

WWF

A BLUEPRINT FOR SUSTAINABLE TROPICAL SHRIMP TRAWL FISHERIES



**A WWF COMMISSIONED REPORT COMPLETED BY
POSEIDON AQUATIC RESOURCE MANAGEMENT LTD**

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The views contained in this report are those of the authors and do not necessarily represent the official views of WWF. The content of this report relates to the date of publication, but may be superseded by ongoing developments in many of the fisheries profiled.

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Abstract

The report provides a global review of tropical shrimp trawl fisheries, focussing on the fleets involved, catch and stock trends, governance and management arrangements, and the positive and economic drivers of current performance. It examines the many problems in such fisheries with regards to environmental, economic and social sustainability, and uses case study information to highlight both good and bad practice. This case study information is then used to benchmark tropical shrimp trawl fisheries against the Marine Stewardship Council standards. A blueprint for sustainable tropical shrimp trawl fisheries is then presented which is underpinned by the key lessons learned.

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ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource Economics
AFMA	Australian Fisheries Management Authority
BAP	Bycatch Action Plan
BED	Bycatch Exclusion Device
BMSY	biomass exploited at maximum sustainable levels
BRD	Bycatch Reduction Device
BRPL	Research Institute for Marine Fisheries (Indonesia)
BRS	Bureau of Rural Sciences (Australia)
CIFT	Central Institute of Fisheries Technology (India)
CIMFR	Central Institute of Marine Fisheries Research (India)
CONAPESCA	Comisión Nacional de Acuacultura y Pesca (Mexico)
CPUE	Catch Per Unit of Effort
CRFM	Caribbean Regional Fishery Mechanism
CSP	Centre de Surveillance des Pêches (Madagascar)
DARD	Department of Agriculture and Rural Development (Vietnam)
DEHWA	Department of the Environment, Water, Heritage and the Arts
DKP	Dinas Perikanan Provinsi (Provincial Fishery Department (Indonesia))
DNAP	National Directorate of Fisheries Administration, of the Ministry of Fisheries (Mozambique)
EAF	Ecosystem Approach to Fisheries
EBCD	Environment Protection and Biodiversity Conservation Act 1999
EBFM	Ecosystem Based Fisheries Management
EC	European Commission
EDF	Environmental Defense Fund
EEZ	Exclusive Economic Zone
EPBC	Environmental Protection Biodiversity Conservation (Act in Australia)
ETP	Endangered, Threatened and Protected
FAC	Fisheries Administration Commission (Mozambique)
FAM	Fisheries Assessment Methodology
FAO	Food & Agriculture Organisation of the United Nations
FDF	Department of Fisheries (Nigeria)
GACPM	Groupement des Aquaculteurs et Pêcheurs de Crevettes de Madagascar
GEF	Global Environment Fund
GFEU	Gear Fishing Effort Units
HCR	Harvest Control Rule

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HP	Horse Power
HPPI	Association of Indonesian Shrimp Catching Companies (Indonesia)
HSP	Harvest Strategy Policy
IBFM	Incentive Based Fisheries Management (Mexico)
INP	National Fisheries Institute (Mexico)
IQ	Individual quota
IRD	Institut de Recherche pour le Développement
ITE	Individual Transferable Effort
ITFR	Individual Transferable Fishing Rights
IUCN	World Conservation Union
IUU	Illegal Unreported and Unregulated
JTED	Juvenile and Trash Excluder Device
M	metres
MAC	Management Advisory Council
MAEP	Ministère de l'Agriculture de l'Élevage et de la Pêche (Madagascar)
MAERH	Ministère de l'Agriculture de l'Élevage et des Ressources Halieutiques (Madagascar)
MAERH	Ministère de l'Agriculture de l'Élevage et des Ressources Halieutiques (Madagascar)
MARD	Ministry of Agriculture and Rural Development
MEY	Maximum Economic Yield
MFRA	Marine Fisheries Regulation Act (India)
MMAF	Ministry of Marine Affairs and Fisheries (Indonesia)
MMAF	Ministry of Marine Affairs and Fisheries (Indonesia)
MoA	Ministry of Agriculture (India)
MPEDA	Marine Products Export Development Authority (India)
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non Governmental Organisation
NIOMR	Nigerian Institute for Oceanography and Marine Research
NITOA	Nigerian Trawler Owners Association
NMFS	National Marine Fisheries Service (USA)
NOM	National Conservation Measures (Mexico)
NORAD	Norwegian Agency for Development Cooperation
NORMAC	Northern Prawn Fishery Management Advisory Committee
NOS	Noroeste Sustentable
NPF	Northern Prawn Fishery

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NPFI	Northern Prawn Fishery Pty Ltd (Australia)
OEFC	l'Observatoire Economique de la Filière Crevetrière (Madagascar)
PIRSA	Department of Primary Industries and Resources, South Australia
PISGs	Performance Indicators and Scoring Guideposts
PNRC	Programme National de Recherche Crevetrière (Madagascar)
RVP	Revs per minute
SARDI	South Australian Research and Development Institute
SEAFDEC	South East Asia Fisheries Development Centre
SFR	Statutory Fishing Right
SG	Spencer Gulf (Australia)
SGWCPFA	Spencer Gulf and West Coast Prawn Fishermen's Association (Australia)
T	Tonnes
TAC	Total Allowable Catch
TED	Turtle Excluder Device
TEP	Threatened, Endangered or Protected
TST	Tropical Shrimp Trawl
UN	United Nations
UNEP	United Nations Environment Programme
UNIMA	Groupe Unima (Madagascar fishing company)
USA	United States of America
VMS	Vessel Monitoring System
WTO	World Trade Organisation
WWF	World Wild Fund for Nature
ZMC	Zonal Management Conserve (Madagascar)

EXECUTIVE SUMMARY

Background to shrimp fisheries and some current problems

One point three million tonnes of tropical and temperate shrimp are caught annually throughout the world. An approximate estimate¹ is that 419,000 trawlers from 65 countries catch shrimp, mostly using bottom trawls and generating employment for around 900,000 fishers. There are in addition hundreds of thousands of coastal/artisanal fishers using a variety of fishing gears, including small trawls, trammel nets, bag nets and seines. This group is responsible for catching less than 5% of the total annual shrimp catches, but can have significant impacts on sustainability.

Shrimp trawling is considered to be one of the most unselective and damaging fishing methods used in the world. Bycatch of commercial and non-commercial species may significantly outweigh catches of target species. This fact, along with the impacts of bottom trawls on the benthic environment can result in significant negative impacts of tropical shrimp trawls on ecosystems.

Fishing fleets have expanded at rapid rates in the last 30 or so years, with the result that shrimp catch per unit of effort in most fisheries is in decline.

Fleets of different sizes and fishing methods access most tropical shrimp fisheries. This often results in conflicts between fishers from different groups. A particularly worrying sign that appears to have received little emphasis in studies to date, and which in part may be a reason for increased levels of conflict, is the growth in artisanal fisheries which often catch smaller-sized shrimp from inshore breeding and nursery areas. Whilst much of the management attention and concern to-date has been focused on the activities of the larger industrial shrimp fleets, the activities of these artisanal groups are having a severe impact on both shrimp stocks and the economics of offshore vessels. The focus on managing larger vessels in the absence of similar management efforts for inshore fisheries is a significant shortcoming.

In many countries, governments focus on food security and the political risks of limiting access on the one hand, and long-term environmental, economic and social sustainability issues on the other. Typically short-term objectives have been chosen, and there has been a reluctance to control access to the shrimp resource, and to adapt management initiatives that focus on limiting bycatch. Consequently markets have developed for bycatch species, which may include food for coastal populations and in some cases inputs to fishmeal used as feed in the aquaculture sector. As this report shows, short term focus is ill founded, and contradicts the rationale for supporting long term sustainability of the resource in the interests of food security and benefits to coastal communities.

Some positive developments

There are some limited examples of what can be considered well-managed shrimp trawl fisheries; the most widely cited examples of best practice come from Australia, where shrimp trawl fisheries are managed relatively well and many best practice lessons can be drawn. Shrimp fisheries in French Guiana are also well managed. Some other examples of improved practices in tropical shrimp trawl fishery management and stakeholder interaction can be drawn from positive initiatives in the USA, Madagascar, Mexico, Suriname and Mozambique. Positive developments in these countries focus on effort control, bycatch reduction and in some cases, the ecosystem approach to fisheries management, but there remain significant problems and

¹ Extracted from national data provided in Appendices to this report

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room for improvements in these fisheries. In addition, positive developments have been taking place with regards to the establishment of sector partnerships (e.g. between government and the private sector, between NGOs and the private sector, and between links in the supply chain) which are greatly assisting with identifying and putting into place improved practices for greater sustainability.

The purpose of this report and the methodology used in its completion

This report seeks to identify and understand the critical problems found in tropical shrimp trawl fisheries and their causes, and to create, based on examples of best practice and potential solutions, a 'blueprint' which can support a transition for tropical shrimp trawl fisheries to more sustainable practices.

The report follows on from a workshop, convened by WWF in Darwin, Australia (July 2008) that brought together both external experts and WWF staff to 'brainstorm' global TST fisheries, the aim of which was to determine opportunities to drive these fisheries towards substantially improved management regimes.

This study involved an extensive review of fishery practices adopted in tropical shrimp fisheries. It was informed by work undertaken by the FAO, most notably Gillette (2008) and the outputs from the GEF/UNEP/FAO programme². The work also draws heavily on inputs from WWF fishery officers, government officials, private sector companies and other individuals who provided information on existing practices, management systems and governance in 11 countries based on a detailed questionnaire prepared by the consultants (Australia, Suriname, French Guiana, India, Indonesia, Madagascar, Mexico, Mozambique, Nigeria, USA and Vietnam). Outputs were also elaborated through country visits to India, Indonesia, Madagascar and Vietnam, and through a review of other available literature.

Based on the case study fisheries, this report then provides a benchmarking of tropical shrimp trawl fisheries, using the Marine Stewardship Council's sustainability assessment framework. This framework assesses fisheries against three main principles: the status of stocks; impacts on the ecosystem; and management conditions. Within each principle, a number of performance indicators are specified. The benchmarking exercise is provided for tropical shrimp trawl fisheries as a whole, rather than for all individual fisheries reviewed as part of the study, but suggests that very few shrimp trawl fisheries would pass an MSC assessment process based on current performance, and that significant steps need to be taken across most performance indicators in many, but not all, countries.

Some conclusions

In reviewing the case study fisheries around the world, this report presents a wide range of detailed information, and draws a number of conclusions as follows:

- Forty four per cent of total catches are taken in the Coral triangle region, with Indonesia and Vietnam accounting for 60% of this region's total, while 32% is taken in the Indian subcontinent, with India accounting for 88% of the catch in this region. The Americas³ account for 16% of total catches, and West and East Africa and the Middle East account for the remaining 8%;
- Industrial trawlers over 18m in length account for a large proportion of catches in both Africa and the Middle East, while in the Indian sub-continent and in the Americas, semi-

² The main objective of this multi-year global programme is to reduce discards in tropical shrimp trawl fisheries by introducing appropriate fishing technologies. The project objectives also include the reduction of overall by-catch by shrimp trawlers, in particular the capture of juveniles of commercially valuable species, and a better understanding of the impact of shrimp trawling on marine habitats.

³ All countries in north, central and south America

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industrial vessels i.e. 12-18m dominate catches. Catches in the Coral triangle region are dominated by small-scale trawlers of around 8-12m in length;

- Very few individual countries show downward trends in overall catches, the exceptions being Senegal, Thailand, and the USA. However, catches per unit of effort in most countries show declines, and in some cases these declines are very significant. These trends are a reflection of increased numbers of boats and increased numbers of trawls used;
- There are very few stocks that appear to be stable. Examples of stocks harvested to optimal levels include fisheries in Australia, USA, and two stocks in Mexico (Pacific and Atlantic brown shrimp). All other stocks, including most stocks in Mexico, are experiencing strong declines;
- In fisheries with open access regimes (e.g. India, Indonesia, Vietnam, Mexico, Nigeria and Guyana) fishing effort may need to be cut by at least 50% in order to restore fisheries to sustainable levels;
- The ratio of shrimp to other species in landed catch⁴ weight ranges from 1:8-20 in multi-taxa fisheries (e.g. Indian sub-continent countries: India, Pakistan, Myanmar and Bangladesh; Coral Sea countries: Indonesia, Vietnam, Thailand, Malaysia; Venezuela; West African countries; and the Gulf States), through 1:5-7.5 in fisheries with selectivity problems but with improved bycatch performance (many south and central American countries, Colombia, Costa Rica, Cuba, Mexico (Pacific), and the USA (penaeid trawlers)), to 1:1 in some well managed fisheries, or fisheries where bycatch is significantly reduced through effective introduction of selectivity devices (such as Australian fisheries and some others (Suriname seabob⁵, Madagascar (seasonal)));
- Shrimp trawl fisheries can, in many cases, result in significant impacts on ecosystems in the form of bycatch of endangered, threatened and protected species, and impacts on benthic environments;
- Governance arrangements in different fisheries include a range and mix of top-down centralised administration (such as in Thailand, Madagascar, Mozambique, Iran, Saudi Arabia, Guyana, Suriname and Australian Commonwealth fisheries, where policy is determined at central level, with other functions such as licensing, compliance and research coordinated centrally), delegated provincial and district powers (e.g. Indonesia, Vietnam, USA and Australian States), and co-management with a range of small-scale and company-led inputs to governance. Within this range, very few fisheries show strong overall levels of governance;
- With respect to management systems, many fisheries remain largely open-access. However some examples of input controls that have been used or are currently in use include: buy-back schemes in Australia and decommissioning in French Guiana to reduce capacity; fishing input rights based on changes to the fishing gear such as headrope length (e.g. Australia and Mexico); removal of unused licences (e.g. USA) or licences held by those infringing regulations (e.g. Indonesia); and seasonal and area restrictions in a number of countries. Output controls used include: TACs (in selected fisheries e.g. in Indonesia, Mozambique, French Guiana, USA); individual boat quotas (e.g.

⁴ Excludes discarded bycatch

⁵ *Xiphopenaeus kroyeri*

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Mozambique, Madagascar); minimum landing sizes; average mean sizes (e.g. Australia); and fish bycatch restrictions. Technical measures in use in some countries include: minimum mesh sizes; headrope length; and bycatch reduction devices;

- Increases in farmed shrimp production and associated global declines in shrimp prices, coupled with rising/fluctuating fuel prices, and worsening catches per unit of effort, have made the financial position of many shrimp trawl vessels very precarious. Some potential solutions include: branding and market benefits that can be gained if fisheries can move towards, or demonstrate, sustainability. Some fisheries are presently going through the process of MSC certification; transfer of effort to other fisheries (on the assumption that these other fisheries are also not being over-exploited); and altering the balance of target species, including increasing dependency on other retained species; and
- Other business drivers which negatively impact on sustainability include: augmenting low wages (e.g. Nigeria, Colombia and Indonesia) with crew being paid partly through the sale of bycatch species – this leads to a reduction in selectivity, reduced and illegal mesh sizes, and a failure to apply Bycatch Reduction Devices (BRDs) and Turtle Excluder Devices (TEDs); and fuel subsidies, which are applied in many countries⁶ and perpetuate retention of inefficient capacity in the fleet. Positive business drivers include fuel savings caused through gear changes that allow for increased margins to reward best practice. An example being skipper and crew with wage premiums for catching larger-sized shrimps (Madagascar).

A blueprint to achieve sustainable tropical shrimp trawl fisheries and recommendations to assist with implementation

In the final section of this report, a blueprint to achieve sustainable tropical shrimp trawl fisheries is provided, focusing on four key objectives which can be expected to result in improved sustainability. These are:

- Creating a management framework which ensures the setting of appropriate harvest control rules that support the sustainability of the target species and make adequate provision for safeguarding the supporting ecosystems;
- Providing a system of strong compliance and facilitating industry participation in all aspects of decision making;
- Creating a monitoring and evaluation framework to assess results of blueprint implementation; and
- Facilitating the development of positive business drivers linked to improved fishing practices and market incentives.

Under each of these objectives a number of results are articulated, and specific activities proposed that would help to bring these results about. The type of indicators that could be used to demonstrate that activities have been successfully undertaken is also provided.

In taking the outputs of this work forward, the consultants recommend that fisheries administrators and other relevant stakeholders should review the lessons learned from this report, and conduct a gap analysis of current performance against the lessons learned and the blueprint provided in this report. This is likely to require additional work to compare the performance of fisheries in individual countries against the blueprint.

⁶ A recent study showed that, of the 34 largest shrimp producing nations, 19 countries had fuel subsidies (Gillette 2008)

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The blueprint presented in this report is generic and applicable to all tropical shrimp trawl fisheries. Thus in order for implementation to be successful it should in all cases be reviewed by local stakeholders and amended as appropriate. This is critically important for four reasons:

1. To ensure that the blueprint adopted for any one country/fishery is specific to the needs of that country/fishery;
2. To ensure that stakeholders in the country/fishery have the opportunity to participate in finalising the blueprint, thereby generating a sense of ownership of it;
3. So that adaptation of the blueprint in a particular country/fishery can include the specification of a detailed and appropriate timeframe, with responsibilities assigned for all actions; and
4. To ensure that appropriate resources (financial and staffing) are carefully assessed and identified for all necessary improvements.

1 INTRODUCTION TO THIS REPORT

This report has been prepared by Poseidon⁷ on behalf of the WWF. It follows on from a workshop, convened by WWF in Darwin, Australia (July 2008), that brought together both external experts and WWF staff to 'brainstorm' global tropical shrimp trawl (TST) fisheries. The aim of the meeting was to determine opportunities to drive these fisheries toward substantially improved management regimes.

This study has involved an extensive review of fishery practices adopted in tropical shrimp fisheries. It has been informed by work undertaken by FAO, most notably Gillette (2008) and the outputs from the GEF/UNEP/FAO programme⁸. The work also draws heavily on inputs from WWF fishery officers, government officials, private sector companies and other individuals who provided information on existing practices, management systems and governance in 11 countries based on a detailed questionnaire prepared by the consultants (Australia, French Guiana, Suriname, India, Indonesia, Madagascar, Mexico, Mozambique, Nigeria, USA and Vietnam). Outputs were also elaborated through country visits to India, Indonesia, Madagascar and Vietnam, and through a review of other available literature.

Following this short introduction, the report is divided into three main sections, supported by considerable additional information which can be found in the Appendices.

Section 2 presents a wide array of background data and information on TST fisheries around the world. The section focuses on, and discusses, the types of fleets involved, trends in catches and stock status, governance and management systems being applied, and positive and negative economic drivers affecting sustainability.

Section 3 then 'benchmarks' TST fisheries using the MSC standard as an assessment tool. This benchmarking exercise highlights the many problems exhibited in such fisheries, as well as some positive developments that have been occurring in a number of developed and developing countries.

Section 4 provides the Blueprint for sustainable tropical shrimp trawl fisheries. The blueprint is presented in the form of a logical framework with accompanying explanation/notes, and is underpinned by a number of lessons learned from the preceding sections, which we feel are essential requirements for sustainability.

The intention of the blueprint is to provide an aspirational framework for fisheries managers and practitioners to assess, benchmark and improve performance. The blueprint provides for a generic framework that can be applied to all TST fisheries, but which needs to be refined by stakeholders themselves in any particular country/fishery to meet their specific circumstances and requirements.

⁷ www.consult-poseidon.com

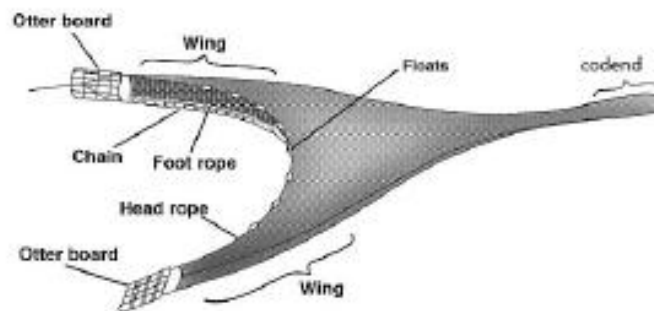
⁸ The main objective of this multi-year global programme is to reduce discards in tropical shrimp trawl fisheries by introducing appropriate fishing technologies. The project objectives also include the reduction of overall by-catch by shrimp trawlers, in particular the capture of juveniles of commercially valuable species, and a better understanding of the impact of shrimp trawling on marine habitats.

2 BACKGROUND TO TROPICAL SHRIMP TRAWLING

2.1 DESCRIPTION OF THE FISHERY

The otter trawl is the predominant fishing method used to catch shrimp. This consists of a cone shaped net kept open horizontally by two otter boards. The vertical opening is maintained with floats and/or hydrodynamic devices (kites) on the upper edge (floatline) and weights on the groundrope. The trawl is designed and rigged to have bottom contact during fishing. A groundrope is used which may be a chain or weighted rope, and may be equipped with rubber discs, bobbins or spacers, to shield the lower leading margin of the trawl from ground damage while maintaining ground contact. Trawlers may tow anywhere from one to four nets. Using more than one net is increasingly popular as it improves that rate of catch and therefore fuel efficiency.

Figure 2-1: Shrimp trawl



Other critical components to the fishing method are the mesh size in the cod end, the trawl wings, whether gear attachments are applied to reduce bycatches and the length of tow. The range of minimum mesh size applied is from around 20 mm to 60 mm. Smaller meshes retain more fish and prawns, including juvenile prawns and trash fish. Longer tows also add to the volume of catches in the net, thereby reducing gear selectivity. Bycatch Reduction Devices (BRDs) have been developed to improve the escapement of juvenile fish and other species. These include Bycatch Reduction Devices (BRDs), Juvenile and Trash Excluder Device (JTEDs) and Turtle Excluder Devices (TEDs). BRDs are placed in critically important areas of the net to allow non-target fish and other animals to escape. Other adjustments can be made to trawl gear to allow trawls to be lighter. Such adjustments, usually developed by trawler companies themselves and fishing boat owners, include the design of the trawl boards (with a focus on lighter weights to reduce drag), and elimination of tickler chains. Other critical trawl design factors are the position of the headline behind the footline, and adequate space between the dropper and the foot wire.

Fishing can take place at a variety of depths and distances from the coast. Shallow water fisheries range from 1 m to 120 m, deepwater fisheries generally from 300 m to 750 m. Coastal artisanal vessels usually operate in shallow water within 2 to 3 n.miles of land, small-scale trawlers, up to 6 miles offshore and semi-industrial and industrial boats between 2 n.miles to 300 miles offshore. Some national management systems define operational demarcation zones, but these are not necessarily respected. Fishing for white shrimp (e.g. banana prawns) predominantly takes place during the day when shrimp are most active, or at night during the full moon. Brown shrimp (including tiger prawns) are generally caught at night. Tow times range from 45 minutes to 4 hours, depending on the main focus of the target species. Boats seeking to concentrate on shrimp and minimizing bycatches typically tow between 45 minutes and 1 hour. As and when vessels target more fish, and smaller size shrimp species, tows may take up to 4 hours.

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The target species covered in this report are tropical water species⁹.

- | | |
|---|---|
| ✦ Atlantic seabob (<i>Xiphopenaeus kroyeri</i>) | ✦ Kiddi shrimp (<i>Parapennaeus stylifera</i>) |
| ✦ Blue endeavour prawn (<i>Metapennaeus endeavouri</i>) | ✦ Kuruma shrimp (<i>Marsupennaeus japonicus</i>) |
| ✦ Blue shrimp (<i>Litopenaeus stylirostris</i>) | ✦ Pink shrimp (<i>Pennaeus notialis</i>) |
| ✦ Brown shrimp, (<i>Parapennaesis atlantica</i>) | ✦ Pink shrimp (<i>F. duorarum</i>) |
| ✦ Brown shrimp (<i>Farfantepennaeus aztecus</i>) | ✦ Pacific brown shrimp (<i>F. californiensis</i>) |
| ✦ Brown tiger prawn (<i>Pennaeus esculentus</i>) | ✦ Red endeavour prawn (<i>Metapennaeus ensis</i>) |
| ✦ Caribbean pink shrimp (<i>F. duorarum</i>) | ✦ Speckled shrimp (<i>Metapennaeus monoceros</i>) |
| ✦ Caribbean Red shrimp (<i>F. brasiliensis</i>) | ✦ Red-spot king prawn (<i>Melicertus longistylus</i>) |
| ✦ Giant tiger shrimp (<i>P. monodon</i>) | ✦ Western king prawn (<i>Melicertus latisulcatus</i>) |
| ✦ Grey shrimp (<i>P. kerathurus</i>) | ✦ White banana prawn (<i>Fenneropenaeus merguensis</i>) |
| ✦ Grooved tiger prawn (<i>P. semisulcatus</i>) | ✦ Whiteleg shrimp (<i>Pennaeus vannamei</i>) |
| ✦ Indian white shrimp/Red legged banana prawn
(<i>P. indicus</i>) | ✦ White shrimp (<i>P. merguensis</i>) |
| ✦ Kadal shrimp/Indian banana shrimp (<i>Metapennaeus
dobsoni</i>) | ✦ White shrimp (<i>L. setiferus</i>) |

TST is actively used in as many as 65 countries (Table 2-1). These countries are divided into 6 regional groupings.

The table shows that:

1. 1.3 million tonnes of tropical shrimp is caught annually;
2. Forty four per cent is taken in the Coral triangle region, with Indonesia and Vietnam accounting for 60% of this region's total. Australia's catch is by comparison quite small relative to the other Coral Sea countries;
3. Thirty two per cent is taken in the Indian subcontinent, with India accounting for 88% of the region's catch;
4. Sixteen per cent is taken in the Americas¹⁰ with Mexico, Brazil and the Guianas accounting for 66% of the region's total. Other significant TST activities within the region are in the USA, Venezuela, Peru and Panama;
5. West and East Africa and the Middle East account for the remaining 8%, with major producing countries being Nigeria, Cameroon, Mozambique, Madagascar, Iran and Saudi Arabia.

⁹ The number of different tropical shrimp species caught run into the thousands, but those not listed here would form a minority of the retained species.

¹⁰ Defined as all countries in north, central and south america

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Table 2-1: Summary of average shrimp catches by region and country (Tonnes, average 2000-2007)

CORAL TRIANGLE		AMERICAS		WEST AFRICA	
Indonesia	239,240 (18%)	Mexico	65,523 (5%)	Nigeria	25,075 (2%)
Vietnam	102,971 (8%)	Brazil	34,416 (3%)	Cameroon	9,595 (1%)
Thailand	77,364 (6%)	Guyana	20,533 (2%)	Senegal	4,300
Malaysia	73,472 (6%)	USA	18,727 (1%)	Angola	2,276
Philippines	45,599 (4%)	Suriname	12,181 (1%)	Benin	2,274
Australia	22,610 (2%)	Venezuela	11,174 (1%)	Gabon	2,118
Cambodia	11,163 (1%)	Peru	7,420 (1%)	Sierra Leone	1,424
Papua New Guinea	1,008	Panama	6,642 (1%)	Ghana	1,282
Singapore	322	Chile	4,639	Congo	820
Solomon Islands	12	Nicaragua	3,650	Côte d'Ivoire	459
Total	573,761 (44%)	Ecuador	3,407	Gambia	363
INDIAN SUB CONTINENT		French Guiana	2,883	Guinea-Bissau	269
India	374,517 (29 %)	Colombia	2,755	Guinea	155
Myanmar	23,588 (2 %)	Costa Rica	2,319	Liberia	103
Pakistan	22,106 (2 %)	Guatemala	1,871	Total	50,513 (4%)
Bangladesh	3,444	El Salvador	1,740	EAST AFRICA	
Total	423,655 (33 %)	Honduras	1,500	Mozambique	12,450 (1%)
MIDDLE EAST		Cuba	1,361	Madagascar	12,125 (1%)
Iran	7,261 (1%)	Trinidad and Tobago	830	Tanzania	1,795
Saudi Arabia	7,003 (1%)	Haiti	634	Eritrea	447
Kuwait	1,773	Belize	225	Kenya	392
Bahrain	1,738	Dominican Republic	65	South Africa	134
Yemen	1,485	Uruguay	35	Total	27,323 (2%)
Oman	489	Jamaica	29	Grand Total	1,299,619
Iraq	60	Total	204,559 (16%)		
Total	19,808 (2%)				

Source: FAO Fishstat. Brackets of percentage global production included if figures 1% or more of total.

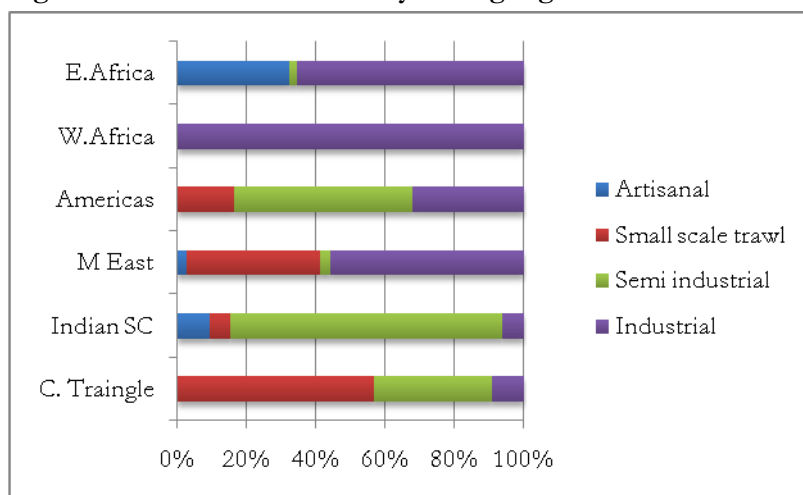
2.2 FLEET STRUCTURE

Vessel groupings and definitions may differ between countries, but broadly fall into the following:

- Industrial trawlers, usually upwards of 18 m in length with engine sizes from 300 to 1,500 hp and on board freezers, fishing long trips and operating between 5 and 55 days at sea;
- Semi-industrial trawlers, usually from 10-18 m in length, with engine sizes from 90 to 250 hp, with limited on-board storage, usually icing shrimp, but occasionally with freezing capacity, operating short trips (between 1 and 5 days);
- Small-scale trawlers, usually around 8-12 m in length, with engine sizes from 33 to 90 hp, operating trawls in shallower waters and close to shore; and
- Artisanal boats, usually with small outboard engines, or sail, using a variety of fishing nets, including gill and tangle nets, seines, traps, push nets and small meshed trawls.

Based on the results of the literature review and the survey completed during this work, it is estimated that there are as many as 10,100 industrial sized trawlers, 5,800 semi-industrial and 190,000 small-scale trawlers, together with a large number (in the hundreds of thousands) of multi-gear artisanal vessels. An estimate of catch distribution by vessel segment in each region is shown in Figure 2-2. An example of national segments and gear applications of these fleets is summarized in Box 2-1.

Figure 2-2: Catch distribution by fishing segment



Source: Catch data (FAO Fishstat); fleet data Poseidon country surveys and literature review

Box 2-1: Characteristics of the principal national fleet groupings

India has 29,000 semi-industrial trawlers (12-17m) as well as an industrial fleet of 73 trawlers. Semi-industrial fishing is concentrated in the States of Kerala (SW India), Orissa and West Bengal (NE India), and industrial trawling from Gujarat (NW India). Small coastal boats are also active in all locations using a combination of stake and bag nets. The semi-industrial boats that make up the bulk of the fleet have engine sizes of 85-150 hp and carry one shrimp net. All semi-industrial and industrial boats are required by law to fish outside 12 n.miles. Around half of the west coast boats also target deep water shrimp, as an alternative fishery during lean fishing period. Some boats carry larger mesh bottom trawl or semi pelagic gear to allow a switch method to finfish species, when shrimp catches are lean. Some of the larger boats also carry trawl nets.

Indonesia has a dedicated shrimp fleet of 90 national industrial trawlers fishing specifically in one province, Papua (Arafura Sea and Mareoke). An additional number of foreign trawlers are also licensed to fish in the same fishery, but reports on the active number range from 200 to 330 (Malaysian, Philippine and Thailand). Most trawlers carry 2 nets, but some up to 4. There are also thousands of artisanal, small-scale trawl and semi-industrial boats targeting shrimp within the archipelago, but exact numbers are

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unknown. These boats use a variety of fishing methods including trawl, which are banned in areas other than the Arafura Sea, and inshore trammel nets. A new trawl fishery has also just started in East Kalimantan. Details of activity in this district are unclear but are believed to include both national and foreign (Malaysian/Philippines) vessels.

Vietnam has 29,000 shrimp trawlers divided into two groups, otter trawls (90%) and beam trawlers (10%). The vessels also fall into two categories, small-scale trawlers of < 90 hp (97.5%) fishing in coastal waters (but officially fishing outside 6 n.miles) and semi-industrial vessels of > 90 hp (2.5%), fishing outside of 24 n.miles. Smaller boats are single rigged, but most trawlers comprise twin riggers. Both fishing groups are unlikely to respect demarcation zones with frequent alleged transgressions into coastal waters. Trawling is concentrated in the two main fishing grounds: Gulf of Tonkin (provinces with large fleet are Quang Ninh and Hai Phong) and southeast water of EEZ (provinces with large fleet are Ba Ria-Vung Tau, Tien Giang, Ben Tre, Bac Lieu, Cau Mau, Kien Giang).

The Philippines has banned trawling in some areas since the 1980s. However, there are 20 trawlers described as fully dependent on shrimp as well as 445 trawlers that also target demersal and pelagic species in separate fisheries. Important shrimp fishing grounds are Samar Sea, Lingayen Gulf, San Miguel Bay, and Manila Bay.

Mexico has 2,212 industrial offshore shrimp vessels, using either two nets (Pacific side) or four nets (Atlantic side). These account for 57% of the shrimp catch, There are as many as 102,000 artisanal vessels. These catch 43% of the total shrimp landed. The artisanal fleet has tripled in size in 17 years.

Nigeria has a fleet of 156 industrial trawlers of between 23 to 30m. The trawlers fish outside 5 n.miles and use between 2 and 4 nets. Inside 5 n.miles, there are many coastal artisanal canoes using conical nets which are towed in shallow water 5-15m to catch prawn (*Nematopalaemon bastatus*).

Suriname 31 licences in the penaeid/marine shrimp sector, and 20 in the seabob sector, following recent reductions (2010). Vessels are between 18-22m in length, and use twin rig. In Suriname penaeid shrimp trawlers are demarcated to fish in depths greater than 30m. The Atlantic Seabob trawlers operate in depths between 18m and 30m, and vessels are predominantly foreign-owned (Japan, Korea) with Guyana-based skippers.

French Guiana 53 licences available for penaeid/marine shrimp, 23 vessels of around 24m, each using two 22m trawls. These are Twin rig vessels built in Florida with average age of around 20 years. Vessels must stay outside of the 30m depth contour.

Madagascar has a fleet of 70 industrial trawlers (23 to 30 m and ranging from 250 to 500 HP). Sixty-four fish on the west coast, and 6 on the east coast. Fishing takes place between 2 and 30 metres, confined to 4 zones (including one of the east coast). There has been an uncontrolled expansion of artisanal vessels of 3-4m in length operating in the fishery. Consequently, the catch of industrial trawlers has fallen to 3,000 from 8,400 with only 21 industrial vessels operational in the west coast fishery in 2008. The artisanal fleet is reported to catch 3,400 tonnes, the semi-industrial trawl fleet 400 tonnes.

Mozambique has 43 industrial vessels, 49 semi-industrial, and 15,250 artisanal vessels fishing in shallow waters, and 7 industrial vessels fishing in deep waters. Trawlers use between 1 and 4 nets. Artisanal catches range from 100-400 t, or 1-10% of the weight, semi-industrial catches 400 t, and industrial catches around 6,500 t. Industrial vessels are not allowed to trawl within 3n.miles off the coast, and semi-industrials have to operate beyond 1n.mile off the coastline.

Iran has 39 industrial trawlers (27m and 750 hp) fishing with two trawls; 870 wooden dhows (1 m / 100-220 hp) (Dhows); and 1,500 fiberglass boats of 7m / 25-45 hp.

Australia has 10 distinctive fisheries, with a total of 1,182 participating vessels. The fleet comprises a combination of semi-industrial vessels (upwards of 13 m) and industrial vessels (up to 29 m), falling under individual and corporate ownership. However, despite the size categories most of these are

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considered to be 'industrial' as they freeze their product and stay at sea from 1 to 4 months at a time. Two of the fisheries fall under Commonwealth jurisdiction, the Northern Prawn Fishery and the Torres Strait fishery. These fisheries account for 52 and 70 vessels respectively. The largest of the State fisheries are the Queensland east coast prawn fishery and the New South Wales prawn fishery, each with 478 and 304 vessels respectively. There are also small Gulf type fisheries, a notable example being the Spencer Gulf, with 39 vessels. Trawlers carry between 2 and 4 nets per vessel, depending on the specific management system applied.

USA has 3,500-4,500 fishing vessels in two fisheries, the Gulf of Mexico and the Atlantic (South). Atlantic fishing vessels are generally of a small semi-industrial size, whereas Gulf of Mexico vessels can be larger. Vessels move in and out of the fishery based on resource abundance and product prices.

Source: Poseidon country surveys, UNEP/GEF/FAO workshop reports, and other national reports

The distinction between industrial, semi-industrial and small-scale trawls is not only one of size, but more often one of ownership structure. Industrial vessels usually form part of a company corporate structure, often working together under the umbrella of a trawler owner's society. Semi-industrial trawlers may be company owned or operated by individuals. These may be part of a trawler owners' society, or may operate independently. Joint venture and foreign ownership is a common feature among many of the developing country industrial trawler fleets. National or local businessmen may own semi-industrial trawlers. The relationship between the industrial trawler groups and national, provincial and district government is usually quite strong, yielding both positive and negative influences, as this report will later highlight. In cases where rights-based systems have become established, semi-industrial trawlers gravitate increasingly into the company-owned sector. Small-scale trawl and artisanal fishers are usually poorly organized, lacking a group organizational structure, and often using local figureheads or village leaders as spokespersons. The connection between these groups and district fisheries authorities is usually extremely weak.

2.3 CATCH TRENDS

An examination of the catch records by region (Figure 2-2 to Figure 2-6) shows some contrasting trends. Very few fisheries show growth in catch (although some do such as Saudi Arabia, Cameroon, Peru, Vietnam and Brazil). In some cases growth reflects a rapid expansion of catch by artisanal as opposed to industrial vessels (Madagascar and Mexico), with corresponding reductions in catches by the other groups. However, very few countries show any downward trends in overall catch, the exceptions being Senegal, Thailand, and the USA.

