift effort (not reduce it) and there are limits on licenses for trawlers & push nets. No license limits for purse seine. Therefore there is not really a harvest strategy relating to the stock,			

PI	Title	Weak	Intermediate	Good	Reference
		and no evidence it is achieving any stated objectives.			
1.2.2	Harvest control rules and tools	✓			
Explanatory Statement		There are no harvest control rules			
1.2.3	Information / monitoring		✓		
Explanatory Statement		There are good levels of information and data collated, but these do not feed into direct management of the stock through output measures, rather management of the fleet (inputs). There remain significant gaps e.g. knowledge of extent of stock (one or more than one stock), and estimates of SSB are lacking to determine the level at which recruitment would be impaired. There is however regular collection of information from: • log books (newly introduced for purposes of exporting to the EU) • Market sampling (10% from each type of fishing gear – see stats) for total landings and establishing length/weight • Interviews with fishermen by staff at ASRC			
1.2.4	Stock Assessment (not if RBF)		✓		ASRI
Explanatory Statement		As indicated earlier, a number of population parameters have been calculated for this species, but these are based on a single research project rather than regular assessment.			

2.1.2 Key Weaknesses with Current P1 Performance

There is no regular assessment of spawning stock biomass (SSB) on which to base stock management. It is not known whether the stock is a single stock or whether there are distinct sub-stocks along the Andaman Sea coast. A CPUE model has been used to estimate that fishing mortality is approximately 30% above MSY, despite reduced numbers of vessels in the last 5 years.

As Chantawong (2008) notes:

"Information on spawning grounds, season, size at first maturity, life span, food and feeding, growth and mortalities of many species is still lacking. Information on stock identification through various means (morphometric, meristics, DNA analysis and tagging) for a number of important pelagic [does not exist]. A basic requirement in stock assessment is…time series analysis of catch and effort and size composition by species. Although the statistics, particularly catch by species and/or group of species and its associated effort are available, its reliability is still questionable."

2.1.3 Key Recommendations to Address P1 Performance Weaknesses

- Research on population dynamics including a genetic component to establish stock extent and composition;
- Development of fishery-specific harvest control strategy and implementation of harvest control rules, based on scientific evidence of stock status; and
- Collaboration with neighboring countries on the above. should research show shared stocks.

2.2 PRINCIPLE 2: ECOSYSTEM IMPACTS

2.2.1 Purse seine

PI	Title	Weak	Intermediate	Good	Reference
Other Retained species					
2.1.1	Retained spp. Status		✓		Chantawong, 2008
Explanatory Statement		Main retained species associated with the small pelagic fishery are Indo-Pacific mackerel (*Rastrelliger brachysoma*), Indian mackerel (*R. kanagurta*), round scads (*Decapterus maruadsi*, *D. macrosoma* and *D. macarellrus*) and small tunas (*Thunnus tonggol*, *Euthynnus affinis*, *Auxis thazard*, *Katsuwonus pelamis* and *Sarda orientalis*). Similar levels of information are available for indo-pacific mackerel as for Indian mackerel. The status of Indo-Pacific mackerel is known and MSY is estimated to be 23,765 mt and average annual catch rates of 30,553 mt which is 28% over MSY. For this reason an intermediate score is appropriate.			
2.1.2	Retained spp. management		✓		
Explanatory Statement		Thailand operates seasonal closed areas in inshore locations, specifically to protect spawning periods for a combination of small pelagic species. The breeding of Indo Pacific mackerel have been protected by temporal closure of the Phang-nga Bay during 15 April to 15 June, since 1985. This has allowed an intermediate level of management to be achieved. There are also closed areas to protect coral reef systems which act to indirectly protect fish in these areas. There are no other specific strategies in place for minimization of bycatch of other retained species and in particular the level of juvenile landings may become a concern for these species and their continued recruitment.			
2.1.3	Retained spp. Information			✓	
Explanatory Statement		It is understood that there is no discarding in the purse seine fishery, and the good information that is available on landed catch represents good levels of information on retained species.			
Discards					
2.2.1	Discard spp. Status			✓	
Explanatory Statement		There are no discards in the purse seine fishery – this is evidenced by the large size range in landings. Small, unsaleable fish are minced and/or used for fish sauce, so everything caught is used.			
2.2.2	Discard spp. Management			✓	