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Figure 2-3: Regional and national shrimp catches (Indian sub-continent)

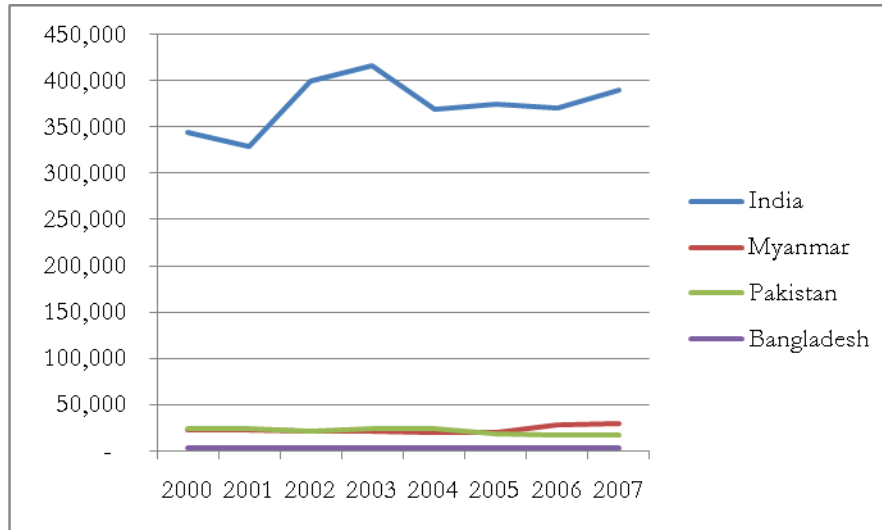


Figure 2-5: Regional and national shrimp catches (Americas)

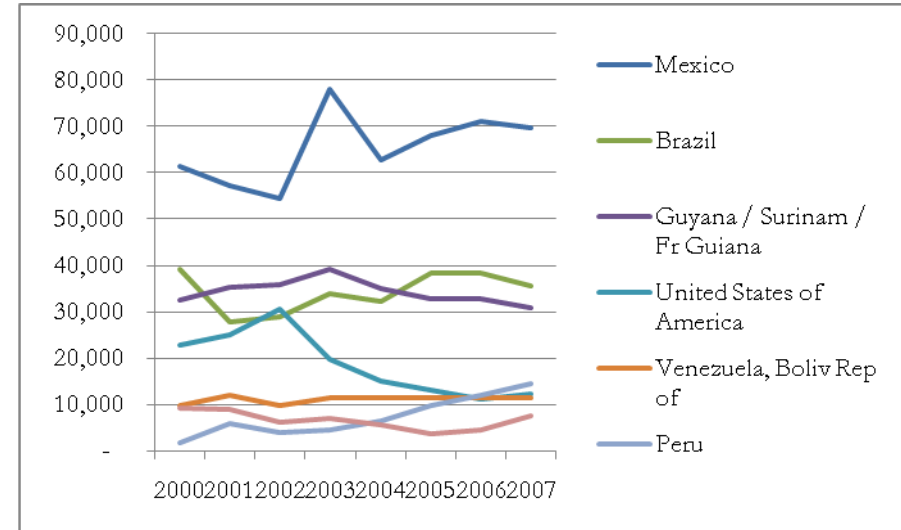
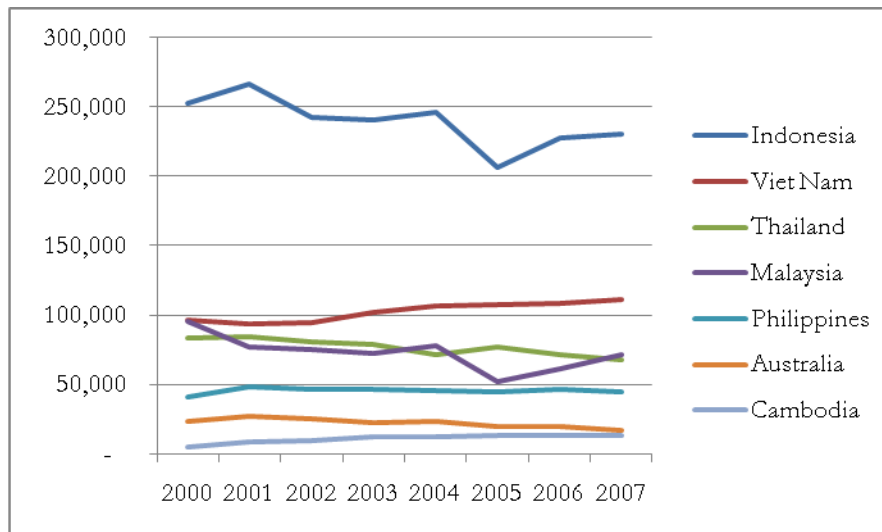


Figure 2-4: Regional and national shrimp catches (Coral Triangle)



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Figure 2-6: Regional and national shrimp catches (Africa)

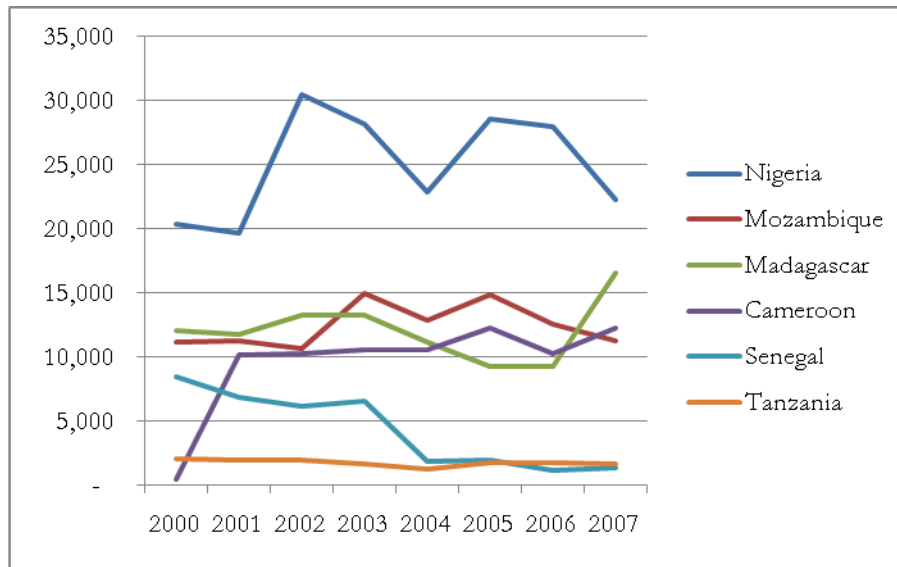
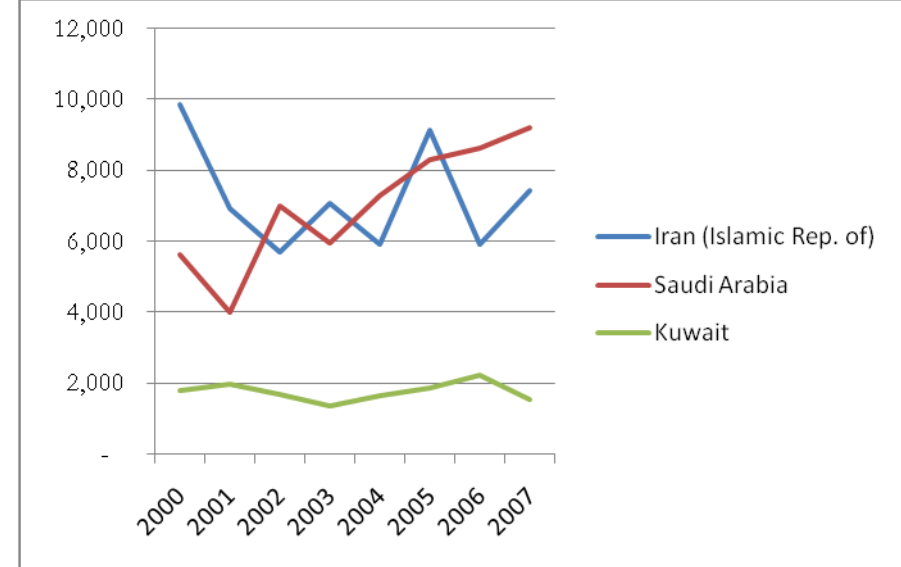


Figure 2-7: Regional and national shrimp catches (Middle East)



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A summary of CPUE trends shows consistent reporting of declines (Box 2-2) in all developing countries, with partial recovery in only one country (Mozambique).

Box 2-2: Summary trends in CPUE

- **Australia:** Northern Prawn and Spencer Gulf fisheries have stable catches. Both fisheries have experienced concerns about effort creep and have responded in specific ways to deal with these (Rights-based capacity exchanges linked to headrope lengths [Northern Prawn fishery], and closed seasons/limited fishing periods).
- **USA:** Generally improving CPUEs since mid to late 1980s.
- **Mozambique:** CPUE has declined in the shallow water stocks and concerted efforts have been made to reduce effort using closed seasons, particularly for the industrial fleet. The declining trend has been reversed. CPUE levels for deep-water pink prawns have been remarkably consistent since 1992.
- **India:** Declining stocks, with CPUE (for all species) falling from 80 kg/boat/hour in the 1980s to 30kg/boat/hour at present (2009). Shrimp makeup 15% of the total catch, with variations between areas (25%, Kerala and 7%, Orissa). This percentage dependency has remained constant between 1980 and 2009.
- **Indonesia:** Decreasing trend in shrimp CPUE in recent years in the Arafura Sea. Catch/vessel/day has decreased from 500 kg /Gross Tons/year two decades ago to the present 250-300 kg.
- **Vietnam:** Uncontrolled access to fisheries in all principal shrimp fishing provinces (Quang Ninh, Hai Phong, Ba Ria-Vung Tau, Tien Giang, Ben Tre, Bac Lieu, Cau Mau, Kien Giang,) with acknowledged reduction in catch/day.
- **Mexico's** industrial fleet catch has fallen by 40% in 10 years, from 6.4 tonnes/vessel/annum to 3.6 tonnes/vessel/annum.
- **Cambodia:** Shift in fishing gears towards more modern and efficient methods, decreasing CPUE 20 kg to 5 kg per night).
- **Nigeria:** Declining stocks, very pronounced/prominent.
- **Guianas:** The Caribbean Regional Fisheries Mechanism (CRFM) conducts scientific workshops to monitor stock status, and each time concern has been raised that fishing effort has been too high, particularly in Guyana, and that there is a risk of over-fishing.
- **Madagascar:** Gradually declining CPUE, but major fall in shrimp catches in 2005. Catches per vessel down from 150 tonnes to 100 tonnes/annum/vessel.
- **Bangladesh:** The CPUE of shrimp (kg/day/shrimp trawler) has steadily decreased since the early nineties.
- **Kuwait:** High level of effort and low CPUE seem to indicate that the stock has been over exploited since 1993;
- **Trinidad and Tobago:** Fully or over exploited condition of shrimp stocks and over capitalization in the trawl fishery.
- **Philippines:** 24 trawling grounds existed from the mid 1950s. Catch rates were between 200-400 kg/hr. By the mid 1970s, catch rates had fallen to 10-15kg/hour, forcing the Government to ban trawling in some areas (Ingles, pers com, 2009.)

Source: Poseidon country survey. Red/italic text indicates declining CPUE, Orange/underlined text recovering CPUE, and green/normal text CPUE maintained at reasonably good levels.

These trends are a reflection of increased numbers of boats and increased number of trawls used. In some cases, the number of boats has declined in response to lower CPUEs, causing boats to leave the fishery (Madagascar). The only countries with constant or even improved CPUEs are those that have implemented a series of fishery management measures and have some controls on access (Australia and USA). However, the systems in both these countries have had to be supported by restructuring programs (including national and state buy-back schemes), which in the case of Australia's Northern Prawn Fishery (Case Study A.1) reduced capacity in the number of vessels by 68% over a period of 30 years, and in

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Texas, USA, by 25% over 12 years¹¹. The most recent Australian buy back scheme was implemented on condition that the fishery moved from a Statutory Fishing Rights Gear Units System based on headrope length to Statutory Fishing Rights based on Individual Transferable Quotas. The gear SFRs, linked to headrope length, had also been successful in removing 43 vessels since 2000.

2.4 STOCK ASSESSMENT

The summary table of biological stock status (Table 2-2) presents information from individual fishery stock assessment reports. It also gives the main indicators of stock status and reference points against which status is assessed. This is generally a comparison of stock biomass, catch, effort and/or catch rates, and biological targets as applicable.

Table 2-2: Results of stock assessment from national and regional institutions and other experts

Country	Species status	Comments
Australia (Northern Prawn Fishery)	(1) Red-legged banana prawn (<i>Fenneropenaeus indicus</i>) (2) Brown tiger prawn (<i>Penaes esculentus</i>)	(1) Stable catches and species biology provide no evidence of overfishing. (2) Spawning biomass not overfished. MEY target applies across multiple species (Larcombe <i>et al</i> 2008).
Australia (Spencer Gulf)	Western king prawn (<i>Melicertus latisulcatus</i>)	Catches have been relatively stable since 1987/1988. Nominal effort (hours fished) has reduced to around 40% of the 1978/1979 peak. Mean harvested prawn size was larger in recent years than in 1978/1979 (Hooper <i>et al</i> , (2007).
USA (Gulf of Mexico)	Brown shrimp (<i>Farfantepenaeus aztecus</i>) Pink shrimp (<i>Farfantepenaeus duorarum</i>) White shrimp (<i>Litopenaeus setiferus</i>)	Exploitation much reduced due to economic factors, supported by some capacity reduction. Recruitment and stock abundance improved since mid to late 1980s, but some localized recruitment overfishing (Louisiana). Otherwise fully to under exploited (Nance 2009).
India	Kadal shrimp (<i>Metapenaeus dobsoni</i>), Kiddi shrimp (<i>Parapennaes stylifera</i>), Kuruma shrimp (<i>Marsupenaeus japonicus</i>), Indian shrimp/Red legged banana prawn (<i>F. indicus</i>) Grooved tiger prawn (<i>Penaes semisulcatus</i>)	All fisheries over-exploited at between 0.6 to 0.75BMSY. However, scientists stress that 0.5 BMSY is over zealous in tropical fisheries due to high fecundity, fast growth rates, and continuous spawning. Some issues of recruitment overfishing (CMFRI). Their perceived target is 0.6 BMSY. Scientists have advised States of a need for 50% reduction in fishing effort.
Indonesia (Arafura Sea)	Endeavour, Tiger, white, banana	Increased fishing effort and destruction of fish habitats. TAC based on 80% BMSY set but always exceeded. Absence of data makes it impossible for scientists to set robust TACs. The last stock assessment done in 2001 (BRKP).
Vietnam	Banana shrimp (<i>P.indicus</i> , <i>P.merguensis</i>); tiger shrimp (<i>P.semisulcatus</i>); Endeavour (<i>Metapanens ensis</i>)	The shrimp trawl fishery was heavily exploited and the fishing effort in year 2004 should be reduced 12-44% to achieve MSY and 46-61% to achieve MEY (Thanh, 2006).
Mexico	Mexican Pacific: Blue shrimp (<i>Litopenaeus stylirostris</i>); Brown shrimp (<i>Farfantepenaeus californiensis</i>) White shrimp (<i>Litopenaeus vannamei</i>) Gulf of Mexico: Brown shrimp (<i>Farfantepenaeus aztecus</i>); White shrimp (<i>Litopenaeus setiferus</i>); Pink shrimp (<i>Farfantepenaeus duorarum</i>); Seabob shrimp (<i>Xiphopenaeus kroyeri</i>)	Catches have been steadily decreasing since 1997 (-10 percent/year in the Gulf of Mexico and -6 percent/year in the Pacific: white shrimp is a critical concern, blue shrimp high concern, brown shrimp harvested to optimal levels; Gulf of Mexico: Overall, in the Gulf of Mexico, the stock status of brown and seabob shrimp is moderate, while the stock status of pink and white shrimp is poor due to their declining trends and depleted biomass. (INP, 2008). Overfishing, vulnerability to environmental changes and habitat deterioration and destruction have an inherent importance on population dynamics. Conservation International identified the need for a 50% reduction in capacity.

¹¹ <http://www.ccatexas.org/cca-texas-helps-complete-shrimp-license-buyback-program/>

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Mozambique	<i>Penaeus indicus</i> and <i>Metapenaeus monoceros</i> , with lesser quantities of <i>P. japonicus</i> , <i>P. latisulcatus</i> , <i>P. monodon</i> and <i>P. semisulcatus</i> ; Deepwater fishery target shrimp species comprising <i>Haliporoides triarthrus</i> , and amounts of <i>Aristaemorpha foliaceae</i> , <i>Aristeus antennatus</i> , <i>Plesiopenaeus edwardsianus</i> , <i>Penaeopsis balsi</i>	<i>Fishing mortality approximately at the target level for M. monoceros, but higher than the target level required for P. indicus and, because catches are mainly comprised of this species, it follows that trawling effort was 18% higher than the target effort of 220 000 standardised trawl hours. Efforts made to reduce fishing effort by establishing closed seasons, particularly for the industrial fleet. CPUE has since shown improvement (IIP, 2004-2009). Also now considering recruitment overfishing issues from artisanal fisheries. It is estimated that there should be 40% fewer boats operating in the shallower water (as opposed to deep sea) industrial fishery (MoF).</i>
Suriname/ Guyana	Atlantic seabob (<i>Xiphopenaeus kroyeri</i>) <i>Penaeus</i>	<i>Over the last ten years a number of attempts have been made by national and international scientists at the bi-annual scientific workshops to monitor stock status. Each time concern has been raised that fishing effort has been too high, particularly in Guyana, and that there is a risk of over-fishing. However stock status in both countries, and for both main species, is not well known, although declining CPUE suggests problems.</i>
Nigeria	<i>Penaeus notialis</i> , <i>P. kerathurus</i> , <i>P. monodon</i> and <i>Parapenaeopsis atlantica</i> are caught mainly between 15 – 60m. <i>Parapenaeus logirostris</i> which occurs in deep water 60 – 400m has remained largely unexploited	<i>Declining CPUE and overfishing of key stocks Nigerian Institute for Oceanography and Marine Research (NIOMR)</i>
Madagascar	<i>Fenneropenaeus indicus</i> , <i>Metapenaeus monoceros</i> , <i>Penaeus semisulcatus</i> , <i>Penaeus monodon</i> , <i>Marsupenaeus japonicus</i>	<i>In 2004, stocks were at MSY, growth in fishing effort (change to quad trawls) required a subsequent reduction. Management measures taken by the industrial fleet, but now CPUE declining as a result of high levels of juvenile shrimp caught in nursery areas by coastal fishers. (Caveriniere et al (2008))</i>

Key to colour coding:

Not overfished/Not subject to overfishing	CPUE stable but <u>additional management actions required to sustain levels</u>	Heavily overfished
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Source: National research institutes.

The table provides some useful conclusions

- There are very few stocks that appear to be stable. Examples of stocks harvested to optimal levels include fisheries in Australia, USA, and two stocks in Mexico (Pacific and Atlantic brown shrimp). All others, including most stocks in Mexico, are experiencing strong declines in recruitment, some to critical levels;
- Stocks are generally over-exploited in countries where there has been a policy of open access;
- Effort reduction measures (fleet reduction through buy out schemes, tradable statutory fishing rights, closed seasons), have allowed some fisheries to establish stable yields;
- Fisheries with open access regimes (India, Indonesia, Vietnam, Mexico, Nigeria and Guyana) suggest that fishing effort needs to be cut by at least 50% in order to restore fisheries to sustainable levels; and
- Recruitment overfishing (Madagascar, Mozambique) is an issue that needs to be factored into any stock assessment. Unregulated fishing in coastal waters, mangroves and estuaries usually causes this.

Stock assessment for other retained and bycatch species is rarely available. Fisheries scientists trace declines in fish populations through intermittent bycatch surveys, though the exact dimensions of the fish stock depletion are unclear. Examples on such feedback include the Arafura Sea (Indonesia), Mozambique and Mexico. India has a robust survey system of retained species sampling. This has allowed for monitoring the impact of trash fish extraction. It has noted catches of demersal (as opposed to pelagic) species, especially, ribbonfish, pomfrets and croakers have declined by up to 40%. These stocks

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are estimated to be around 0.75 BMSY.

In many cases, other fisheries (e.g. artisanal fishers targeting fish species) are experiencing declines in fish stocks. This leads to increasing conflict between fishers and severe social unrest. Examples include Philippines, Nigeria and Mexico.

Even in Australian fisheries, there may be no detailed information on bycatch/byproduct species for some fisheries. In such cases, the management authority undertakes a risk assessment to determine the level of interaction and impact caused by shrimp trawls.

2.5 CATCH COMPOSITION AND BYCATCH RETENTION

2.5.1 Fish species

The table below highlights the catch composition of shrimp and retained other species. The data have been accessed using the results provided in a questionnaire to WWF and FAO correspondents, and also from other published sources. The table shows the composition of shrimp in the total catch, and the levels and composition of retained other species. It does not reflect the actual levels of discards or the degree of selectivity of specific national fleets.

Shrimp and retained other fish can be grouped as follows:

- Multi-taxa fisheries (Indian sub-continent countries: India, Pakistan, Myanmar and Bangladesh; Coral Sea countries: Indonesia, Vietnam, Thailand, Malaysia; Venezuela; West African countries; and the Gulf States) reported fish:shrimp catch ratios of 1:8-20;
- Fisheries with selectivity problems but with improved bycatch performance¹² (many south and central American countries, Colombia, Costa Rica, Cuba, Mexico (Pacific), USA and Guianas [penaeid trawlers]) reported fish:shrimp ratios of 1:5-7.5;
- Transitional fisheries (Mexican [Atlantic] and some Madagascan fisheries) reported fish:shrimp ratios of less than 1:3;
- Well-managed fisheries, or fisheries where bycatch is significantly reduced through effective introduction of selectivity devices, in some cases reported to have fallen to one third of the amount pre BRDs/TEDs and hoppers. These include most Australian fisheries and some others (Suriname/Guyana seabob, Madagascar (seasonal)). The retained other species catches are usually in the region of 1:1 or less; and
- Catches volumes reflect an increasing dependency on demersal fish as a component part of the catch. This is usually the result of fish caught as a bycatch but, in some cases, fish dependency increases significantly. Interactions include a large variety of species including croakers (Sciaenidae), pompanos (Carangidae), goatfishes (Mullidae), lizardfishes (Synodontidae), mojarras (Gerridae), threadfins (Nemipteridae and Polynemidae), tooth ponies (Leiognathidae), flounders (Bothidae), rays (Dasayatidae), catfish (Siluridae), snappers (Lutjanidae), tonguesoles (Cynoglossidae), grunts (Pomadidae), barracudas (Sphyraenidae), shark, squids, octopus, and cuttlefish (cephalopods), hairtails, ribbon fish (Trichurus), crabs, slipper lobster, lobster, mussels and scallops. In many cases individual species may account for more than 5% of the total catch¹³. Trawl catches of pelagic species are minimal.

¹² Significant improvements emanated from BRD initiatives undertaken as part of the UNEP/GEF/FAO project (Hermes 2009)

¹³ 5% is a selected indicator used by the Marine Stewardship Council (MSC) to assess main species interdependencies: *Both scoring guidepost (SG) 60 and SG80 use the qualifier 'main retained species'. 'Main' in this context is intended to allow consideration of the weight, value or vulnerability of species caught. For instance, a species that comprises less than 5% of the total catch by weight may normally be considered to be a minor species, i.e., not 'main', in the catch.* Marine Stewardship Council Fisheries Assessment Methodology, 2010

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Table 2-3: Shrimp dependencies and principal bycatch characteristics

Country	Shrimp catch (tonnes)	Other fish species (tonnes)	Shrimp:Fish ratio	Species which individually represent > 5% of total catch	Species which individually represent < 5% of total catch	Fish composition: Marketable or juvenile	Discarded or retained
India	374,517	663,000	1:14 (Kerala) 1:5 (Orissa)	Ribbon fish, croaker, pomfret, silverbellies, mussels and whelks	Up to 50 species of fish (juvenile and marketable) and gastropods/ bivalve molluscs	Marketable = 65% Juvenile= 35%	A very small amount of discards of non edible varieties at sea (crabs and invertebrates)
Indonesia	6,702 (domestic trawl only)	100,000	1:15 (shrimp trawl only)	Croakers (38%), Juvenile shrimp, , Flounder, rays, giant threadfin, squid, octopus, Selaroides, snapper.	Many additional species	Marketable fish (30%)	Juvenile fish discarded (60%)
Vietnam	102,971	350,000	1:8 Otter trawl (90%), 1:3 beam trawl (10%)	Juvenile shrimp, crabs, cuttlefish, squid, trash fish	Many additional species	90% trash fish	No discards
Mexico	65,523	390,000	1:6 (1:9 PC;1:3 GoM)	187 species of fish, 83 crustaceans and 31 molluscs. Species commonly caught as bycatch are: <i>Syacium</i> spp. (halibut, “lenguado”), <i>Lutjanus campechanus</i> (red snapper, “huachinango”), <i>Pristipomoides aquilonaris</i> (Wenchman, “voraz”), <i>Upeneus parvus</i> (dwarf goatfish, “chivo”), <i>Eucinostomus</i> spp., <i>Synodus</i> spp., <i>Trichurus</i> spp., <i>Cetengraulis</i> spp., <i>Cynoscion</i> spp., <i>Balistes</i> spp., <i>Arius</i> spp., <i>Haemulon</i> spp., and <i>Pristipomoides</i> spp For crustaceans, a <i>Squilla empusa</i> (Mantis shrimp, “cucaracha”), <i>Calappa sulcata</i> (a crab species, “cangrejo”), <i>C. flammea</i> (a crab species, “cangrejo”) and <i>Portunus</i> spp. (crab, “jaiba” or “cangrejo”).	n/a	n/a	n/a
Philippines	45,599			Demersal, cephalopods, sharks and rays.	n/a	Marketable & juvenile	No discards
Nigeria	25,075	200,000	1:9	Juvenile shrimp, croakers (Sciaenidae); soles (Cynoglossidae); silver fish/hairtails (Trichiuridae); big eye grunts (Haemulidae); barracudas (Sphyraenidae), snappers (Lutjanidae); catfish (Ariidae)	n/a	Booming domestic trades in bycatch	No
Australia	22,610 NPF (2008): Banana 5816 t; Tiger prawns 1035 t,	Most retained species are individual	1:<.01-.05	-	Slipper lobster (<i>Thenus</i> spp.) Finfish (various) Scampi (<i>Metanephrops</i> spp.) Scallops (<i>Amusium</i>)	n/a	n/a

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Country	Shrimp catch (tonnes)	Other fish species (tonnes)	Shrimp:Fish ratio	Species which individually represent > 5% of total catch	Species which individually represent < 5% of total catch	Fish composition: Marketable or juvenile	Discarded or retained
	Endeavour 217 t, king 7 t Spencer Gulf: 3,000 tonnes	ly below 5%and comprise slipper lobster and squid.			spp.) Squid (<i>Photololigo</i> spp.)		
Guyana	20,533		1:0.4 (seabob trawl) 1:5 (shrimp trawl)	Finfish of commercial size: Demersal roundfish (around 5% or less): Bangamry (<i>Macrodon ancylodon</i>) Rockhead (<i>Larimus brevicep</i>)	Demersal: catfish, trout, butterfish, sharks and rays, sole, flounder Pelagic: netley and herring	Marketable fish=10% Trash fish=30%	Trash fish discarded Trash fish discarded The penaeid shrimp fisheries have discard rates of 80%
USA	18,727	90,000	1:5	Red snapper			
Mozambique	12,450	62,250	1:5, 1:2 in early season	Sciaenid (<i>Otolithes ruber</i>) / Tiger toothed croaker and red listed elasmobranchs.	n/a	n/a	Large quantities discarded because of lack of storage space on vessels
Madagascar	3,400	1000	1:0.28, was 1:1-1:6 pre BRD	<i>Otolithes ruber</i> (Sciaenidae), <i>Pomadasyd basta</i> (Haemulidae), <i>Nemipterus bleekeri</i> (Nemipteridae) et <i>Saurida micropectoralis</i> (Synodontidae)	79% marketable, around 800 tonnes from 3000 t shrimp	Historically 66% discarded, now 21% of fish caught., after BRD (200 t)	180 t of marketable fish given to fishermen's cooperative as means to facilitate dialogue. Only given to card carrying cooperative members.
Suriname	12,181	35,000	1:0.4 for seabob, Atlantic shrimp not known	As per Guyana for seabob fishery	As per Guyana for seabob fishery		As per Guyana for seabob fishery
Cambodia	11,163			Fish and squid	n/a	Marketable & juvenile	No
Iran	7,261	56,000	1:8		n/a	10-25% small fish 40-60% juvenile fish	No discards. Trash fish landed for fish meal

Source: Poseidon country surveys and UNEP/GEF/FAO workshop reports. Note: Information not provided where data are not available

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Fish species may be retained or discarded depending on a number of factors, but usually local demand for food and aquaculture feed, or the ability of vessels to retain quantities of byproduct are influential factors. Other critical problems are found when crews extract revenues from bycatch. A disincentive for bycatch retention is the lack of hold space. The evident problem is that as shrimp catch declines in poorly managed fisheries, the available hold space increases, and is then utilized for marketable sized finfish. Some examples of bycatch retention and discarding are highlighted in the box below.

Box 2-3: Summary of bycatch selectivity characteristics

Australia: An assortment of BRD/BEDs and bycatch mitigation methods are applied. Bycatches are defined into commercial species (slipper lobster, squid and selected finfish species (NPF)), and non commercial (e.g. blue swimming crabs). In the Northern Prawn fishery, as a result of the application of BRDs and TEDs, has seen a reduction in bycatches by from 1:30 to 1:10 (Brewer, 2006). The Spencer Gulf fishery prohibits the landing of any finfish as well as blue swimming crabs. Blue swimming crabs (and some finfish) are separated on deck and returned to sea using a separate bag and on-deck hoppers.

India: (Kerala and Orissa): Almost no discards, with use of very small meshed nets to retain all species. 35% of fish taken, comprise trash fish. Commercial species are also small and before the age of maturity. No BRDs applied to date. Legislation to include BRDs is contained in the forthcoming MFRA. Ground-breaking effort into hard and soft BRDs undertaken by the Central Institute of Fisheries Technology (CIFT). 100% grants are available from Marine Products Export Development Authority (MPEDA) for the introduction of TEDs. There is some discussion about developing surimi machines to optimize the use of trash fish.

Indonesia (Arafura Sea and Mareoke): Apply BRDs. However, skipper and crew from some companies remove BRDs up until 10 days before returning to port and crew retain the white fish catch for sale, to supplement their income. However, field evidence suggested that this practice was actively discouraged within some trawl companies and strict codes had been established to prevent such practice. There is some discussion about developing surimi machines to optimize the use of trash fish.

Vietnam/Bangladesh: Large quantities of fish caught are juveniles (up to 50%) by volume. These are sold as trash fish for aquaculture feed. The remaining quantities of fish are sold to the domestic market. Vietnam uses a minimum mesh size used is 20-30 mm, Bangladesh 45 mm. No BRDs are used.

Mexico: BRDs are applied, and its application has led to a 45% reduction in bycatch

Nigeria: BRDs are used by up to 80% of the fleet. Three types of BRD are used but these vary in design. The minimum mesh size is 44 mm. Fishers are paid low wages (typically around \$45/month), so supplement their wages from retained catch. There is a thriving canoe trade taking fish from trawlers for sale onto the domestic market. Almost no fish are discarded and there is a market for all sizes of fish, including juveniles. A similar policy is evident in **Colombia**.

The Guianas: Fr. Guiana/Suriname have achieved significant success with the recent introduction of BRDs. In French Guiana the use of trash fish and turtle excluder devices has been particularly successful.

Mozambique: BRDs are used but bycatches account for between 50-80% depending on season. Industrial trawlers (90% of total national catch), are less likely to retain bycatch because it takes up valuable freezer space. Fishers are actively exploring ways to reduce bycatch, e.g. leaving a gap between foot rope and ground rope to allow escape of soles.

Madagascar: 21% of bycatch is discarded. The rate of bycatch reduced from 66% after the introduction of BRDs. Species caught which exceed 5% include: *Otolithes ruber* (Sciaenidae), *Pomadasys hasta* (Haemulidae), *Nemipterus bleekeri* (Nemipteridae) and *Saurida micropectoralis* (Synodontidae). These are landed for commercial sale but around 200 tonnes is given to local fishery cooperative members as a means of facilitating closer cooperation.

Venezuela: reportedly has the highest fish to shrimp dependency in any of the multi-taxa fisheries, and probably the least selectivity. Shrimp only accounts for about 5% of the total catch. Its shrimp fleet lands 35% of its fish catch. Up to 80% of the quantity discarded are juveniles. The remainder are non-commercial species.

USA: BRDs are used but discards can be as high as 83% and 57% from its Atlantic and Gulf of Mexico

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shrimp trawl fisheries. Bycatches of red snapper have posed an acute problem. In the 1980s and 1990s, the bycatch of juvenile red snapper in shrimp trawl fisheries of the Gulf of Mexico was identified as the reason why the commercially valuable red snapper could not recover from overfishing (Cascorbi, 2004b)

Iran: Bycatch is landed. Juvenile fish and non-commercial fish, e.g. sharks (45-60% of total catch) are used as fish meal, with the remaining fish (25% of total catch) sold for human consumption.

Trinidad and Tobago's artisanal fleet targets fish and shrimp collectively. This has caused considerable conflict between domestic fishing groups. Industrial trawlers retain 40% of their fish catch for sale on the domestic market. The remaining 60% comprises juveniles and non-commercial species.

Kuwait: 98% of the bycatch is discarded. Bycatches include juveniles and adult finfish, sharks, rays, crustaceans, sea snakes, turtles, soft corals, molluscs and echinoderms.

Source: Poseidon survey and UNEP/GEF/FAO workshop reports.

2.5.2 Juvenile shrimp

Reference was made earlier in Table 2-2 to recruitment overfishing. In the past, due to high fecundity, it has been generally assumed that shrimp are difficult to overfish. However this is not the case, and some examples of recruitment overfishing are highlighted below.

Box 2-4: Examples of recruitment overfishing

Madagascar: 200,000 fishers established themselves in the coastal belt adjacent to Madagascar's most prolific fishery (Ambaro Bay, Zone A). The use of mosquito nets in the mangroves, with catches of averaging 0.6 grams per shrimp caught, and with a total 3,000 tonnes, has led to dramatic reductions in the country's national catch. The result is that CPUE levels in this zone are too low to make industrial fishing sustainable. This fishery traditionally supported 65 industrial vessels. The small sized shrimp are sold on the domestic markets, and *feudal* landlords or influential middlemen support their activities. (B.Couteaux (UNIMA) pers com 2009).

Mozambique: There are 16,500 sets of coastal fishing gear, 25% are beach seines; 15,250 boats; 3% motorized (2002). Drag nets and scoop nets are operated by one or two persons in shallow water. The "purses" of all nets are frequently lined with mosquito mesh in order to minimize catch loss. Estuarine creeks, channels and river mouths are frequently fished as they harbour high concentrations of prawns at certain times. The coastal fisheries operate throughout the year, although there is supposed to be a closed season for prawns. Coastal artisanal fishers maintain that theirs is not a prawn-directed fishery, but rather fish-directed with a prawn bycatch, so they cannot stop fishing or they would have nothing to eat. Almost the whole catch is retained, unless the organisms are very small (<2 cm). Generally, there is no attempt made at preservation of catches, which are sold soon after landing. Prawn catches comprise 1-10% by weight of total artisanal catches, also depending on area and season. Extrapolations of artisanal catches of juvenile prawns indicate that, in some areas, artisanal catches are of a similar order of magnitude to the industrial catches, but these are not incorporated into the annual stock assessments (Ministério das Pescas, 2009).

India: Fishing by artisanal fishers, using bag and stake nets. This activity is reported to be increasing and is endemic to most regions. These boats fish between the coastline and 5 kms.

Indonesia: The Government banned shrimp trawling in many areas in 1982. Trawling was restricted to the Arafura Sea, with no restrictions applied on access, consequently the fleet grew from 90 to 300 plus vessels. Illegal fishing inside the 10 km isobath has led to recruitment overfishing in Indonesia (Purbayanto, pers com 2009)

Vietnam: Fishing is banned within 6 miles of the Vietnamese coast, but frequent violations take place within the zones by artisanal fishers and illegal trawling activity. Vietnamese trawlers are also using mesh sizes below the minimum, with the result that small shrimps are caught (Thuy *et al* (2008)).

Mexico: Open access regime, with a 100,000 strong artisanal fleet targeting juvenile shrimp in coastal waters as they migrate to the offshore grounds.

Nigeria: Coastal/artisanal small-scale fishing gear used within 5n. miles catches large quantities of prawn *Nematopalaemon hastatus* (B. Solarin, FAO national correspondent, Oct 2009)

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Louisiana (USA): Louisiana has no control on access, and places a heavy focus on support for coastal communities. The absence of management measures as provided by other state and Federal regulations, has meant that the localised stocks (within 3 n.miles) are vulnerable to recruitment overfishing (C. Dorset, Ocean Conservancy, pers com, October, 2009).

Source: Poseidon country survey and UNEP/GEF/FAO workshop reports

There is often a particular danger of recruitment overfishing associated with coastal artisanal fisheries. Some key issues are:

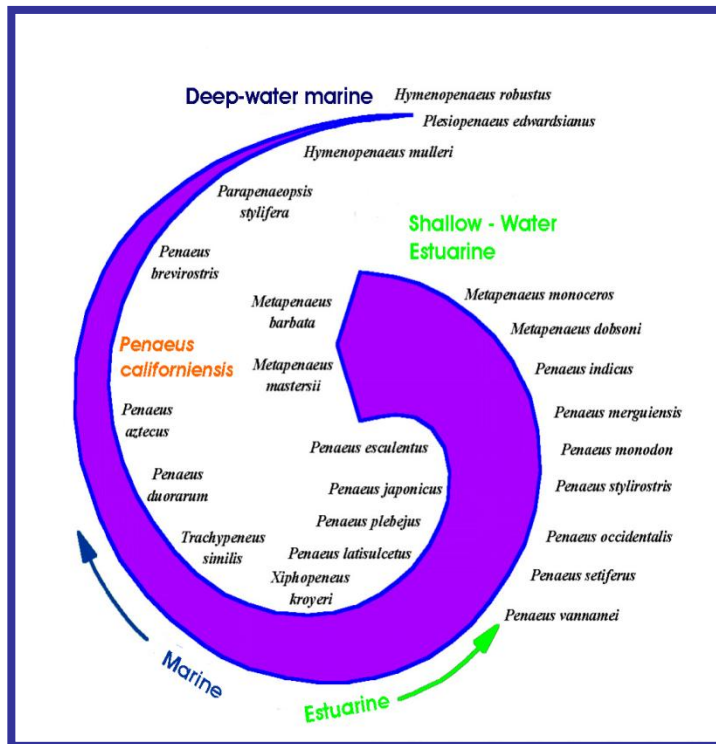
- Artisanal fishers can account for up to half the total catch of shrimp in some countries. In these cases they intercept juvenile shrimp before their gravid stages and have a very serious impact on recruitment;
- Artisanal fishers may or may not deliberately target shrimp, but in many cases, local markets have developed for this product;
- Artisanal fishers are usually poorly organised and fall under control of middlemen who supply credit and other inputs. There is often no formal professional organisation with which management authorities can engage; and
- Artisanal fishers usually fall outside the control system. Their activities are rarely checked and they are active during closed seasons.

However artisanal fisheries are not solely to blame for recruitment overfishing. Issues associated with industrial fisheries are:

- Trawling activity may take place inside designated non-trawl or sensitive inshore zones. These areas are the spawning and grow-out areas for the shrimp before spawning;
- Shrimp may be caught by small meshed nets, as a consequence of targeting multi-taxa compositions;
- The lack of BRDs can lead to greater catch volumes of all species including small shrimps; and
- The length of towing time also affects bycatch and small shrimp retention.

Time spent inside coastal areas by one species to another (Figure 2-7), illustrates the attraction of artisanal and larger trawlers to inshore fishing grounds.

Figure 2-8: Time spent inside of coastal lagoons during the life cycle for some penaeid species.



Source: Dall *et al.* 1990

2.5.3 Other threatened species

Other species interactions and observations are reported as turtles, sharks, sponges, jellyfish and syngnathids. Some specific findings on non-fish species interactions are highlighted in Box 2-5 below.

These include interactions with Endangered, Threatened or Protected species (ETPs). The classification of TEPs species is determined by either national legislation or classified by IUCN as vulnerable, endangered or critical. These include turtles, some syngnathids, some sea snakes, sharks and some fish species. Local species populations (TEPs and non ETP species) may be considered as threatened when interactions are sufficient to cause population cascades. It should be noted that examples cited represent specific cases of problems identified, usually through observer programmes. In many cases there has been extensive focus on turtles but not other species. In addition, in many cases, observer programmes do not exist, or when present, do not sufficiently focus on other vertebrate and non-vertebrate bycatch species. As such, fishery independent records are not very comprehensive. It is however recognized that apart from turtles, shrimp trawling may cause a problem for sea snake, syngnathid, sponge, jellyfish and shark populations. Species not considered particularly vulnerable to shrimp trawl activities include most dugongs and whales. However, high levels of localized activities in some waters may also affect these species and their habitats. Examples of bycatch interactions before and after TED introductions, and other selected examples of problem areas, are highlighted below.

Box 2-5: Examples of ETP and other species interactions

Australia's Northern Prawn fishery reported 780 turtles pre-TED (2000); 96 were released alive. The current mortalities are reported at between 0 and 1% (Brewer, 2006). Sea snake and sawfish interactions are also problematic. The former has been reduced by the popeye fish box BRD (down by 43%) (Milton, 2009). The effects of trawling on sawfish populations, particularly *Pristis microdon*, continues to be the subject of research in the NPF. A particular problem is that sawfish are prone to entanglement in trawl nets due to the numerous teeth along their rostrum (Fry, 2008).

India has provided 3,000 boats in Orissa 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

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management plan. Adoption is slow and enforcement lacking. When applied, the TEDs have been modified to suite 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.

Vietnam: Has a fleet of 29,000 shrimp/multi taxa trawlers, 0.5 to 10 sea turtles caught per trawler/annum. TEDs have not been introduced.

Indonesia: WWF observer programme recorded an average 11 turtles per trawler in one 55 day campaign. TEDs are now applied, resulting in fewer interactions. Other reported species encounters include sea snakes (around 20 in number per day/trawler) and jellyfish swarms.

Mexico: Turtle bycatch was reduced up to 98%. However, TED regulations (and all elements of the turtle protection law) are not necessarily well enforced, and it is known that at least some of the industrial fleet avoids using TEDs. Major concerns relate to catches of totoaba (*Totoaba macdonaldi*) which is a marine species that is indigenous to the northern half of the Sea of Cortez in Mexico. Formerly abundant and subject to an intensive fishery, the totoaba has become rare, and is listed on CITES^[1], the IUCN Red List of Threatened Species. Further concerns relate to interactions with vaquita, a rare porpoise, and area closures for shrimp fleets are in place at the Upper Gulf of California to address this for the sake of vaquita (*Phocoena sinus*) conservation.

Mozambique reports 2,000 to 5,000 turtle encounters annually.

Madagascar's observer programme recorded 42 turtle mortalities in 2002, before the introduction of TEDs. Jellyfish swarms and syngnathids (during periods of clear water) were also witnessed (but not reported) by CSP observers.

India: has a high interaction of turtles in Orissa.

Suriname/Guyana fisheries report occasional interactions with turtles as part of a WWF and Department of Fisheries data collection programme.

Australia's Northern Prawn fishery reported 780 turtles pre-TED (2000); 96 were released alive. Sea snake interactions are also problematic, but reduced by the introduction of the popeye fish box.

Australia's Spencer Gulf records interactions with Port Jackson sharks, but these have a high survival rate because of low stress levels. There is some debate over the impact of repetitive capture. Sponge and syngnathid interactions are also problematic. Some syngnathids are ETP species. These interactions take place close to sea grass beds, or in periods of high water clarity or seaweed drift.

In the USA, the debate is now focussed on repetitive trawl capture as it is revealed that turtles drown.

Nigeria reports interactions with turtles, sea snakes and jellyfish swarms.

Kuwait reports interactions with turtles and sea snakes.

Source: Poseidon country survey and UNEP/GEF/FAO working group reports.

2.5.4 Benthic interactions

The effects of shrimp fishing on benthic habitats can be divided into several categories: alteration of physical structure; sediment suspension; changes in chemistry; and changes to the benthic community, resulting in changes to the ecosystem. The degree to which shrimp fishing, specifically trawling, alters the seabed and the associated effects on biodiversity have generated an enormous amount of discussion and controversy, echoing and contributing to the more general and controversial debate on trawling. The factors complicating this debate include: the difficulty in clearly separating fishing impacts from environmental variability; lack of information on the original state of some fishing grounds; a lack of agreement on the level and quality of the evidence of impacts; doubts about the reversibility of these impacts; the objective difficulty in assessing the more insidious impact of the overall flattening of the seabed and the less visible impacts on the benthic and microbial fauna; and the relative importance attached to the ecological, social, economic and societal costs and benefits of fishing.

The normal process of trawling comprises trawlers using otter boards, with two steel or wooden trawl doors weighing 350 kg to 900 kg each; footrope weighted with chains and rubber discs, sometimes with a "tickler" chain in advance of the footrope; headrope buoyed with floats; codend mesh size ranging from

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20 mm to 40 mm; trawls may be deployed from booms, using a combination of doors and skids, up to four trawls per vessel. The spread of the trawl (mouth opening) depends on the number of trawls used (more trawls = smaller individual spread); total spread probably around 50m. The footrope/tickler chain ideally just skims the sediment (with no penetration beyond the first 2-3 cm), although the doors will cause deeper furrows (probably up to 20 cm) because of their weight. Most shrimp trawl grounds comprise mud or soft sediment. There are however some reported interactions with seagrass beds (Cambodia), which are known habitats for juvenile fish and other sensitive organisms. Deeper water trawls also require extra weight (up to double that of shallower water) to reduce trawl gear buoyancy during sinking (WWF, Mozambique).

Some 'low risk' distinguishing features are the coverage of an area and length of season. Some of the trawl grounds represent less than 15% of the total area. Both Spencer Gulf and Northern Prawn fisheries in Australia are associated with low coverage. These two fisheries, comprising of king shrimp (SG) and the banana and tiger shrimp (NPF), are also associated with limited fishing seasons: sixty days in the case of Spencer Gulf, and 4 to 10 weeks and four months in the Northern Prawn Fishery (Case Study A.1 and A.2).

Other significant features are weight of the gear. In many fisheries, fishers have adopted lighter gear. Most advances have been made in using light-weight gears (trawl doors), changing the angle of the door, removing the tickler chain, attaching floats to the head rope and using larger meshed gear in the trawl wings and cod end. These initiatives have also had a marked effect on reducing drag and as such lead to considerable fuel cost savings. These initiatives reduce seabed penetration significantly. Examples of initiatives are provided below.

Box 2-6: Examples of gear selectivity, bycatch reduction, and fuel savings initiatives related to benthic interactions

Australian Spencer Gulf (Case study A.1): The Spencer Gulf and West Coast Prawn Fishermen's Association (SGWCPFA) initiative comprises the angle of the trawl boards (too acute angle would result in digging); not using tickler chains; the position of the headline in front of the footline; adequate space between the dropper and the foot wire. Seabed analysis identified the absence of some species, bearded mussel (*Trichomya hirsutus*), southern hammer oyster (*Malleus meridianus*) and razor clam (*Pinna bicolor*), from common trawl sites is believed to be in response to trawling. However benthos changes are not exclusively linked to trawling such as the effects of changes to salinity and anthropogenic disturbance may also be contributory factors. The low coverage of trawl gear over the area of the Gulf (8%) resulted in categorization of benthos impact from trawling as low risk.

Madagascar (Case study A.3): UNIMA / WWF partnership removing tickler chains, installing light weight plastic doors, larger mesh sizes to reduce drag and prevent congestion in the net, and short haul times (1 hour to 1 hour 20 minutes) to reduce build up of bycatch. These initiatives resulted in a 31% saving in fuel costs. In these cases, seabed penetration is reported as low. In one benthic impact case study, IRD measured seabed impacts before and after adoption of new systems over a 5 and 18 month period. The analysis showed that reduced penetration of the seabed, by up to two thirds (from 20 cm to 8 cm), showed very little subsequent evidence of trawl activity after 5 months. Furthermore, as the tickler chain skimmed the surface (2-3 cm), there was very little evidence of trawl activity. The trawl area within the zone was between 43% and 61%.

Shrimp Round Table (USA) (Case Study A.4): Ocean Conservancy and the Sustainable Fisheries Partnership (SFP) are working in the Gulf of Mexico to bring together shrimp fishermen, seafood buyers, and other fishery experts to explore new and innovative ways to move this valuable and important fishery towards sustainability. The overarching goals of the project are to reduce the environmental impact of the Gulf of Mexico shrimp fishery, improve and strengthen management, and make the fishery more sustainable while assisting Gulf shrimp fishermen in improving quality through the transition to cleaner, more fuel-efficient fishing gear. (<http://www.youtube.com/watch?v=E-2V1qe7pnY>). Technology improvements have been developed that reduce bycatch by more than 30% and reduce fuel consumption by up to 39%. This reduction in fuel consumption will significantly reduce the carbon footprint of the fishery and provide much needed relief to fishermen struggling with the rising cost of fuel.

Indonesia: Companies have voluntarily reduced the weight of trawls by reducing the length of net from 30 m to 26 m, increasing the mesh size in the cod end from 30 to 45 mm, and reducing the weight of the trawl door from 500 to 350 kg and reducing propeller RPM from 1,200 to 900.

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India: Support has been provided for the development of low intensity trawl activity in Kerala. A significant push has been in promoting the use of larger mesh size (moving from the statutory minimum to 45 mm), shortening tow times, to reduce the build up of bycatch and adding square mesh panels to the cod ends. The adoption of these practices, by albeit a small minority of fishers, has led to improved quality, efficiencies in sorting times, and some minor savings in fuel costs (around 2%).

Source: Poseidon country survey for this study

2.5.5 Ecosystem interactions

If the abundance of key species is reduced through bycatch, major and unpredictable changes may occur in food chains. This impact is similar whether the removal results from targeted catch or bycatch. One aspect of this issue is the removal of shrimp predators by trawling that can result in profound changes in the food chain, such as increased abundance of shrimp. This has been observed in both warm and coldwater shrimp fisheries.

Seabirds and dolphins are known to consume discarded shrimp fishing bycatch. This may result in improvement of the reproductive rate of these animals, but may also lead to difficulties if they become dependent on the discards or are injured in the process of taking the bycatch.

The impact of the discards on the bottom detritus feeders and microbial fauna is not well known, although information on temperate fisheries is generally better than that for tropical fisheries. The oxygen depletion that may occur when discards sink to the sea bottom of shallow, poorly circulated inshore areas may cause effects on the benthic community.

2.6 GOVERNANCE SYSTEMS AND JURISDICTIONAL MANAGEMENT

Fisheries governance can take many forms. The range of governance systems applied is summarised below.

Table 2-4: Summary of governance systems in principal shrimp producing countries

Country	Central/national administration	Provincial / State administration	Co-management	Private company
India	✓	✓		
Indonesia	✓			✓
Vietnam	✓	✓		
Thailand	✓			
Mexico	✓	✓	✓	✓
Australia	✓	✓	✓	
Guyana	✓			✓
USA		✓		
Madagascar	✓		✓	✓
Mozambique	✓			
Suriname	✓			✓
Iran	✓			
Saudi Arabia	✓			

Source: Poseidon country survey

Expanding on the summary provided in the table above, there are a number of different management systems in operation:

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Top down, centralised administration is applied in many countries (Thailand, Madagascar, Mozambique, Iran, Saudi Arabia, Guyana, Suriname and Australian Commonwealth fisheries) where policy is determined at a central level, with other functions such as licensing, compliance, and research coordinated centrally. In some cases, the inspection may be directly attached to a central Ministry, in others, it may be a semi-autonomous agency, or delegated to another organisation such as the Navy. Compliance uses many mediums including port inspectors, at sea inspections, VMS and observers. Research operates centrally with, on occasions, locally based research centres. Funding sources include industry levies, donor support or central Government. An example of a full cost recovery system is the Australian Commonwealth system where the cost of management in the Northern Prawn fishery is funded through fishery management levies which equate to approximately 3% of annual Gross Value Production, equivalent to A\$2.3 million. These monies are allocated for research, compliance, observer schemes, Management Advisory Committees, data management, log books, licensing, and administration. The specific cost component for research is \$ 866,000 (1% on revenue), and compliance 586,000 (0.7% on revenue).

Box 2-7: Examples of central government management planning in the shrimp sector

Advanced governance

Australia's Northern Prawn fishery falls under the responsibility of the Australian Commonwealth Fisheries Management Authority (AFMA). AFMA has a central administration base in Canberra, with a team of 130 personnel with responsibility for 27 fisheries. The Bureau of Rural Sciences has responsibility for some fishery research, however the majority of fishery research is managed through the Fisheries Research & Development Corporation. AFMA is responsible for compliance (*AFMA compliance*). Under the Management Plan, the Northern Prawn Fishery Management Advisory Committee is responsible for assessing the performance of the fishery against a pre defined management plan and the NPF Harvest Strategy. This Committee and its defined functions preserve the independence (from outside political influences). NORMAC advises on changes to the management system, and actions are implemented through the plan. An annual report is prepared and submitted to the Minister for approval. The members of NORMAC are drawn from AFMA, the industry research and environmental organisation of the State Governments. The industry pays a levy, which funds the functions of AFMA, the research, and a proportion of the compliance functions. The fishery is required to comply with set actions plans. These cover:

- NPF Management Plan;
- Bycatch Action Plans;
- NPF Harvest Strategy;
- Integrated Scientific Monitoring Program;
- NPF Strategic Ecosystem Data Plan, 2004;
- NPF Five-year Strategic Research Plan (2001-2006); and
- Compliance risk assessment and action Plan.

The plans are developed against set objectives where the ecosystem approach to fisheries management is a priority.

The industry is organised through an industry company, the NPF Industry Pty Ltd (NPFII). The NPFII has joined with AFMA to implement a co-management project whereby the Company is responsible for making recommendations directly to AFMA in a number of areas, including fishery budgets, research priorities and fishing season lengths. The NPFII liaises with MAC members on relevant issues as required to ensure its recommendations comply with the above plans.

The Australian Commonwealth takes responsibility for fisheries that transcend several state boundaries or are offshore. It's fisheries are required to respect national guidelines, most specifically as an Ecologically Sustainably Managed Fishery under part 13 and 13(A) of the EPBC Act 1999. The Commonwealth DEWHA plays a critical role in evaluating the fishery's environmental credentials. All fisheries, from which product is exported, must undergo assessment to determine the extent to which management arrangements will ensure that the fishery is managed in an ecologically sustainable way. Wildlife Trade Operation (WTO) approval is established subject to meeting criteria on fishery conservation, reduction and mitigation of bycatch and interactions with ETP species. Each fishery is required to have a Management Plan that lays down the system parameters to control capacity, effort, selectivity and bycatch mitigation. Harvest control strategies are set based on these parameters and stock assessment.

Developed governance

US Federal Gulf of Mexico and South Atlantic shrimp fisheries fall under the management of two separate Federal Management Councils covered under the Magnuson-Stevens Fishery Conservation and Management Act.

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Each Council is responsible for shrimp fisheries falling under Federal jurisdiction (from 3 – 9 miles out to 200 miles, according to specific State jurisdictions). The National Marine Fisheries Service (NMFS) is responsible for research and compliance with some activities shared with State bodies. A distinction between the USA and Australian system is that the USA does not focus on an ecosystem-based management approach. Some critical issues such as turtle bycatch reduction are addressed, but bycatch reduction is largely driven by avoidance of valuable recreational fisheries as opposed to management mitigation measures driven by all ecosystem impacts.

The Council formulates a Fisheries Management Plan and follows pre-defined guidelines. The Plan also requires the production of a fishery impact statement for the fishery which shall assess, specify, and analyze the likely effects, if any, including the cumulative conservation, economic, and social impacts, of the conservation and management measures.

The Council consists of 17 voting members: the Regional Administrator of NMFS (or his/her designee), the directors of the five Gulf state marine resource management agencies (or their designees), and 11 members who are nominated by the state governors and appointed by the Secretary of Commerce. Appointments are three-year terms with a maximum of three consecutive terms. In addition, there are four non-voting members representing the USA Coast Guard; USA Fish and Wildlife Service; Department of State; and the Gulf States Marine Fisheries Commission.

The Council meets five times a year at various locations around the Gulf coast. Prior to taking final action on any proposed rule change, public hearings are held throughout the Gulf. Public testimony is also heard during the meeting at which final action is scheduled. Proposed rule changes are then submitted to NMFS for further review and approval before implementation.

NMFS is currently exploring the possibility of increasing emphasis on ecosystem impacts as a conservation impact statement.

Developing governance

Mozambique: Some important structures are created in terms of the Fisheries Act, including the Committee for Co-Management of Fisheries, which is the main forum for participatory management. Access to marine resources is controlled by DNAP (National Directorate of Fisheries Administration, of the Ministry of Fisheries), which issues licenses and quotas. License rental fees are charged, with DNAP having a policy of full cost recovery since 1996. DNAP convenes the Fisheries Administration Commission (FAC), which comprises all stakeholders, including representatives from management, compliance, research, product quality, small-scale fisheries and industry. The Commission meets quarterly to discuss management of the prawn fishery, and makes recommendations regarding the setting of TACs and quotas. A management plan is in the process of finalisation at the time of writing. Its formulation has been supported with technical input from Australia and Norway.

Mexico: Responsibility for fisheries management falls under the responsibility of Comisión Nacional de Acuicultura y Pesca (CONAPESCA). The Comisión has a set of national conservation measures (NOMs) in place including gear restrictions (minimum mesh sizes and maximum headrope length. Management Plans (Planes de Manejo) are new instruments aimed at providing guidelines and strategies to manage fisheries, including the shrimp sector. In 2007, the ecosystem-based management approach was introduced as a required component of the planning process, though there is no evidence of supporting risk analysis or bycatch management strategies in place at present. The National Committee for Fisheries and Aquaculture negotiates management and ordinance policies, and amongst other things, determines the lengths of closed seasons, with fishers and fleet owners. The Committee comprises the CONAPESCA and INP. Academic research experts may be invited to attend. There are neither industry representatives on the Committee, nor NGOs.

Madagascar: Responsibility for fisheries management falls under the responsibility of Ministère de l'Agriculture de l'Élevage et des Ressources Halieutiques. MAERH formulates policy in consultation with the industry, and directs CSP to implement a control strategy. A management system is in place, which involves restrictive access, effort controls, zoning, technical measures and control systems (VMS and observer coverage). This industry pays a levy of 8% of annual revenue, of which 80% is redirected to fisheries research, development and compliance. A formal Management consultative body (Zonal Management Conserve) exists to discuss management planning, but initiatives are largely industry driven. The ZMC comprises GAPCM (shrimp association), MAEP, CSP (Control Agency), PNRC (Stock assessment research) and OEFC (Economic research). MAEP is subject to political influences, which threatens the independence and integrity of the governance structure. Many industry management decisions have been advanced under the auspices of the industry body GACPM, or by specific companies such as Unima. However, lack of political will, and the inadequate mandate given to ZMC has prevented action in dealing with the growing impact of artisanal fishers in some fishing zones. Consequently, industrial shrimp vessels have been forced to withdraw from the fishery.

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Under-developed governance

Guyana: Legal systems are in place and Guyana has a stated policy objective of promoting sustainability for its fisheries resources. However, policy decisions often go against scientific advice, such as restricting the number of shrimp licences granted. The Guyana Fisheries Department is under-funded with associated problems of low morale. There is no effective fishery management and control structure in place. The relevant authorities do not act on contraventions so there is little incentive for compliance. Guyana has no VMS (as opposed to neighbouring Suriname). Licensing fees are paid but these cover administration costs.

No research plans are in place. Representatives from both Fishery Departments periodically participate in the annual CRFM stock assessment workshop (and are party to the debates that take place in these workshops, and the advice given by international scientists on how the basis of management of the seabob fishery might be improved upon). No apparent attempt has been made to follow the advice, or to improve on the data collected relating to this fishery, or to identify and instigate relevant research.

Indonesia: The Ministry of Marine Affairs and Fisheries (MMAF) Indonesia, is responsible for implementation of policy at national level, and the licensing and management of all vessels over 30 GT, and fisheries outside 12 n.miles. This includes all dedicated shrimp trawlers. National fisheries policy objectives focus on increasing production and fisheries development. In 1982 Indonesia banned shrimp trawlers in all regions, with the exception of the Arafura Sea. This was because of widespread concern about the damage caused to fish stocks. MMAF is responsible for licensing offshore and foreign trawlers. Revenues charged to national boats represents around 2% of vessel sales. There is no available information on fees charged to foreign fishing companies.

Dinas Perikanan (DKP) undertakes provincial fisheries management responsibilities (inside 12 n.miles). Linkages between DKP and MMAF remain strong, but a primary constraint is that DKP is funded through Provincial Government, and it competes for revenues from other Provincial Departments. Consequently, it uses income from permits to fund its operations. This has allowed the proliferation of many different fishing methods, including the restoration of artisanal trawl fisheries under Provincial jurisdiction. Nevertheless, in some districts and provinces, the fishermen's organisations, the Panglima Laot Lhok (local community structure), have managed to prevent shrimp trawling in coastal waters. Trawling usually proliferates in communities where these organisations are weak.

MMAF introduced a series of fishery management measures for shrimp trawling as early as 1975 (mesh size and capacity limits), TACs in 1999, and more latterly additional bycatch restrictions in 2000. However, shrimp trawlers are reported as widely ignoring these restrictions whilst actions by MMAF / Indonesian Navy appear to be sporadic, usually in response domestic pressure to eliminate illegal fishing. Indonesian management experts advocate policies of needing effort restriction and closed seasons, bycatch management and community participation, but there is no political will to implement these. MMAF has now a reported strategy of not reissuing licences to those vessels that are perceived as non-compliant, but this is highly subjective, and is also undermined at higher political level. MMAF has no formal management / consultative committee, and management decision making is very top down. The Association of Indonesian Shrimp Catching Companies (HPPI) supports a policy of effort reduction and seasonal closures, but is frustrated by the proliferation of illegal and foreign trawl activities. The conclusion from the experts and studies undertaken is that there is much wishful thinking about what policies should be introduced in Indonesia, but no political will to implement.

Source: Poseidon interviews and questionnaires

Delegated provincial and district powers apply in some countries (Indonesia, Vietnam, USA and Australia). In Vietnam and Indonesia, management and control responsibilities fall under the National, Provincial and District authorities. National management applies outside 12 miles (Indonesia) and 24 miles (Vietnam), but provincial management applies within these limits, or in the case of Indonesia, District management applies between 0 to 4 n.miles. This means that shrimp fisheries could fall under the responsibility of multi-jurisdictional management. Artisanal fisheries would generally fall under District control, small-scale trawl under Provincial control, and offshore fisheries under national jurisdiction. This is also the case in the USA where semi-industrial trawling takes place inside State jurisdiction, 9 miles in the case of Texas and Florida, and three miles for the other states, including Louisiana. Australia's State shrimp fisheries fall within 12 n.miles. Where these occur, Spencer Gulf, Exmouth, Queensland East Coast and New South Wales management falls under the responsibility of separate State Departments of Primary Industry. Some examples of the different systems are outlined below.

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Box 2-8: Examples of delegated provincial government management planning in the shrimp sector

Advanced Governance

The **Australian Spencer Gulf** fishery, whilst subject to the State Fisheries Act, conforms to Commonwealth guidelines. The State Fisheries Act provides the means to undertake these operations including the setting of a Management Plan, an outline of goals, objectives and strategies, and the setting of performance indicators for target species sustainability and ecological risk minimization. The Fisheries Council of South Australia is drawn from Industry, the State fisheries management body (PIRSA), the research organisation (SARDI), recreational and indigenous interests, and an NGO. The Council's primary objectives are (a) the implementation of proper conservation and management measures and (b) the protection of aquatic habitats and adherence to the ecosystem approach to fisheries management. In this context, fisheries performance is peer-reviewed by the Department of Environment (DEHWA) as determined by conditions laid down by the EPBC Act 1999. The fisheries performance is judged against a Management Plan which lays down management goals, strategies, activities and indicators. These details are provided in Case Study A.2.

Under developed governance and multi jurisdictional fisheries

India: The Ministry of Agriculture is responsible for preparing the core Fisheries Acts, with Harvest Control Rules identified. It is also responsible for managing fisheries beyond 12 n.miles, unless delegated to the State authority. In the case of the shrimp sector MoA delegates responsibility for the semi-industrial trawl sector to State fisheries, but retains responsibility for the 73 industrial trawlers. The State authorities are also responsible for artisanal fishers.

The National (and State) legal frameworks are in place, but there is very limited implementation of HCRs other than the closed seasons. Bycatch reduction devices have not been introduced up to now, and there is continual political debate about a 47 day closed season. Political influences by politicians and a heavily unionised stakeholder structure prevent management measures from being imposed.

Even were these measures to be imposed, State ministries lack the manpower to implement controls. An example being that one of the largest districts, Quilon in Kerala, has 4 fishery inspectors to check 1,200 shrimp trawlers. Sanctions are implemented with nominal fines of Rs. 5,000, Rs. 25,000 (US\$ 100-US\$ 530), but offences are being continually repeated. Consequently, there is no compliance because of inadequate resources and very low fines.

The strength of the Indian system lies in their two core research institutions, the Central Institute for Fisheries Technology and the Central Marine Fisheries Research Institute, which have both produced appropriate and ground breaking advice for the policy makers. Another influential organisation is the Marine Products Export Promotion Authority, which is now promoting full traceability against the background of the EC IUU Regulation.

The national Shrimp Trawlers Association is responsible for fishers. However, its members or representatives are not involved in any of the numerous management committees that have been created. Consultative processes exist but these tend to be retrospective, creating highly politicised interactions. Advisory management committees (17 since 1980) have produced logical HCR and capacity reduction recommendations (Buy-back), but these have not been heeded at central Government level.

There are some initiatives taking place on co-management but these are not particularly strong in the shrimp sector. NGOs (including WWF) support these activities and are especially important in the context of promoting participatory management as part of their TED /CIFT / STA partnership. Credit support is provided in some states (Kerala) with the support channelled through Matsyafed cooperative. This system reduces the dependency on middlemen.

Some changes are taking place with the production of a new Fisheries Management Regulation Act, which includes provision for the ecosystem approach to fisheries management.

Vietnam: The Government of Vietnam operates its fisheries systems through a central organisation, Ministry of Agriculture and Rural Development (MARD), and delegates responsibility for fisheries management for inshore fisheries (within 24 n.miles) to the Department of Agriculture and Rural Development (DARD). In the context of shrimp fisheries, fisheries are managed by multi-jurisdictional activities. MARD is responsible for the semi-industrial fleet, whilst DARD (primarily in 4 provinces, Ben Tre, Tra Vinh, Kien Giang, Ba Ria Vung Tau) is responsible for the management of small-scale trawl and artisanal fisheries. MARD has a number of core policy objectives which are required to be followed at provincial level, but as is usually the case in many countries, Vietnam has a stated objective of increasing employment opportunities and living standards, as well as a policy commitment to scientific management and decision making as a precondition for sustainable management practices. In practice, its activities focus only on employment generation and supporting open access to its fisheries. The concept of employment generation is also heavily enshrined with the Provincial Peoples Committee, which is the consultative body for fisheries management issues at Provincial and District level. Vietnam has as a core policy, the prevention of fishing

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(of any fishery) within 3 n.miles from the coastline, and a series of national technical measures, but enforcement of the measures falls well short of what is required (i.e. small mesh sizes and no bycatch excluder devices). Some specific problems identified in all its fisheries are: Growth in coastal communities and use of destructive fishing gears; inadequate human resources at Government level; open access and over-capitalisation; fuel subsidies; no effective management or compliance; and weak fisher community structures. The administration lacks the political support to be able to implement management decisions and lacks the capacity to understand the longer-term goals of sustainable fishery resources. Consequently, the resources are heavily exploited, requiring a substantial reduction in fishing effort (Table 2-2), and ETP species mortalities are probably one of the highest of any of the Coral Triangle countries.

Indonesia: The Ministry of Marine Affairs and Fisheries (MMAF), Indonesia, is responsible for implementation of policy at national level, and the licensing and management of all vessels over 30 GT, and fisheries outside 12 n.miles. National fisheries policy objectives focus on increasing production and fisheries development. Indonesia banned shrimp trawlers in all regions with the exception of the Arafuru Sea in 1982. This was because of widespread concern about the damage caused to fish stocks. Dinas Perikanan (DKP) undertakes provincial fisheries management responsibilities (inside 12 n.miles). Linkages between DKP and MMAF remain strong, but a primary constraint is that DKP is funded through Provincial Government, and it competes for revenues from other Provincial Departments. Consequently, it uses income from permits to fund its operations. This has allowed the proliferation of many different fishing methods, including the restoration of small-scale trawl fisheries under Provincial jurisdiction. Nevertheless, in some districts and provinces, the fishermen's organisations - the Panglima Laot Lhok (local community structure) - have managed to prevent shrimp trawling in coastal waters. Trawling usually proliferates in communities where these organisations are weak. MMAF introduced a series of fishery management measures for shrimp trawling as early as 1975 (mesh size and capacity limits), TACs in 1999, and more latterly additional bycatch restrictions in 2000. However, shrimp trawlers are reported as widely ignoring these restrictions, and actions by MMAF appear to be non-existent. Indonesia management experts advocate policies of effort restriction and closed seasons, bycatch management, community participation, but there is no political will to implement these. The conclusion from the experts and studies undertaken is that there is much wishful thinking, but no will to implement.

Co-management systems are beginning to emerge in some fisheries. The Indonesian example demonstrates the power of communities where the activities of shrimp trawlers impinge on the well-being of coastal communities. These issues are largely preventative at the local level, and when single management demarcations exist. Such actions are not applied at multi-jurisdictional level where artisanal fishers livelihoods appear threatened by shrimp trawlers (examples including Nigeria, Trinidad and Tobago and the Philippines), or where industrial fisher livelihoods are threatened by coastal fishers targeting immature shrimp (Madagascar and Mozambique). In the case of the Philippines, artisanal fishermen place artificial obstacles on known trawl grounds as a disincentive to trawling.

A good example of co-management in industrial fisheries can be seen in Australia's Spencer Gulf prawn fishery. The SGWCPFA applies, through the *Committee at Sea*, a real-time management decision making process. Catching of prawns up to a target limit referencepoint, catching a high volume of gravid females, or interactions with bycatch species (i.e. blue crab, leather jackets or syngnathids) results in the fishers taking a collective decision to move on. In some cases high bycatch hot spots have been designated as voluntary closed areas. The SGWCPFA also provides, in addition to independent observer coverage, its own observers (crew members from other vessels) to record catch and bycatch data. The quality of the information provided has been independently validated as sufficiently robust. Australia's NPF is implementing a similar observer scheme, in particular in recording bycatches of TEPs and implementing 'move on' provisions in small prawn areas. The NPF co-management trials also include industry taking responsibility for logbook and data management functions (following up over-due log book returns, data integrity and verification, reconciling log book data with seasonal landings data, and creating data summaries); and advising AFMA on commercial and operational matters (season start and end dates, spatial and temporal closures, gear trial areas, in season management arrangements and NPF fishery budgets).

Mexico is an example of a country with a strong cooperative structure. The Government has recently introduced a community quota system (i.e. allocating community quotas to artisanal fishers through fisher cooperatives) as a forerunner to a more elaborate scheme. The scheme, though supported by strong logistical support from Government (data collection and catch recording), also demonstrates an increased level of community participation, and a significant reduction in the level of non-compliance.

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Company-led governance may also exist where there is government inaction, or where rights-based fisheries systems are an established part of the fishery. An example of such a system applies in Madagascar (Unima), Suriname (Guinana Seafoods) and Guyana (Noble House)¹⁴ where individual companies have taken unilateral actions to reduce bycatch and improve the operational efficiency of their vessels (See case study A.7). This, against the background of broad inaction by the regulatory authorities, often succumbs to political interference. However, in these fisheries, there remains an important role for Government because of interaction with other fisheries groups. In Madagascar, the company's initiatives have, to large extent, been undermined because of a failure of Government to control the growth in the artisanal fishery, which is catching large volumes (around half) of shrimp in its juvenile stages. This has resulted in the collapse of the offshore fisheries adjacent to artisanal fisher activity. A similar problem is occurring in the Guianas with non-licensed shrimp trawlers fishing illegally for seabob (*Xiphopenaeus kroyeri*). Details of initiatives made by various individual companies are highlighted in the case studies.

A small number of partnership initiatives, usually with NGOs, have also been established. Examples of these are shown below in Box 2-9.

¹⁴ Guinana Seafoods and Noble House are part of the Netherlands Heiploeg BV group of companies.

Box 2-9: Examples of development initiatives between industry, Donors and NGOs

UNEP/GEF/FAO: This multi-year global project had a total budget of US\$9,150,000 and a duration of six years (June 2002-June 2008). It was implemented by the United Nations Environment Programme (UNEP), executed by Fisheries Department of the Food and Agriculture Organisation of the United Nations (FAO) and co-funded by the Global Environment Facility (GEF), FAO and the twelve participating countries. The main objective of the project was to reduce discards in tropical shrimp trawl fisheries by introducing appropriate fishing technologies. The project objectives also included the reduction of overall bycatch by shrimp trawlers, in particular the capture of juveniles of commercially valuable species, and a better understanding of the impact of shrimp trawling on marine habitats. Overall, the project made important progress towards the objective of reducing discards and bycatch although there were differences in progress among countries.

Outputs produced included:

- Tests on BRDs and decisions on what devices should be promoted/recommended for regulations completed for some fisheries. Probable bycatch reductions estimated to be around 30-40 percent. Revised or new legislation adopted in some countries, and legal reviews in others;
- Recognition of the need for a wider fisheries management approach reinforced including, for example, effort controls through closed seasons/areas and limits on number of trawlers;
- Extensive technical regional (and global) collaboration established and cooperation initialised and steps taken towards harmonisation of bycatch reduction at sub-regional level (Nigeria/Cameroon/Gulf of Guinea countries, Mexico/Latin America and the Caribbean, SEAFDEC/Southeast Asia);
- Increased knowledge of bycatches – composition and quantities;
- Cooperation between governments (officials and researchers) and the shrimp trawl industry / private sector established, or strengthened in countries where it existed pre-project;
- Awareness of the importance and usefulness of BRDs and the knowledge of possible technical solutions enhanced among relevant national institutions and administrations as well as within the fishing industry;
- An FAO manual/guide on BRDs published ('A Guide to Bycatch Reduction in Tropical Shrimp Trawl Fisheries');
- Training materials on Juvenile and Trashfish Excluder Devices (JTEDs) developed (by SEAFDEC) and set-up of a project website.

NORAD/Government of Mozambique: NORAD funded a consultant for the preparation of a highly credible Management Plan (Ministry of Fisheries 2009). This is the only one of its kind outside of Australia and the US.

WWF / EDF/ CONAPESCA / INAPESCA / NOS: A major precedent in the cooperation between Government, International NGO, local NGO and funders focuses on Incentive Based Fisheries Management (IBFM) in Mexico. Funded by the Walton Family Foundation, this project started in 2008, by creating a working group with the main task of evaluating national capacity and enabling environment for implementing IBFM. In 2009, the project established a quota system for the artisanal shrimp fishery in the State of Sinaloa in the Gulf of California. Along with an extensive effort by the Federal Government (CONAPESCA) and the State Government of Sinaloa, in establishing an accurate record of artisanal fishers in the shrimp fishery, the Project managed to establish the required inputs for the first steps toward a successful IBFM system: a calculation of TAC, establishment and allocation of quota, and a third party monitoring system in every port of arrival. For 2010, the Project will consolidate the quota system in Sinaloa and may expand to artisanal shrimp fishery in Sonora State. It is expected that in the medium-term the industrial fleet will participate in the quota management system.

WWF/UNIMA sustainability partnership (Madagascar). UNIMA's trawling operations have a strong focus on sustainability best practice. Main issues addressed are: trawl nets and BRDs/TEDs designed to reduce bycatch (these activities are at least in part driven by fuel efficiency and cost saving opportunities) and to reduce carbon emissions; focus on responsible effort reduction strategies and partnerships (closed areas, voluntary reductions in active vessel numbers); instigate co-management discussions with artisanal fisher groups in cooperation with WWF and development agencies, including donating % of fish caught to fisher cooperative members; participation in WWF turtle catch recording programmes; and implementation of UNIMA crew best practice programmes. WWF focuses on using its influence to promote UNIMA's responsible/sustainable fishing practice to strategically important retail outlets, and to leverage the better practices that the company has developed within the trawling and other business lines to other companies globally. The resulting benefits: (1) promote more sustainable business practices and demonstrate that such practices can generate financial and market benefits; (2) demonstrate the role that private companies can play in protecting the natural environment and in enabling social and economic development; (3) encourage wider adoption of sustainability in the business models and financing of private sector activities; (4) demonstrate that partnerships can achieve faster, more credible, and more substantive progress towards sustainable business.

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Shrimp Round Table (USA). Partnership between a Texas Seafood Company, The Ocean Conservancy (TOC) and Environmental Defense Fund (EDF) to improve the shrimp fisheries in the USA Gulf of Mexico and South Atlantic (<http://www.youtube.com/watch?v=E-2V1qe7pnY>). Developing Best Management Practices: Doors produced 28% fuel saving in changing doors; BRDs reducing bycatch by 50%, and reducing crew workload. Current focus is on minimizing impacts on wider shrimp habitats, and bycatch reduction strategies.

WWF / CIFT / Forest & Wildlife / State Fisheries: TED trial runs, Dharma and Paradeep, Orissa, India: TED trials undertaken of 0.45 hrs to 1 hr in partnership with semi-industrial trawlers. Bycatch and turtle interactions measured, and gear adjusted to suit fishermen's concerns on fish loss.

WWF US: The WWF-US Fisheries Program uses the Marine Stewardship Council (MSC) certification process as a tool to create economic incentives for sustainable fishing. WWF first partner with major seafood businesses to gain their commitment to sourcing MSC-certified products, evaluate the sustainability of their source fisheries and collaborate with fishers, seafood industry leaders, and governments to help the source fisheries meet the MSC standard.

WWF-US has over ten years experience facilitating MSC certification of small-scale and community-based fisheries. They use the MSC pre-assessment process to help identify barriers to sustainability, and the full assessment process to reward responsible fisheries in the marketplace and incentivize change in similar fisheries around the world.

If after pre-assessment a fishery is found to not yet meet the MSC standard, WWF-US uses the results of the pre-assessment to engage stakeholders in the design and implementation of a fishery improvement project that will move the fishery toward the MSC standard.

This three-pronged approach consisting of company outreach, MSC certification, and fishery improvement projects is changing seafood markets from both ends of the supply chain. With assistance from WWF's global network and our partnerships with local NGOs, these MSC-based efforts have generated conservation successes in over 40 fisheries worldwide. WWF-US is presently working with the respective in-country network offices to guide two shrimp trawl fisheries through the MSC process.

On the basis of the above examples of applied governance across a range of countries, some specific summary points are made:

- (1) Policy objectives are provided in many countries. These usually provide for reference to sustainable management of resources, but where economic development/employment generation/food security is a stated as an objective, along with sustainable fisheries management, economic development takes priority. No attempt appears to justify the fact that a long-term focus on sustainable fisheries management reduces the risk to coastal community preservation and supports food security;
- (2) Only one country, Australia, has endorsed ecosystem-based management as a core management principle;
- (3) Implementation of objectives is achievable only when there is a management plan with set objectives, goals, defined results, activities and monitoring indicators assigned;
- (4) Management councils/committees need to be established with the variety of stakeholders present. This includes fishers from all groups, national and provincial/state administrations, research organisations, compliance organisations and NGOs. These organisations report to the established objectives, goals and activities, and performance is judged against the indicators;
- (5) Management plans preserve the independent integrity of actions and are the best mechanism to avoid political interference;
- (6) Management plans need to be assessed and monitored. This requires an independent peer review process; and
- (7) Cost recovery systems are in place in some developed (Australia) and some developing country fisheries (Madagascar, Mozambique). These are proven to work effectively, and form the basis for institutional strengthening (license administration, compliance and research).

2.7 MANAGEMENT SYSTEMS

Fisheries management tools are often grouped into:

- Input or fishing effort controls such as the number and size of fishing vessels (fishing capacity controls), the amount of time fishing vessels are allowed to fish (vessel usage controls), or the product of capacity and usage (fishing effort controls);
- Output or catch controls such as ITQs, which limit the tonnage of fish or the number of fish that may be caught from a fishery in a period of time; and
- Technical regulations relating to fishing gear (such as mesh size) or to area or time restrictions which restrict access to an area by fishers in some way;

This section considers the use of such measures in TST fisheries.

2.7.1 Input controls

Examples of applied input management controls are summarised in Table 2-5.

Reference has already been made to the lack of any access control in many of the shrimp fisheries described. Fishery managers with the foresight to establish restrictive access are very rare, including in developed economies. Failure to implement access control has ultimately required the use of a different capacity reduction schemes to address excess levels of fishing effort and fleet capacities. These include the following capacity reduction measures:

Buy back schemes to reduce capacity were applied in Australia's Northern Prawn fishery on three successive occasions (mid 1980s, 1990 and 2006/07), removing 250 vessels over 25 years; and in Texas state, US, a buy back scheme applied over a period of 19 years removed fishing effort by an estimated 48%. In the case of the Texas scheme, funding was provided from public finances. Early Australian scheme funding was primarily funded by a loan repaid by industry levies. The Commonwealth Government wholly funded the latest scheme on the condition that the fishery move to a system of Individual Transferable Quotas (ITQs). Mexico is the only other country known to have applied a buy back scheme, but the scheme bought out latent capacity and was undermined by subsequent re-entry of trawlers.

Gear Statutory Fishing Rights are established in two countries based on headrope length. These are applied in Australia's Northern Prawn Fishery, but with the precedent followed in Madagascar. This scheme was implemented to provide a flexible restructuring tool when reductions in effort and/or capacity are required. It proved successful in Australia with the removal of 48 vessels with a 50% reduction in headrope length over two successive compulsory reduction schemes. The scheme works on the basis of gradually reducing the headrope length, requiring the industry to purchase additional entitlements within the sector, or reduce their own company fleet capacity. The scheme has not been successful in Madagascar because the initial allocation of gear SFRs was inadequate to cause sufficient reductions in capacity. The lack of capacity reduction, coupled with increases in effort by the artisanal fleet has not resulted in a corresponding medium to long-term increases in CPUE. Mexico has an established headrope restriction of 13.5m, but these are not tradable, and were introduced to prevent increases in multi-trawl configurations.

Box 2-10: Description of the Gear Statutory Fishing Right system applied in Australia's NPF

Entry to the NPF is through the holding of statutory fishing rights (SFRs) under the Act. SFRs are recognised as being a form of property right created by statute. The NPF Plan requires that to fish in the fishery, operators must hold SFRs which control fishing capacity by placing limits on the number of trawlers (Class B SFRs) and the amount of gear permitted, i.e. the limit of headrope length a fisher can use (gear SFRs) in the fishery.

Operators must hold both a Class B SFR and the appropriate number of gear SFRs for the length of headrope they wish to use. There is a minimum holding of 100 gear SFRs for each Class B SFR.

There is currently a total of 52 Class B SFRs and 35,479 gear SFRs issued for the fishery. A gear SFR

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currently represents 7.481cm of operational headrope for operators towing twin gear and 6.732cm of headrope for operators towing quad gear or tongue nets.

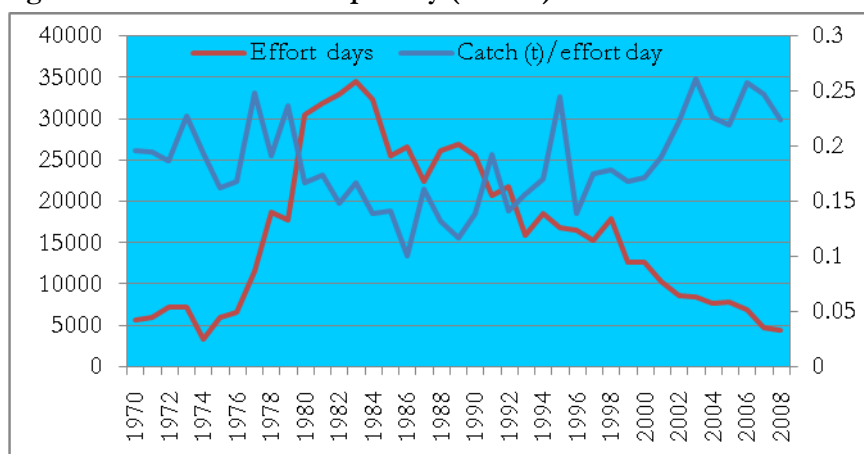
All SFRs in the fishery are fully transferable and may be bought, sold or leased. Persons who are granted SFRs under the Plan (the owners of the fishing concessions) are able to lease them to other parties who then become the holders of those SFRs for the term of the lease. In those instances the SFR holder has a leased interest in the fishing right, with the interest expiring at the expiration of the lease.

The number of total gear units allocated does not change. However, the value of all gear units can be adjusted (upwards or downwards) in response to biological and/or economic parameters in the pursuit of the fishery's MEY target. This is done through increasing or decreasing operational headrope length on a proportional basis.

Source: A.Jarrett, NPF Industry Pty Ltd, Pers. Comm.

When addressed, and applied with substantial reductions in capacity supported by gear SFRs (to eliminate technical creep), significant levels of reduction applied are also accompanied by substantial increases in catch.

Figure 2-9: Effort and catch per day (tonnes) in the Australian Northern Tiger prawn fishery



Source: NPF Industry Pty Ltd

Surrender of fishing rights. In 2008 companies voluntarily surrendered fishing licences in Madagascar from 75 to 70 vessels as a response to an immediate requirement to reduce effort, and a failure of the Government to introduce punitive SFR reductions. Current expectation is that the fleet may reduce in size to 20 vessels in response to rapidly declining CPUE.

Removal of latent fishing rights: At the time of writing, the USA Federal Government is seeking to eliminate latent licenses in the Federal fishery to prevent effort expanding, if and when economic conditions improve. The Federal fishery reports 526 latent licenses.

Removing of licences as a result of bad practice: MMAF Indonesia reports a policy of removing licences for vessels with a record of non-compliance. It is not clear how effective this scheme is, and reports are that decisions taken were undermined by political interference.

Diversification of fishing activities: The Vietnamese, Nigerian, Mozambiquan and Indian governments encourage diversification to other species, or to deeper water prawns. This does not appear to have reduced capacity, but in some cases has reduced fishing effort for short periods.

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Seasonal prohibition is a further mechanism to reduce active fishing effort¹⁵. The closures are usually set when female prawns are gravid, or when juvenile prawns are on the fishing grounds. Intermediate closed periods (4-6 months) are applied in Madagascar, Australia's Northern Prawn Fishery, Australia's Spencer Gulf fishery, Mozambique and Mexico, and shorter periods (i.e. around 1-2 months), in India, Indonesia, USA, and Vietnam.