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		No reported discarding of by-catch, and thus no need for a management strategy to reduce discards. All catch is landed, and fish that might otherwise be discarded is landed and sold as 'trash fish'.			
2.2.3	Discard spp. Information		✓		
Explanatory Statement		While it is generally accepted and known that there is no reported discarding of by-catch, this is not monitored or corroborated. Thus some brief observational studies would be useful to prove that this is indeed the case.			
ETP species					
2.3.1	ETP spp. Status		✓		
Explanatory Statement		Potential purse seine interaction with ETP species is likely to be limited to dolphins and turtles, both of which are released alive prior to hauling nets. A high survivability rate (>90%) is expected. A risk assessment in the Pacific Ocean (Kirby, 2006) indicates that sharks are the highest risk group in purse seines – at greatest risk are the low fecundity silky shark, short-finned mako, porbeagle, and oceanic whitetip rather than the more fecund blue sharks and hammerheads. These shark species are at more risk from the tuna fisheries than the small pelagic fisheries since they often trail schools of tuna for prey. Overall the risk of the small pelagic purse seine fishery is of intermediate concern, based primarily on shark interactions.			
2.3.2	ETP spp. Management		✓		
Explanatory Statement		Purse seiners claim that there are no interactions and that management of ETP interactions is unnecessary. In addition there are certain closed areas to protect turtle nesting beaches areas. However, interactions cannot be totally discounted, and a strategy would therefore be useful.			
2.3.3	ETP spp. Information		✓		
Explanatory Statement		There is comparatively good information on some ETP species, but monitoring of fisheries impacts is not a regular occurrence. Thus some brief observational studies would be useful			
Habitats					
2.4.1	Habitat Status (SICA only)			✓	
Explanatory Statement		Interactions between the purse seine fishery and critical habitats are thought to be low. There are no impacts for example on coral reefs,			

PI	Title	Weak	Intermediate	Good	Reference
		mangroves or seagrass areas.			
2.4.2	Habitat Management		✓		
Explanatory Statement		Certain areas are protected, however the specification of these areas is mainly associated with coral reef areas, rather than with larger marine areas. There are seasonal closured for the protection of spawning grounds which will also act as an impartial strategy. Please advise whether closed fishery areas for coral protection are closed to all gears, including purse seiners?			
2.4.3	Habitat Information		✓		
Explanatory Statement		Good level of information on extent of key habitats and their status such as coral reefs, seagrass and mangrove. However knowledge of the extent and status of other marine habitats is more limited. General areas targeted by the purse seine fishery are understood, but not adequately mapped or regularly monitored to allow full determination of the level of effort across different habitats. While this gear is unlikely to impact the habitat due to lack of bottom contact, the loss of gear or FADs have the potential to interact with sensitive habitats and such events should be better understood.			
Ecosystems					
2.5.1	Ecosystem Status		✓		
Explanatory Statement		While certain resources are depleted, the key elements of ecosystem structure are intact and the fishery in its current form is unlikely to cause serious or irreversible harm. It is understood that the small pelagic recourses are in better condition than the demersal and shrimp fisheries and therefore total removals by the purse seine fleet will have less significant impacts to the overall ecosystem and food web structure.			
2.5.2	Ecosystem Management		✓		
Explanatory Statement		Thailand has committed to ecosystem management, but with limited resources at present implementation currently relates primarily to managing national park areas, including marine parks. Consequently there is less consideration of the wider marine ecosystem, or the impacts and need to manage the ecosystem impacts of the purse seine fishery per se. Management should be focused on how large removals of juvenile fish impacts the overall food web structure. This relates to the indirect effects of removing target and retained species from the ecosystem as current quantities and sizes classes of fish. Such management measures would also be appropriate to Retained management (2.1.2).			

PI	Title	Weak	Intermediate	Good	Reference
2.5.3	Ecosystem Information		✓		ASEAN, 2009
Explanatory Statement		A reasonable level of information on the status of the marine ecosystem including maps and distribution of endangered species and coral cover and condition of coral reefs. The general food web structure is also understood for the area and species groups involved in these fisheries. However, information and features are not regularly monitored and reported and no ecosystem modeling has been undertaken.			