Fishing demarcation zones are established in a large number of countries. These are used to (a) partly separate different fisheries, and (b) to protect inshore areas from trawl activity, including sensitive habitats such as seagrass beds. These demarcations apply in India, Indonesia, French Guiana, Suriname, Vietnam, Australia, Nigeria, Mozambique, Madagascar, Cambodia and Cameroon. The range of specific demarcations shows very little consistency in definition. Some fisheries allow trawling from the low tide mark, others from the 5, 10 or 25 metre isobath. Some fisheries allow trawling within 2 n.miles, others from 2-3 n.miles and beyond.

Trawl bans have been instigated in three countries: Indonesia from 1982, Philippines from 1984, and Venezuela in 2009. These are in response to the impact on other fisheries and pressure from coastal communities. In the cases of Philippines and Indonesia, these bans are being abused in some areas.

2.7.2 Output controls

Examples of applied output management controls are summarised in Table 2-5.

Total Allowable Catches have been introduced as a management tool in Indonesia, French Guiana, Mozambique, USA (one species - Royal Red shrimp). The industry and management authorities have ignored the Indonesian catch quota since its inception, and scientists state that they have no basis on which to make annual assessments of changes to the TACs. Mozambique TACs apply to the industrial fishery, but are seldom reached, and, if reached, it is likely that the TAC would be increased to accommodate specific companies. TACs are used successfully as a tool in the Australian Spencer Gulf fishery during the spawning period to prevent over-exploitation of the spawning stock. TACs/IQs have just been introduced in Mexico, and applied to the artisanal fishery, but not as yet to industrial vessels. The divisions are quite controversial given the growth in the artisanal sector, from 20 to 50% of the catch from 2000 onwards. TACs are about to be introduced as a management tool in Australia's Northern Prawn Fishery in conjunction with individual transferable quota (ITQ) SFRs.

Individual boat quotas are applied in the Mozambique and the Malagasy industrial and semi-industrial fisheries. There is strong resistance to IQs from the industrial fishery largely because they (a) have seen their segment catch shares diminish; and (b) because they perceive that there is little incentive to transfer quotas as CPUEs are falling. The Madagascan companies have theoretically had IQs in place for some time, but have had no incentive to apply them because of reduced catches and reduced profitability. There is no incentive to purchase IQs when CPUEs are falling. ITQs are to be introduced into Australia's NPF. The allocations are reportedly to be based on existing gear SFRs. However, the industry is opposed to this change, whilst the Government sees the ITQ system as preferable to the existing gear SFR system as it will purportedly facilitate more autonomous adjustment than the gear SFR system.

Mexico has introduced a pilot community quota scheme for artisanal fishers. The scheme has the support of extensive logistics for data collection (184 landing sites) and inspection. TACs are set for bays and lagoons. The quota system may be extended to the industrial trawl sector over the next two seasons, but it has been important to demonstrate control of the artisanal sector in order to secure the support of the industrial sector. The pilot study has shown a marked increase in compliance.

Minimum landing sizes are to be used as a tool in only two fisheries: Louisiana State shrimp fishery and Vietnam. In both cases, there appears to be little evidence that the regulation is applied.

Average mean sizes are used in real time fisheries management measure in the Spencer Gulf fishery. Harvest strategy decision rules permit 'mean size', dependent on fishing period and strategy to be applied,

¹⁵ Seasonal prohibitions could also be classified as a technical control measure. However, on review of its applications, it is to a large extent used partially to protect gravid females and juveniles, but fishing seasons are increasingly reduced as a means of supporting a system of effort control.

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i.e. November and December, the mean is $<250/7\text{kg}$, in March under a standard strategy the mean is $<220/7\text{kg}$. If the mean size is below this, the Committee at Sea will change to another fishing area. If consistently below the benchmark, the fishery will close.

Bycatch retention is used as a means to ensure sufficient bycatch is landed in some fisheries to bolster the supply of fish for domestic food security. Such measures are reported in Madagascar, French Guiana, Mozambique, and Nigeria.

Australian fisheries **bycatch exclusion** regulations are implemented to ensure that certain species are not targeted. These usually relate to fish species (sharks, skates and rays, barramundi, threadfin salmon, Jewfish, queenfish, and others).

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Table 2-5: Examples of Input and output management controls applied in the shrimp sector.

	Effort/Input controls				Output controls			
County	Restricted access licensing	Days at sea/seasonal closures	Fishing gear units	Vessel operational demarcations/ No trawl zones	TACs	IQs and user rights	Minimum landing size (shrimp)	Fish bycatch restriction as % of total
India	A maximum vessel number set for each province. Previously a large number of entries facilitated through fuel subsidies	Monsoon trawl ban (Kerala: June 14 – July 31. Orissa April-June). Implemented by all the coastal states of India (47 days) Trawl exclusion (turtle season) in Orissa (November-April) (depending on the monsoon).	✓	Trawlers restricted to beyond 12 n.miles, but Orissa applies a dispensation to allow trawlers to fish from 5 km.				
Indonesia	Open access but some more recent limitations on reissuing licences, Vessels fish 280 days per annum with trips of 40-60 days	A ban on monsoon trawling, of 45 days		Trawlable area is the eastern part of 130° longitude line and beyond 10 meter of sobaths line. Trawling only permitted in the Arafura Sea. Trawl bans applied elsewhere.	✓, but not enforced.	Individual Company quotas based on vessel GT, but the system is not transparent, and vessel landings are not comprehensively checked		
Vietnam	Licenses are granted on the basis of submitting a number of supporting documents such as vessel inspection and registration papers. A small license fee, proportional to engine size is levied.	Around March to July every year depending on different areas		>90 HP vessels must trawl offshore (from 24 nm), zone 3 <90HP can trawl zone 2 (6-24 nm)			Yes, but not enforced	
Mexico	Restrictions on access to industrial fisheries, but some re-entry	Fishing season is modified according to the results of biological research. Pacific Coast	Maximum legal size of headrope for the artisanal	Area closures: Established for the protection of juvenile	In 2009 Mexican INAPESCA performed the first	Allocation for artisanal fishery, with Community		

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	Effort/Input controls				Output controls			
County	Restricted access licensing	Days at sea/seasonal closures	Fishing gear units	Vessel operational demarcations/ No trawl zones	TACs	IQs and user rights	Minimum landing size (shrimp)	Fish bycatch restriction as % of total
	occurred/re capitalisation. No restrictions on artisanal access until 2009	September to February, Gulf of Mexico May to August, mid May to October in two different areas. Closed season extended to all fisheries	“Magdalena P” system (13.5 m)	shrimp like the coastal waters (up to 15 n.miles from shore) and lagoons in the Yucatan peninsula. Also, trawling is forbidden in waters of less than five fathoms. Enforcement has been rather lax	TAC estimation for artisanal shrimp fisheries of the Mexican Pacific coast, and that TAC and quota allocations were made in the past for artisanal fleets in Campeche (Gulf of Mexico).	quotas divided between cooperatives		
Philippines				Trawl ban implemented for some areas, but not enforced.				
Nigeria	Open access, but restriction in size of a shrimp trawler to less than 23.2-m length overall and 130 GT			Delimitation of a non-trawling zone of 5 n.miles				70%. A regulation concerning minimum sizes at sea
Australia	Limited entry, and historic support for buy-back (Industry/Gov co-funded). Implementing new boat replacement polices aimed at	Restricted fishing seasons Northern Prawn Trawl: Banana prawn 6-10 weeks from March/April to early June; Tiger prawn 1 August to 28 November plus time of day closures; Spencer Gulf: Open periods restricted to 60 nights in full	SFRs:Maximum headrope length Some fisheries: Twin rig only.	No trawl zone inside 5 n.miles from the coastline. Does not apply in Queensland East coast where fishing is allowed up to low tide mark. Spencer Gulf: waters	NPF: TAC proposed from 2010 SG:catch limit mean reference points (xxkg/hr), period quotas (especially during	Tradable Statutory Fishing rights linked to net (headrope) length ¹⁶ ITQs introduced from 2010/2012.		

¹⁶ No more than 53,844 gear statutory fishing rights are in force. A prawn trawl net with an operational headrope of a length calculated by dividing the total length of operational headrope specified in the determination by 53 844 (measured when the rope is taut); and (ii) a prawn trawl net with an operational footrope of a length calculated by multiplying the length of operational headrope worked out under sub-paragraph (i) by 1.15 (measured when the rope is taut)

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	Effort/Input controls				Output controls			
County	Restricted access licensing	Days at sea/seasonal closures	Fishing gear units	Vessel operational demarcations/ No trawl zones	TACs	IQs and user rights	Minimum landing size (shrimp)	Fish bycatch restriction as % of total
	limiting and reducing capacity (NPF)	moon periods, generally outside spawning season. A limited spawning season fishery in December (10 days)		greater than 10m depth, permanent voluntary closures, fishing closures dependent on prawn sizes and catches.	the spawning season)			
Guyana	Government issuing additional seabob fishing licences against both industry and scientific advice	6 week closed season (September / October), but not consistent with scientific advice (April – June) when females are gravid						
French Guiana	Yes	No	2 *22m trawls Per boat	No trawling inside 30m	Yes 4108 T			All bycatch landed
USA	Federal licensing requirement but access rights to 16,000 vessels, when 3,500-4,500 are active	Royal Red shrimp quota opens 1/1 and closes when quota ends; 45-90 days seasonal closure in Texas. Other seasonal restrictions may apply			TAC for Royal Red shrimp		Louisiana a minimum size limit on white shrimp	
Mozambique	Restrictive access. No cap on deep water licenses	6-month closed season was instituted, from September to March		Not allowed to fish within three n.miles of the shore or <10m water depth; semi-industrial trawlers are not allowed within 2 n.miles	TAC for industrial fleet (Shallow and deepwater) and not semi-industrial or artisanal	IQ allocated to companies		Obligatory 2:1 bycatch:prawn ratio
Madagascar	Restricted access to zones A,B,C, D divided between	Fishing season begins on 1 March and ends on 30 November, East coast fishery	SFRs: Headrope length	Voluntary restrictions include: a night fishing ban during the first 45		Tradable Statutory Fishing rights linked to		Each kilogram of landed

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	Effort/Input controls				Output controls			
County	Restricted access licensing	Days at sea/seasonal closures	Fishing gear units	Vessel operational demarcations/ No trawl zones	TACs	IQs and user rights	Minimum landing size (shrimp)	Fish bycatch restriction as % of total
	industrial and artisanal	open all year. Night fishing prohibited up to 14 April.		days of the fishing seasons in 2005 and 2006; not using tickler chains in front of the body of the net (a practice that was widespread in the past); and alternation between day and night fishing during the season.		net (headrope) length ¹⁷ Vessels are allocated fishing rights for 20 years. These are transferable between operators. Licenses and engine units may be sold or rented, but no one company can own more than 40% of the licenses. Engine unit values are fixed, and agreed annually. It is possible to transfer values from semi-industrial to industrial, but weighted at a penalty of 1.5:1. A maximum of 90 m is set for		shrimp be accompanied by at least a half a kilogram of fish

¹⁷ No more than 53,844 gear statutory fishing rights are in force. A prawn trawl net with an operational headrope of a length calculated by dividing the total length of operational headrope specified in the determination by 53 844 (measured when the rope is taut); and (ii) a prawn trawl net with an operational footrope of a length calculated by multiplying the length of operational headrope worked out under subparagraph (i) by 1.15 (measured when the rope is taut)

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County	Effort/Input controls				Output controls			
	Restricted access licensing	Days at sea/seasonal closures	Fishing gear units	Vessel operational demarcations/ No trawl zones	TACs	IQs and user rights	Minimum landing size (shrimp)	Fish bycatch restriction as % of total
						new vessels.		
Cambodia				Prohibits trawling between the shore and the 20-m isobath (up to 10 km offshore)				
Venezuela				Trawl ban implemented from 2009.				
Iran		Fishing season in each province is approximately six weeks, and opening and closing is based on the maturity and body length of shrimp and percentage (20%) of remaining stock	✓					

Source: Poseidon country surveys

Table 2-6: Examples of technical measures applied in shrimp catching countries

Country	Minimum cod end mesh size	BRD/JTED and other bycatch mitigation systems	TED	Closed areas
India	35 mm, but 8-10mm used by most fishers		Compulsory in Orissa only because of proximity of trawl grounds to rookeries.	Closed areas in other states like Orissa, Gujarat, Tamil Nadu
Indonesia	25 mm, 45 mm for foreign trawlers	✓	TEDs are a legal requirement. Work funded by GEF under auspices of SEAFDEC to introduce JTED in the process of introduction	
Vietnam	20 mm for boats with engine <33 HP & 30 mm for boats with engine >33 HP		Promotion programmes exist, but no real evidence of application.	Marine protected areas, 15 presently in the planning stage but not necessarily related to the preservation of juvenile shrimp

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Country	Minimum cod end mesh size	BRD/JTED and other bycatch mitigation systems	TED	Closed areas
Mexico	37.5 mm. Maximum legal size of headrope for the artisanal "Magdalena" system (13.5 m)	Mandatory	Mandatory to all vessels greater than 10 metric tonnes	
Nigeria	44mm, but considering 60 mm to minimize bycatch	Square mesh window (SMW); Square mesh codend (SMC); 90 degree or gentle codend	Requirement since September 1996 but is still not fully implemented. Grid types include bent rod.	
Australia	45-60 mm	Permitted BRDs (Square mesh codend/panels, fisheye specifications, Radial escape and pop eye fish box (NPF)). BRD and Crab separator bad (Spencer Gulf) and the use of on desk sorting hoppers.	TEDs in all fisheries except the Spencer Gulf where there are no turtle interactions. TED application accompanied by an extensive crew training programme.	Gazetted / 'green zone' areas of prospective high bycatch interactions, seagrass beds and all areas less than 5 metres in some (but not all) and voluntary closed areas
Guyana		TEDs required by law, BRDs not compulsory, but successful trials leading to widespread adoption.		
French Guiana	45mm		TTEDs	Inside 30m
USA		BRDs applied and continually under development. Major issue with Red snapper selectivity. Construction and instalment manuals provided http://sero.nmfs.noaa.gov/sf/BRDs.htm	Applied and continually evolving. Current concerns about large sized turtles and repetitive capture.	Tortugas Shrimp Sanctuary, Texas Flower Gardens, and the Florida Middle Grounds

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Country	Minimum cod end mesh size	BRD/JTED and other bycatch mitigation systems	TED	Closed areas
Mozambique	60 mm	No, some skippers may rig their gear in order to reduce bycatch of soles, for example by leaving a gap between the footrope and the ground rope		
Madagascar	25 mm, but industry applies 50	Applied since 2003	Applied since 2003 (70 mm)	
Cambodia	Non gazetted are 40-50 mm			No trawl zones
Suriname	45 mm for all trawlers	BRDs not compulsory, but the result of on-going trials must lead to widespread adoption and will be made compulsory by law.	TED is required by law.	The zone from the coastline up to the line nominal to the 18 m isobath for seabob; The zone from the coastline up to the line nominal to the 30 m isobath for marine shrimp.
Cameroon	25 mm			

Source: Poseidon country surveys and GEF/UNEP/FAO working group reports

2.7.3 Input versus output controls

There has been substantial work done by the Australian Government (primarily ABARE) to review preferred management options for the NPF. An ABARE paper published in 2004¹⁸ provides a comprehensive analysis on future management options for the Northern Prawn fishery, centred on economic efficiency considerations. This fishery was the recipient of a Government funded buy back scheme, but also had successfully applied the gear SFR scheme (Box 2-10). The ABARE research, along with separate work commissioned by AFMA (MRAG, 2007) identified strengths and weaknesses of the different input and output control schemes.

¹⁸ R. Rose, and T. Kompas, 2004. ABARE Report 04.12 *Management Options for the Australian Northern Prawn Fishery - an economic assessment*: http://www.abareconomics.com/publications_html/fisheries/fisheries_04/er04_nbn_prawn.pdf

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Table 2-7: Strengths and weaknesses of effort management and individual quota schemes.

Strengths	Weaknesses
<p>ITE controls</p> <p>In general are self adjusting such that in times of high catchability (i.e. abundance) CPUE increases, and catches for a given effort input are larger. Reverse occurs in periods of low catchability.</p> <p>Real effort reductions have occurred through the reductions/sale of SFRs, with resultant loss in real effort.</p> <p>As catch volumes are not capped, effort based systems are less prone to high-grading and/or discarding behaviour.</p> <p>Are more likely to be more effective than output controls where CPUE is relatively stable in comparison to seasonal variation in stock abundance (as is the case for tiger prawns)¹⁹.</p> <p>Are generally more acceptable to fishers - perhaps because individual operators believe they can catch more fish with a given effort level through superior fishing knowledge and/or efficiency.</p>	<p>There is a constant and strong incentive for operators to substitute the managed input/s with alternative unrestrained inputs to increase their relative fishing power²⁰.</p> <p>Normal effort creep through better knowledge/knowledge sharing, improved technology etc routinely undermines management and complicates assessment and management processes.</p> <p>Inevitable structural adjustment programs, and alternate management policies to ratchet back effective fishing effort are costly to government and industry.</p> <p>Delays inherent in processes to introduce new input based management controls (policy development, legislative processes, consultation etc) may enable effort substitution strategies to be applied at much the same time as new management constraints are introduced.</p> <p>Governments have been reluctant to introduce cuts in effort as recommended by scientists</p>
<p>ITQ controls</p> <p>Provide a more accurate match between actual fishing mortality of target species (landings plus discards/highgrades) and the desired fishing mortality as determined by stock assessment processes;</p> <p>ITQ management should encourage industry to maximize the economic returns from their available quota share through fishing at least cost, and at optimal times for sizes/grades that will maximize market returns. Minimizes likelihood of competitive and inefficient race to fish behaviour.</p> <p>Quota transferability encourages flow of quota to more economically efficient operators optimizing the economic return for a given amount of product.</p> <p>Having a defined share of the TAC under a strong property right should encourage operators to fish responsibly to maximize returns and protect their investment.</p>	<p>May encourage high-grading and discarding of smaller or less valuable prawns subject to the cost of fishing and the price differential between different size/grade prawns.</p> <p>The need to closely monitor catches at the individual boat (quota) level, and across the fleet in aggregate may contribute to high monitoring and compliance costs²¹. This results in very high control costs where fleets are in large numbers. For example, Company quotas were introduced in Indonesia but abandoned because of the inability to monitor uptake. <i>Mexico's IQs system, applying to artisanal boats, is heavily resourced by fishery data collectors and inspectors. This is not accompanied by a formal system of cost recovery.</i></p> <p>Pre season surveys and/or stock assessment work to enable a relatively accurate estimate of recruitment and/or available biomass, and hence TAC, for the following seasons are likely to be costly.</p>

Source: Extracted from COBALT (2009), MRAG 2007 and ABARE (2004) and amended according to additional observations.

¹⁹ ABARE, 2004. P3.

²⁰ ABARE 2004 notes that the first NPF ITE system based on A units increased the costs and decreased the efficiency of fishing. At the same time substantial effort reductions under this system failed to reduce effective effort by similar amounts due to input substitution (i.e. using more gear to compensate for reduced vessel power).

²¹ If the risk of high-grading under current economic circumstances for the NPF is relatively low this will mitigate against excessive monitoring and enforcement costs. There remains a risk of unreported landings outside the quota system which would require additional monitoring resources.

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2.7.4 Technical measures

Technical measures are intervention measures introduced to improve selectivity and reduce bycatch in order to reduce waste and threats to vulnerable or endangered species.

Almost all countries apply **minimum mesh sizes** in the trawl wings and cod ends. However, cod end mesh sizes range from 20 mm to 60 mm. Countries applying small mesh sizes are those that are more reliant on trash fish bycatches. These are Vietnam (20-30 mm), Indonesia and Cameroon (25 mm), India (35 mm), and Mexico (37.5 mm). Nigeria more recently increased its mesh size to 44 mm and is considering an increase 60 mm. Most other fishery cod mesh sizes range from 45 mm to 60 mm.

The **headrope length** restriction is applied in only two countries - Australia and Madagascar²². It is used as an input control measure, but is an important additional technical constraint in that it reflects the size of the total individual vessel number of trawls used. It could therefore be used as a technical control measure.

Bycatch reduction devices (BEDs/BRDs/JTEDs) are used to eliminate fish and other bycatches from the catch. These are applied in most fisheries, but there are exceptions, notably India, Vietnam and Mozambique. Indonesia applies a BRD rule, but this is partly ignored. Resistance to devices is reported where there is a fear of loss of company revenue from bycatches (India), where crew remuneration (Nigeria, Indonesia, Colombia) is partly paid with revenue derived from bycatches, where there is a policy focus on trash fish (Vietnam), and where there is general misunderstanding in its application (Mozambique). A large number of other countries are also about to apply the Popeye Fishbox. Trials in Australia's NPF have reduced small-sized bycatch by up to 48% and bycatch of sea snakes by up to 87%.

Box 2-11: Examples of TED application

Reported to be applied effectively: Australia, Belize, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Madagascar, Mexico, Nicaragua, Nigeria, Pakistan, Panama, Suriname, Venezuela.

Lessons learned from TED application emanate from **USA**, which has a strong compliance with BRDs/TEDs. 97% of turtles caught in TED nets escape. However, TEDs reduce the shrimp catch by 10% (NMFS). TEDs can be ineffective as a result of: (i) improper installation (ii) inexperience of the crew; and (iii) variation in trawling conditions. Some countries, most notably USA and Australia, have applied extensive training programmes to industry to facilitate the introduction of TEDs. Training in the application of BRDs, TED and JTEDs (trash excluder devices) form the basis of the FAO GEF Bycatch reduction programme.

TEDs were introduced to **Australia's** Northern Prawn Fishery in 2001. In 1999, 96 turtle mortalities were reported and 780 marine turtles were released alive; in 2007, no mortalities were reported and 55 turtles were released alive. This is a substantial reduction which has been confirmed by observer programmes. **Madagascar**, following a similar policy to Australia, introduced TEDs in 2003, and the capture of turtles fell from 42 in 2005 to 2 in 2008. Both Madagascar and Australia apply observer programmes that record bycatch data (fish, invertebrates and TEPs).

Countries where TEDs are statutory in legislation but not effectively applied include: Indonesia, Trinidad and Tobago and Mozambique.

In some countries, TEDs are said to be unusable because the vessels are too small (Cambodia).

JTEDs have been developed by SEAFDEC, funded under the UNEP/GEF/FAO programme. The initiative is aimed at eliminating trash fish in some of the Coral Triangle TST fisheries: Indonesia, Philippines, Thailand and Malaysia. SEAFDEC participated in sea trials and coordinated a number of workshops and training-of-trainer exercises in Indonesia.

Temporary and permanent closed areas are established usually to protect habitats, e.g. seagrass beds and coral reefs, areas where juvenile fish and prawns are prevalent, areas where there are known fish aggregations/hot spots (as opposed to prawns) or areas with a high interaction with TEPs (turtles, syngnathids, sea snakes, dugongs). Examples of networks of extensive closed areas are provided in two

²² There are reports (Hermes, 2009) that Iran also applies a gear measure restriction.

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case studies (Australia's NPF and USA's Gulf of Mexico). Closed areas are used as a management tool in a number of other countries, Mexico and India.

In most cases VMS is a requirement for semi-industrial and industrial vessels. It is not applied to artisanal vessels, which tend to have high incidences of failing to comply with demarcation zone boundaries (India, Vietnam).

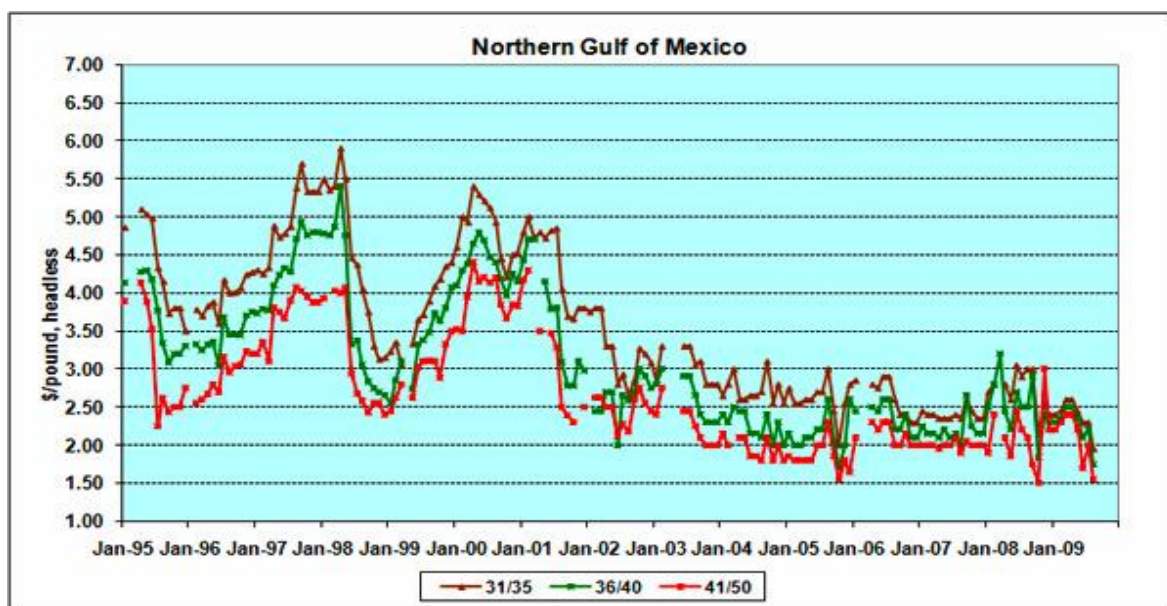
2.8 BUSINESS DRIVERS AND CURRENT PRACTICES

Business drivers are an integral component of the fishery sector's behaviour, providing both negative and positive reactions to changes in costs and earnings. The principal business drivers are market share and accessibility, vessel turnover and profitability, wages and salaries, fuel costs and gear efficiencies.

2.8.1 Market share, accessibility, and prices

All fishery segments evaluated in this report are witnessing a significant loss in market share as a result of the growth in aquaculture production, and competition from other capture fisheries, most notably the high volumes of Argentine gamba (deepwater shrimp) and other coldwater shrimp species. Nevertheless, wild-caught shrimp usually commands a price premium over its aquaculture competitors of between 20% to 30%. An example of price trends for wild-caught shrimp is presented below, and are typical of many shrimp fisheries.

Figure 2-10: Price trends USA Gulf of Mexico fishery, 1995 to 2009.



Source: <http://coastal.msstate.edu/shrimp%20landing%20prices.html>

Positive solutions to market competition are:

Seek to sustain, or improve market share by promoting sustainable products: Mozambique, Madagascar, Suriname and two Australian fisheries are presently going through the process of MSC certification. GACPM, the Malagasy shrimp producers' organisation, sees the transition as essential to sustain the product's competitiveness and product niche. However, it is not clear as to whether MSC certification will command a price premium. One leading European importer was of the view that price premiums in the region of 10-15% could be obtained as a result of MSC certification. The more notable area of concern to the fishery sector, is that non-certified products, or evidence of unsustainable fisheries, could cause European and North American buyers to change sources of supply. In this context one European seafood importer is in the process of switching its source of supply away from India (Macfadyen *et al*, 2009)

A key competitive edge can certainly be gained by satisfying the growing demand for sustainably caught products. Many seafood retailers in the USA and Europe, and to a lesser extent, Japan (i.e. the three main markets for shrimp products), have made commitments to sourcing sustainable products. Many seafood retailers and wholesalers now use MSC, or alternative certification standards and information sources such as published data from regional fisheries management organisations or their own audits, to evaluate their suppliers' performance and sustainable fishing practices. Examples of trends linked to sustainable fisheries and main shrimp markets are highlighted below in Box 2-12.

Box 2-12: Market focus on sustainability

Netherlands Retail consortium has a commitment to sourcing sustainable fish products by 2011. Netherlands is the largest Northern European consumer/capita of shrimp in Northern Europe. Heiploeg (Netherlands), the leading EU buyer of tropical shrimp, buys Chinese crayfish and Indian shrimp from fisheries that might be considered partly 'small-scale', as well as shrimp from Indonesia and Bangladesh. The company reported that "We have stopped buying raw materials from certain sources due to a variety of reasons, including environmental concerns, but none of these were from small-scale fisheries.... However we are now considering dropping Indian trawled shrimp due to a variety of reasons, environmental and ecological care included. We have just replaced the Indian shrimp in some retail products with south American shrimp (Suriname)". Pers. Comm. **Heiploeg**, September 2009)

Major **European retail outlets** in Germany (Aldi, Costa, EDEKA, LID, Metro real, Netto, REWE Grossverbraucher-Service), Belgium (Delhaize), France (Carrefour) and UK (Asda, Sainsbury's, Marks & Spencer, Tesco and Waitrose) have similar commitments to MSC and sustainability. By way of example, one UK-based importer/processor/wholesaler, supplying leading retail chains and the food service sector, stated that "Detailed self-audit questionnaires have to be completed by every supplier or potential supplier. References must be given to any statements they make. Scientific information on fish stocks is required along with catch data and independent advice. Also catch records, traceability to vessels, vessel legality and registration details, etc. We require bycatch volumes including unwanted bycatch and where national catch records don't require record of bycatch (wanted or unwanted) we seek to have suppliers implement catch records that do include them." (Anonymous, pers. Comm., 2009).

USA's largest retailer, **Wal-Mart**, is committed to sourcing 100% MSC certified seafood by 2011 (wild - fresh & frozen). **Other USA retailers**, Kroger, Supervalu, and Giant Eagle, as well as the US's largest food service distributor, Sysco, have also committed to working with WWF to develop sustainable seafood sourcing strategies.

MEL Japan, a leading Japanese certification scheme, was launched at the end of 2007 to "make provision for informed decisions by purchasers whose choice can be relied upon to promote and stimulate the sustainable use of fishery resources". MSC has also set up its Asian headquarters in Japan and is participating in a leading cartoon advertising campaign aimed at promoting sustainably sourced product.

Source: Macfadyen *et al*, 2009 and MSC.

It should be noted that the aquaculture industry is also developing equivalent certification standards in response to growing environmental concerns. To date these standards have not developed as quickly as those available for the capture sector. However, as aquaculture standards for groups such as the Aquaculture Stewardship Council and GlobalGap become finalised and gain credibility, any market advantage that may be gained through certification of capture fisheries may be eroded.

Another option, though seldom used, involves:

Withdrawing from the fishery and transferring activities elsewhere. The USA shrimp fisheries have seen a marked downturn in participation, and a switch to non shrimp fisheries. This has resulted in a marked reduction in effort and has allowed the Gulf of Mexico and South Atlantic fisheries to remain within safe biological limits.

Other business practices which may be thought less positive resulting from increased market competition and declining prices include:

Altering the balance of target species, including increasing dependency on other retained species e.g. squid, cuttlefish, deeper water shrimp, and demersal species, including smaller shrimp. This is a path followed by many developing country fishing groups leading to less selective fishing practices in the hope of retaining other species. The focus is on both export markets (cephalopods) and domestic markets (demersal species and small shrimp).

Developing a market for small shrimps: Artisanal fishers are typically successful in selling juvenile shrimp in market stalls. These may be fresh or dried and such markets exist in East Africa, India and some Coral Sea countries (e.g. Vietnam and Indonesia).

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Applying shadow pricing practices: Many industrial vessels are owned by joint venture partners. Prices on offer by the joint venture partner may be deliberately low so as to preserve the profitability of the parent company, and to reduce related export tariffs. The national company, however, sees falling prices as poor business practice, which could promote a change in company production practices, and act as a disincentive to investing in improved selectivity and cost saving practices.

2.8.2 Wage and salary remuneration systems

A positive business driver can be to reward skippers and crew with wage premiums for catching larger-sized shrimps. This is a practice followed by some companies in Madagascar, and occasionally elsewhere, including some Sorong-based firms in Indonesia. An example cited by one company (PT Alfa Kurnia) was that in response to a declining CPUE, crews focussed on smaller shrimps and bycatch. The former were difficult to sell, while the latter utilised storage space. The company adopted a price reference scheme. Small shrimp were paid one third of the reference price, and large shrimp three times the reference price. This reward system resulted in retention of selectivity devices, when other companies would discard them, and a more careful targeting of trawl sites and use of try nets to minimise bycatches. Boats targeting bycatch would result in the sacking of skippers and crew. The company also cited that this new practice reduces crew-sorting times.

A negative driver is that in some countries (Nigeria, Colombia and again Indonesia), crews are paid a minimal wage (e.g. US\$20/month in Nigeria), and are forced to make up their wages through the sale of bycatch species. This leads to a reduction in selectivity, promoting reduced and illegal mesh sizes, no application of BRDs and TEDs, and a focus on less efficient trawling practices that promote a build up of fish in the cod end. The result is also a heavy build up of trash fish.

2.8.3 Changes in cost structures

Positive drivers in terms of cost efficiencies have been generated as a result of falling margins, following a decrease in shrimp prices allied to substantial increases in the price of fuel in 2007 and 2008. Fuel costs can account for between 39 per cent and 45 per cent of total operating costs. As a result, many fishing companies have adopted a series of measures aimed at improving fuel efficiencies. These have included new more efficient propellers, lighter gears (trawl doors/shorter wings), increasing mesh sizes, shorter tows and removing tickler chains. These have in some cases resulted in fuel savings of 30-35%. In other cases, companies have evaluated their carbon emissions leading to a number of changes in operational practices (UNIMA, 2008). Examples of cost saving initiatives have been identified by this study in Australia, Madagascar, Indonesia and USA.

A critical negative driver, and one that is all too common, is the provision of fuel subsidies. These are applied in many countries and perpetuate retention of inefficient capacity, and can discourage initiatives such as those presented above. A recent study showed that, of the 34 largest shrimp producing nations, 19 countries had fuel subsidies (Gillette 2008). Fuel subsidies are reported in the principal producing countries of India, Vietnam, Mexico, and Mozambique. Fuel subsidies have been removed in Indonesia's industrial fisheries (including the shrimp trawl sector), causing companies to lay up some of their more inefficient vessels.

A hypothetical example of positive drivers and elimination of negative drivers and how this may affect the costs and earnings profile of a small-scale trawler is shown below in Figure 2-10. The example shows that profitability can be improved through improved practices.

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Figure 2-11: Hypothetical implementation of positive drivers and elimination of negative drivers in a small-scale shrimp trawler (India).

	Current costs and earnings, US\$	Assumptions	Changes to costs and earnings with proposed business drivers (US \$)
Shrimp	25,381	Shrimp price premium (MSC premium (15%), average size increase premium (22%)) + 37%; Reduction in catch weight 15%	29,556
Marketable fish	24,625	Larger fish price reduction in juvenile target species by 50%	17,048
Trash fish	750	Zero trash fish	0
Total earnings	50,756		46,604
Variable costs			
Fuel & oil	23,088	Fuel cost reduction (30%), but loss in fuel subsidy (5%)	17,316
Wages	9,333	50% of the benefit from fuel savings transferred to crew wage premium paid for larger average size selection	11,456
Food & water	956	No change	1,209
Ice	1,643	Reduction on fish volume - 50%	822
Maintenance	2,101	No change	2101
Misc	1,280	No change	1,280
Total costs	38,401		34,183
Gross cash flow	12,355		15,629
Depreciation	3,155	RPM/gear change (replacement only) + 25%	3,944
Net profit	9,200		11,685

Source: Core data extracted from Indian shrimp trawl, CIFT, 2008, Note Shrimp revenues will improve as CPUE increases.

2.9 SOCIAL ISSUES

Conflict between fisher groups is widespread, with mixing of fishing activities through incursions by larger fishing boats into inshore areas and movement further offshore of small-scale vessels. These conflicts in the most extreme cases have resulted in piracy and murder. Such conflicts are typically a symptom of overfishing. Conflict resolution can be achieved through regular inter-group dialogue, eradication of targeting of juvenile shrimp, and introduction of VMS.

3 BENCHMARKING ASSESSMENT OF SHRIMP FISHERIES

3.1 ASSESSMENT METHODOLOGY

The Darwin workshop identified a number of characteristics of successful and sustainable fisheries:

- An effective governance structure in place;
- The management process is transparent and accountable, including co-management with NGOs and other stakeholders, and has a culture of adaptive management;
- Strong industry leadership including presence of apex bodies and councils;
- The fishery is economically viable with the financial ability to support restructuring;
- There are effort and input controls, and some form of limitation of access;
- Effective monitoring and compliance systems are applied in a cost-effective way;
- There is an understanding of the resource, its status, and the ecosystem and its vulnerabilities;
- Target and reference points exist in an established framework so that it is possible to assess limits and management performance.

Many of these characteristics are inherent requirements of existing fishery certification schemes. The Marine Stewardship Council (MSC) fishery assessment standards for example are consistent with these characteristics but organise them under three component principles for sustainable fishing: the state of the fish stock, the impact of the fishery on the associated ecosystem, and the performance of the management system. This report uses the MSC standards, called the Principles and Criteria for Sustainable Fishing, as a benchmark framework to assess the performance of tropical shrimp trawling. MSC standards can be considered robust given that they are themselves based on the FAO Code of Conduct for Responsible Fisheries and the FAO Guidelines on Eco-labeling, and that WWF and many other private sector fishing, processing, wholesaling, and retail/food service sector companies are active supporters. The design of the MSC principles and the components and performance indicators has evolved over a number of years through consultation with experts in stock assessment, marine ecosystems, conservation and the social and legal aspects of fisheries, industry, environment groups, and consumer and regional interests. MSC fishery assessments are underway in a number of tropical and temperate shrimp fisheries. To date, only three shrimp fisheries, all coldwater fisheries, have been awarded MSC certification.

Some fisheries management specialists however express the view that the MSC bar is set relatively high and almost all shrimp fisheries would struggle to reach it, and that because only relatively well-managed, sustainable fisheries are likely to make the grade to MSC certification, the real impacts of certification on poor practices in most of the world's shrimp fisheries are likely to be limited (I. Cartwright, 2008²³). The view taken in this analysis is that fisheries require standards to aspire to and the design of mechanisms to support the achievement of these standards. However, it is also realistic to understand that the successful application of the MSC standards will take time to implement, and will need to be adapted to suit specific circumstances. The fact that a number of tropical shrimp fisheries are close to achieving MSC accreditation suggests that the goals of achieving sustainable fishing are within reach.

However, in addition to the three MSC Principles, this evaluation adds a fourth principle, the economic and social framework, against which TST fisheries are assessed, which ensures that negative economic and social drivers are not in place to prevent necessary restructuring (Box 3-1). Economic and social standards have been extracted based on a review of key drivers identified in the previous section of this report.

Together, these four principles are used as an assessment tool for lessons learned and actions (discussed in the opening section of the blueprint in Section (4) of this report, which help to identify common

²³ Gillette R. (2008)

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deficiencies based on the case study information.

Box 3-1: Principles and category definitions for sustainable fisheries, including an additional Principle 4 (P4) for the purposes of this study

MSC component P1: Sustainability of the target stock	MSC component P2: Impact on the ecosystem
P 1.1 Management outcomes P 1.2 Harvest strategy P 1.3 The precautionary approach and effective harvest strategy	P 2.1 Retained non-target species P 2.2 Discarded species P.2.3 Endangered, Threatened and Protected (ETP) species P 2.4 Habitat P.2.5 Ecosystem
MSC component P 3: Governance and Policy Performance	P4: Economic and social framework
P 3.1 Governance and policy P 3. 2 The fishery-specific management system	P 4.1 National and international price drivers P 4.2 Input cost drivers P 4.3 Remuneration and working systems P 4.4 Conflict resolution

Source: MSC Fisheries Assessment Methodology 2009, and study findings

A brief synopsis of the MSC Components, Principles and Performance Indicators and Scoring Guideposts (PISGs), and our resulting assessment based on the case studies is provided in the following text.

3.2 MSC ASSESSMENT

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.

Management outcomes

This performance indicator (P 1.1) addresses the sustainability of the target species and considers the tools, measures and strategies that are being used to manage the impact of the fishery on the target species. Target species are defined as those that are usually 20% or more of the total weight of the catch.

Box 3-2: Target species MSC categories and assessment

Primary guideposts
Stock status (Category P 1.1.1) requires that the target stocks are at a level which maintains a high productivity and has a low probability of recruitment overfishing. This requires that the stock is above the point where recruitment is impaired and fluctuating around a target reference point. Default limit reference points are defined as being 50%B _{MSY} or 20% of B ₀ ²⁴ .
Reference points (Category P 1.1.2) requires that limit and target reference points are set for the stocks. These should be set above the level at which there is an appreciable risk of impairing reproductive capacity and that there is no danger that genetic changes in the stock would reduce reproductive capacity.
Stock rebuilding (Category P 1.1.3) is where there is some evidence of stock rebuilding where the stock has been depleted, i.e. that strategies are in place and there is evidence (modelling or by extrapolated evidence) that recovery will be achieved within specified time scales.
Assessment
Catch per unit of effort in most of the fisheries examined in this report is declining. Only Australia, USA and brown shrimp in Mexico exhibit sustainable characteristics. ½B _{MSY} is used as a limit reference point to establish effort controls in these countries. Mozambique applies F _{0.1} for its main species along with a target effort trawling level (expressed in standardised fishing hours). There is no evidence that ½B _{MSY} is applied as the default limit reference point elsewhere, and the broad consensus is that current levels of fishing effort are twice what they should be. India applies 0.6 B _{MSY} on the grounds that tropical conditions produce lower levels of vulnerability (high fecundity,

²⁴ Unexploited biomass

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growth rates etc). However, the current level of exploitation is $0.75B_{MSY}$ without any mechanism (TACs/effort control) to implement exploitation controls.

Recruitment overfishing is reported in a large number of countries where artisanal vessels are targeting juvenile species. Moreover, because closed seasons are short (with the exception of Australia and Iran), it is highly likely that some fisheries target stocks in peak spawning periods, and as such significantly exceed $\frac{1}{2}B_{MSY}$. The result, as witnessed in many fisheries, is that the target species dependencies are falling, with a heavy emphasis on multi-taxa fisheries. However, a comment made by Indian scientists is that spawning within tropical waters has no seasonal boundaries for some major species, making it difficult to decide on the length of closed seasons.