2.2.2 Trawl fishery

PI	Title	Weak	Intermediate	Good	Reference
Other Retained species					
2.1.1	Retained spp. Status	✓			
Explanatory Statement		Main retained species within the bottom otter trawl fishery are demersal finfish and shrimp. The status of these species are not as well understood or studied compared to the small and large pelagic species. In general it is considered that the demersal finfish and shrimp stocks are likely to be over exploited, in relation to the small pelagic species. Is there any additional information on the status of the various finfish and shrimp species also caught in these fisheries?			
2.1.2	Retained spp. management	✓			
Explanatory Statement		There is no specific strategy in place for minimization of bycatch of other retained species. The seasonal closed area within Phang-nga Bay is for protection of small pelagic species spawning grounds and it is unknown whether this area and period is important for demersal finfish spawning. Minimum mesh sizes do not allow juvenile fish to escape and this is likely to lead towards growth overfishing.			
2.1.3	Retained spp. Information			✓	
Explanatory Statement		It is understood that there is no discarding in the purse seine fishery, and this the good information that is available on landed catch represents good levels of information on retained species.			
Discards					
2.2.1	Discard spp. Status			✓	
Explanatory Statement		There are no discards in the trawl fishery – this is evidenced by the large size range in landings. Small, unsaleable fish are minced and/or			

PI	Title	Weak	Intermediate	Good	Reference
		used for fish sauce, so everything caught is used.			
2.2.2	Discard spp. Management			✓	
Explanatory Statement		No reported discarding of by-catch, and thus no need for a management strategy to reduce discards. All catch is landed, and fish that might otherwise be discarded is landed and sold as 'trash fish'.			
2.2.3	Discard spp. Information		✓		
Explanatory Statement		While it is generally accepted and known that there is no reported discarding of by-catch, this is not monitored or corroborated. Thus some brief observational studies would be useful to prove that this is indeed the case.			
ETP species					
2.3.1	ETP spp. Status	✓			
Explanatory Statement		Of the ETP species present within Thai waters, turtles are at most risk of incidental capture by demersal trawling gear. Five species of turtles are present in Thai waters: green, hawksbill, Olive Ridley, loggerhead and leatherback. However, over the past 15 years, the number of sea turtles laying eggs has been reduced by 90%. This drastic decline is in part thought to be due to over fishing and the capture of females preparing to nest.			
2.3.2	ETP spp. Management	✓			
Explanatory Statement		Trawls have occasional interactions with ETP species e.g. with turtle. There is conflicting information on whether TEDs are used by Thai vessels. This suggests that any legal requirement is not strictly applied. Due to the illegal hunting of sea turtles for human consumption, the Department of Fisheries issues a notification prohibiting fishing within 3 km off the coast. This also acts as a measure to reduce any potential interaction with turtles coming to shore to lay eggs. Several turtle nesting sites have also been declared National Parks and Fisheries Preservation Zones. The Government, in cooperation with the private sector and local communities, supports programs for the annual release of baby turtles to the Andaman Sea. However, while these programs and regulations are in place, it is reported that enforcement is weak. Furthermore, there is evidence (as stated under 2.3.1) that these measures are not working and further management (e.g. enforcing use of TEDs) is necessary.			
2.3.3	ETP spp. Information		✓		

PI	Title	Weak	Intermediate	Good	Reference
Explanatory Statement		There is comparatively good information on the extent and distribution of ETP species including monitoring of sea turtles and dugong. However the true extent to which trawling interacts with ETP species is largely unknown. There is no data to show annual catch rates of turtles, for example. Furthermore, protection efforts associated with marine parks and not monitored comprehensively.			
Habitats					
2.4.1	Habitat Status	✓			CREP Thailand, 2008; Hutomo *et al* 2009.
Explanatory Statement		The distribution and condition of coral reefs in Thailand are well understood based on comprehensive surveys undertaken from 1995 to 1998. Approximately half are classified as in fair to excellent condition and half are poor or very poor condition. Damage to coral reefs in the Andaman Sea has predominately been caused by storms, crown-of-thorn starfish epidemic and the Tsunami in 2004. While trawling is not considered to be the primary fishing method causing destruction to habitats (compared to blasting) it has the potential to significantly impact coral and seagrass habitats and this may be to the point where irreversible harm is caused. So while impacts of trawling may be secondary to natural events and land-based impacts such as coastal development and pollution, they are still considered significant.			
2.4.2	Habitat Management		✓		
Explanatory Statement		There is some habitat management e.g. a closed area from Phuket to Ko Lanta Yai –closed April 1st to June 30th. One reason for the closed area is given as habitat protection, but if sensitive habitats are damaged a seasonal closure would not be sufficient to allow recovery. Fishers are also proposing other closed areas that can be implemented at a local level. However there is no overall strategy for habitat management.			
2.4.3	Habitat Information		✓		
Explanatory Statement		Good level of information on extent of key habitats and their status such as coral reefs, seagrass and mangrove. However knowledge of the extent and status of other marine habitats is more limited. General areas targeted by the trawl fishery are understood, but not adequately mapped or regularly monitored to allow full determination of extent of potential habitat interactions with this gear type.			
Ecosystems					
2.5.1	Ecosystem Status	✓			
Explanatory Statement		The unselective nature of the trawl fishery and its capture of numerous			