In many cases, the suite of targets and limits relating to exploitation rate, recruitment index, and size at first capture, are not available and there is a need for good accurate recording of data as a “surrogate” “consistent with B_{MSY} ”. Australia, USA, India, Mexico, Mozambique and Madagascar report having limit reference points, but these are exceeded in the latter four countries.

Mozambique represents an example of stock rebuilding where the stock has been depleted, primarily through the use of extended closed seasons, with evidence from modelling and extrapolated evidence that recovery is being achieved within specified time scales. The scale of closed season extension is from 6 to 7 months (40,000 effort hours).

Harvest strategy

Performance indicator P 1.2 assesses the harvest strategy’s ability to manage the impact on target stocks so as to achieve the primary guideposts for the target species. This requires assessment of the plausibility of the strategy and the tools to control exploitation. These measures should demonstrate a substantial likelihood of success.

Box 3-3: Harvest strategy MSC categories and assessment

Primary guideposts

Harvest strategy (Category P 1.2.1) requires that there is a robust and precautionary harvest strategy in place, such that harvest strategy objectives will be achieved. This requires that monitoring systems are in place to determine that the harvest strategy is achieving its objectives (i.e., the status of the resource, determined from average catch rates observed on surveys, as well as the distribution by age and sex).

Harvest control rules (Category P 1.2.2) are required to be consistent with the harvest strategy, and act to reduce the exploitation rate as the limit reference points are approached. This also requires that HCRs account for uncertainties such as environmental variables, and requires that the most appropriate management tools are in place to ensure effective control of fishing activities.

Information monitoring (Category P 1.2.3) ensures that relevant data is collected (age, size at maturity, fecundity, stock productivity, fleet composition, fishing effort, etc), and collated with sufficient frequency.

Assessment of stock status (Category P 1.2.4) requires that there is an adequate assessment procedure for the stock, whereby the stock status is evaluated against the specified reference points.

Assessment

Harvest control rules are lacking, or lacking application in many countries the most critical problem being unfettered open access. In some cases, fisheries have reached such a critical level that trawling has been banned (Venezuela).

Australian fisheries have developed the most sophisticated system of harvest control rules, focussing on input and output controls as well as real time at-sea decision rules, supported by in-season fishery independent surveys and real time monitoring of stocks. A wide set of performance indicators are used in a well-developed decision-making framework to determine fishing strategies (conservative, standard, maximum), along with output controls. Different Australian fisheries apply different harvest control rules, but principle components are restricted access, capacity and fishing effort limits (gear headrope length), and closed seasons that focus specifically on fishing effort as well as protected species during vulnerable stages (i.e. pre spawning and nursery stages). The Australian SFR system was broadly followed by Madagascar, but largely undermined by recruitment overfishing in other fisheries, and insufficient application of effort reduction as recommended by the scientists.

TACs and ITQs are a relatively recent phenomenon in Australian shrimp fisheries, and have also just been introduced as a management measures in Mexico. TACs may exist as a legal measure elsewhere but are not applied with sufficient vigour, and in some cases lack a sound scientific basis for their application (e.g. Indonesia).

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Closed seasons are also used as a partial system of effort management in Australia, USA and Mozambique, but not to any great extent elsewhere. In many cases closed seasons are extremely short (confined to monsoon months) and may be insufficient in length to protect pre-spawning females, or to provide substantive benefits in terms of effort reduction.

Vessel demarcation zones are used in many countries, but frequently ignored. A common theme is restricting industrial trawl activity to vessels > 10m, but allowing for access by other groups in inshore waters. The latter has led to recruitment overfishing.

In many countries, the precautionary management approach would suggest that fishing effort is reduced by at least 50% for industrial trawlers, that small-scale trawl fisheries are limited to deeper depths (> 5 m) than at present and that artisanal fishing for shrimps is eliminated. A system of HCRs would have to be established in many countries, based on such a strategy including capacity reduction, effort hours, closed seasons, gear SFRs, TACs and, probably, implementation of real time management decisions supported by strong co-management systems.

Implementation will have to be supported by a more robust system of data collection and established performance reference points. This will require appropriate and periodic biomass and recruitment surveys, the deployment of observers on trawlers, and an accurate system of catch recording.

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.

Retained non-target species

Performance indicator P 2.1 addresses the sustainability of the retained species and considers the tools, measures and strategies that are being used to manage the impact of the fishery on the retained species. Retained species are species that are not targeted by the fishing method yet retained by the fishery under assessment, usually because they are commercially valuable, or because they are retained as part of the management rules. Retained species are defined as main retained species if above 5% but below 20% of the total weight of the catch. Minor species are those that are below 5% of the total weight of the catch, but may be considered as part of the evaluation if perceived to be particularly vulnerable to the type of fishing activity (e.g. elasmobranchs may be vulnerable because of their low fecundity).

Box 3-4: Retained species MSC categories and assessment

Primary guideposts

Retained stock status (Category P 2.1.1) requires that the fishery does not pose a risk of serious or irreversible harm to the retained species (other than the target species) and does not hinder recovery of depleted retained species. This requires that the main retained species are within biologically based limits.

Management strategy (Category P 2.1.2) requires that there is a strategy 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. This requires that measures are in place that are expected to maintain the main retained species (i.e. where above 5% of a specific species as a proportion of the total catch) at levels that are likely to be within safe biological limits.

Information monitoring (Category P 2.1.3) requires that information on the retained species is adequate to determine the risk posed by the fishery and the effectiveness of the applied management strategy. This will require the collection of sufficient information to assess species statistics with respect to biologically based limits.

Assessment

In almost all TST fisheries, non-prawn bycatch is far greater than the target catch. Australia provides the only exception where in the case study fisheries, retained species are under 5%. Retained species can be divided into marketable fish and trash fish. This assessment was unable to identify how many of these species are reported to be over-exploited. In most cases the status of retained species is unknown and there is limited or no recording of bycatch. *Otolithes ruber*, a Sciaenidae indigenous to East Africa is reported to be in decline in Mozambique, reflected by a decline in mean length of trawled species. However, in neighbouring Madagascar, the same species is not perceived to be overfished. Indian fisheries have seen a 40% decline in targeted finfish fisheries (croakers, pomfrets, silver bellies and ribbon fish). CIFR stock assessment identifies non-selectivity/trash fish as the cause of this decline. The implication is that countries not applying BRDs (India and Vietnam) are likely to experience significant problems with a decline in retained species, as well as shrimp catches.

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Policies on retained species exist in some countries (India, Indonesia, Mozambique, Madagascar and Nigeria) as a means of supplementing domestic supplies to support food security. However, this control measure is not monitored or enforced. Australian HCRs prevent the retention of finfish species as a means to facilitate improved selectivity.

Recording of retained species occurs where there are logbooks and observer programmes. However, there is rarely any systematic analysis of the data. In some cases, the data collected by observers is not transferred to the scientific community. Trawling companies in Madagascar, Guiana and Suriname also hold historical data on bycatches that could be incorporated into stock assessment.

Bycatch species

Performance indicator P 2.2 addresses the sustainability of the bycatch species and considers the tools, measures and strategies that are being used to reduce the impact of the fishery on the bycatch. Bycatch species as far as the MSC are concerned are defined as organisms that have been taken incidentally and are not retained because they have no commercial value, or because they are not retained as part of the management rules to promote selectivity of at risk species.

Box 3-5: Bycatch species MSC category and assessment

Primary guideposts

Bycatch species stock status (Category P 2.2.1) requires that the fishery does not pose a risk of serious or irreversible harm to bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups. The main bycatch species should be within safe biologically based limits, or if outside these limits, there are mitigation measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding.

Management strategy (Category P 2.2.2) where there is strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations. This requires that measures are in place that are expected to maintain the main bycatch species at levels that are likely to be within safe biological limits, or to ensure that the fishery does not hinder their recovery.

Information monitoring (Category P 2.2.3) Information on the bycatch species is adequate to determine the risk posed by the fishery and the effectiveness of the applied management strategy. This will require the selection of bycatch risk assessment species indicators, to allow the focus on collection of sufficient information to assess species statistics in respect to biologically based limits.

Assessment

Some fisheries have no bycatch as all species are retained. Where bycatch/discards are occurring, these may include small finfish, non-edible species and elasmobranchs. Finfish bycatches are mitigated by using BRDs, but in some cases, fish do not swim out through these. Red snappers and leather jackets are known to sit in the net, but more recent bycatch reduction systems have been applied (such as the pop eye fish box) to facilitate escape. Coastal sharks and rays are perceived to be problematic in many countries, but bycatches are not recorded accurately. Endangered bycatch species in Mexico include the bluntnose stingray (*Dasyatis say*), Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), southern stingray (*Dasyatis americana*), cownose ray (*Rhinoptera bonasus*), silky shark (*Carcharhinus falciformis*), bonnethead (*Sphyrna tiburo*), bancroft's numbfish (*Narcine bancroftii*), scalloped hammerhead (*Sphyrna lewini*), and smooth butterfly ray (*Gymnura micrura*). Pre-2001, 50 species of sharks and rays were caught in the Australian Northern Prawn fishery. Shark catch was reduced by 17.7% and rays by 36.3% through BRD and TED use, and improved fishing practices. Catches of large sharks and rays was reduced by 86% and 94% respectively.

Australian Commonwealth Government policy requires that Bycatch Action Plans (BAPs) are prepared by the respective fishery Management Advisory Committees (MACs), with HCRs implemented. It should be noted that BAPs require specific at-risk species to be identified, so that monitoring is undertaken of these to determine the impacts of the action plans. Other countries focus on the use of BRDs and JTEDs, but the application of these is very variable. Some countries, particularly the higher producing countries of India and Vietnam, do not have any form of bycatch mitigation measures in place.

In some cases fishers themselves may develop their own strategies, e.g. through identifying fish hot spots which they will avoid.

Recording of bycatch species data occurs where there are log books and observer programmes. However, there is

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rarely any systematic analysis of the data. In some of these cases, the data collected by observers is not transferred to the scientific community.

Endangered, Threatened, and Protected (ETP) species

ETP species are those that are recognised by national legislation or by binding international agreements to which jurisdictions controlling the fishery are finding. These species may be taken accidentally or threatened as a result of the fishing activity. Performance indicator P 2.3 addresses the sustainability of the ETP species encountered by the fishery and considers the tools, measures and strategies that are being used to reduce the impact of the fishery on the ETP species.

Box 3-6: ETP species categories and assessment

Primary Guideposts

ETP species status (Category P 2.3.1) requires that the fishery complies with the international (IUCN) and national requirement to minimise damage to ETP species. The fishery should therefore not pose a risk of serious or irreversible harm to ETP species and should not hinder their recovery.

Management strategy (Category P 2.3.2) requires that the fishery has in place precautionary management strategies, along with accompanying measures, to meet the national and international requirements, ensure that the fishery does not pose a risk of serious or irreversible harm to ETP species, ensures that the fishery does not hinder their recovery, and that ETP mortalities are minimised.

Information monitoring (Category P 2.3.3) requires that relevant information is collected to support the management of fishery impacts on ETP species in the context of supporting strategy development, management effectiveness and measuring the outcomes on the ETP species.

Assessment

The principal bycatch issue for shrimp trawlers is the interaction with sea turtles. Many trawling areas interact with turtle migration corridors. These interactions have necessitated the introduction of the TED, which prompts turtles to swim through escape bars. These have been very successful when introduced, but their successful introduction comes with a strong requirement for fisher training. Australia and USA provide regular training courses, and literature on the setting of TEDs.

WWF India also provides technical support and training programmes to many turtle hot spots. However, industry resistance remains, which is usually the result of a lack of training available to fishers, and in many cases, minimal enforcement. TED introduction is being facilitated in some cases with the support of grants. MPEDA in India provides 100% support in the application of TEDs. One main buyer, Heiploeg BV, has also provided TEDs to their main suppliers. Large sharks are also able to escape from TEDs.

Sea snakes, syngnathids and jellyfish swarms represent other IUCN/national focus species for protection. The scale of sea snake interaction is not widely reported. The Arafura Sea fishery identifies around 20 snakes recorded per day. Some success has been achieved with these species as a result of the introduction of the pop eye fish box in Australia's NPF.

Syngnathids are usually found in coastal areas, or adjacent to coral reefs. Closed areas are a means to deal with these interactions but thousands of syngnathids may be taken in some fisheries. It is unlikely, however, that these interactions will result in a risk of serious or irreversible harm, but Australian BAPs are increasingly focussing on this problem.

Very little information exists on ETP interactions. Observer programmes record the interactions with turtles, but seldom focus on other species. Some of Australia's fisheries apply trained fisher observers to record other species interactions, as well as turtles and elasmobranchs.

Habitats

Performance indicator P 2.4 addresses the sustainability of the habitats (seabed, sea grasses, and coral reefs) and benthic assemblages and considers the tools, measures and strategies that are being used to reduce the impact of the fishery on these habitats. The assessment relates to the habitats within which the fishery operates, usually within a defined bioregional area. Serious harm may occur if the habitats and abundances are distorted or do not recover in the short to medium-term.

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Box 3-7: Habitat category and assessment

Primary Guideposts
<p>Habitat status (Category P 2.4.1) requires that the fishery does not cause serious or irreversible harm to habitat structure considered on a regional or bio regional basis, or on a temporal or spatial scale. This would mean that the fishery would not reduce habitat structure or impair its recovery.</p>
<p>Management strategy (Category P 2.4.2) requires that measures are in place to ensure that there is no serious or irreversible harm to habitat structure which would impair the bioregional basis and function of habitats.</p>
<p>Information monitoring (Category P 2.4.3) requires that information is adequate to determine the risks posed to habitat types by fishing gears, including the likely impact of other variables (latitudinal affects caused by salinity, rainfall and temperature fluctuations), and to measure the effectiveness of management measures.</p>
Assessment
<p>Most shrimp trawl grounds comprise mud or soft sediment. Targeted research reports investigating fishery impacts on the benthos and related ecology have been undertaken in the NPF, Madagascar and India. Studies in these trawled waters suggest that in areas where there are highly focussed trawling impacts, benthic taxa and communities analysed appeared to recover relatively quickly from trawl effects. In the case of Madagascar and the NPF, impacts of trawling are contained to a relatively small area of the fishery due to the concentration of vessels on the most productive grounds, an extensive system of permanent and temporary fishery closures, and significant areas of the fishery that are not suitable for trawling. These fisheries also use light gears. Indian fisheries, whilst using light gear, are more widespread. However, continually trawled areas have lost benthic assemblages, with impacts being especially felt by gastropods and bivalve molluscs. There have been no assessments of grounds fished by heavier gears. In many cases, the Indian benthic habitats receive little respite, and the weights of gear could impair benthic recovery. Deep water trawling is also likely to have greater impact on the benthos since the gear is heavy to counter buoyancy on descent.</p> <p>The most effective strategy is to reduce the coverage of gears on specific sites, to reduce the weight, and to avoid fishing in vulnerable habitats (sea grasses, coral reefs, or high intensity shellfish beds).</p> <p>Research into benthic impacts is sporadic, and needs strengthening in all fisheries. Little work has been done in this area, even in some of the countries classified as 'developed' (e.g. USA).</p>

Ecosystem

Performance indicator P 2.5 addresses the impacts of the fishery on the broader ecosystem elements such as trophic structure and function of community composition. Issues of concern would be the threat of trophic cascades (i.e. decreased diversity of species low in the food web), depletion of top predators caused by depletion of key prey, reduced rate of recovery as a result of severely truncated size composition, gross change in species diversity of the ecological community (e.g. loss of major species, or changes in species evenness and dominance) caused by direct and indirect fishing (e.g. discarding) and changes in the genetic diversity of species caused by selective fishing and resulting in genetically determined changes in growth and reproductive outputs.

Box 3-8: Ecosystem MSC categories and assessment

Primary Guideposts
<p>Ecosystem status (Category P 2.5.1) requires that the fishery is unlikely to disrupt the key elements underlying the ecosystem structure to a point where there would be serious or irreversible harm. This refers to issues such as disruption to trophic interactions, which may cause species cascades.</p>
<p>Management strategy (Category P 2.5.2) requires that there are measures in place that prevent damage to the ecosystem to the point of irreversible harm.</p>
<p>Information monitoring (Category P 2.5.3) requires that there is adequate information to identify the ecosystem (e.g. trophic structure and function, community composition, productivity pattern and bio diversity). This requires that the main functions of the components (target and other retained species, bycatch, habitats) in the ecosystem are known.</p>
Assessment
<p>It is difficult to draw conclusions on the impacts of the various fisheries on the ecosystem from the selection of case</p>

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studies, largely because necessary information for such an assessment is not available and has not been collected. What is evident is that there are declines in both shrimp and fish stocks. Shrimps are low in the food chain, and these declines will impact on their main predators, larger fish and elasmobranchs, and other species such as cetaceans. Declines in fish populations are also evident as and when trash fish are extracted. There would not appear to be any evidence of trophic cascades, but these declines will most certainly impact on species dependent on the food chain. Nevertheless, research by CIFR (India) had measured a 9 % decline in trophic levels in what is perceived as one of the heavier exploited fisheries. Countries where stocks and fleets exhibit similar characteristics to India are likely to be experiencing similar problems.

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

Governance and policy

Performance indicator P 3.1 assesses the framework in which the management system operates. A fishery management system's legal and/or customary framework is considered to be the underlying supporting structure, be it formal or informal, that incorporates all the formal and informal practices, procedures and instruments that control, or have an impact on, a fishery. This includes policies and practices of both government and private sectors, including (but not limited to) implementing agencies (e.g. fisheries agencies, conservation agencies), fishery business groups (e.g. catch sector cooperatives, industry associations), fishing vessel owners, indigenous groups, local civil society or community groups and so on. The government sector includes all applicable government systems, the courts and the relevant parliamentary and regulatory bodies. The management system is not limited to government legislation, nor to industry or customary practice, but is the complex interaction of all such elements, controls and practices that are used in a fishery and result in 'hard' (law) or 'soft' (accepted practice) controls over actual 'on-water' catching practices.

Box 3-9: Governance MSC categories and MSC assessment

Primary Guideposts

Legal and customary framework (Category P 3.1.1) requires that a management system is in place, with an effective legal framework, to support the achievement of sustainable fisheries in accordance with Principles 1 and 2; that observes the legal rights created explicitly for those that are dependent on fishing for food or livelihoods; and incorporates an appropriate dispute resolution framework.

Consultation roles and responsibilities (Category P 3.1.2) requires that the management system has effective consultation processes that are open to interested and affected parties. Organisations involved in the management process are clearly identified and their functions, roles and responsibilities are understood, and the consultation process must take account of relevant information from the main affected parties including local knowledge to inform the management system.

Long-term objectives (Category P 3.1.3) requires that the management system has clear long term objectives to guide the decision making that are consistent with MSC principles and criteria, and incorporates the precautionary approach. Fisheries policy objectives should focus on long-term stock sustainability, and not just satisfy short-term food security or other market demands (e.g. fish meal or fertiliser).

Incentives for sustainable fishing (Category P 3.1.4) The management system provides economic and social incentives to encourage sustainable fishing (and does not operate with subsidies).

Assessment

The inference is that, with an appropriate implementation capacity, shrimp fishing, including shrimp trawling, is indeed manageable. In many countries, however, weak agencies dealing with fisheries and lack of political will cause failures in the management of shrimp fisheries. In all cases evaluated, the legal foundations for legislation appeared to be strong, with adequate facility for dispute resolution.

In many cases, fishermen's groups have capacity to make representations but are excluded from whatever dialogue there is on policy. In some countries where policy is weak, some private companies even participate in sustainable fishing initiatives. A critical problem, however, is that some groups lack representation (e.g. traditional fishers), or are at the same time impossible to control because of the sheer number of fishers involved.

Long-term objectives exist, and in many cases provide for sustainability, but this priority is greatly outweighed by

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growth and social objectives (e.g. reference to food security). Consequently there is little regulation on entry into the sector, and long-term economic and social objectives that would result from a stronger emphasis on sustainability are being outweighed by short-term gains. But even in the US, Louisiana prefers to advance a policy similar to that pursued in so many developing countries: preservation of fishing communities. Others, India, Indonesia and Vietnam, openly advocate expansion on production. In some cases (Indonesia), the motivation for short-term expansion includes the collection of revenues for national, central and district institutions. However, Australia is one country that clearly advocates the Ecosystem Based Management approach to fisheries management above all else. While some others appear to be moving towards EBM (USA, Mexico, Mozambique and Nigeria). The issue of subsidies is covered under Principle 4 below.

Fishery-specific management system

Performance indicator P 3.2 addresses the objectives of the fishery management system applied as opposed to the strategies and measures that implement these objectives (Section 3.1.10).

Box 3-10: Fishery management system categories and assessment

Primary Guideposts

Fishery-specific objectives (Category P 3.2.1) requires that the fishery has clear, specific objectives designed to achieve the outcomes expressed by MSC principles 1 and 2, and are implicit within the management system.

Decision-making process (Category P 3.2.2) requires that there are decision-making processes (informal or formal) that result in measures and strategies to achieve the fishery-specific objectives.

Compliance and enforcement (Category P 3.2.3) requires that monitoring, control and surveillance systems are in place and are effective, that sanctions for non-compliance exist and are applied, and that fishers comply with the management system as well as have input into strengthening the management system.

Research Plan (Category P 3.2.4) requires that a research plan exists and provides the management system with inputs in a reliable and timely manner that support the achievement of the objectives.

Monitoring and management performance evaluation (Category P 3.2.5) requires that there is a system for monitoring and evaluating performance of the fishery-specific management system against the objectives.

Assessment

Australian fisheries management plans go beyond mere reference to the Ecosystem Based Management approach, to implementing measures that relate to objectives, goals and compliance with pre-set reference points. These are applied in the form of fishery-specific management goals and BAPs. The strength of the Australian system lies in the structure of its management system: Management Committees or Councils, drawn from primary stakeholders (fishers, scientists, fishery management and compliance representatives, NGOs and processors). A similar model is followed in the US, but with a weaker objective and output-orientated structure compared to Australia. A critical component of the Committee/Council structure is that it creates a body that is provided with the responsibility for determining management decisions and cannot be influenced by political interference. This, in the case of Australia, is further supported by a peer review structure, through an independent organization (DEHWA). Mozambique is the first of the developing countries to implement a comprehensive Management Plan (presently in its draft stages), but the plan contains far-reaching proposals aimed at capacity reduction, dealing with the vexed question of juvenile overfishing, closed seasons, improved compliance and a strengthening of scientific assessment (Case Study A.6).

In other country cases, there exists only one possible example of existing structures evolving into management councils (e.g. Zonal Management Conserves in Madagascar), but in this grouping, management functions are limited. In other cases, where industrial fishing vessel owners are organized into associations (India, Indonesia, Mexico and Nigeria) there are informal (non council) linkages between industry and government, but there are no examples of all the main players coming together, notably, all the different fishery groupings, fishery and compliance managers, fishery scientists and economists and environmental NGOs. Mexico has a management council, but this is exclusive to industry stakeholders and NGOs. And in Suriname there is a seabob working group that informs management authorities. It would seem that there is a clear reluctance of the majority of fisheries administrations to divest responsibility for fisheries management to a Council. Decision-making processes are thus top down, and usually exclusive. Politicians and trade unionists can heavily influence decisions with no heed to advice from supporting central institutions. An example of this is to be found in India where the national supporting framework is very strong, but there is no political will to carry out their advice.

The performance of National, State and District fisheries administrations is very mixed. The advanced

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administrations demonstrate strong management and compliance capacity. Australian fisheries are also linked to full cost recovery from the fishery sector. Weaker organizations demonstrate no will to implement management decision making, even when those within the organizations are fully aware of what is required. The ability to implement decision making is undermined by (a) political interference resulting in a failure to implement management systems (b) lack of funding dedicated to implementation (c) lack of internal capacity (d) physical remoteness from fisheries.

Fishery compliance is weak in all the case study developing countries considered in this study. Very few controls are applied to artisanal fishers, observer coverage where it exists is insufficient, and there is insufficient attention to training programmes. Specific initiatives such as UNEP/GEF/FAO are worthy of note, but it is evident that there are questions about sustainability post project completion. Common offences committed are fishing inside demarcation areas, lack of support for TEDs and BRDs, and on some occasions (e.g. India) failure to adhere to mesh size restrictions.

In contrast, co-management is applied in Australian fisheries, which ranges from the example of the Spencer Gulf's Committee at Sea implementing real-time management decisions usually to mitigate against catching small shrimp or bycatch interactions, to fisher participation on data collection and observer schemes (again the SG fishery and also the Northern Prawn fishery).

Principle 4: Economic and social framework

This analysis also incorporates a fourth principle - the economic and socio-economic framework. The economic and social framework relates to the key drivers of change that are outside the realm of traditional fisheries management control systems. These do not form part of the MSC assessment process, but as already identified, good and bad practice drivers have evolved in various fisheries, the negative elements of which seriously jeopardise the achievement of sustainable fisheries.

Box 3-11: Economic and social categories and assessment

Primary guideposts

P 4.1 National and international price drivers: Requires that pricing systems are transparent and provide reward for mature target and other retained species, as opposed to juvenile and immature fish species. This requires market regulation to prevent the sale of immature fish. Shadow pricing occurs where foreign companies undertake joint ventures with domestic companies. Joint venture companies may sell at below market rates as a means of reducing export tariffs. This also inflates the profits of the foreign beneficial owners, and creates a lower level of profit in the domestic company which can result in lower returns on capital, bad practices, and lower capital investment.

P 4.2 Input cost drivers: Requires that business drivers are actively in place to promote sustainable fishing but optimal application of costs within the fishing method are evaluated, so as to ensure a good return on investment and provide sufficient margin to contribute, if applied, to management and/or research costs. Price and input cost subsidies discourage efficiencies.

P 4.3 Remuneration and working systems: Requires that best practice and reward systems are in place that prevent reduced selectivity and high grading.

P 4.4 Conflict resolution: Access systems reward sustainable fishing practices that lead to reduced conflicts.

Assessment

No TST fleets in developing countries have as yet achieved recognition in terms of economic sustainability. Some have adapted their fishing practices to eliminate juvenile shrimps and focus on larger sizes. The most negative issue encountered is the sale of juvenile shrimp into domestic markets. Shadow pricing also acts negatively in terms of failing to adequately reward national companies for shrimp caught and creates a disincentive to invest in improved practices.

Fuel subsidies remain prevalent in a number of major producing countries (India, Vietnam and Mexico). This creates artificial profitability levels for fishing vessels, and encourages overcapacity within the sector, and discourages cost savings such as gear adjustments to save fuel costs. The latter has proved to be a very encouraging development within the sector, since not only does it reduce fuel costs, but the initiative has encouraged selectivity, prompted retention of sorting devices, and reduced carbon emissions.

Remuneration and working systems in some countries have actively encouraged a focus on retaining non-shrimp

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species (Nigeria, Colombia, and Indonesia). Some of the practices are beginning to change, but if such systems prevail, it prevents uptake of selection devices. The focus should be to switch savings in fuel costs resulting from low weight gear adjustments to improved fisher reward systems linked to improved selectivity and larger average sizes of shrimp.

Conflicts between fisher groups are widespread and are usually a result of recruitment overfishing by larger-scale vessels. This emphasises the importance of demarcation areas for non-targeting of shrimp and the application of VMS to trawlers.

3.3 SUMMARY OF PROBLEM ANALYSIS AND CURRENT PERFORMANCE

The fishery management objective for TST is to sustain the health of the target resource (shrimp and low-risk byproducts), ensure that ecosystem impacts are low risk, and that fleets are able to sustain catch levels in order to remain viable. In countries that have effectively managed shrimp fisheries, legislation often requires or encourages certain positive features (Gillette (2008)). These include fisheries management plans; bycatch management plans; collaboration among the various stakeholders; provisions for keeping management interventions at arms' length from the political process; ecosystem-based management; and the flexibility to intervene quickly, as a result of research findings or changing fishery conditions.

Conversely, the consequences of management inaction are:

- Growth in fleet numbers (including artisanal to industrial) resulting from open access;
- Growth in fishing effort without appropriate control mechanisms;
- Reduced catch per unit of effort for the target species;
- Increased reliance on byproducts leading to multi-taxa fishing;
- Greater risks for non-target species and ecosystem as fishing methods are altered to catch a larger proportion of byproducts;
- Potential damage to juvenile shrimp which would have previously escaped;
- Reduced profits, wages and employment for fishing vessels;
- Bad practices in crew behaviour as wages decrease; and
- A reduction in investment with resulting implications and problems in terms of crew safety.

The main problems (extracted from the analysis above) facing the development of 'sustainable' shrimp fisheries management are considered in Box 3-12 below. These are categorised in sequence based on cause and effect, linked to a) governance, b) the failure to implement input/output harvest control strategies and technical measures to limit overfishing, and c) bad business drivers. All issues require equal weight in focus. No one issue can be tackled without considering the other.

Box 3-12: Problem analysis in Tropical Shrimp Trawling

Governance

Poor governance, remote and centralised management, poor stakeholder interaction: Poor governance stems from political interference and/or lack of political will, an inability to identify fishery specific goals, a results-based approach that cannot be deflected by outside influences, exclusion of relevant stakeholders, and remoteness from the day-to-day activities of the fishery.

HCRs not appropriately designed or linked to stock assessment and ecosystem management: Management measures may exist but in many cases are not applied or enforced, with the result that there are increasing negative developments such as reduced selectivity and change to other retained species. Scientific capacity is insufficient in many countries, and often lacks the financial resources needed to assess the state of the fishery. The ecosystem approach to fisheries management is generally not applied which prevents sufficient focus on the non-commercial elements of the fishery. There is insufficient engagement with the industry to explain the benefits in applying specific technical control measures, and politicians also lack the will to implement decisions that will lead to positive results, often pacifying minority or voter interests.

Limited enforcement and compliance: Resources are insufficient in many countries to apply appropriate risk assessments with the result that existing control systems, when applied, are weak. Co-management is either not frequently applied, or is not effective.

Input /output harvest control strategies:

Open access in all fisheries leading to overfishing and a decline in CPUE: Many fisheries are associated with unfettered access, supported by a policy focus on increasing employment and production. Many fisheries now require effort reductions to the level of 50% in order to achieve sustainable levels of production. Only three countries have successfully applied buy back schemes (Australia, USA and Iran). It is noteworthy that it took the Northern Prawn fishery (Australia) 30 years to achieve the required capacity reduction. Whilst this and other schemes (and US) have been successful, these require a high financial commitment from Government and industry, and have had to form part of a package that allows for other systems to be implemented post buy-back to provide for autonomous adjustment. A critical problem for sustainability in many fisheries has been the failure to control access and expansion by the artisanal fishery sector. Failure to deal with the issue has in one case (Madagascar) led to the near collapse of the commercial shrimp sector because of heavy recruitment overfishing.

Lack of supporting effort control measures leading to technical (effort) creep: Many fisheries have seen the evolution towards multi-rig trawling. In many cases, technical improvements have led to an increase in real effort. The solution in some of the well-managed fisheries is to implement rights based management (SFRs - NPF), and to heavily restrict the number of days fished. In extreme cases, one fishery, Spencer Gulf, operates for only 60 days per annum. However, against this background, the fishery is successful because of the high catch rates sustained by the effective application of the control systems.

Catch controls not implemented or enforced: Annual or seasonal catch limits are rarely set for target species or bycatches. This allows for overfishing, targeting of species at vulnerable stages in their life cycle, and significant imbalances in the trophic dependencies and ecosystem. It remains to be seen if ITQs can be applied successfully in shrimp fisheries as there are presently no working examples from which to test this issue. A critical issue is that unprofitable fisheries are not likely to experience a dynamic trading environment (B.Couteaux [UNIMA, Madagascar], pers com). Another major concern is the ability of scientists (or lack thereof) to produce robust TAC's, particularly where recruitment is highly variable.

Inadequacies in the application of technical measures: Fear of loss in commercial catch, lack of training in awareness and application, weaknesses in design, and poor enforcement all lead to abandonment of TEDs and BRDs, and adoption of small mesh sizes lead to significant detrimental effects on juvenile species and possible trophic cascades for commercial and non-commercial species.

Inadequate enforcement: Poor enforcement appears to stem from insufficient operational budgets, inadequate enforcement infrastructure, weak institutions, political considerations affecting enforcement priorities, and corruption. In many cases where there is efficient enforcement, the fishing industry itself has at least some enforcement responsibilities. If penalties for non-compliance are harsh enough, then the actual detection efforts do not need to be so great.

An increase in reliance on byproducts leading to multi-taxa fishing: Multi-taxa fishing is often a symptom of a failed fishery management regime and a near collapse of the main retained species. It should not lead to a quest to recognise a multi species fishery. It represents a call for urgency in redressing these issues, since failure to deal with

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these issues will lead to potential trophic cascades (e.g. India).

Greater risks for non-target species and ecosystems as fishing methods are altered to catch a larger proportion of byproducts: As dependencies increase on retention of other retained species, the impact on invertebrates and benthic assemblages increases, reducing the ability of benthic habitats to recover from trawling.

Negative business drivers

Reduced profits, wages and employment for fishing vessels: Profits fall as catch volumes decline through overfishing as highlighted by the CPUE reductions in this report. External influences such as negative price trends and high fuel prices exacerbate the problem.

Bad practices in crew behavior as wages decrease: Resulting pressures on crew remuneration as a result of falling vessel turnover lead to bad practices (less selectivity) and a change on focus towards other commercial species. This also creates additional workloads for crew in sorting, and damage to commercial shrimp catches.

A reduction in investment with potential problems for crew safety: Falling profits lead to low returns on capital and unwillingness to re-invest. Poor equipment maintenance can lead to accidents on board.

Subsidies lead to economic inefficiencies and fleet expansion: Subsidies result in false profits and stimulate further activity and investment (e.g. Vietnam). Greater numbers of fishers lead to a reduction of individual profits for those already within the sector, leading to some of the negative drivers listed above.

4 BLUEPRINT FOR SUSTAINABLE TROPICAL SHRIMP TRAWL FISHERIES

4.1 INTRODUCCION

Improvements in sustainability of tropical shrimp trawl fisheries are critical given the very significant economic and social benefits that are derived from such fisheries, which must be safeguarded for future generations.

This blueprint for sustainable tropical shrimp trawl fisheries is based on key lessons learned from an extensive literature review, and information collected using questionnaires and field visits to all major tropical shrimp trawl fisheries around the world.

The intention of the blueprint is to provide an aspirational framework for fisheries managers and practitioners in these fisheries to assess, benchmark and improve performance. It is recognised that bringing about necessary changes will in most countries take considerable time and resources. Nevertheless, it is expected that many concrete actions can and should be taken quickly; so as to improve the sustainability of tropical shrimp trawl fisheries throughout the world. Certainly an inability to adopt all the recommendations of the blueprint quickly is not an excuse for delaying action on those items that can be addressed in the short-to-medium-term.

The blueprint provides for a generic framework that can be applied to all tropical shrimp trawl fisheries, and thus specific parameters will have to be defined to fit individual circumstances and requirements of different countries/fisheries.

4.2 LESSONS LEARNED

A global review of tropical shrimp trawl fisheries suggests that sustainable shrimp fisheries can only be achieved when a number of general conditions are in place and fisheries are being governed and managed based on certain standards. These 'lessons learned' are presented below and then incorporated into, and used to inform, the blueprint presented in Section 4.3.

Governance

1. Sustainability needs to be a priority. Food security and social and economic sustainability must become long-term outputs from a management plan which prioritizes long-term environmental sustainability, as opposed to (short-term) production and growth-lead policies, because long-term environmental sustainability is the basis on which long-term social and economic sustainability rests;
2. Great care must be taken to ensure management of all different fleet segments (e.g. industrial, semi-industrial, coastal/artisanal) exploiting a resource, so that positive improvements in sustainability in some sub-sectors are not undermined by unsustainable practices in other sub-sectors;
3. Conflicts with small-scale fishers and other groups can be addressed through zonal management accompanied by strict enforcement and improved stakeholder communication forums. VMS is an especially appropriate support mechanism;
4. Government should undertake the role of custodian as defined by the fisheries act, but allow for independent management councils (e.g. Australia, USA);
5. Collaborative and partnership-based approaches to fisheries management between government and industry yield strong results (e.g. Australia, USA and signs of improved structures emerging in Mozambique), and co-management approaches should therefore be supported and underpinned by appropriate legislation and human and institutional capacity development;
6. Decentralized management for specific fisheries, linked to national guidelines, strengthens the ability to undertake rapid decision-making (e.g. Australia). Remoteness of managers to the fishery leads to an inability to properly identify fishery-specific management priorities, and serves to isolate industry from the decision making (India, Indonesia);
7. Political stability and strong governance capacity is critical in forming a cohesive management plan;
8. Strong leadership and industry champions in the private sector typically play a crucial role and must be identified and/or nurtured. Industry participation and leadership is an essential part of driving positive management changes. Demarcation of responsibilities must be clear (e.g. Australia, USA,

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- Suriname, Madagascar);
9. Clear goals and deliverables (results) must be applied to fishery-specific management objectives (e.g. as contained in Australian and Mozambique management plans);
 10. Goals should support the ecosystem-based approach to fisheries management to ensure that bycatch and ecosystem issues are accounted for as a component of management measures introduced (e.g. Australia, Madagascar, Mozambique and Mexico);
 11. Prevention of overfishing requires a strong focus on a very wide range of potential issues/activities, including educational programmes, market regulation, a switch to selective fishing methods, alternative livelihoods and improved compliance, input controls, output controls, and technical measures;
 12. Rights-based management systems (e.g. gear SFRs) which limit capacity and allocate fishing rights to individual operators and/or groups should be made with some provision for transfer between individuals and/or groups. Such allocatory policies provide a realistic option when participation in the fishery is of a size that equates to an adequate compliance infrastructure (Note: Mexico sought to strengthen its compliance and data collection capacity to deal with the change to collective quotas for the artisanal sector). The Australian NPF is a good example of operating Rights Based Management through gear SFRs, which achieved a 46 % reduction in capacity over a period of 9 years. Nevertheless, the levels of adjustment required significant support from three successive buy-back schemes, and management measures such as closed seasons allowed for a rapid recovery in CPUE, which provided the economic incentive for change;
 13. Quota management systems are not yet tried and tested in shrimp fisheries. They have been successful in achieving fleet rationalisation in some non-shrimp fisheries, but usually in cases where fleet numbers are small and profitable, creating the incentive to acquire additional rights from others (e.g. Australia);
 14. Management and governance must be based on a risk-based framework. This requires supporting of data and pro-active interaction with the fishery sector to identify key risks (e.g. fleets, locations, areas, species, etc);
 15. The performance of fishery management systems needs to be evaluated by a separate department or through an independent peer review authority (e.g. Australia's DEHWA).

Managing fleet capacity, and setting and enforcing harvest control rules

16. Supporting structures must be in place (e.g. for compliance and research) that are commensurate with the size and scale of the fishery concerned so as to ensure that harvest control rules can be defined and enforced;
17. A reasonable degree of compliance with some of the technical measures (mesh sizes, BRDs) typically requires at least some onboard observer coverage. Good enforcement of shrimp fisheries management requirements already occurs in some developing countries (Mexico, Mozambique and Nigeria);
18. The identification of appropriate shrimp stock assessment models (or proxies) is necessary for use in many developing tropical countries so that harvest control rules can be specified;
19. Centralizing research capacity through a regional apex body (e.g. SEAFDEC, CRFM) or centre of excellence (e.g. CSIRO [Australia], or CIFR [India]) can generate some efficiencies and counter existing weaknesses in capacities at national level;
20. Bycatch reduction measures can form a useful catalytic starting point to improvements in management measures. Strong focus needs to be placed on shrimp selectivity, and change in gears if other species are to be the target species. The UNEP/GEF/FAO project has demonstrated that those countries advancing such technologies can more readily transfer experiences to others, e.g. Mexico to Cuba and Colombia, Nigeria to Cameroon;
21. Fleet capacity controls and effort limitation systems need to be addressed at an early stage. The consequences of failing to do so typically requires a very heavy subsequent commitment to buy-back schemes (all countries) and results in significant difficulties in removing capacity;
22. Recovery in catch rates are usually rapid following a significant reduction in effort;
23. Alternatives to buy-back schemes can include a package of measures including license removal for non-compliance, license auctions and other adjustments based on financial incentives or legislation;
24. The concept of multi-taxa trawling is counter to sound management of shrimp fisheries. The focus

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on other species is a symptom of the problem of overfishing which needs to be correctly addressed with the application of appropriate management measures, including a focus on BRDs and separator panels, so as to allow the sustainability of other retained species. Income derived from trash fish is so small (1% of total revenue in Indian fisheries), that its loss will generally not impact on the economics of fishing operations;

25. Ongoing training processes and the production of clear guidelines must accompany the application of harvest control rules and supporting input/output/technical measures on their application (e.g. Australia, USA, SEAFDEC).
26. Temporal and spatial closed areas can and do act as a good mechanism to reduce overall fishing effort, and to avoid juvenile overfishing and protect vulnerable habitats.

Financial support for improvements

27. Budgets must adequately reflect the need for structural adjustment through reduction in capacity, and ensure that the support structures are appropriately funded;
28. Donors and support institutions must provide the necessary assistance in terms of funding and technical advice to allow for the strengthening of management systems and to assist industry in pursuing positive business drivers;
29. Transparent financial partnerships between government and industry (co-funding through cost recovery) must be established and maintained so as to guarantee servicing of the management requirements and ensure wide-spread participation in management planning and implementation. Fee systems must be transparent and reflect actual needs (e.g. Australia) as opposed to supporting alternative government income streams (e.g. Indonesia);
30. Understanding business drivers is critical to specification of appropriate management policy, e.g. the adoption of gear selectivity technology. This includes demonstration of the application of cost effective and fuel-efficient technologies, and the elimination of fuel subsidies and bycatch-linked remuneration schemes which perpetuate non-selectivity and inefficiencies at both the individual vessel and fleet level. A much stronger focus on business planning and supporting economic analysis is required than has been the case to date (e.g. USA, India, Vietnam, Mexico);
31. Market drivers are critical to the evolution of positive business outcomes. The focus on sustainable shrimp practices will achieve positive outcomes through support of certification schemes such as the MSC (Australia, Mozambique).
32. NGOs can play an important part in encouraging partnerships within industry, and focusing in a constructive and participatory manner on the EBFM and risk analysis through participation in influential advisory councils.

The lessons learned (above) can be presented schematically as shown below to reflect key problems and their solutions. These solutions are then specified and elaborated in the following blueprint.

Figure 4-1: Problem analysis and related solutions for sustainable tropical shrimp trawl fisheries

Problems	Means / Solutions	Result
<ul style="list-style-type: none"> • Poor governance, remote and centralized management, poor stakeholder interaction • HCRs not appropriately designed or linked to stock assessment and EBM • Limited enforcement and compliance 	<ul style="list-style-type: none"> • Governments undertake role of custodian as defined in fisheries acts • Management tasks provided by independent body • Collaborative and partnership-based approach to management • Industry participation and leadership • Decentralised management • Clear goals and deliverables applied to fishery-specific management objectives • Improved research • Cost recovery 	<ul style="list-style-type: none"> • Acts strengthened to focus on sustainable fisheries • Management Councils established • Funding and transparent cost recovery secured • Stock assessment and bycatch risk assessment procedures established/strengthened • Compliance strengthened
<ul style="list-style-type: none"> • Open access fisheries leading to overcapacity and declining CPUE • Lack of supporting effort control measures leading to technical creep • Catch controls not implemented or enforced 	<ul style="list-style-type: none"> • Economic overfishing in shrimp fisheries addressed by limiting/reducing participation through various input, output and technical measures 	<ul style="list-style-type: none"> • Limited entry licensing supported by by-back schemes, licence removal • Gear fishing rights established • Closed seasons in place • Community and individual quotas
<ul style="list-style-type: none"> • Increased reliance on byproducts leading to multi-taxa fishing • Greater risks for non-target species and ecosystems • Potential damage to juvenile shrimp resources 	<ul style="list-style-type: none"> • Strong focus on adult shrimp selectivity • Focus on bycatch retention linked to commercially sustainable retained species • Focus on BRDs • Closed areas and zoning to protect key areas/species • Gear designs to minimize benthos damage 	<ul style="list-style-type: none"> • Cod end mesh size .45mm • Minimum landing sizes reduce juvenile catches • Locally conditioned BRDs/JTEDs linked to training and extension for their use • Lighter gears used to minimize benthos impacts (and generate economic savings through lower fuel use)
<ul style="list-style-type: none"> • Reduced profits, wages and employment • Poor crew practices as wages decrease • Reduced investment with resulting safety and other problems • Subsidies leading to economic inefficiencies and fleet expansion 	<ul style="list-style-type: none"> • Focus on business planning and necessary supportive economic analysis. Understanding business drivers is critical. • Use market drivers to effect positive changes 	<ul style="list-style-type: none"> • Removal of harmful subsidies • Introduction of market-based incentives such as certification • Business planning and investment in cost saving measures with associated environmental impacts.

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4.3 THE BLUEPRINT

As part of overall guidance for planning for sustainability, it is important to specify an over-riding or high-level objective. The following primary objective is specified as the basis for the blueprint:

“To ensure shrimp resources are managed in a sustainable ecosystem-based manner, to ensure the long-term sustainable livelihoods of fishers and fishing communities”

The blueprint provided below is structured around the following secondary outcomes in support of the objective:

- To create a management framework which ensures the setting of appropriate harvest control rules that support the sustainability of the target species and make adequate provision for safeguarding the supporting ecosystems;
- To provide a system of strong compliance and facilitate industry participation in all aspects of decision making;
- To create a monitoring and evaluation framework to assess results of blueprint implementation;
- To facilitate development of positive business drivers linked to improved fishing practices and market incentives.

Table 4.1 below provides a TST blueprint in the form of a logical framework for use by management authorities.

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Table 4-1: Log frame matrix providing a blueprint for sustainable tropical shrimp trawl fisheries

Objective and Outcomes	Outputs	Activities	Objective verifiable indicators ²⁵
<i>Objective: To ensure shrimp resources are managed in a sustainable ecosystem-based manner, to ensure the long-term sustainable livelihoods of fishers and fishing communities</i>			
Outcome 1. To create a management framework which ensures the setting of appropriate harvest control rules, that support the sustainability of the target species, and make adequate provision for safeguarding the supporting ecosystems	1a. Governance system strengthened	<ul style="list-style-type: none"> • Governance policy objectives strengthened by giving priority to sustainability and the ecosystem approach to fisheries management • Fishery specific Management Advisory Councils created with clearly defined roles • Strengthen the capacity of the fisheries administration to service the MAC • Establish community fisher organisations • Determine the annual real costs of management, research and compliance for the fishery • Prepare Management Plan 	<ul style="list-style-type: none"> • Fisheries Acts amended • Legislation adjusted to confirm the independence, powers and duties of the Management Council • Fishery managers and MAC participants provided with training on MAC functionality and service delivery • Community organizations strengthened for small-scale trawl and artisanal fisher groups • Long term financial support systems established • Annual budget efficiency exercises undertaken and approved • Management Plan prepared
	1b. Shrimp biomass exploited at sustainable levels	<ul style="list-style-type: none"> • Prepare a research plan required to generate inputs necessary for the shrimp management plan • Regional centres of excellence developed for stock assessment and gear technology • Stock assessment models strengthened to ensure consistency and implementation of scientifically acceptable standards (0.5-0.6 B_{MSY}) • Collect fishery-dependent information through landing records (sex and size) • Collect appropriate data to aid assessment 	<ul style="list-style-type: none"> • Research plan prepared with funding provided from each Management Council • Regional centre of excellence confirmed with agreed MoUs with national research organizations and the Management Council • Stock assessment blueprint established and adjusted for regionally specific fishery characteristics • Environmental risk assessment parameters established for bycatch species • Common data collection systems agreed and established

²⁵ Log frames usually contain means of verification and assumptions. These would be established as and when the country-specific blueprints are agreed.

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Objective and Outcomes	Outputs	Activities	Objective verifiable indicators ²⁵
		<ul style="list-style-type: none"> • Agree on a set of measures that can support the restructuring of the fishery. These will include: <ul style="list-style-type: none"> ○ Removing redundant licenses ○ Industry buy back ○ Setting gear SFRs ○ Possible transition to ITQs but taking account of stock assessment needs, management costs and compliance requirements and associated costs • Establish input management restrictions which are consistent with scientific advice <ul style="list-style-type: none"> ○ Restricted entry licensing ○ Gear SFRs and Rights Based Fishery Management, i.e allowing for tradeable fishing rights ○ Closed seasons ○ Demarcation zones for specific fisheries • Establish output management restrictions: <ul style="list-style-type: none"> ○ Fishery specific TACs ○ Minimum size limits for shrimp and other retained species • Establish technical measures <ul style="list-style-type: none"> ○ Minimum mesh sizes > 45 mm ○ BRDs appropriate for specific species interactions ○ On deck hoppers to reduce mortalities for discarded crustaceans and finfish (which may be required by law) ○ Transition of artisanal fishing methods to alternative selective fisheries • Introduce ongoing training and awareness programmes • Develop spatially and temporally explicit (closed areas) harvest strategies for periods to protect spawning aggregations and environmentally sensitive zones. VMS or strong co-management system must be introduced to support this. 	<ul style="list-style-type: none"> • Activities specified in management plans • TST capacity adjustment strategy agreed with Government • Financial support for buy back secured • Legislation in place to confirm restricted entry licensing conditions, gear SFRs, a facility to change closed season parameters, reconfirm zonal parameters (that ensure protection of juvenile species), TACs, minimum landing sizes, gear parameters • Training curricula established with ongoing support programmes provided by the regulatory authority

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Objective and Outcomes	Outputs	Activities	Objective verifiable indicators ²⁵
	1c. Fishery impacts on bycatch, byproduct species and ecosystems minimized	<ul style="list-style-type: none"> • Establish technical measures - TEDs and other ETP species selectivity devices • Maintain a limit on the amount of gear used in the fishery to minimize benthic impacts • Develop spatially and temporally explicit (closed areas) harvest strategies for an appropriate period to protect environmentally sensitive zones. VMS or strong co-management system must be introduced to support this. • Undertake continuous risk assessment to determine the vulnerability of bycatch and byproduct species to overfishing • Continuously develop management measures to avoid interactions with ETP species. Provide a system of education and training for skipper and crews which can extend to a participatory observer scheme • Collect appropriate environmental data to aid ecosystems-based approach 	<ul style="list-style-type: none"> • Activities specified in management plans • Risk assessment species established • Bycatch action plan prepared and published • Closed areas established and gazetted by law • Bycatch reduction devices installed with supporting training for fishers and crew • Gear parameters reviewed to ensure minimal impact on the benthos • On board participatory observer schemes operational • Training provided • Data required for ecosystems-based approach collected and used to inform management decisions
	1d. Measures introduced to support and control artisanal fishers	<ul style="list-style-type: none"> • Community organizations created • Demarcation zones secured, but including coastal no-go areas • Fishery authorities empowered at district level • Gear parameters set • Market control mechanisms established to prevent sale of juvenile species 	<ul style="list-style-type: none"> • Activities specified in management plans • Funding support secured (e.g. NGOs and donor organizations) • Definition of a typical district structure and organisation, with a clear definition of the attributes and powers of the administrator, the district structure responsible for fisheries administration, and the role of the community organisations; • Training of fishery administration and inspection staff at district level; • Establishment of the participatory fishery management bodies at district level; • Gear application parameters set and promoted at district level
Outcome 2. To provide a system of strong compliance and facilitate industry participation in decision making	2a. Fishery compliance systems strengthened	<ul style="list-style-type: none"> • Risk assessment strategies undertaken and deployment strategies determined (VMS, observers, reporting in, aerial surveys, marine and land inspection systems established) • Budgets and inspection strategies agreed with the MAC • Penalty systems established • Compliance training • A policy of intervention for the artisanal fishery sector 	<ul style="list-style-type: none"> • Deployment strategies prepared outlining: observer coverage, port inspection coverage, VMS displacement and reporting systems • Standard operating procedures specified and in operation • Inspector participation in gear application awareness schemes • Introduction of a system of sanctions envisaging the loss of fishing rights • District Inspector participation on community-based management schemes

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Objective and Outcomes	Outputs	Activities	Objective verifiable indicators ²⁵
	2b. Co-management participation secured	<ul style="list-style-type: none"> • Co-management responsibilities determined based on above and provided for in legislation • Focus on real time at sea fisher decision making • Fisher participation and partnerships in stock assessment • Fisher and industry participation in observer and data collection schemes 	<ul style="list-style-type: none"> • Documented co-management responsibilities and supportive legislation • Fisher awareness programme on species interactions • Fisher observer training
Outcome 3. To create a monitoring and evaluation framework to assess results of blueprint implementation	3a. Monitoring and evaluation system established	<ul style="list-style-type: none"> • Agree on indicators • Develop a peer review and M&E plan • Agree on M&E practices that ensure the credibility, impartiality, transparency, and usefulness • Set target output indicators 	<ul style="list-style-type: none"> • Peer review report • M&E plan finalised • M&E processes
Outcome 4. To facilitate development of positive business drivers linked to improved fishing practices and market incentives	4a. Private sector partnerships, and fishing vessel best practice systems, operating	<ul style="list-style-type: none"> • Sector partnerships established between catching, processing, export, import, retailer and food service sector stakeholders, facilitated by NGOs • Operational economics reviewed and business plans developed which include crew reward schemes for improved selectivity; gear adaptations which reduce fuel utilization and create carbon savings introduced • Network established within and between countries to share positive experiences of adopting improved business drivers and impacts on bottom line so as to support uptake/replicability in other areas • All negative forms of fishing subsidies removed. 	<ul style="list-style-type: none"> • MoUs established which provide for an built-in price reward structure for changes towards environmentally sustainable fishing practices • Individual company assessments undertaken • Network system developed through industry partnerships initiative • Subsidies removed

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In seeking to further elaborate on some of the parameters specified in the blueprint above, some additional clarification and explanation is presented below, structured around the key results of the blueprint log frame.

1a. Governance system strengthened

Legal developments in support of sustainability

Legislation embraces all instruments having the force of law, such as Acts, Regulations, Decrees, Orders and local by-laws. It provides the legal framework to support the blueprint through the detail specified in such instruments, and through powers relating to enforcement and sanctions for those infringing the law. Changes to established policy may require associated legislative change, and the implementation of new policy is very likely to require an assessment of the extent to which current legislation needs to be changed/strengthened to support the successful implementation of policy.

Not all of the blueprint needs to be supported and 'hardwired' into formal legislation if, for example, there are well established informal rules and norms already established which support particular initiatives. Effective implementation of policy may also be best achieved through other means, for example by the use of economic instruments, or support/promotion and ad-hoc programmes that don't necessarily require enforcement by the rule of law. However, legislation may often be crucial, especially in terms of (a) stipulation of powers of enforcement and sanctions, and (b) ensuring that certain rights are enshrined that cannot be eroded through social, economic and political marginalisation.

As with policy, it is very important that all relevant stakeholders are incorporated into the process of developing legislation (both within fisheries and in other sectors), even if the process can be a long one. Only by doing so can it be hoped that conflicts will be minimized and that legislation will have a measure of legitimacy. Processes for legislative development are different in all countries, but better compliance can be fostered by legislation that involves all stakeholders in its development as stakeholders can then claim 'ownership' over such laws.

It should be recognized that legislation has the potential to marginalize and create conflict, as well as to provide a framework for implementing policy and managing conflict issues. Importantly, legislation is often not neutral in its impact on different socio-economic groups. This raises the importance of ensuring that legislation is carefully tailored to suit the needs and conditions in individual countries and situations. It may also be appropriate to have an overriding national framework/legislation, and then local community management norms/rules to reflect different situations.

Management council

A management council should be drawn from the principal stakeholders. The Minister would usually make the decision on the appointment of members of the Council. Options for the composition of the council could include:

- An independent chairman
- The fisheries manager (from the fisheries Ministry)
- Industry champions derived from each subsector (industrial, semi-industrial, small-scale and artisanal)
- Representatives of the principal buying companies and middlemen
- Fisheries scientist
- Fisheries economist
- A compliance officer
- A Non Governmental Organisation

The Chairman must be fully independent without any linkage to existing stakeholders. He/she must be able to support the effective implementation of the management plan. It is important he/she and the co-opted industry members possess strong charisma to ensure the support of the wider industry, but are

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independent of the wider industry and able to work within the operational requirements of the Committee's terms of reference.

Provision is made to include an economist in the MAC. This is important so as to be able to determine the economic impact that any proposed MAC measure may have on the sector.

The MAC could be decentralised to ensure that regionally specific fisheries are managed at the provincial level, subject to appropriate safeguards from a nominated peer review authority which could be the National Ministry of Fisheries or Environment (or equivalent Ministry).

The MAC should have the following functions:

- a) to prepare annual management plans including setting of management indicators (stock abundance, catch per unit of effort, stock fecundity, economic indicators);
- b) to propose management measures that ensure that the plans can be implemented effectively;
- c) to conduct reviews of management plans based on the results from stock assessment and assessment on ecosystem impacts;
- d) to promote the co-management of fisheries;
- e) to promote research, education and training in relation to fisheries and the management of fisheries;
- f) to determine the fee structure to pay for a research and development fund, the operating expenses for the council and an independent peer review.;
- g) to prepare or promote codes of practice concerning matters of relevance to fishery authorities and other stakeholders.

Management Plan

The Management Plan should aim to achieve outcomes that are consistent with sustainability objectives for the management of the species and the supporting ecosystem. The Plan should:

- Set out the fishery-specific management objectives and implement a strategy for achieving these;
- Identify research needs and priorities;
- Set out the resources required to implement the plan;
- Describe the biological, economic and social characteristics of the fishery;
- Identify the impacts or potential impacts of the fishery on its associated ecosystem or ecosystems, including impacts on non-target species of fish or other aquatic resources;
- Identify any ecological factors that could have an impact on the performance of the fishery;
- Assess the risks to the ecosystem and set out strategies for addressing those risks; and
- Set out methods for monitoring the performance of the fishery and the effectiveness of the plan, including performance indicators, trigger points for review, or action and progress reporting.

Management Authority staff strengthened

The blueprint will identify clear activities which will require allocation to specific stakeholders. Some key issues that need to be addressed are as follows:

- Small, efficient and cost effective units will have to be created to undertake specific tasks;
- Tasks will be defined by clear Terms of Reference;
- Staff will have to demonstrate a capacity to implement the tasks; this may require needs assessment and capacity strengthening;
- Deliverables and timelines will be set for the various tasks to ensure appropriate support to the work of the MAC;
- Barriers will need to be identified and constraints unblocked (e.g. legal issues);
- Replicability in tasks must be avoided at all costs (e.g. important to define the relationships between national and regional governance).

It is important in this situation not to re-invent the wheel. MAC service delivery is a composite part of Australian and USA fisheries management. These organisations can assist in terms of exchanges or provision of short-term technical support. Australian expertise has been used to support the development

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of institutional structures in Mozambique and Madagascar, for example.

1b. Shrimp biomass exploited at sustainable levels

Research Plan

Each Management Council should agree a budget for research, appoint a lead scientist(s) and support an annual research programme as specified in a research plan. The research programme could be implemented by a regional centre of excellence, or by a national research organisation with linkages to more regional research work.

Some specific research components will depend on resources available and the suitability of the fishery to different approaches. Research options should include:

- Recording average catch rates observed on surveys, nominal effort (hours fished) and mean harvested prawn size;

Then deploying either²⁶:

- A sophisticated approach linked to a suite of dynamic stock assessment models (yield per recruit/age-structured); or
- Establishing targets and limits relating to exploitation rate, recruitment index, size at first capture, which can be used as a “surrogate” “consistent with Bmsy”.

In each case allowances will need to be made for environmental variables as well as models evaluating the impacts of changes to fishing power (e.g. as and when gear SFRs are deployed). In some cases, there may be a large number of different species, requiring a combination of the above.

Given the cost and complexity of the a sophisticated approach the later option would appear far more practical for most developing country groupings.

Some attributes of successful research specification and delivery are:

- Research delivery time-scales need to be relevant to blueprint needs, with a balance between operational, strategic and more fundamental research needing careful consideration;
- Research findings and policy implications need to be clearly communicated to their target audiences and linked to management action;
- By including more stakeholders in research, especially end-users such as fishers and fishworkers, research can become more demand-led and ownership will increase, thereby ensuring that results are more likely to feed back into action;
- In targeting research to policy-makers, it should be recalled that policy-makers are not just those in government, but also those making informal policy in the private sector;
- Research will be most effective if embedded in a review and planning process ensuring that it is more action-orientated; and
- Research capacity building is often required in developing countries, but is only sustainable if incentives for retaining that capacity can be addressed.

Fishery restructuring

Most fisheries are likely to require a package of measures for re-adjustment backed by significant political will. Decision-making will be largely dependent on the philosophical direction that a country may wish to pursue, and whether it is more free-market or socially orientated. However, there should be a note of caution with regards to the ability to police the management regime. Output restrictions such as TACs are extremely expensive to police, particularly in remote fisheries or where there are many individual fleet operators. If company structures exist (as per most semi-industrial and industrial groupings), with vessels within these, a system of ITQs is more attractive because these groups can identify the benefits of rationalisation, economies of scale and the likelihood of a fast recovery in shrimp stocks. Buy back

²⁶ The modelling approach is used to support research in Australia’s Northern Prawn fishery. In contrast, the South Australian Spencer Gulf fishery uses various measurable targets and limits to cater for real time management (Zacharin *et al*).

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schemes are infinitely preferable, but require significant central government and/or industry outlay and probably longer-term time horizons. Resources may be available in some countries but not in others.

Irrespective of the approach taken to buy back, individual transferable fishing rights (ITFRs) (e.g. gear SFRs)²⁷ are good means of establishing a system of input limitation and capacity adjustment. In some cases where multi-rig trawling has yet to evolve, it will be important to establish such a system. However, ITFRs, if sufficiently punitive, can also achieve significant reductions in capacity.

The order of adjustment should follow the sequence of events as presented below:

- Remove redundant licences. This strategy has some advantage in the current climate where uneconomic vessels have been withdrawn from the fishery;
- Introduce a buy back scheme. Such a system would need to be centrally-government funded. An array of different systems may be applied such as flat rate schemes, tenders, or payments linked to real as opposed to nominal capacity. What cannot be allowed to happen is that a regime change occurs and additional vessels are allowed to re-enter into the fishery after restructuring has occurred;
- Introduce individual transferable fishing rights (e.g. gear SFRs) as a supporting or alternative system to buy back. If it is an alternative, governments must accept that calls for reductions in the total SFRs will be extreme, but could be phased in over a period, for example 50% over 5 years. What cannot happen is governments failing to follow the scientific advice (usually in response to lobbying from fishing companies) and not setting the required reductions;
- Introduce a system of company or community quotas as an alternative to gear SFRs, where the fleets are sufficiently small in number and compliance can be demonstrated.

Harvest control rules

The management system must contain the following elements.

1. Access to the fishery needs to be controlled, with a licensing regime specifying operating areas and permissible net lengths
2. Closed seasons should be set which protect spawning aggregations, but also compliment effort control systems. These should relate to the protection of juveniles and gravid females and be meaningful (i.e. should not be set in lean fishing periods).
3. Demarcation zones should be set
4. The minimum landing size should be reviewed for target species to prevent juvenile overfishing
5. All of the above should be supported by continuous awareness schemes undertaken by the regulatory authority.

1c. Fishery impacts on bycatch, byproduct species and ecosystems minimized

The management system must contain the following elements.

1. Gear configurations should be adjusted to prevent the build-up of bycatches;
2. Closed areas should be established to protect spawning stocks or areas of high risk to ETPs and environmentally dependent bycatch species;
3. ETP exclusion devices should be introduced and should not necessarily be exclusive to TEDs, as other interactions are problematic, e.g. sea snakes and syngnathids;
4. Benthic impacts should be evaluated and gear modifications made to reduce impacts. Fishers have been particularly innovative themselves with initiatives in this area;
5. Inclusion of all of the above into a documented bycatch action plan examining all options (utilize, avoid or reduce).

²⁷ Other forms of ITFRs which could be further explored for adoption in shrimp fisheries are the Boat Units System (Torres Prawn Fishery) and Time Units (Qld East Coast Trawl Fishery)

Box 4-1: Ecosystem approach to fisheries management

An ecosystem approach entails taking careful account of the condition of ecosystems that may affect fish stocks and their productivity. It also means taking equally careful account of the ways that fishing activities may affect marine ecosystems. This means, where necessary (e.g. within agreed levels of impact), changing the way in which the fishery operates, adjusting the type of gear used, or imposing closed areas to protect biodiversity or habitats critical to the whole fishery or to the biodiversity of the region. Furthermore, it means taking an inclusive approach to setting goals and objectives for harvested fish and the fish ecosystem, recognizing ecosystem interactions, possibly integrating activities across a range of other users and resource sectors, and respecting the broad range of society's values for the marine environment.

The ecosystem approach aims at environmental and human well-being by:

- Maintaining the natural structure, function, biodiversity and productivity of natural systems;
- Accounting for human needs and values of ecosystems when establishing objectives;
- Recognizing that ecosystems are dynamic with attributes and boundaries constantly changing and that consequently, interactions with human uses are also dynamic;
- Accepting that natural resources are best managed within a management system based on a shared vision and a set of objectives developed among stakeholders;
- Adopting adaptive management procedures, based on scientific knowledge, continual social learning and recurrent audit and evaluation of the management performance.

In moving towards an ecosystem approach to shrimp fisheries a number of steps should be taken to:

- Delineate the practical boundaries of the shrimp fishery ecosystem inland and at sea;
- Identify critical habitats (e.g. lagoons, mangroves, seagrass beds, mudflats, spawning grounds), their state and existing threats (agriculture, urbanization, etc.);
- Identify the species assemblage and information available on it, predators and preys;
- Identify all stakeholders and catalogue the different values of the ecosystem for them;
- Identify potential partners, e.g. in the Ministry of the Environment, Non-governmental Organizations (NGOs), etc.;
- Assess, at least qualitatively, the bycatch issue, looking for threats to protected/endangered species;
- Identify institutional zones such as reserves and exclusion zones for industrial fishing;
- Identify potential external drivers such as climate oscillations, rainfall and market forces, etc.;
- Identify potential sources of threats such as pollution sources, competing sectors, urban development, and oil industry and dumping activities;
- Identify patterns of variability and change; and
- Identify explicit and implicit objectives.

Source: Extracted from WWF working documents

1d. Measures introduced to support and control artisanal fishers

See comments on both co-management (2.b below), and human capacity development (section 4.4 below)

2a. Fishery compliance systems strengthened

Each fishery will require risk assessment profiling in order to determine the most effective and cost efficient resource deployment strategies. Some observations are as follows:

- Demarcation zones require VMS, or a heavy presence by marine vessels/aerial surveillance where known incursions occur;
- Observer schemes are effective, but can be supplemented by participative co-management;
- Onshore inspections (of fishing gear) are more cost efficient than at sea inspections;
- TAC systems require heavy resourcing. Costs may be reduced through delegating data collection responsibilities to industry organizations; and
- Where artisanal fisheries are significant, special district inspectors will need to be trained and deployed. This role could be delegated to community-based management and co-management groups and/or NGOs.

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2b Co-management participation secured

Co-management in the wide sense of government partnerships with other stakeholders for the purpose of natural resource management, rather than just the narrower concept of community-based management, is an emerging trend. The trend is driven by, amongst other things, an awareness of resource depletion, conflicts both within the sector and between fisheries and other sectors, and the perceived benefits of co-management as an approach. Furthermore, implementation of co-management is now being encouraged, or at least enabled, by decentralisation policies in many countries.

Political will is the key to the establishment of co-management mechanisms. It is a necessary pre-requisite without which co-management initiatives are unlikely to succeed. It must be reflected in policy, legislation and action specific to the fisheries sector, as well as more generally in government policy and legislative support.

For co-management to be successful, a number of factors must be in place:

1. Decentralisation should be provided for in fisheries policy, not just in national non-sectoral policy/legislation, with references being specifically tied to a mention of its importance for co-management;
2. It is better to undertake legal/policy reviews of decentralisation of fisheries management/administration and co-management at the same time to ensure a cohesive and complimentary effect;
3. An enabling environment supportive of co-management is more likely when a wide range of stakeholders are involved in the process to develop the country/fishery-specific blueprint itself. Indeed this could be considered the first step in co-management;
4. The blueprint and its implementation should be supportive of success factors associated with co-management, such as:
 - User rights
 - Institutional strength of local organizations and their leadership
 - Recognition of existing local fisher community organizations as fundamental to the co-management process
 - Local political support
 - Appropriate incentives for local users to engage with co-management.
 - The need for formal legislation to back up/codify community rules and resolve disputes
5. Research may be necessary on how to move beyond pilot approaches to mainstreaming co-management, and on assessing the positive impacts of co-management. Co-management initiatives can also be enhanced and supported through appropriate local level research and better linkages between researchers and policy makers at the local level;
6. Co-management initiatives should ensure that fisheries legislation is supportive of them and of decentralisation of fisheries management before commencing;
7. Co-management legislation should contain dispute resolution mechanisms to deal with user conflicts, and to ensure that local rules/regulations do not conflict with national-level legislation and policy;
8. Co-management legislation should specify the extent to which local autonomy in developing management rules/legislation will be accepted;
9. National fisheries legislation should provide for a broad and flexible legislative framework that enables a choice over co-management arrangements and rules, with detailed mechanisms set out in regulations that can be changed if necessary;
10. National fisheries legislation should contain specific reference to co-management, or provide indirect support to key success factors that need legislative support.

3a. Monitoring and evaluation system established

M&E Plan

Monitoring indicators of fishery management performance should be used for the continuous or periodic (typically quarterly, semi-annual or annual) measuring of the extent to which the activities specified in the

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policy planning hierarchy 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 the policy 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. In terms of policy implementation, they would thus be used to monitor the extent to which the specified activities are being implemented. Typically those responsible for policy implementation would collect monitoring indicators.

Evaluation indicators on the other hand are used to measure results/impacts/benefits. They can be considered equivalent to 'blueprint impact indicators', and are generally strongly focused on performance (although in certain instances some evaluation indicators can also be process indicators). Usually assessments should be made less frequently, i.e. every 3-5 years. Assessment of blueprint implementation impacts may best be made by external specialists with evaluation experience, rather than by those responsible for policy specification and implementation.

For example, in Australia, the Environmental Protection and Biodiversity Conservation Regulation (Australian Commonwealth), 2000, requires that all fisheries from which product is exported must undergo assessment to determine the extent to which management arrangements ensure that the fishery is managed in an ecologically sustainable way. These Wildlife Trade Operations accreditations (WTOs) are set for three years, and 58 fisheries are listed including shrimp fisheries. Accreditations are based on a number of major themes/issues which are evaluated, and which are closely associated with the MSC Principles:

- Fishery area of interest
- Fishery
- Management system
- External influences
- Interaction with protected species
- Ecosystem impact (e.g. habitat, food chains etc)
- Target stock status
- By product and bycatch stock status

Each fishery is subjected to an evaluation organized under the auspices of DEHWA (Australian Department of Environment). The participating Management Authority is required to submit a report highlighting performance against a set of indicators. Each report is then subject to DEHWA review, which involves recruiting an independent specialist as part of the review team. The review monitors performance against a set of output indicators but also makes a number of recommendations for further action. The report is made available to the public for scrutiny.

Importantly, evaluation indicators should also consider the design of the policy planning hierarchy, its implementation and the results, and are used to help answer a number of important evaluation questions relating to the:

- efficiency/value for money (assessing the outputs in relation to inputs, looking at costs, implementing time, and economic and financial results)
- effectiveness (measuring the extent to which the objectives have been achieved or the likelihood that they will be achieved)
- impact (measuring both the positive and negative, foreseen and unforeseen, changes to and effects on society caused by the policy/strategies/activities under evaluation)
- relevance and coherence (assessing the extent to which the policy satisfies the needs of the various interest groups and gauging the degree to which the policy goals/strategies/activities at a given time are justified and fit within the global and national/local environment and development priorities)
- sustainability (measuring the extent to which benefits continue from a particular policy goal/strategy/activity after its completion)

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With increasing emphasis being placed on monitoring and evaluation, and the indicators used to assess policy implementation and its impacts, it is essential that a detailed M&E plan be developed. This plan should contain:

- detailed information on the indicators;
- the frequency and timing separately for a) monitoring and b) evaluation reports;
- specific monitoring and evaluation responsibilities to all relevant parties, i.e. who should be reporting to who;
- the activities required to complete the M&E requirements (e.g. stakeholder consultation, fieldwork, regular reporting);
- methods and tools to be used to collect information/data necessary for different indicators, i.e. the means of verification;
- technical issues related to specific indicators and their means of verification; and
- dissemination components and techniques

The M&E plan should also contain detailed information on the feedback mechanisms for monitoring and evaluation outputs to be used to make changes either to blueprint implementation, or the overall design of the blueprint logframe as it pertains to specific countries/fisheries. And it might also contain a supervision plan specifying the periodicity and make-up of supervision mission teams.

M&E processes

Monitoring and evaluation practices must ensure the credibility, impartiality, transparency, and usefulness of their outputs. Two key mechanisms can help to ensure that this is the case:

- Wide stakeholder consultation (e.g. with the scientific community, NGOs, governments, etc);
- Installation of IT management information systems.

4a. Sector partnerships, and fishing vessel best practice systems, operating

Successful implementation is very likely to depend on the establishment of a) cost recovery mechanisms, b) public-private sector partnerships, and b) supply-chain partnerships in support of improved sustainability. Establishing such mechanisms can be facilitated by demonstrating the advantages of improved sustainability (e.g. through preparation of business plans), thereby also increasing the potential for funding linked to positive changes.

Business practices and analysis of economic strengths and weaknesses are extremely important in the context of development of best industry practice.

- Market-led initiatives are presently underway using MSC guideposts or alternatives such as Seawatch (Mexico) and other mechanisms to promote sustainability and link initiatives to importers and retailers. WWF-US has funded two MSC pre-assessments in TST fisheries and is in partnership with one producer (UNIMA). The Shrimp Round Table (US) is promoting industry/processor partnerships linked to conservation initiatives. One private sector European importer is presently funding a full assessment of a TST fishery. The benefits from this are likely to result in price increases, but there are overwhelming external pressures from non-TST supplies. Nevertheless, wild-caught shrimp always maintains a high price premium;
- Trash fish inclusion is recognised as not contributing substantially to income (CIFT, India), so is questionable in the context of a business model;
- Other retained species may be important to financial viability, but there is a need to ensure that commercial species reach acceptable adult sizes, and that the market takes account of low volume / improved quality;
- Fuel savings of up to 30% can be achieved through improved fishing techniques (lighter gear and reduced haul times);
- Carbon emission studies can also reveal savings in fuel consumption (e.g. propeller RPM and freezer efficiency); and

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- Fuel savings can be transferred into improved crew remuneration systems, most importantly crew premiums for larger shrimps.

These issues can be explored on a company-specific basis through Business Plans, but also the results shared more widely than at present through improved networking between TST companies and sector partnerships.

4.4 IMPLEMENTATION OF THE BLUEPRINT

The implementation of the blueprint presented above is likely to pose significant challenges in many countries. In particular, two areas are worthy of special comment, and some additional advice is therefore provided in support of successful implementation:

Making the generic blueprint country-/fishery-specific

The blueprint presented above is generic and applicable to all tropical shrimp trawl fisheries. However, in order for implementation to be successful it should in all cases be reviewed by local stakeholders and amended as appropriate. This is critically important for two reasons:

1. To ensure that the blueprint adopted for any one country/fishery is specific to the needs of that country/fishery (this is likely to require provision of additional specifics to the generic blueprint);
2. To ensure that stakeholders in the country/fishery have the opportunity to participate in finalising the blueprint, thereby generating a sense of ownership of it, hence the creation of the MAC.

How then can countries/fisheries make the blueprint specific to their needs? The approach taken should be to convene a workshop of all relevant stakeholders (government, private sector, civil society) to review and amend the blueprint presented above. This workshop could be professionally facilitated, and should start by agreeing an overall objective and the four specific objectives proposed. The key anticipated results should then be discussed and agreed before moving to necessary activities in support of these results, and their respective objective verifiable indicators. As noted in the generic blueprint, means of verification should also be agreed.

Of critical importance in the adaptation of the blueprint to any particular country/fishery is that all activities should be allocated a specific timeframe, with responsibilities assigned for their completion. Stakeholder expectations should also be managed carefully from the start of the implementation process so that reasonable goals are identified that are achievable within realistic timeframes. In addition, a central coordinator should be identified to lead the work for a particular fishery so that activities stay on track and stakeholders continue to be engaged in an inclusive and effective manner.

Funding for implementation of the blueprint

A key factor in ensuring that the specified blueprint can actually be implemented is the allocation of appropriate budgets and resources.

This is a two-way process in which:

- All activities should be costed with total cost estimates presented via the MAC to the government/state treasury for inclusion in development and operational budgets for the fisheries/aquaculture sector;
- Once development and operational budgets have been approved, the list of activities to be conducted may need to be revised, depending on how much funding is available;
- Activities and budgets are constantly reviewed by the MAC.

It should be noted of course that an important job of the relevant fisheries Ministry should be to lobby for financial resources from government and stakeholders. This can be facilitated by:

- Careful presentation of the actual and potential benefits of the sector to the nation (e.g. income generation and added value, foreign exchange earnings, employment generation, multiplier

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- effects, taxation, food security, as a safety-net activity for the poor, etc)
- Demonstrating that the blueprint is logical and that all activities are essential to achieving the objectives
- Demonstration of the effective and efficient use of previous funds provided to the sector so as to generate maximum value for money

The issue of allocation of resources also requires careful consideration of the timing of budget allocations/release, and a match of the time-bound responsibilities of activities with the timing of the funds to be provided by the government.

In all countries, government resources are scarce. This places great onus on those in the sector to strive to use resources efficiently and effectively, and where possible to select low-cost options over high-cost ones. It also means that fisheries managers should seek to bring in external funding where possible, which can then be used to support implementation of the blueprint (see also comments above under notes on objective 4a related to partnerships)

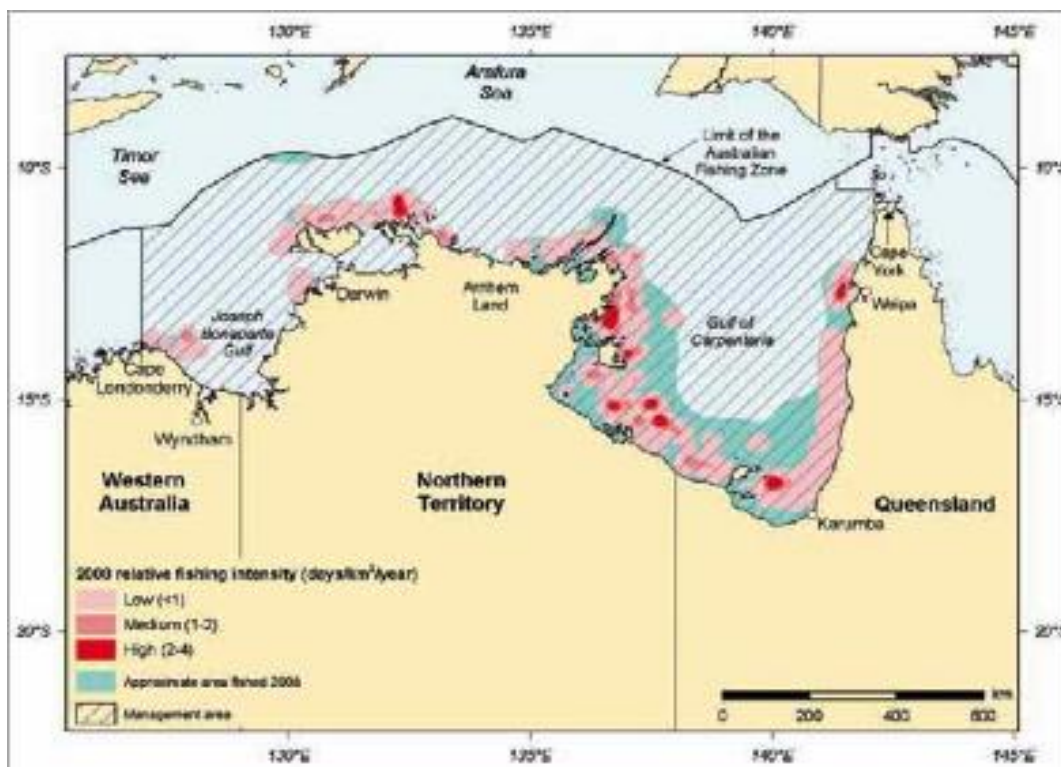
APPENDICES

APPENDIX A. COUNTRY CASE STUDIES

A.1: Northern prawn trawl, Australia

Extract from BRS report, Management Plan, Bycatch management plan, DEHWA report

Feature	Description
Target species	Red-legged banana prawn (<i>Fenneropenaeus indicus</i>) White banana prawn (<i>Fenneropenaeus merguensis</i>) Brown tiger prawn (<i>Penaeus esculentus</i>) Grooved tiger prawn (<i>Penaeus semisulcatus</i>) Blue Endeavour prawn (<i>Metapenaeus endeavouri</i>) Red Endeavour prawn (<i>Metapenaeus ensis</i>) Red-spot king prawn (<i>Melicertus longistylus</i>) Western king prawn (<i>Melicertus latisulcatus</i>)
Byproduct	Slipper lobster/Bugs (<i>Tibinus</i> spp.) Finfish (various) Scampi (<i>Metanephrops</i> spp.) Scallops (<i>Amusium</i> spp.) Squid (<i>Photololigo</i> spp.)
Shrimp dependency	99.5%
Management authority	Australian Fisheries Management Authority
Fishing zone	



Fleet segments 52 industrial trawlers

Management methods Restricted access with 250 vessels bought out through three successive buy-out schemes since mid 1980s.

Input controls, individual tradable gear SFRs: 3029 metres of operational headrope (twin trawl net configuration) (2007) 2654 metres of operational headrope (twin trawl net configuration) (2008). These

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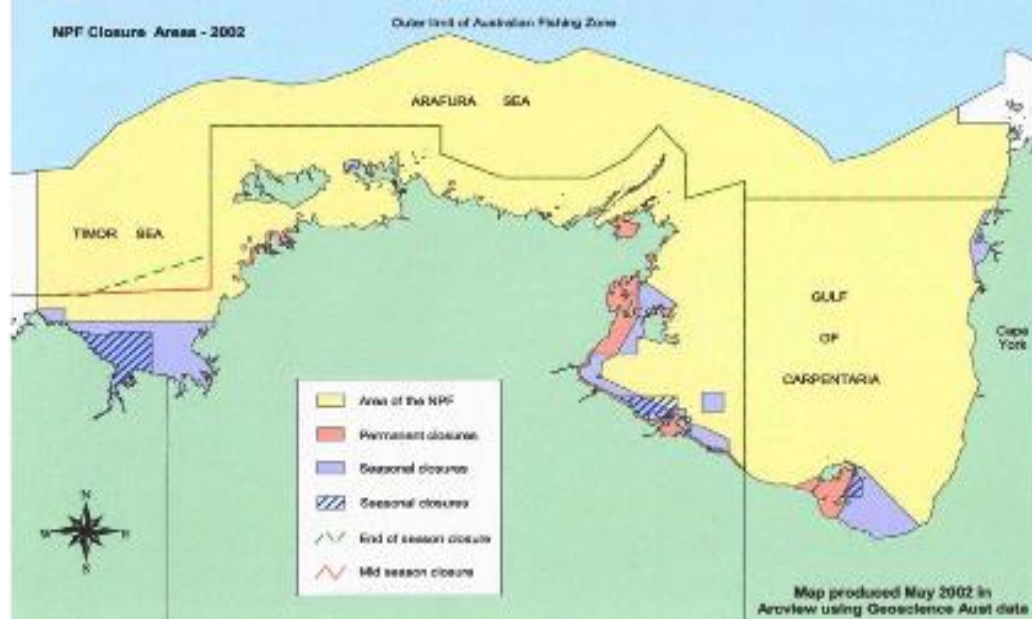
may be transferred subject to AFMA approval. 48 boats removed in 5 years through SFR aggregations.