PI	Title	Weak	Intermediate	Good	Reference
		juveniles of target and by-catch species, along with its impact on benthic habitats, means that the fishery is likely to cause serious and/or irreversible harm to the ecosystem.			
2.5.2	Ecosystem Management		✓		
Explanatory Statement		Thailand has committed to ecosystem management, but with limited resources at present this relates to managing national park areas, including marine parks. Consequently there is less consideration of the wider marine ecosystem and in particular with regard to trawling.			
2.5.3	Ecosystem Information		✓		Hutomo *et al*, 2009
Explanatory Statement		A reasonable level of information on the status of the marine ecosystem including maps and distribution of endangered species and coral cover and condition of coral reefs. The general food web structure is also understood for the area and species groups involved in these fisheries. However, information and features are not regularly monitored and reported and no ecosystem modeling has been undertaken.			

2.2.3 Key Weaknesses with Current Ecosystem Management Performance

The current mesh size for purse seine and trawl gear (and some gill nets) is 1 inch (25mm), which results in high catch rates of juveniles. This is likely to have implications for recruitment and is likely to lead to growth overfishing and possibly ecosystem overfishing. At present this is considered more likely to impact demersal finfish, given their current status, however an increase in mesh size would be advisable across all gear types.

The use of FADs and lights with purse seines results in less selective fisheries than would otherwise be the case.

The lack of discarding within these fisheries is a key strength; however this is primarily due to the landing of all fish including juveniles which itself is due to a lack of management. The landing of juveniles with a low value catch is an inefficient use of the resource and potentially negatively impacts on stock status. However any measures introduced to manage target and retained species (such as TACs) should ensure that the negligible discard rate is maintained.

There is little information on the ecological role of Indian mackerel, its response to natural fluctuations and the impact of its removal from the ecosystem. Ecosystem modeling has not been undertaken.

2.2.4 Key Recommendations to Address Ecosystem Performance Weaknesses

- Improved selectivity of gear (larger mesh sizes);
- Greater spatial management to support fisheries management objectives (i.e. protection of spawning areas and juveniles) as well as habitat protection, particularly relating to the trawl fishing activity; and
- More regular monitoring of ETP status and fishery interactions.

2.3 FISHERY MANAGEMENT FRAMEWORK

PI	Title	Weak	Intermediate	Good	Reference
Governance and policy					
3.1.1	Legal Framework		✓		The Fisheries Act B.E. 1947 (revised in 1953 and 1985) ("the Act") The Act Governing the Right to Fish in Thai Waters B.E. 1939 ("the Thai Waters Act") The Thai Vessel Act B.E. 1938
Explanatory Statement		The Fisheries Act does observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood. The Act provides the overarching framework for fisheries management and sets out arrangements on types of fishing ground (sanctuary, leasable area, reserved area and open area), licensing and penalties and offences. The Act was revised in 1985 to strengthen the severity of penalties and to make domestic vessels responsible for any damage or expense created where they have violated the laws of a foreign state. However there are significant weaknesses in the Act and it requires substantial revision and modernization. The Act has recently been the subject of an extensive 8 year review, with a revised Act recently submitted to parliament for scrutiny. The revisions are aimed at modernizing the fisheries legislation and are expected to come into force during 2011. The Act has been used in the past to apply local co-management arrangements (e.g. Bang Saphan Bay Fisheries Co-Management)[1]. The Thai Waters Act prohibits fishing by foreign flagged vessels. Only Thai nationals or companies are eligible to register fishing rights. In recent years, increasing responsibility for monitoring, control and enforcement have been delegated to the local authority (Sub-district authority or Ao Bo To) consistent with the policy of decentralization in the National Constitution B.E. 2540. Under these arrangements, marine fishers are required to seek permission from Ao Bo To on the use of various fishing gears, as well as submit gears for examination[2]. A number of other environment-related pieces of legislation also influence fisheries management including the Wildlife Reservation and Protection Act B.E. 1992, which lists a number of protected species, and the Enhancement and Conservation of the National Environmental Quality Act B.E. 1992, which provides for the protection wetlands amongst other things. Can details of this Act, the species it protects and associated management be provided. This would also allow further detail to			

[1] Ibid, DoF (2006)

[2] Ibid, DoF (2006)

PI	Title	Weak	Intermediate	Good	Reference
		be added to P2.			
3.1.2	Consultation			✓	DoF, pers. comm.
Explanatory Statement		The roles and responsibilities of organizations and individuals who are involved in the management process are well defined and clearly understood by all relevant parties. There is a fishery conservation committee (multi-stakeholder committee with Department of Fisheries [DoF], Community NGO and Fishermen's reps) which receives analysis and information from capture fisheries research each year. This is then debated and recommendations made to the DoF. DoF then changes rules (e.g. closed areas and seasons) where advised. An example of this practice is that research showed results of a closed season and proposed longer period, resulting in the closure now being over 3 months (April to June) not 2 as was the case.			
3.1.3	Long-term Objectives		✓		DoF (2008). *The Master Plan Marine Fisheries Management of Thailand*. Department of Fisheries, Ministry of Agriculture and Cooperatives. November 2008.
Explanatory Statement		Thailand's domestic and international fisheries policy objectives for marine capture fisheries are set out in a Master Plan for Marine Fisheries ("the Master Plan"), approved by cabinet and commencing from 2010 until 2018. This could be interpreted as long term objectives, but these laudable objectives such as "to manage responsible and sustainable marine fisheries" are supported by production targets rather than science-based reference points. While positive developments such as RBFM & EAFM are proposed, they are yet to be implemented. Due to overstaffing, much of the DoF budget is spent on salaries rather than activities to implement objectives. Despite longstanding evidence of overfishing and overcapacity, fisheries management policies continue to be influenced by production driven targets, including the promotion and development of distant water fishing fleets and few measures have been taken to effectively reduce fishing capacity.			
3.1.4	Incentives	✓			
Explanatory Statement		The main management measures applied include a moratorium on the issues of new licenses, closed areas, closed seasons and minimum legal sizes. Minimum mesh sizes are also applied though there is general agreement they are too small. The heavy reliance on trash fish to support fish meal and other processing has meant that mesh sizes used in both the fish and shrimp trawl sectors have been maintained at a level that results in very high levels of bycatch. The high demand for trash fish incentivizes the use of small mesh and there has been little done to counteract this. No quotas or rights-based management measures are applied which might provide positive incentives.			

PI	Title	Weak	Intermediate	Good	Reference
Fishery specific					
3.2.1	Fishery Objectives	✓			FAO (2005). *Report of the National Seminar on the Reduction and Management of Commercial Fishing Capacity in Thailand.* Cha-Am, Thailand, 11-14 May 2004. Food and Agriculture Organization of the United Nations Rome, 2005
Explanatory Statement		No fishery specific management plans specifying long-term and fishery-specific objectives have been developed for the main fisheries, or for Indian mackerel specifically, and few of the measures outlined in the CCRF in relation to management planning – for example, the development of target and limit reference points appropriate to the stock and appropriate harvest control rules – have been applied. Most fisheries remain open access, and previous attempts to introduce limited licensing systems have failed.			
3.2.2	Decision making processes		✓		
Explanatory Statement		No institutional barriers exist to incorporating scientific advice into management decision making, however it is not often done. Political and stakeholder views have historically been given greater weight than scientific advice, and the absence of 'take up' of scientific advice by managers results in a disincentive for scientists to enthusiastically participate in management processes.			
3.2.3	Compliance & Enforcement		✓		DoF
Explanatory Statement		The main Centre for fisheries control is in Krabi. Patrols are conducted at sea to ensure fishing takes place in a legal manner. The Centre claims good compliance, but there is no evidence to support this. Management is devolved to a regional level to identify local issues and ensure compliance. However this can make enforcement disjointed and inconsistent. There are approximately 20 pilot MCS groups operating at the Tambon level. These groups are trained and provided with basic equipment – binoculars, life jackets and radios – to police their own zones. The initiative for the MCS pilot projects came from fishers and follows the successful EU-funded CHARM project in which community groups were engaged in CBFM. No information was available regarding the level of compliance or infringement in the fishery, but enforcement of certain regulations is understood to be limited.			
3.2.4	Research Plan		✓		AFRDC, pers. comm..
Explanatory Statement		The evidence base provided for this assessment shows there has been extensive work on fisheries science with a comparatively good level of research capacity to support the Andaman Sea part of the BOBLME			