Output controls from 2010/2012. Quota likely based on existing SFR holdings. SFRs accepted as the property right in the fishery.

Seasonal closures: Banana prawn season from 27 March for 6-10 weeks; Tiger prawn season runs from 1 August to 28 November 2008. It comprises a fixed 15 weeks, but a two week extensions may be granted if catch rates are more than 300 kg/vessel/night. Mid year closures to protect the spawners and end year closures Dec to 1st March to protect juveniles.

A daylight trawl closure during the tiger prawn season aims to reduce the capture of gravid (pregnant) prawns, which are more likely to be caught during the day. A total of 2.1% of the fishery management area is subject to permanent closures, with 6.3% subject to seasonal closures. Less than 11% of the total area of the fishery is actually fished.

Permanent and seasonal area closures - to help protect nursery areas and sustain the productivity of the Fishery; End of season and midyear closures – to reduce the capture of juveniles and gravid tiger prawns.



Cobourg Marine Park contains extensive live coral reefs and seagrass meadows, and is rich in marine life. The conservation values of the Park are:

- ◆ the diversity of marine habitats;
- ◆ the occurrence of live coral reefs and extensive seagrass meadows;
- ◆ the occurrence of breeding grounds for dugong, turtles and other marine life;
- ◆ the occurrence of critical habitat for a variety of marine animals;
- ◆ the occurrence of nursery areas for marine life in the form of a well- developed benthos;
- ◆ the presence of endangered species such as dugongs, turtles and the estuarine crocodile, *Crocodylus porosus*.

History

1960's: Fishery started in mid 1960's

1970's: Up to 200 vessels operating

1971: Seasonal closures for banana prawns introduced

1977: Interim Management Plan developed; first formal multi-stakeholder management advisory committee (NORPAC) formed to provide management advice to Government. Limited entry introduced through 3 year moratorium on licenses and new vessels entering the fishery. 1980: Controls on vessel replacement relaxed to allow smaller trawlers to replace to 'subsidy size' trawlers with no penalty.

1984: Unitization introduced as a response to concerns about fishing capacity and over-capitalization. Adoption of A-units as measure of vessel size and power. B-units introduced to authorize the right for a vessel to fish, and to limit total capacity. NORMAC formed to replace NORPAC.

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1985: First formal NPF Management Plan implemented.

Mid to late 1980s: Mid-1980s buyback scheme aimed to reduce A-units to 70000 by 1990. Plan was for an initial voluntary buyback followed by a compulsory surrender, however the compulsory component of the scheme was not implemented due to lack of industry support. Voluntary buyback extended to B-units. The scheme removed approx 90 vessels.

1987: Mid-season closure (usually May - August) introduced to reduce effort on tiger prawns before they spawn, in response to decline in tiger prawn recruitment. Daylight trawling during the tiger prawn season banned. Vessels restricted to towing two nets (from quad or triple gear). Additional restrictions on boat replacement implemented.

1988: Fishery became solely managed by the Commonwealth under Offshore Constitutional Settlement arrangements.

1990-1993: Buyback scheme refinanced, with amended target of 53,844 A-units by early 1993, achieved through combination of buy back and compulsory surrender (30.76%). License numbers reduced from 212 to 137 (132 active trawlers).

1995: Management plan and A and B class SFRs introduced, based on existing effort units in the fishery, to replace class A and B units.

1998: Northern Prawn Resource Assessment Group advise that the effective effort directed at tiger prawns was well above MSY and should be reduced by 25–30%. First Bycatch Action Plan developed.

2000: Fishery moved to gear-based management using headrope length, with A and B units replaced by Gear SFRs and B (boat) SFRs.

2000. TEDs became compulsory

2001: BRDs became compulsory

2002: 40% effort reduction target met through a 25% reduction in total allowable headrope length and shortening of season (to 134 total days in 2002, 2003 and 2004).

2004: NORMAC established MEY as the overall management objective of the fishery. MSY redefined as limit reference point. NORMAC recommended 25% reduction in gear SFRs.

2005: 25% reduction in total allowable headrope length. Second (tiger prawn) season lengthened, with additional measures to minimise tiger prawn catch in the first (banana prawn) season.

2006: NPF Management Plan 1995 amended to allow for the use of different gear types (notably quad gear) and provide for the collection of prawn broodstock. A \$68m AUD structural adjustment package ‘*Securing Our Fishing Future*’ removed 43 class B SFRs and 18,365 gear SFRs purchased from the fishery (45% and 34% reduction, respectively). A condition of participation was for the fishery to move to output control management (i.e. individual transferable quotas).

2007: NPF Harvest Strategy Under Input Controls introduced, which aims to maximize profit by changing effort levels using the results of a bioeconomic assessment of the tiger prawn fishery.

2008: 33% increase in total gear in the fishery, resulting in an increase in the value of each gear SFR from 0.5625 cm to 0.7481 cm.

Management Plan *Northern Prawn Fishery Management Plan 1995* (DAFF 1995) (last amended July 2006)

The objectives of this Plan are to make sure:

- a) That the objectives pursued by the Minister in the administration of the Act, and by AFMA in the performance of its functions, are met in relation to the Northern Prawn Fishery;
- b) That the incidental catch of non-target commercial and other species in that Fishery is reduced to a minimum.

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The measures by which the objectives of this plan are to be attained include:

- developing and implementing appropriate management measures (including directions referred to in subsection 17 (5A) of the Act) in relation to the Northern Prawn Fishery;
- implementing an effective program of surveillance for the Northern Prawn Fishery to ensure compliance with this plan; and
- promoting research that is relevant to the Northern Prawn Fishery;
- preparing an annual budget of costs associated with managing the Northern Prawn Fishery;
- setting and collecting levies and fees in relation to the Northern Prawn Fishery; and
- collecting data that can be used to assess the status of the Northern Prawn Fishery;
- monitoring the impact of catching operations in the fishery on ecologically related species and implementing any practical strategies that are necessary to minimise the impact of those operations on those species; and) developing and implementing a bycatch action plan.

The performance criteria against which the measures taken may be assessed are:

- the status of economic efficiency of the Northern Prawn Fishery; and
- the status of the biological resources and environmental conditions in the Northern Prawn Fishery area; and
- the cost effectiveness of the Northern Prawn Fishery.

AFMA and the Northern Prawn Fishery Management Advisory Committee must, from time to time, conduct assessments of the effectiveness of the measures taken to implement the objectives of this plan by reference to the performance criteria. AFMA must publish an annual report assessing the performance of this plan The following specific plans are prepared.

FMA. 1995. NPF Management Plan:

http://www.afma.gov.au/fisheries/northern_trawl/northern_prawn/publications/default.htm

Commonwealth Policy on Fisheries Bycatch, June 2000:

www.daffa.gov.au/__data/assets/pdf_file/5812/bycatch.pdf

AFMA. Bycatch Action Plans – Northern Prawn Fishery:

<http://www.afma.gov.au/information/publications/fishery/baps/default.htm>

Integrated Scientific Monitoring Program: observer reports, 2001 – 2005:

http://www.afma.gov.au/fisheries/northern_trawl/northern_prawn/publications/default.htm

AFMA. NPF Northern Prawn Fishery Strategic Ecosystem Data Plan, 2004:

http://www.afma.gov.au/fisheries/northern_trawl/northern_prawn/publications/default.htm

AFMA. NPF Five-year Strategic Research Plan (2001-2006):

http://www.afma.gov.au/fisheries/northern_trawl/northern_prawn/publications/default.htm

Governance

AFMA undertakes primary responsibility for fisheries management, with a dedicated senior manager and support staff.

NORMAC

NPF Industry Pty Ltd

Harvest strategy

Commonwealth Fisheries Harvest Strategy Policy (HSP). The strategy's control rules operated in 2008

Tiger prawns: Target reference point: MEY from the tiger prawn fishery as a whole (including byproduct of Endeavour prawns) Limit reference point: 0.5SMSY (half the spawning stock size required for maximum sustainable yield). A maximum of 52 vessels fished during 2008. The fishing effort for brown and grooved tiger prawn fleets is set for a two-year period to maximise profits over a seven- year moving window, based on the results of a bioeconomic assessment conducted every two years. Fishing effort is controlled by modification of area, season and gear (headrope length). If the limit reference point is triggered, targeted fishing of the species concerned ceases. Standardised fishing effort for the fleet in any one year cannot be less than half of the standardised effort targeted at brown tiger prawns in 2006.

Banana prawns: There are no specific target or limit reference points for banana prawn but these are managed through an escapement policy. The season is limited to 6 weeks, with the possibility of extension to 8 or 10 weeks provided that banana prawn catch rates are maintained (>500 kg/vessel per day) and tiger

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prawn bycatch is low (<6.6 t/week). The rules are based on historical data which indicates that this approach is likely to result in a sustainable fishery.

King prawns are monitored through logbooks, surveys and seasonal landings. If a consistent decline in abundance is detected over a three- year period, appropriate management measures (including additional spatial closures) will be implemented to reduce fishing pressure.

The **scampi** status is assessed through examination of trends in total annual catch, vessel participation, catch rates and size distribution. A catch of 30 t or greater, or participation of eight or more vessels, in a year will trigger a 30 t total allowable catch (TAC) in the following year.

Bycatch work plans	Harvest strategies to be replaced by TACs/IQs in 2010. <i>Northern Prawn Fishery Bycatch Action Plan 2007</i> (AFMA 2007)
Key features	EPBC Act assessments: listed species (Part 13) international movement of wildlife specimens (Part 13A). Current accreditation dated 12 January 2006. Current accreditation (exempt) dated 22 December 2008; expires 9 January 2014 Significant emphasis on capacity reduction (buy back and SFRs) with the removal of 250 vessels over 25 years. Strong industry cohesiveness. NORMAC proactively involved in fisheries management decision making, with extensive stakeholder interaction and production of harvest strategy (to prevent over exploitation) and bycatch action plans (to provide mitigation measures for bycatch species). High quality stock assessment and bycatch mitigation strategies applied through NORMAC. NPF includes a high proportion of bycatch, interactions with protected species (such as sea turtles and sea snakes) and the potential impacts of trawling on benthic communities. The industry has been involved through crew-member monitoring of bycatch and evaluation of the effectiveness of bycatch reduction measures since 2000. Industry education programs in the application of TEDs have been effective in reducing marine turtle bycatch and, to some extent, bycatch of other large species. In 1999, 96 turtle mortalities were reported and 780 marine turtles were released alive; in 2007, no mortalities were reported and 55 turtles were released alive. BRDs still under development. The latest approved BRD, the Popeye Fishbox, reduced small-sized bycatch by up to 48% and bycatch of sea snakes by up to 87% in trials. An ecological risk assessment of the NPF was completed in 2009. Because of the low coverage area within the fishing region (10-12%) and seasonal closures, the application of a cohesive closed area policy, and use of TEDs and BRDs, the fishery is judged to be low risk. VMS but good level of compliance, with risk assessment strategies applied. Peer review process through DHWA audits.
Problems	Continued heavy emphasis on bycatch mitigation. Potential industry concern about change to ITQ management from the gear SFR system that has proven to be effective. High management costs (AFMA) for relatively small fishery. The NPF is exposed to factors beyond the direct control of operators and fishery managers. Banana prawn stock levels are substantially influenced by rainfall. In addition, prawn price, fuel price and exchange rate movement have substantially affected financial returns in the fishery.
Actions taken	Continued emphasis on harvest strategies and bycatch mitigation. Strengthening focus on market based mechanisms to reduce capacity (ITQs).
Lessons learned	Ecosystem approach to fisheries management applied successfully. Strong focus on stock assessment. Significant financial resources required to reduce capacity.

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Adaptive management been successful, gear SFRs have dealt with growth in effort (multi-trawls), with additional benefits secured through gear unit aggregations.

Strong industry cohesiveness.

Formation of NORMAC with deliverables on action plans for bycatch mitigation and harvest control. The ecosystem approach to fisheries management proven to be highly effective. Strong support for co-management approaches.

Effective peer review processes in place to ensure strong management.

A.2 Spencer Gulf prawn trawl, South Australia

Feature	Description
Target species	King prawns (<i>Melicertus latisulcatus</i>)
Byproduct	Calamary (<i>Ibacus</i> spp.) Slipper lobster (<i>Sepioteuthis australis</i>).
Shrimp dependency	95%
Management authority	Primary Industries, South Australia (PIRSA)
Fishing zone	
Fleet segments	39 industrial trawlers
Management methods	<p>Restricted night-time fishing (60 days i.e. no more than 14 nights per month over the dark of the moon), gear restrictions (twin trawl/maximum headline length/minimum mesh size 45 mm), maximum vessel length and HP, bycatch reduction devices.</p> <p>Gazetted and voluntary closed areas</p> <p>Voluntary gear revisions:</p> <ul style="list-style-type: none"> • The slight angle of the trawl boards, too acute angle would result in digging; • Not using tickler chains; • The position of the headline in front of the footline; • Adequate space between the dropper and the foot wire.
History	<p>The trawl fishery began in 1967</p> <p>Restricted access from 1976</p> <p>First Management Committee and Management plan from 1982</p> <p>Ecosystem approach to fisheries management initiated in 1999</p>

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Management Plan The current Management Plan aims to achieve outcomes that are consistent with broader Government objectives for the management of the marine environment. These include:

- The National Strategy for Ecologically Sustainable Development;
- The Precautionary Principle, as set out in the Intergovernmental Agreement on the Environment;
- The Australian Government ‘Guidelines for the Ecologically Sustainable Management of Fisheries’, which relate to the requirements of the *Environment Protection and Biodiversity Conservation Act 1999*; and
- The National Policy on Fisheries Bycatch.

The Plan:

- Sets out the management objectives and implements a strategy for achieving these;
- Sets out the resources required to implement the plan;
- Describes the biological, economic and social characteristics of the fishery;
- Identifies the impacts or potential impacts of the fishery on its associated ecosystem or ecosystems, including impacts on non-target species of fish or other aquatic resources;
- Identifies any ecological factors that could have an impact on the performance of the fishery;
- Assesses the risks to the ecosystem and set out strategies for addressing those risks;
- Sets out methods for monitoring the performance of the fishery and the effectiveness of the plan, including performance indicators, trigger points for review or action and progress reporting.

The Management goals, objectives and strategies for the management of the Spencer Gulf Prawn Fishery during 2007-2011.

Goal	Objectives	Activities
1. Maintain an ecologically sustainable prawn biomass	1a. Spencer Gulf prawn stocks harvested at ecologically sustainable levels	<ul style="list-style-type: none"> • Maintain a restriction on the number of licenses and the total amount of gear in the fishery; • Develop spatially and temporally explicit harvest strategies for each fishing period in line with established target and limit reference levels and decision rules; • If the stock is determined to be operating below the established limits, the fishery will be managed to promote recovery to ecologically viable stock levels, within agreed timeframes.
	1b. Sufficient biological and ecological information exists to inform management decisions	<ul style="list-style-type: none"> • Collect fishery-dependent information through commercial logbooks; • Maintain the fishery-independent prawn survey program; • Assess the status of the stock through quantitative stock assessment; • Collect appropriate environmental data to aid assessment; • Review and update the strategic research and monitoring plan
2. Ensure optimal utilization and equitable distribution	2a. A fishery exploited for maximum economic value	<ul style="list-style-type: none"> • Within a framework of sustainable exploitation, develop harvest strategies that match target size with market requirements; • When targets are reached, allow for higher exploitation levels to capture economic benefits from the fishery (subject to the constraints outlined under goal 1)
	2b. An economically efficient fleet	<ul style="list-style-type: none"> • Develop management arrangements that allow commercial operators to maximise operational flexibility and economic efficiency; • Undertake economic surveys of the commercial fishery to assess economic performance against a set of economic indicators.
	2c. Equitable public access	<ul style="list-style-type: none"> • Review appropriateness of access arrangements between sectors once within the life of the Management Plan • Develop a mechanism for altering access arrangements should a change be required
3. Minimise impacts on the ecosystem	3a. Minimise fishery impacts on bycatch and byproduct species	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery; • Maintain permanent closed areas. • Undertake a risk assessment to determine the vulnerability of bycatch and byproduct species to overfishing from prawn trawling; • Develop mitigation strategies for bycatch and by-product species deemed at high risk of overfishing from prawn trawling. • Promote the development of environmentally friendly fishing practices.
	3b. Avoid the incidental	<ul style="list-style-type: none"> • Undertake a risk assessment to determine the vulnerability of endangered, threatened and protected species to fishing operations

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	mortality of endangered, threatened and protected species	<ul style="list-style-type: none"> • Improve data recording systems to capture fishing interactions with endangered, threatened and protected species • Develop management measures to avoid interactions with endangered, threatened and protected species.
	3c. Minimise fishery impacts on benthic habitats and associated species communities	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery • Maintain permanent closed areas • Promote the development of environmentally friendly fishing gear and fishing practices • Develop strategies for assessment of impacts on habitat and associated species communities.
4. Enable effective and participative management of the fishery	4a. Industry delegated greater responsibility in management	<ul style="list-style-type: none"> • Industry manage the spot survey process and develop harvest strategies (with reference to PIRSA Fisheries and SARDI); • Industry manage all at-sea operations of the fleet; • Develop an improved industry decision-making structure to satisfy governance requirements; • Develop explicit allocation of prawn resources between sectors; • Develop a process for the industry association to review the necessary ecological assessment report to the CDEH for export accreditation.
	4b. Management arrangements reflect concerns and interests of the wider community	<ul style="list-style-type: none"> • Promote stakeholder input to the management of the fishery, through established co-management processes; • Ensure that social and cultural issues are given appropriate consideration when new management strategies are being developed; • Communicate management arrangements to the wider Community.
	4c. Management arrangements are complied with	<ul style="list-style-type: none"> • Undertake annual compliance risk assessment; • Implement a cost-effective compliance and monitoring program to address identified risks; • Promote high levels of stakeholder stewardship through established management processes and Fishwatch activities.
	4d. Costs of management of the fishery funded by the relevant stakeholders	<ul style="list-style-type: none"> • Ensure stakeholders are involved in development of management arrangements for achieving management objectives; • Determine the annual real costs of management, research and compliance for the fishery; • Recover an economic return from commercial licence holders, sufficient to cover the attributed costs of fisheries management, research and compliance in line with established cost recovery principles.

Source: Management Plan, 2007

Performance indicators for assessment of the Spencer Gulf Prawn Fishery.

Objective	Performance Indicator	Limit Reference Point
1 b	Fishery independent surveys	3 surveys completed
1 b	Stock assessment report	Completed
2 b	Economic report	Completed
1 a	Indices of future and current biomass	Neither index is below lower threshold levels
1 a	Recruitment index	>35
1 a & 2 a	Total commercial catch (t)	>1800
1 a & 2 a	Mean commercial CPUE (kg/hr)	>80
2 a	% vessel nights with mean size >280prawns/7 kg	<2%
2 b	Gross Value of Production (GVP)	<0% change
2 b	Management Costs	>10% increase

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2 b	Return on investment	<0% change
4 a	Committee comply with harvest strategy decision rules	Committee develops all harvest strategies based on results of surveys and in accord with decision rules
4 c	Fleet complies with harvest strategies	Fleet operates within prescribed open areas and times described in every harvest strategy

Source: Management Plan (2007)

Performance indicators measured for 5-year assessment of ecosystem impacts for the Spencer Gulf Prawn Fishery.

Objective	Performance Indicator	Measurement Frequency	Limit Reference Point
3 a & 3 b	Undertake a bycatch risk assessment	Within 5 years	In the development stage
3 a	Develop mitigation strategies for high-risk species.	Prior to the conduct of the next risk assessment	Ongoing and awaiting details from bycatch surveys
3 a	Measure the success of each mitigation strategy.	Within 1 year of development of the mitigation strategy	Successfully reduced the risk, when known. Investigating other interactions (e.g. TEP, sponges)
3 a	Measure the effectiveness of mitigation strategies by assessing differences in consecutive risk assessments.	5 years after the previous risk assessment	Reduced number of species deemed at high risk
3 b	Develop measures to record interactions with endangered, threatened and protected species.	Within 5 years	Completed
3 b	Develop measures to reduce interactions with endangered, threatened and protected species.	Within 5 years	Successfully reduced the risk to some species. Other mitigation strategies to be prepared
3 c	Maintain permanent closed areas	Annual	Completed and ever increasing gazetted sites.
3 c	Develop strategies to assess impacts on benthic habitats and associated Communities	Within 5 years	Ongoing

Source: Management Plan (2007), with authors comments based on reported findings

Actions taken in the event that harvest strategies fail to comply with stock assessment indicators

<ol style="list-style-type: none"> 1. Notify the Minister for Agriculture, Food and Fisheries and participants in the fishery as appropriate. 2. Undertake a detailed review including an assessment of the additional performance measures (Tables 4 and 5) where appropriate. Provide a synopsis of the causes and implications of failure to achieve the minimum desired performance. 3. Where appropriate, consult with key stakeholder groups regarding the need for alternative management strategies and the collection of additional data. 4. Provide a report to the Minister, within three months of the initial notification, on the effects of breaching the performance indicator, including any recommendations on management strategies. 5. Minister or Director of Fisheries to consider recommendations, endorse supported strategies and implement as appropriate.

Harvest strategy The fishery is managed in real time adaptive mode as the system is dynamic. The fishery manages effort, catch and prawn size on a “quasi-quota” over 5-6 fishing periods with catch and effort “allocated” in proportion to biomass of the stock, annual recruitment strength, the amount of effective spawners (females > 42 mm carapace length (CL), the maturation and spawning status and size composition of prawns over grounds.

Bycatch work plans Risk assessment ongoing. Mitigation measures included temporary and permanent closed areas. Committee at Sea responds to bycatch interactions (syngnathids, leather jackets)

Key features Restrictive entry licensing
 Strong stakeholder cooperation through Management Committee
 Cohesive fishing industry structure
 Fisheries Council of South Australia with

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Restricted night-time fishing (60 days i.e. no more than 14 nights per month over the dark of the moon), gear restrictions (twin trawl/maximum headline length/minimum mesh size 45 mm), maximum vessel length and HP, bycatch reduction devices.

Gazetted and voluntary closed areas

Voluntary gear revisions:

- The slight angle of the trawl boards, too acute angle would result in digging;
- Not using tickler chains;
- The position of the headline in front of the footline;
- Adequate space between the dropper and the foot wire.

The trawl fishery began in 1967

Restricted access from 1976

First Management Committee and Management plan from 1982

Ecosystem approach to fisheries management initiated in 1999

The current Management Plan aims to achieve outcomes that are consistent with broader Government objectives for the management of the marine environment. These include:

- The National Strategy for Ecologically Sustainable Development;
- The Precautionary Principle, as set out in the Intergovernmental Agreement on the Environment;
- The Australian Government 'Guidelines for the Ecologically Sustainable Management of Fisheries', which relate to the requirements of the *Environment Protection and Biodiversity Conservation Act 1999*; and
- The National Policy on Fisheries Bycatch.

The Plan:

- Sets out the management objectives and implements a strategy for achieving these;
- Sets out the resources required to implement the plan;
- Describes the biological, economic and social characteristics of the fishery;
- Identifies the impacts or potential impacts of the fishery on its associated ecosystem or ecosystems, including impacts on non-target species of fish or other aquatic resources;
- Identifies any ecological factors that could have an impact on the performance of the fishery;
- Assesses the risks to the ecosystem and set out strategies for addressing those risks;
- Sets out methods for monitoring the performance of the fishery and the effectiveness of the plan, including performance indicators, trigger points for review or action and progress reporting.

The Management goals, objectives and strategies for the management of the Spencer Gulf Prawn Fishery during 2007-2011.

Goal	Objectives	Activities
1. Maintain an ecologically sustainable prawn biomass	1a. Spencer Gulf prawn stocks harvested at ecologically sustainable levels	<ul style="list-style-type: none"> • Maintain a restriction on the number of licenses and the total amount of gear in the fishery; • Develop spatially and temporally explicit harvest strategies for each fishing period in line with ecosystem reference levels and decision rules; • If the stock is operating below the established limits, the fishery will be managed to promote ecologically viable stock levels, within agreed timeframes.
	1b. Sufficient biological and ecological information exists to inform management decisions	<ul style="list-style-type: none"> • Collect fishery-dependent information through commercial logbooks; • Maintain the fishery-independent prawn survey program; • Assess the status of the stock through quantitative stock assessment; • Collect appropriate environmental data to aid assessment; • Review and update the strategic research and monitoring plan
2. Ensure optimal utilization and equitable distribution	2a. A fishery exploited for maximum economic value	<ul style="list-style-type: none"> • Develop harvest strategies that match target size with market requirements;
	2b. An economically efficient fleet	<ul style="list-style-type: none"> • Develop management arrangements that allow commercial operators to maximise efficiency; • Undertake economic surveys of the commercial fishery to assess economic performance .
	2c. Equitable public access	<ul style="list-style-type: none"> • Review appropriateness of access arrangements between sectors • Develop a mechanism for altering access arrangements should a change be required

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3. Minimise impacts on the ecosystem	3a. Minimise fishery impacts on bycatch and byproduct species	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery; <ul style="list-style-type: none"> • Maintain permanent closed areas. • Undertake a risk assessment to determine the vulnerability of bycatch and byproduct species to overfishing from prawn trawling; • Develop mitigation strategies for bycatch and by-product species deemed at high risk . • Promote the development of environmentally friendly fishing practices.
	3b. Avoid the incidental mortality of endangered, threatened and protected species	<ul style="list-style-type: none"> • Undertake a risk assessment to determine the vulnerability of ETP species to fishing • Improve data recording systems to capture fishing interactions with ETP species • Develop management measures to avoid interactions with ETP species.
	3c. Minimise fishery impacts on benthic habitats and associated species communities	<ul style="list-style-type: none"> • Maintain a limit on the amount of gear used in the fishery • Maintain permanent closed areas • Promote the development of environmentally friendly fishing gear and fishing practices • Develop strategies for assessment of impacts on habitat and associated species communities.
4. Enable effective and participative management of the fishery	4a. Industry delegated greater responsibility in management	<ul style="list-style-type: none"> • Industry manage the spot survey process and develop harvest strategies; • Industry manage all at-sea operations of the fleet; • Develop an improved industry decision-making structure to satisfy governance requirements; • Develop explicit allocation of prawn resources between sectors; • Develop a process for the industry association to review the necessary ecological assessment report to the CD for export accreditation.
	4b. Management arrangements reflect concerns and interests of the wider community	<ul style="list-style-type: none"> • Promote stakeholder input to the management of the fishery, e.eco-management processes; • Ensure that social and cultural issues are given appropriate consideration; • Communicate management arrangements to the wider Community.
	4c. Management arrangements are complied with	<ul style="list-style-type: none"> • Undertake annual compliance risk assessment; • Implement a cost-effective compliance and monitoring program to address identified risks; • Promote high levels of stakeholder stewardship through established management processes and Fishwatch activities.
	4d. Costs of management of the fishery funded by the relevant stakeholders	<ul style="list-style-type: none"> • Stakeholders involved in development of management arrangements; • Determine the annual real costs of management, research and compliance for the fishery; • Recover an economic return from commercial licence holders.

Source: Management Plan, 2007

Performance indicators for assessment of the Spencer Gulf Prawn Fishery.

Objective	Performance Indicator	Limit Reference Point
1 b	Fishery independent surveys	3 surveys completed
1 b	Stock assessment report	Completed
2 b	Economic report	Completed
1 a	Indices of future and current biomass	Neither index is below lower threshold levels
1 a	Recruitment index	>35
1 a & 2 a	Total commercial catch (t)	>1800
1 a & 2 a	Mean commercial CPUE (kg/hr)	>80
2 a	% vessel nights with mean size >280prawns/7 kg	<2%
2 b	Gross Value of Production (GVP)	<0% change
2 b	Management Costs	>10% increase
2 b	Return on investment	<0% change
4 a	Committee comply with harvest strategy decision rules	Committee develops all harvest strategies based on results of surveys and in accord with decision rules
4 c	Fleet complies with harvest strategies	Fleet operates within prescribed open areas and times described in every harvest strategy

Source: Management Plan (2007)

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Performance indicators measured for 5-year assessment of ecosystem impacts for the Spencer Gulf Prawn Fishery.

Objective	Performance Indicator	Measurement Frequency	Limit Reference Point
3 a & 3 b	Undertake a bycatch risk assessment	Within 5 years	In the development stage
3 a	Develop mitigation strategies for high-risk species.	Prior to the conduct of the next risk assessment	Ongoing and awaiting details from bycatch surveys
3 a	Measure the success of each mitigation strategy.	Within 1 year of development of the mitigation strategy	Successfully reduced the risk. Investigating other interactions (e.g. TEP, sponges)
3 a	Measure the effectiveness of mitigation strategies by assessing differences in consecutive risk assessments.	5 years after the previous risk assessment	Reduced number of species deemed at high risk
3 b	Develop measures to record interactions with endangered, threatened and protected species.	Within 5 years	Completed
3 b	Develop measures to reduce interactions with endangered, threatened and protected species.	Within 5 years	Successfully reduced the risk to some species. Other mitigation strategies to be prepared
3 c	Maintain permanent closed areas	Annual	Completed and ever increasing gazetted sites.
3 c	Develop strategies to assess impacts on benthic habitats and associated Communities	Within 5 years	Ongoing

Source: Management Plan (2007), with authors comments based on reported findings

Actions taken in the event that harvest strategies fail to comply with stock assessment indicators

<ol style="list-style-type: none"> 1. Notify the Minister for Agriculture, Food and Fisheries and participants in the fishery as appropriate. 2. Undertake a detailed review including an assessment of the additional performance measures (Tables 4 and 5) where appropriate. Provide a synopsis of the causes and implications of failure to achieve the minimum desired performance. 3. Where appropriate, consult with key stakeholder groups regarding the need for alternative management strategies and the collection of additional data. 4. Provide a report to the Minister, within three months of the initial notification, on the effects of breaching the performance indicator, including any recommendations on management strategies. 5. Minister or Director of Fisheries to consider recommendations, endorse supported strategies and implement as appropriate.

The fishery is managed in real time adaptive mode as the system is dynamic. The fishery manages effort, catch and prawn size on a “quasi-quota” over 5-6 fishing periods with catch and effort “allocated” in proportion to biomass of the stock, annual recruitment strength, the amount of effective spawners (females > 42 mm carapace length (CL), the maturation and spawning status and size composition of prawns over grounds.

Risk assessment ongoing. Mitigation measures included temporary and permanent closed areas. Committee at Sea responds to bycatch interactions (syngnathids, leather jackets).

Restrictive entry licensing.

Strong stakeholder cooperation through industry association governed by Management Committee.

Cohesive fishing industry structure.

Fisheries Council of SA comprises of people with the following knowledge / experience / expertise: recreational fishing; research and development relevant to the use of aquatic resources; conservation of aquatic resources; socio-economics; business; law; aboriginal traditional fishing.

High quality stocks assessment.

HCR and bycatch work plans.

Limited operational area within fishing zone, including no fishing above 10 m.

Gear development and short tows to mitigate against high bycatches.

Temporary and permanent closed areas.

Advanced system of co-management through ‘Committee at Sea’ with direct participation in real time decision making and observer coverage.

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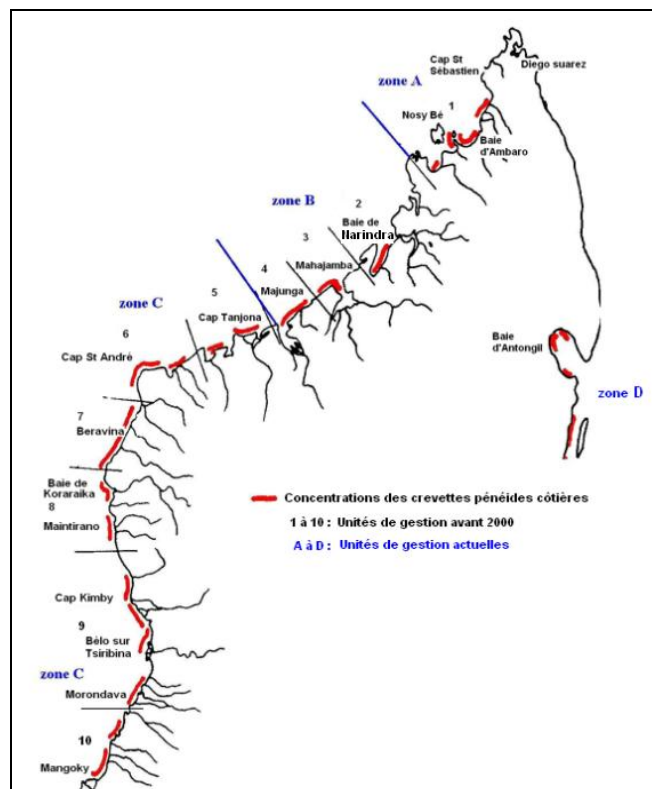
	Full compliance with risk assessments evaluated each year.
	No VMS.
	Peer review process through DEHWA audits.
	Effort creep and review of policy to implement change.
	Continued need to review bycatch mitigation policies.
	Continued emphasis on harvest strategies and bycatch mitigation.
	Ecosystem approach to fisheries management applied.
	Strong focus on stock assessment.
	Highly effective Fisheries Management Council with clear goals, objectives, activities and indicators.
	Real time management actions by fishers to reduce bycatch.
	High compliance.
	Peer review process in place to guarantee conformity.
Problems	Effort creep and review of policy to implement change.
	Continued need to review bycatch mitigation policies.
Actions required	Continued emphasis on harvest strategies and bycatch mitigation.
Lessons learned	Ecosystem approach to fisheries management applied.
	Strong focus on stock assessment.
	Highly effective Fisheries Management Council with clear goals, objectives, activities and indicators.
	Real time management actions by fishers to reduce bycatch.
	High compliance.
	Peer review process in place to guarantee conformity.

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A.3 Malagassy shrimp trawl, Madagascar

Main features and statistics of the Malagasy shrimp fishery

Feature	Description
Target species	<i>Fenneropenaeus indicus</i> , <i>Metapenaeus monoceros</i> , <i>Penaeus semisulcatus</i> , <i>Penaeus monodon</i> , <i>Marsupenaeus japonicus</i>
Byproduct	<i>Otolithes ruber</i> (Sciaenidae), <i>Pomadysys basta</i> (Haemulidae), <i>Nemipterus bleekeri</i> (Nemipteridae) et <i>Saurida micropectoralis</i> (Synodontidae)
Shrimp dependency	1:0.28 (77%)
Management authority	Le Ministère de l'Agriculture de l'Elevage et de la Pêche (MAEP)
Fishing zone	



Fleet segments	Industrial / semi-industrial divided into 5 companies: Somapêche (20), Groupe Unima (20), Groupe Réfrigépêche (7), Pêchexport (7), Pêcheries du Ménabé et du Mélaky (5). Coastal/traditional fishery comprising 200,000 migrant workers.
Management methods	<p>Restricted entry licensing. A system of licensed engine units linked to vessel horse power.</p> <p>The maximum number of industrial licenses is limited by zone: 7 in zone A, 7 in zone B, 45 in zone C and 6 in zone D. The number of semi-industrial licences is limited to 2 in zone A, 3 in zone B and 16 in zone C.</p> <p>BRDs, TEDs, headrope and backrope specifications and minimum mesh size (30 mm in the cod end). Industry self imposed BRD mesh size of 70 mm, and cod end minimum mesh size of 50 mm.</p> <p>Gear fishing effort units (GFEU) based on headrope length. Unit measured in cm: GFUE is a function of vessel unit X annual set $GFUE / 100 =$ annual individual vessel headrope length. No single vessel can have a headrope length greater than 69 m. Headrope lengths are adjusted</p> <p>Voluntary gear revisions to promote fuel efficiency.</p> <p>3 month statutory closed season (including traditional vessels). Operators have themselves extended the closed season to 4.5–5 months per year.</p>

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Fishing season begins on 1 March and ends on 30 November, 50% of total catch is caught in the first 3 months. Closures are implemented for three months from December to February. Night fishing is prohibited up to 14 April. The East coast fishery is open all year.

All trawlers are equipped with ARGOS or INMARSAT transmitters.

On board observers and land inspection (provincial officers) to monitor the fleet activities. 34 observers are deployed on 30-45 days per ship, total 2106 hours, 120 trips. They record effort, catch, catch of other retained species, turtle catches, discards, and the type of offences committed.

History

Restrictive entry licensing introduced in 1970.

Industry organisation body, GACPM set up in 1995 with the support of l'Agence Française de Développement (AFD).

The Programme National de Recherche Crevetière (PNRC) was created in 1997, followed by l'Observatoire Economique de la Filière Crevetière (OEFC) en 2000. PNRC undertake stock assessment work under the guidance of l'Institut (français) de Recherche pour le Développement (IRD). OEFC evaluates the economic performance of the fleet

Individual company license units introduced in 2000, with Government levy (8%). Engine units could be traded as from 2000. Trade between industrial fleet companies, and between industrial and semi-industrial subject to a penalty. Movement from semi-industrial to industrial results in a penalty of 1:1.5. No company can own more than 40% of the engine units.

Technical measures introduced in 2003 at industry's instigation: Backrope and headrope length, minimum mesh sizes, TEDs and BRDs .

Legal requirement that each kilogram of landed shrimp be accompanied by at least a half a kilogram of fish

Gear unit effort control system introduced at industry's instigation in 2007, following technical advice from Australia. Each company may hold up to 1 million GFEUs.

In response to declining CPUE, in 2008, companies reduced fleet size from 75 to 70 vessels. Further reductions expected in fleet numbers, probably by as much as 20 vessels, but with a threat to company participation in the fishery because of marginal economics.

Restrictive entry licensing introduced for traditional fishers with fishing boat, fisher and gear licenses. Enforcement not implemented due to political malaise.

2009 fishing operations cease in Zone A/B because of low CPUE in response to coastal fishing activity.

Management Plan

No formal management plan exists.

Governance

Responsibility for fisheries management falls under the responsibility of Ministère de l'Agriculture de l'Élevage et des Ressources Halieutiques (MAERH) formulates policy in consultation with the industry, and directs CSP to implement a control strategy. This industry pays a levy of 8% of Gross Value Production of which 80% is redirected to fisheries research, development and compliance. A formal Management consultative body (Zonal Management Conserve) exists to discuss management planning, but initiatives are largely industry driven. The ZMC comprises GACM (shrimp association), MAEP, CSP (Control Agency), PNRC and OEFC.

Harvest control strategies

Formal TACs and IQs in place but not reached because of lower CPUE. Vessels stop fishing when fishing becomes unprofitable.

Bycatch work plans

BRDs and TEDS instigated at industries own instigation. TEDs resulted in a 10-15% loss of commercial shrimp. Capture of turtles fallen from 42 in 2005 to 2 in 2008. WWF participate in turtle tagging programmes, but turtles now rarely encountered.

GACPM attempted to instigate a closed area programme with traditional fishers but this failed.

CSP observers report other species encounters (jellyfish and syngnathids).

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Key features	<p>PNRC stock assessment supported by IRD, with support of French Government. However, real time assessments do not take place and analysis is perceived as dated.</p> <p>Government does not have any clear sector objectives, but does fund, through industry levy: CSP (compliance), sanitation, Economic and biological research. A proportion of CSP funding is earmarked for training traditional fishers.</p> <p>Fleet overcapacity. Industry buy-back was sought, and funding secured from French Government, but resisted by Malagasy Government.</p> <p>Industry advocates greater reductions in GFEU, but some political resistance, and reluctance from fellow industry members.</p> <p>Industry, at its own instigation, has advanced and developed technical controls (BRDs, TEDs and the GFEU).</p> <p>Industrial fleet sector needs to be more cooperative in its management actions.</p> <p>Gradually declining CPUE, but major fall in shrimp catches in 2005. Catches per vessel down from 150t/annum to 100 t/annum.</p> <p>Industry reduces operational time on grounds, especially after peak season as economic return is insufficient and high bycatch issues become more problematic.</p> <p>Inter-company effort transfer exists in theory but not utilised because of declining CPUE.</p> <p>Vessels are fully compliant (CSP).</p> <p>Industry, driven by UNIMA, has also developed other gear modifications and trawling practices to increase fuel efficiency. This was in response to the fuel crisis in 2007. Initiatives include reducing the weight of the trawl through removing tickler chains, installing lightweight plastic doors, larger mesh sizes to reduce drag and prevent congestion in the net, and short haul times (1 hour to 1 hour 20 minutes) to reduce build up of bycatch. These initiatives resulted in a 31% saving in fuel costs.</p> <p>Carbon assessment and reduction of emissions programme introduced to reduce overheads. This resulted on increase carbon efficiency for engines (alternator), new propellers on all boats, and a change in cold storage systems. A cost of Euro 210,000, saved 80 cu cm/annum.</p> <p>Industrial fleet owners/ GACPM are seeking MSC accreditation at the time of writing. Concerns are that whilst recognised as important, multiple retailers are always squeezing margins with no rewards for an ecologically sustainable product. Would like to see greater partnership with WWF and incorporation of the WWF logo on products. WWF and UNIMA have formed a partnership agreement. The partnership seeks to promote more sustainable production focus, better and more secure access to international markets and the dissemination of good practices more broadly in the private and NGO sectors.</p> <p>Industry has attempted to engage with coastal fishers, and provides fish to cooperative members as a means to facilitate dialogue, but its efforts have been thwarted due to a lack of enforcement of coastal fishing on the ground.</p> <p>The African Development Bank is in the process of starting a support programme for the professionalisation of traditional fishermen's organisations. The programme is delayed because of the current political malaise.</p>
Strategic partnerships	<p>UNIMA focuses on sustainability best practice. Main issues addressed are: trawl net design and BRDs/TEDs to reduce bycatch and to create fuel efficiencies and reduce carbon emissions; focus on responsible effort reduction strategies and partnerships (closed areas, voluntary reductions in active vessel numbers); instigated co-management discussions with artisanal fisher groups in cooperation with WWF, including donating a percentage of fish caught to fisher cooperative members; cooperates in WWF turtle catch recording programmes; and implements UNIMA crew best practice programmes. WWF focuses on using its influence to promote UNIMA's responsible/sustainable fishing practice to strategically important retail outlets; funds specific initiatives such as carbon emission analysis; and assists in accessing funding for UNIMA sustainability R&D. The resulting benefits are demonstrated as: (1) promote more sustainable business practices and demonstrate that such practices can generate financial and market benefits; (2) demonstrate</p>

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the role that private companies can play in protecting the natural environment and in enabling social and economic development; (3) encourage wider adoption of sustainability in the business models and financing of private sector activities; (4) demonstrate that partnerships can achieve faster, more credible and more substantive progress towards sustainable business.