PI	Title	Weak	Intermediate	Good	Reference
		region. There is a plan in terms of maintaining landings data and conducting regular interviews with fishermen, but resources are limited, and there is no fisheries-specific research plan for Indian mackerel Given the multi-species, multi-gear nature of Thai domestic fisheries, a key need identified by MFRDB staff is increased capacity in multi-species stock assessment techniques. However some scientific information is available that could be used to inform fisheries management, but there is no evidence that it does directly do so. To be more applicable, assessments would require to be on a undertaken on a regular basis to provide timely inputs; currently information is derived from ad hoc research.			
3.2.5	Performance Evaluation		✓		DoF (2008). *The Master Plan Marine Fisheries Management of Thailand*.
Explanatory Statement		It is not evident that the Masterplan has a clear review and evaluation elements that will address shortcomings or changed priorities. These would be required to evaluate the performance of the fishery specific management system against its objectives.			

2.3.1 Key Weaknesses with Current Management Performance

The overarching institutional challenge in this category is to improve the scientific basis for the management of Thailand's fisheries. To date, fisheries management arrangements appear to have been largely influenced by production-driven goals, rather than the sustainable capacity of the target stocks and ecosystems.

The institutional structure and legislative framework is in place, along with a high level strategy to substantially improve fisheries management. However, it is not clear that the political will and so sufficient resources are available to achieve those improvements, particularly if longer-term management means more limits on fishing opportunities.

It is also evident that Thailand's fishing fleets are active throughout the BOBLME region and some responsibility for the conduct of these vessels rests with the flag state as well as the EEZ state where they are operating. The Master Plan states sustainable objectives within its own waters, but production targets remain and it also seeks to develop distant water fisheries.

2.3.2 Key Recommendations to Address Management Weaknesses

- Set and implement a national long-term management plan for small pelagics based on sustainable exploitation of resources;
- Improving data collection, collation and cross checking systems;
- Design a comprehensive plan for future assessments, undertaken on a regular basis;
- Ensure improved scientific information is used as a basis for objective resource management decisions; and
- Develop regional agreements to ensure Thailand's offshore vessels support other country's management measures.

2.4 SUMMARY – INDIAN MACKEREL

The table below provides a summary of the performance for Indian mackerel in Thailand

Table 4: Summary performance table for Indian Mackerel in Thailand

Thailand																																
Unit of Assessment		Principle 1: Stock status							Principle 2: Ecosystem impacts																Principle 3: Governance & Management								
		Outcome			Harvest strategy				Retained			Bycatch			ETP			Habitat			Ecosystem			Governance & Policy				Fishery specific mang				
Species	Gear	1.1.1. Stock status	1.1.2. Reference points	1.1.3. Stock rebuilding if necessary	1.2.1. Performance of Harvest Strategy	1.2.2. Harvest control rules and tools	1.2.3. Information and monitoring	1.2.4. Assessment	2.1.1. Retained status	2.1.2. Retained management	2.1.3. Retained info / monitoring	2.2.1. Discards status	2.2.2. Discards management	2.2.3. Discards info / monitoring	2.3.1. ETP status	2.3.2. ETP management	2.3.3. ETP info / monitoring	2.4.1. Habitat status	2.4.2. Habitat management	2.4.3. Habitat: info / monitoring	2.5.1. Ecosystem status	2.5.2. Ecosystem strategy	2.5.3. Ecosystem info / monitoring	3.1.1. Legal customary framework	responsibilities	3.1.3. Long-term objectives	3.1.4. Incentives for sustainable fishing	3.2.1. Fishery-specific objectives	3.2.2. Decision-making processes	3.2.3. Compliance & enforcement	3.2.4. Research plan	evaluation
I. mackerel	Purse seine	0	0	0	0	0	1	1	1	1	2	2	2	1	1	1	1	2	2	1	1	1	1	1	2	1	0	0	1	1	1	1
I. mackerel	Btm otter trawl	0	0	0	0	0	1	1	0	0	2	2	2	1	0	0	1	0	1	1	0	0	1	1	2	1	0	0	1	1	1	1

Appendix A: References

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Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and to lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

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