Problems

Unfettered growth in traditional fishing active in shrimp nursery grounds using mosquito nets with devastating consequences on offshore CPUE in areas accessible to traditional fishermen. Some industrial companies are pulling out of Zones A&B. Traditionally, 84% of the shrimp catch came from zone A.

85% of the shrimp trawl grounds are in the coastal zone (inside 2 n.miles), creating conflict with other fishers.

Inability of CSP to implement control programme for this sector because of current political malaise

Traditional fishers working for middle men and landowners in feudal type system. Becomes extremely difficult to advance co-management

Potential concern that Government is highly driven by license revenue accrual, with prospect that additional licenses could be granted.

Government generally poor in its response to sustainability and ecosystem based management.

The legal requirement to land (fish) 0.5: 1 (shrimp), is seen as illogical and not ecologically sustainable.

Actions required

Given the damage of rapid growth in the coastal fishery, urgent attention is needed to remove effort from this sector. Focus should be placed on alternative livelihoods, group organisation, education and control.

The need for greater emphasis on stakeholder management and development of a management plan. The plan should clearly set out goals, objectives and strategies, and the setting of performance indicators for target species sustainability and ecological risk minimization.

The industry, under the auspices of GACPM, should work towards a more proactive co-management role which would allow it to directly participate in sea trails in partnership with PNRC, and to be encouraged to take real time management actions in response to changing catch rates, concerns over the composition of the catch (e.g. high quantities of juvenile shrimp or gravid females, and interactions with non target species). The Spencer Gulf 'Committee at Sea' would be a good role model to follow.

Establish closed areas that will allow improved recruitment to offshore fishing grounds.

Review the policy of fishing up to 2 n.miles, which would allow for some reduction in local conflict, but may also have benefits in terms of stock recruitment.

Professionalisation of traditional/coastal fishers.

The need for real time stock assessment and management actions supported by Government.

Improved integration of data collected by observers with subsequent scientific analysis.

Evaluate the risks and mitigation strategies (if appropriate) for non-target species (jellyfish/syngnathids).

Lessons learned

Every effort should be made to prevent growth in artisanal fisheries on a scale witnessed in Madagascar. The focus should be on alternative livelihoods, group organisation, education and control. The profile of these fisheries needs urgent attention from Government and donor organisations.

Industrial trawler owners should heed the lessons learned from UNIMA's efforts to reduce costs. Large scale capital adjustments can be made to fishing vessel operations to make them more economically efficient. Such savings could be transferred to business models that can support a change in vessel remuneration systems. Considerable effort is required

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to change the company/crew psychology of a high focus on bycatch collection.

Where governance is weak, it may not necessarily be the panacea to devote attention solely to strengthening capacity at government level. Professionalising fishermen in associations such as GACPM could yield considerable benefit. However, this also requires a heavy focus on education to change the psychology of trawler owners towards a focus on ecosystem based management.

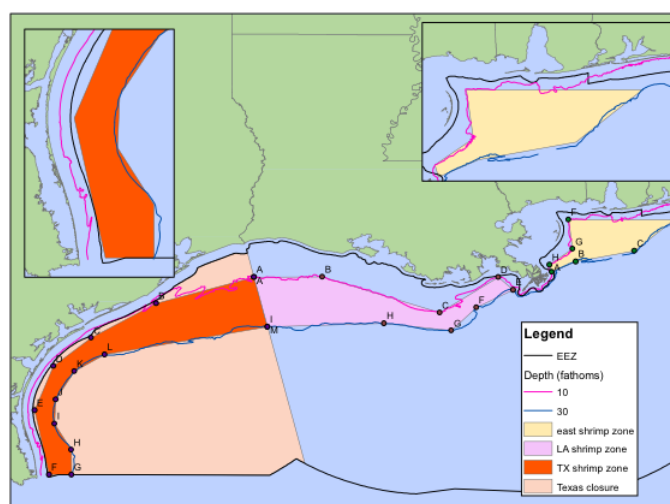
Heavy focus has in the past been placed on strengthening particular elements of Governance e.g. compliance. While this is extremely important, a much greater emphasis needs to be placed on training government officers in evolving management systems, and how these should be prioritised against a set of other objectives (most specifically economic development and growth). Best management practice should precede these.

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A.4 Gulf of Mexico and South Atlantic, USA

Feature	Description
Target species	Brown shrimp (<i>Farfantepenaeus aztecus</i>) Pink shrimp (<i>Farfantepenaeus duorarum</i>) White shrimp (<i>Litopenaeus setiferus</i>).
Byproduct	Restricted to recreational bag limits
Shrimp dependency	1:4 (20%)
Management authority	National Marine Fisheries Service (Federal waters), supported by Gulf of Mexico Fisheries Council, and South Atlantic Fisheries Council. State fisheries (9 miles Texas/ 9 miles Florida, 3 miles from other States).
Fleet segments	3,500-4,500 vessels in total. 1,389 large industrial fishing Gulf of Mexico Federal waters. 1,000 smaller semi-industrial (ice boats) in Atlantic coastal/South Atlantic Federal waters. 1,100-2,100 fishing Gulf coastal States.
Management methods	Permit required for all vessels that intend to fish for shrimp in EEZ waters of the Gulf of Mexico and South Atlantic. Restrictions on the number of Federal permits, as well as for Texas and Florida, but with movement between State lines. No restricted entry for Louisiana and Alabama. Buy back schemes operational in Texas, 48% of inshore fishing effort removed since 1995, reducing the bycatch by an estimated 40%. TEDs and BRDs are mandatory in Federal and all state waters with the exception of Louisiana, with guidelines and manuals provided. Prohibited areas and seasonal closures. Seasonal closures established to protect young shrimp, and may be from 45-90 days (Texas) Vessels with shrimp trawls or entangling net gear aboard may not exceed the recreational reef fish bag limits. Louisiana has a minimum size limit on white shrimp.

Gulf of Mexico Shrimp Closure Zones



History	Fisheries Management Councils formed as from 1976 under Magnuson-Stevens Fishery Conservation and Management Act
Management Plan	Fishery Management Councils, established by the Fishery Conservation and Management Act in 1976 (now called the Magnuson-Stevens Fishery Conservation and Magnuson Act). The Council prepares fishery plans which are designed to manage fishery resources from where state waters end out to the 200-mile limit of the Gulf of Mexico.

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	<p>The Council meets every two months at various locations around the Gulf coast. Before final action on any proposed rule change is taken, public hearings are held throughout the Gulf as well as at the Council meeting where final action is scheduled. Proposed rule changes are then submitted to NMFS for further review and approval before being implemented.</p>
Bycatch work plans	<p>TEDs and BRDs are central to USA and most state conservation regulations. TEDs have been increased in size to account for larger average sizes in the last 5 years. There is also a problem of repetitive capture and fatigue leading to drowning of turtles. BRDs are effective, but not for red snapper which tend to hang in the net. Scientists are attempting to find red snapper hot spots.</p> <p>Red snapper is subject to a rebuilding plan. Shrimp trawlers are allowed limited number of days at 10-30 fathoms in the Northern Gulf. As and when these days are reached certain amount of days in that zone, area closures take effect.</p>
Key features	<p>Strong focus on TEDs/BRDs, implementation and development (http://sero.nmfs.noaa.gov/sf/BRDs.htm).</p> <p>Turtle bycatch mitigation work continues.</p> <p>Insufficient focus on other bycatch species. Prohibitions are driven the recreational sector, were the focus is on preserving recreational fish as opposed to other species. Syngnathid interactions are perceived to be a problem. However, Fishery Management Councils are looking at movement towards Ecosystem based management = ECOSYM modelling.</p> <p>Observer coverage is extremely low (1%).</p> <p>VMS is not implemented for shrimp vessels but applied to other fisher groupings.</p> <p>IQs are not implemented for shrimp vessels but applied to other fisher groupings.</p> <p>Permits are not limited to vessel characteristics (size/hp) or gear rights.</p> <p>The sector is driven by economics. Exit and entry is linked to fuel price and shrimp price values.</p> <p>Texas reduced the size of its shrimp fleet by 25% through a buy-back scheme. NMFS now seeking to recover unused permits.</p> <p>Socio economics and coastal welfare features significantly in Louisiana where support for the fishery sector is seen as a substitute for social welfare. The State fisheries are associated with a high degree of recruitment overfishing, with small shrimp targeted in coastal waters.</p> <p>Prospect of moving to IQ system, once latent licenses withdrawn</p>
Governance issues	<p>The Council consists of 17 voting members: the Regional Administrator of NMFS (or his designee), the directors of the five Gulf state marine resource management agencies (or their designees), and 11 members who are nominated by the state governors and appointed by the Secretary of Commerce. Appointments are three-year terms with a maximum of three consecutive terms. In addition, there are four non-voting members representing the U.S. Coast Guard, USA Fish and Wildlife Service, Department of State, and the Gulf States Marine Fisheries Commission.</p> <p>The Council meets five times a year at various locations around the Gulf coast. Prior to taking final action on any proposed rule change public hearings are held throughout the Gulf. Public testimony is also heard during the meeting at which final action is scheduled. Proposed rule changes are then submitted to NMFS for further review and approval before implementation.</p> <p>When reviewing potential rule changes, the Council draws upon the services of knowledgeable people from other state and federal agencies, universities, and the public, who serve on panels and committees.</p> <p>Compliance generally strong in terms of bycatch mitigation. But there are problems associated with closed / seasonal areas. Use of VMS would resolve this problem.</p>
Strategic partnerships	<p>Shrimp Round Table. The Ocean Conservancy and the Sustainable Fisheries Partnership (SFP) are working in the Gulf of Mexico to bring together shrimp fishermen, seafood buyers, and other fishery experts to explore new and innovative ways to move this valuable</p>

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and important fishery towards sustainability. The over-arching goals of the project are to reduce the environmental impact of the Gulf of Mexico shrimp fishery, improve and strengthen management, and make the fishery more sustainable while assisting Gulf shrimp fishermen in improving quality through the transition to cleaner, more fuel-efficient fishing gear. (<http://www.youtube.com/watch?v=E-2V1qe7pnY>). Technology improvements have been developed that reduce bycatch by more than 30% and reduce fuel consumption by up to 39%. This reduction in fuel consumption will significantly reduce the carbon footprint of the fishery and provide much needed relief to fishermen struggling with the rising cost of fuel. The Ocean Conservancy and SFP are also working to engage major seafood buyers to build a market for more sustainable Gulf shrimp. Seafood buyers can be instrumental in implementing key policy reforms in the shrimp fishery, and supporting improvements in the performance of bycatch reduction devices and other fishing gear. Funding is available from research grants, low or no interest loans and a loan guarantee scheme. Sponsors are also funding specific initiatives within the scheme.

Wild American Shrimp Initiative: Gulf of Mexico shrimpers are trying to regain market share lost to cheaper farm-raised imports by advertising theirs as a better product. The campaign, financed by the eight-states, coincides with a new law requiring that many foods sold in supermarkets be labeled with the country of origin. Shrimpers are promoting their catch as more natural, tastier, fresher and more tender than the farmed imports which have taken over 87 percent of the USA market. There is no link to any sustainability assessment criteria.

Problems

Individual state jurisdictions means that number of active vessels and real effort is not known. There are 526 inactive licenses that fall under state jurisdiction.

Policies tend to be driven by short-term responses to economic issues as opposed to ecosystem management (WASI).

The USA still supports a fishing vessel structural programme (soft loans).

Insufficient focus to date on ecosystem approach, driven very much by recreational agendas and concentrated on sport fish preservation.

The observer scheme pays insufficient attention to bycatch reduction on non commercial species.

97 percent of turtles caught in TED nets can escape. TEDs reduce the shrimp catch by 10% (NMFS), but also do not overcome the problem of repeated capture.

Louisiana's social policy focus undermines the national credibility in shrimp conservation.

Lessons learned

Seasonal closures and bycatch reduction tools would seem to be the most effective mechanisms for management, but other measures (gear management/capacity reduction) are, to a large extent, redundant.

Effective buy back schemes have been partially successful, but focus now is to withdraw inactive licenses.

Difficulties to see how closed areas can be advocated without VMS applied.

Bycatch reduction and mitigation.

Shrimp Round Table has made very significant advances, with its initiatives covering some 1,100 vessels. The NGO/Private sector initiative has been extremely effective to date in marrying economics with bycatch reduction.

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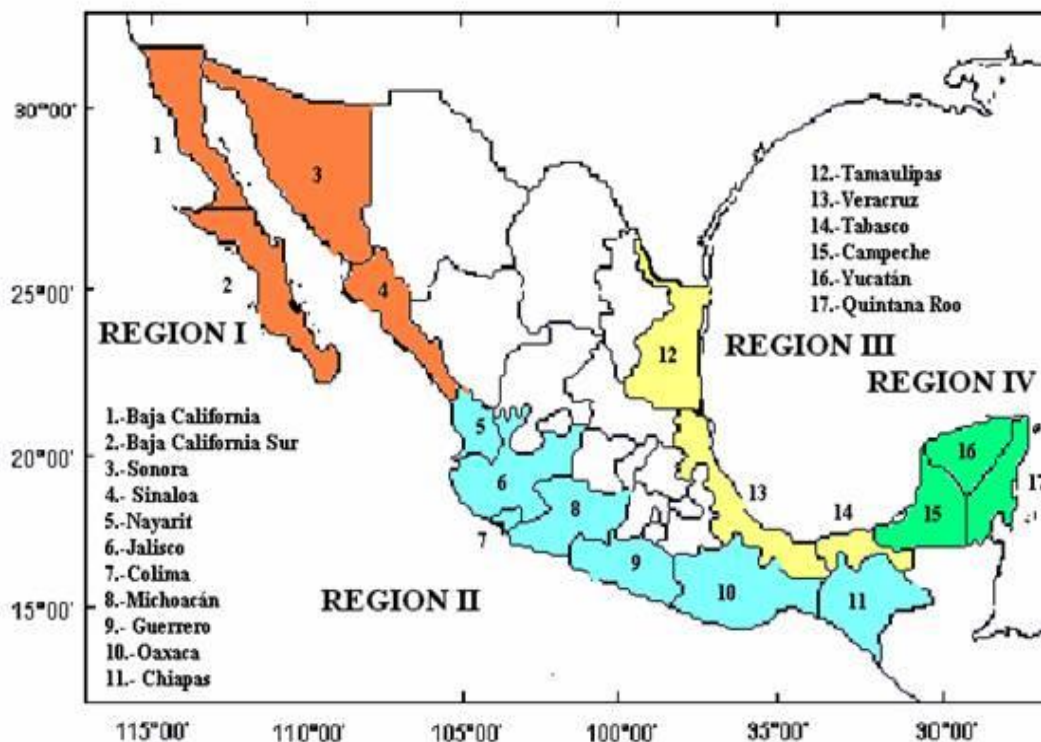
A.5 Mexico shrimp trawl

Feature	Description
Target species	<p>Pacific shrimp <i>Litopenaeus stylirostris</i> (blue shrimp), <i>L. setiferus</i> (white shrimp), <i>Farfantepenaeus californiensis</i> (brown shrimp) and other from <i>Sicyonia</i> and <i>Trachypenaeus</i>.</p> <p>Gulf of Mexico and Caribbean shrimp <i>Litopenaeus vannamei</i> (whiteleg shrimp), <i>Farfantepenaeus aztecus</i> (brown shrimp), <i>F. duorarum</i> (pink shrimp), <i>F. brasiliensis</i> (red shrimp) and other species from the <i>Sicyonia</i> and <i>Xiphopenaeus</i> genus.</p>
Byproduct	187 species of fish, 83 crustaceans and 31 molluscs. Species commonly caught as bycatch are: <i>Syacium</i> spp. (halibut, “lenguado”), <i>Lutjanus campechanus</i> (red snapper, “huachinango”), <i>Pristipomoides aquilonaris</i> (Wenchman, “voraz”), <i>Upeneus parvus</i> (dwarf goatfish, “chivo”), <i>Eucinostomus</i> spp., <i>Synodus</i> spp., <i>Trichurus</i> spp., <i>Cetengraulis</i> spp., <i>Cynoscion</i> spp., <i>Balistes</i> spp., <i>Arius</i> spp., <i>Haemulon</i> spp., and <i>Pristipomoides</i> spp. For crustaceans, a <i>Squilla empusa</i> (Mantis shrimp, “cucaracha”), <i>Calappa sulcata</i> (a crab species, “cangrejo”), <i>C. flammea</i> (a crab species, “cangrejo”) and <i>Portunus</i> spp. (crab, “jaiba” or “cangrejo”).
Shrimp dependency	Bycatch to shrimp was 9:1 on the Pacific coast and 3:1 in the Gulf of Mexico. without BRDs, the average ratio of shrimp to bycatch is 1:10 in the Pacific and 1:3 in the Gulf of Mexico and the Caribbean.
Management authority	Commission of Fisheries
Fleet segments	2,212 Industrial offshore shrimp vessels, using either two nets (Pacific side) or four nets (Atlantic side). Industrial trawlers account for 57% of the catch (was once 82% [2000], artisanal vessel 43%. Three fleets: Region I (Gulf of California) 1456. Region II (Pacific coast): 991, Region III/IV (GoMexico/Yucatan) 703, Estimated 102,000 artisanal craft.
Management methods	<p>Buy back packages have been introduced in the past, but were ineffective as they decommissioned obsolete components of the fleet, and monies stimulated reinvestment and the Government subsequently allowed for re-entry.</p> <p>The Government is now applying an incentive scheme for artisanal vessel to stop using specific gears, and to acquire new engines, supported by a subsidised credit scheme. The concern is that the scheme is further capitalising expansion in the fishery, with newer more efficient equipment and replaced engines remaining in the fishery. CONANP, the Management Authority for the Upper Gulf of California, is supporting the replacement of shrimp drift gillnets by the shrimp trawling prototype RS-INP and promoting the voluntary definitive retirement of artisanal fishers were not mentioned.</p> <p>Normas Oficiales Mexicanas, NOMs (NOMs) regulate mesh sizes, types of fishing gear used, spatial-temporal restrictions and other features. Open and closed seasons are additional management strategies.</p> <p>No restriction on fishing power or its modifications exists either.</p> <p>Gear specifications: 37.5mm cod end mesh size; a maximum legal size of headrope for the artisanal "MagdalenaI" system (13.5 m).</p> <p>Seasonal closures (applied to High seas, estuaries and bays). Fishing season is modified according to the results of biological research. These apply to artisanal vessels for lagoons and estuaries; But there is some non compliance by this segment in the closed season. Industrial vessels must have VMS.</p> <p>Area closures: Established for the protection of juvenile shrimp like the coastal waters (up to 15 n.milesfrom shore) and lagoons in the Yucatan peninsula. Also, trawling is forbidden in waters of less than five fathoms. Some access is allowed to MPAs on submission of EIAs.</p> <p>Area closures for shrimp fleets at the Upper Gulf of California in sake of vaquita (<i>Phocoena sinus</i>), a rare species of porpoise, conservation.</p> <p>TED & BEDs are mandatory in the industrial fleet, and for all artisanal trawlers greater than 10 GT.</p> <p>Artisanal quotas, managed through fisher cooperatives, introduced as a pilot in the artisanal sector for Sinaloan artisanal shrimp fisheries during 2009 and 2010, with extensive logistical support to data collection (184 landing sites). TACs are set for bays and lagoons. The quota system will be extended to the industrial trawl sector over the next two seasons. But it has been important to demonstrate order on the artisanal sector in order to secure the support of the industrial sector. The</p>

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pilot study has shown a marked increase in compliance.

Location



History

1994: Gear restriction introduced (mesh sizes, closed seasons, closed areas, BEDs and TEDs)

Shrimp Management Plan for shrimp fisheries, updated regularly.

2004 VMS – Industrial fleet only

2007 Ecosystem Based Management included as a component of the management Plan.

2009 EIAs have to be submitted to allow fishing inside sensitive areas (MPAs).

Management Plan

Management Plans (Planes de Manejo) are new instruments aimed at providing guidelines and strategies to manage particular fisheries stated as a particular objective in the recent Sectoral Plan.

The fishery is managed as follows:

- The General Law of Sustainable Fisheries and Aquaculture defines access rights and obligations for users;
- The “Ley de Metrología y Normalización” regulates the generation of Official Standards;
- The General Law for Cooperative Societies regulates fishers’ organizations;
- The “Ley General del Equilibrio Ecológico y Protección al Ambiente” (LGEEPA) protects the environment;
- Mexican Official Standards states rules for fishing gears and operations (Mexican Standard for shrimp fisheries NOM-002-PESC-1993 and its modifications decreed in November 2006 and July 2007);
- The National Fisheries Chart provides official statements about stock status and management strategies. Strategies are defined by management plans (e.g. the Management Plan for Shrimp Fisheries of the Mexican Pacific Ocean);
- The National Committee for Fisheries and Aquaculture negotiates management and ordinance policies, amongst other things, determine the lengths of closed seasons, with fishers and fleet owners. There is where co-management occurs;
- Management plans of NPAs, MPAs and other special protection areas are also taken into account.

The Committee included Government and industry, but not State or Municipal Governments, and NGOs. Academics are invited to participate.

Ecosystem Based Management formerly included from 2007 with new general law of fisheries and

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aquaculture. It is yet neither defined nor implemented.

Governance Principal institutions Commission of Fisheries and National Fisheries Institute (INP). The agency responsible for fisheries management, monitoring and enforcement is the National Commission of Aquaculture and Fisheries (Comisión Nacional de Acuicultura y Pesca, CONAPESCA).

The National Fisheries Institute (INP) bears responsibility for, among others, assessment of the status of national fisheries as well as the evaluation of fishing gear. INP has the function of defining levels of fishing effort applicable to species and groups of species in specific areas and giving guidelines, strategies and provisions for conservation, protection, restoration and management of aquatic resources that could affect their habitat and ecosystems. This modification of the Fisheries Regulation gave the CNP a binding character that must be considered in the process of decision-making by management authorities.

Major stakeholders include the industrial fishermen, most of them grouped under the National Fisheries and Aquaculture Industry Chamber (Cámara Nacional de la Industria Pesquera y Acuicola, CANAINPESCA). Artisanal fishermen are usually organized in fishing cooperatives, grouped under the National Confederation of Fishing Cooperatives. (Confederación Nacional de Cooperativas Pesqueras, CNCP) However, there are many cooperatives not affiliated to that organization. Many fishermen belong to “Social Solidarity Societies” (SSS) and many “free fishermen” do not belong to any group so the representativeness of the CNCP is not as complete as that of CANAINPESCA.

Before the mid-nineties emphasis was put on increasing catches, the National Fisheries Development Plan 1988-1994 set as an objective to reach the “Maximum Sustainable Yield”. In the early nineties, a change of emphasis began to take shape in part as a result of the international forums held at that time (Mexico was an active promoter of the Code of Conduct for Responsible Fisheries) and Fisheries management was incorporated in 1994 in the newly formed Secretariat of Environment, Natural Resources and Fisheries which gave due consideration to the importance of marine resources as part of natural resources. The new Fisheries Plan stated sustainability as a goal and the Precautionary Principle as a guideline. Since the end of the year 2000, at the beginning of the present administration, fisheries institutions were transferred to the (present) Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, SAGARPA) with emphasis seemingly shifting again to “promotion” (“fomento”) of the fisheries sector, although sustainability remains an objective but without the inclusion of the Precautionary Principle.

Bycatch work plans The gear and devices tested include trawl nets of new material with slightly different design and bigger mesh (2”1/4 instead of 2” or 1”3/4 depending on the area), fish eye (double or single), double foot rope and double cover TEDs. The results show that: Bycatch is reduced (25-70% reduction depending on combination of devices) and the quality of the shrimp catch is improved, i.e. larger size shrimp. The new nets, which are lighter than the old ones, decrease fuel consumption by some 30%. Work onboard, i.e. sorting of catch, has become easier and is quicker. The industry takes a great interest in the new nets considering the reduction in fuel consumption.

Key features Four main shrimp fleets in Mexico: The offshore trawl (PC, GoM): 18-25 m, 240–624 HP. PC boats, fish 9 and 64 m deep, using two trawl nets. The nets have a headline of 23–36 m, 3.81– 4.13 cm mesh in the codend. GoM boats fish 9 and 64 m deep, using four trawl nets. The nets have a headline of 10.6–13.6 m, 3.81–4.45 cminshore, seabob Magdalena fleet, are large smaller craft, using many gears (including trawl), up to 80,000 in total fishing between 5-15 m. mesh sizes are regulated. Non compliance was 40-60%.

Strategic partnerships WWF and Environmental Defense Fund (EDF) and the Commission of Fisheries examination of fuel efficiencies. Draft technical report on test of selective trawling prototypes. Economic studies. Generation of saving scenarios. Carbon trading/reduction.

Problems Open access continues.

Overcapacity / declining CPUE.

Subsidies – diesel, new engines.

Conflict between industrial and artisanal (violent).

Non compliance 40-60%.

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Juvenile shrimp targeted by the artisanal sector.

Strong resistance from the sector to effort control.

Resistance to IQ system by the industrial fleet against the background of lost fishing opportunities to the industrial sector.

High levels of discarding. Bycatch to shrimp was 9:1 on the Pacific coast and 3:1 in the Gulf of Mexico. Without BRDs, the average ratio of shrimp to bycatch is 1:10 in the Pacific and 1:3 in the Gulf of Mexico and the Caribbean. Bycatch is generally not used or wanted.

Lack of management of the interactions between the three different types of shrimp fisheries in Mexico (high seas, bays, estuaries).

There is a fuel subsidy for all shrimp fishing vessels (industrial and artisanal).

Lax enforcement of closed seasons and other measures.

Lessons learned

The need for greater stakeholder consultation in management planning.

A much heavier focus on bycatch mitigation, and species sustainability within Management planning.

The need to establish management controls on inshore fishing activity.

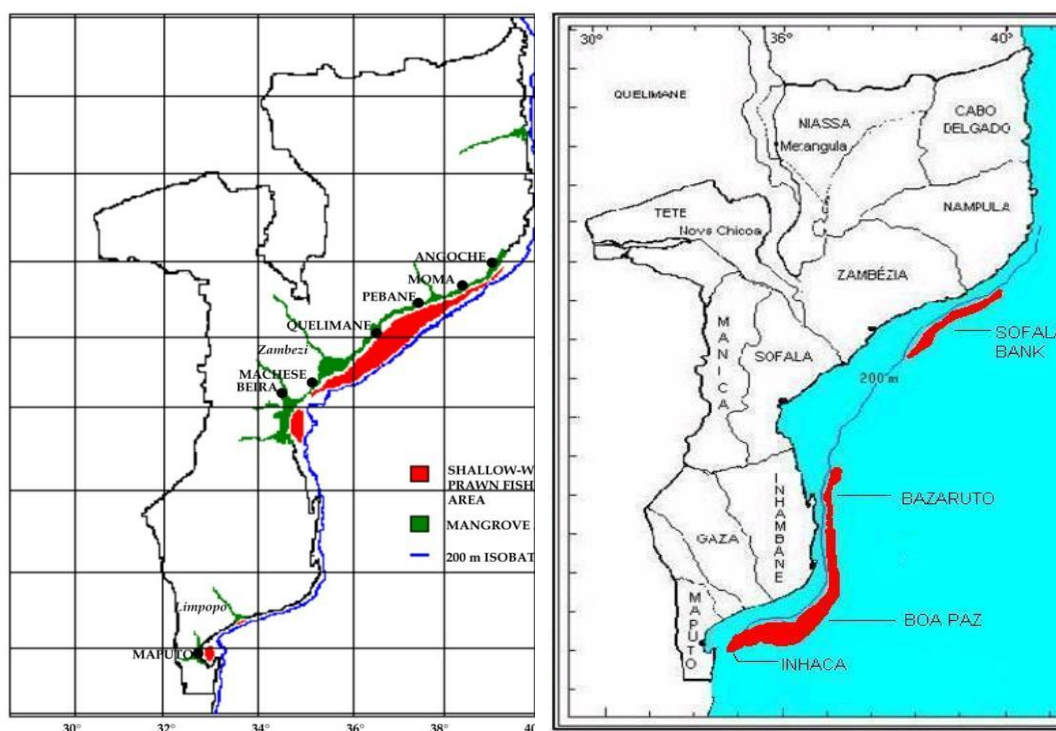
The need to establish management systems that are devoid of political interference.

The system of Community quotas and ITQs is very expensive to police, given the size of the fleets. Regional fisher cooperatives may be able to reduce the costs by participating in co-management initiatives.

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A.6 Deep and shallow waters prawn fisheries, Mozambique

Feature	Description
Target species	Shallow-water fishery target shrimp species comprising: <i>Penaeus indicus</i> and <i>Metapenaeus monoceros</i> , with lesser quantities of <i>P. japonicus</i> , <i>P. latissulcatus</i> , <i>P. monodon</i> and <i>P. semisulcatus</i> ; Deepwater fishery target shrimp species comprising <i>Haliporoides triarthrus</i> , and amounts of <i>Aristaemorpha foliacea</i> , <i>Aristeus antennatus</i> , <i>Plesiopenaeus edwardsianus</i> , <i>Penaeopsis balsi</i>
Byproduct	Shallow waters: sciaenid <i>Otolithes rubber</i> , Deeper waters: <i>Metanephrops mozambicus</i> (langoustine), <i>Chaceon macphersoni</i> (crab) and <i>Palinurus delagoae</i> (deep-water spiny lobster)
Shrimp dependency	1:2 to 1:5 (25% to 10% depending on season) 1:12 for deepwater (crustaceans : other organisms)
Management authority	The Ministry of Fisheries comprises several divisions (but explicitly DNAP (National Directorate of Fisheries Administration))
Fishing zone	



Fleet segments
 43 industrial shallow water including 7 industrial deep (9% of the catch)
 44 49 semi-industrial (6% of catch)
 15,250 artisanal (3% of catch)

Management methods
 Restricted entry licensing for shallow waters, but no cap on deep-water licenses.

There are no license limits or catch limits for the artisanal sector (shallow-water), although once the current levels of effort (gear and fishers) are established by census it is intended to cap them at this level. Both the semi-industrial and industrial shallow-water sectors have a cap on the number of licenses.

The semi-industrial ice vessels (shallow-water) do not have catch limits (quotas). The industrial fleet (including semi-industrial freezer vessels) has an annual TAC for shallow-water prawns (all species combined), which is determined based on input from the research agency IIP. The TAC is allocated to companies as quotas by the ministry at an open consultative forum (the Fisheries Administration Commission - FAC) before the season starts.

The FAC is a body comprising representatives from the ministry and industry. It is not clear exactly how the quotas are allocated to each company (number of vessels is a factor), but DNAP maintains that it is an "open" process. DNAP would like to move towards allocating quotas per vessel.

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The deep-water fishery is not managed by a TAC, but quotas are issued for prawns and langoustines.

6-month closed season for the shallow-water fishery extending from September to March (the exact dates vary annually based on input from IIP and industry at the FAC); for semi-industrial boats in Maputo Bay, Limpopo and south of Beira, the closed season is only two months (January - February), while the deep-water fishery operates throughout the year.

Both deep-water and shallow-water trawl nets have a minimum mesh size of 55mm.

No bycatch reduction devices are used, although some skippers may rig their gear in order to reduce bycatch of soles, for example by leaving a gap between the footrope and the ground rope.

TEDs required by Law but not implemented.

Obligatory 2:1 bycatch:prawn ratio.

Industrial vessels are not allowed to trawl within 3n.miles of the coast, and semi-industrials have to operate beyond 1n.miles of the coastline.

Industrial vessels are required to use VMS; trawlers have to submit summarized catch statistics every 10 days to DNAP, and must submit logbooks annually.

While the inspectorate is under-resourced in terms of manpower and other logistic support, it is generally acknowledged by both industry and those involved in compliance, that adherence to regulations has improved in the last year, since the advent of the Monitoring, Control and Surveillance (MCS) campaign with it's associated use of a patrol vessel and at-sea inspections.

Scientific observers are placed onboard trawlers, although this activity appears to be limited; trawl logbooks are submitted to the ministry and scientists, and trawler catch reports are submitted every 10 days; trawl landings are monitored by inspectors.

History Artisanal vessels not controlled. And there is a growing problem in the use of mosquito nets.
The industrial shrimp fishery only developed from the late 1960s

From 1976 Mozambique controlled access and effort.

Management Plan DNAP is in process of finalising a comprehensive "Management Plan" for the shrimp fisheries of the Sofala Bank.

Objective: The Sofala Bank shrimp resource exploited so as to provide maximum overall net benefits (economic, social and financial) to society, for poverty reduction, in a framework of the sustainability of the resource in particular and of the aquatic ecosystem in general.

Governance This objective can be achieved through the following outputs: (1) reduced fishing effort on the Sofala Bank shrimp resources; (2) strengthened fisheries administration and surveillance capacity to better control the evolution of the fisheries and enforce laws, regulations and management measures; (3) increased knowledge about the resource and the fisheries in order to follow their evolution, and so that the recommended management measures may be more effective; (4) revised some aspects of the organisation of the three fisheries that exploit the common shrimp resource; (5) reduced operational costs for the various fishing fleets, and (6) increased added value of the exported product.

Some important structures are created in terms of the Act, including the Committee for Co-Management of Fisheries which is the main forum for participatory management. Access to marine resources is controlled by DNAP (National Directorate of Fisheries Administration, of the Ministry of Fisheries), which issues licenses and quotas. DNAP convenes the Fisheries Administration Commission (FAC), which comprises all stakeholders, including representatives from management, compliance, research, product quality, small-scale fisheries and industry. The Commission meets quarterly to discuss management of the prawn fishery, and makes recommendations regarding the setting of TACs and quotas.

Harvest control rules TACs and closed seasons.

Bycatch work plans There is a strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality but compliance is poor. There is no specific spatial plan to reduce habitat impacts.

Key features The Ministry of Fisheries comprises several divisions, including DNAP (National Directorate of Fisheries Administration), which controls access to resources by means of issuing licenses and quotas;

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and

IIP (the Fisheries Research Institute) undertakes biological research to establish biomass and stock status of resources.

DNAP is in process of finalising a comprehensive “Management Plan for the shrimp fisheries of the Sofala Bank (PGC/BS). Inputs in June-August 2009 were based on the formation of an “Ecosystem Approach to Fisheries. Implementation of the plan and recommended effort controls are anticipated for the 2010 fishing season.

Actual fishing effort in 2007 was assessed as being about 18% higher than the target effort of 220 000 standardised trawl hours²⁸. Note that this was before the 6-month closed season was instituted.

All three sectors (artisanal, semi-industrial and industrial) are required to have and pay licences. The freezer semi-industrial vessels are effectively managed as industrial vessels.

There appears to be limited adherence to the requirement for landing twice as much bycatch as prawn – industry pays a levy for this based on their quota allocation, regardless of whether they land the bycatch or not, and consequently there is little incentive to fill up their freezers with bycatch.

Only about 60% of vessels submit logbooks. Although required by law, the VMS system is not fully operational.

TED use has been exempted by DNAP as a result of representations made by industry at DNAP – particularly relating to a lack of knowledge about TEDs.

The administration of fishing is expressed locally in the provinces and districts. The administration of semi-industrial and industrial fishing is exercised by the provincial fisheries administration body, currently integrated into the Provincial Fisheries Directorates (DPPs). In the districts, any power in terms of licensing and inspecting artisanal fishing has been, as from 1 October 2006, exercised by the district administrator or by the body to which he/she delegates this task in the District Services for Economic Activities.

The IIP undertakes annual stock assessments for the shallow-water and deep-water industrial trawl fisheries, and makes recommendations to the ministry on appropriate TAC/quota levels and timing of the closed season. Assessment of the shallow-water industrial fishery is based on a range of data sources, including monthly catch production and vessel characteristics, logbooks, biological sampling and an annual pre-season recruitment survey (always using the same vessel). The assessment incorporates factors affecting the catch rate and mean weight of the two main species, such as location, seasonal trends, depth, time of day, vessel type and biological characteristics of these species. Consultants from Australia and Norway are contracted to assist with the assessment, which is essentially a yield- and value-per-recruit assessment incorporating a stock-recruit relationship. In 2007, a target $F_{0.1}$ level of $\sim 2.2 \text{ yr}^{-1}$ was determined separately for these two species and for both species combined, and F_{current} at that stage was calculated as 3.5 yr^{-1} for *P. indicus*, 2.2 yr^{-1} for *M. monoceros* and 3.3 yr^{-1} for both species combined.

Actual fishing effort in 2007 was assessed as being about 18% higher than the target effort of 220 000 standardised trawl hours²⁹. Note that this was before the 6-month closed season was instituted. Overall CPUE for deep water prawns (dominated by *H. triarthrus*) has remained remarkably constant since 1990.

Problems Biomass, and consequently catches and the CPUE are currently at their lowest levels ever.

The total quota distributed for each annual campaign (9,285 tonnes) exceeds by almost 30% what should have been the TAC of 7,200 tonnes recommended by the research.

TAC restrictions alone are not sufficient to adequately manage the fishery, and are combined with effort control (closed season), although the effective level of effort is not known owing to effort creep.

²⁸ IIP use a “standard vessel” based on historic effort levels of a subset of vessels in the fishery. Effort is either raised or lowered for vessels of lesser or greater power.

²⁹ IIP use a “standard vessel” based on historic effort levels of a subset of vessels in the fishery. Effort is either raised or lowered for vessels of lesser or greater power.

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Non-prawn bycatch is far greater than the target catch, and the majority is discarded. A large variety of species (mainly fishes, but also cephalopods and other crustaceans) and substantial quantities are involved.

For the two main shallow-water target species *P. indicus* and *M. monoceros*, there appears a conflict relating to stock status with one species apparently recovering (*P. indicus*) and the other species declining.

A commonly discarded fish species (*Otolithes ruber*) is reported to be over-exploited in the mid-1980s and there are reported declines in mean length of trawled *O. ruber*. Because of the large bycatch and range of species caught (including large pelagic species and sharks, predominantly in the shallow water trawls), ecosystem cascade effects are likely.

The system of collecting fishing license fees by volumes allocated in a factor of pressure to increase fiscal revenue.

The current difficulties ensure that some ship-owners are abandoning the fishery or selling their vessels to the large companies that replace them with vessels that have greater operational capacity.

Loggerhead and green turtles do occur frequently in trawls and in artisanal beach-seines; leatherbacks far less frequently. Estimates of numbers (~2 000-5 000) caught by the former sector are questionable, and estimates for the latter are not readily available. It is likely that some red-listed elasmobranchs are also caught, but detailed information is not available.

There is a fuel subsidy for Mozambican-registered vessels.

The performance of the MCS system has not reached the level required. It did not prevent breaches of the law and fishing regulations.

Actions **Reduced fishing effort – first pre-condition for making the objectives viable on time**

Components of the management plan are:

1. Withdrawal of fishing effort by the State;
2. An initial reduction in the total quota allocated in the industrial fishery, with a corresponding decrease in the number of vessels;
3. Extension of the closed periods;
4. If deemed necessary, a second adjustment in the total quota allocated in the industrial fishery, with a corresponding decrease in the number of ships;
5. Cancelling unused fishing licenses;
6. Restricting the concentration of quotas in the industrial fishery;
7. Negotiating the replacement of vessels;
8. Confirmation of the current rule on dispensing with the requirement for a minimum tonnage before chartering fishing vessels envisaged in the RGPM;
9. Introduction of sanctions envisaging the loss of fishing rights;
10. Improved control over the industrial and semi-industrial catches through a quota system.

Strengthened MCS system (research, fisheries administration and enforcement) – the second pre-condition for making the objectives viable in due time

1. Strengthen the capacity of the fisheries administration;
2. Restructuring of the fisheries administration (DNAP) at central and provincial levels;
3. Training fisheries administration staff at central and provincial levels;
4. Strengthening and expanding data collection concerning the activities of the fleets in the two fisheries;
5. Making analyses in order to increase the cost-effectiveness and cost-efficiency of the fisheries administration in general;
6. Strengthen inter-sector cooperation concerning the two non-artisanal fisheries;
7. Strengthen regional cooperation concerning the two non-artisanal fisheries;
8. Review the regulatory framework and the sanctions with regard to these two fisheries;
9. Strengthening fisheries inspection;
10. Regular aerial and maritime patrols in the Sofala Bank shrimp fishing areas, especially in the areas and seasons of greatest risk, now noted;
11. Training fisheries inspection staff at central and provincial levels;

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12. Put the VMS system into operation, regularly supplying data on fishing activities in the industrial fishery;
13. Strengthen and expand inspection from the base ports;
14. A policy of intervention for the artisanal fishery sector;
15. Definition of a typical district structure and organisation, with a clear definition of the attributes and powers of the administrator, of the district structure responsible for fisheries administration, and the role of the CCPs;
16. Training of fishery administration and inspection staff at district level;
17. Establishment of the participatory fishery management bodies at district level;
18. In the particular case of the beach seining fishery, definition of the number of units to be licensed in the district, for the various fishing centres.

Greater knowledge provided by research into the shrimp resource and the various fisheries that exploit it

1. Improved gathering of the actual fishing data (catch, effort, biological data);
2. Discards of small shrimps and bycatch in the industrial fishery;
3. Use of the bycatch either by the industrial and semi-industrial fleet or through exchanges established with the artisanal fishermen;
4. Volumes and composition of shrimp catch by artisanal fishing in the various areas.

Lessons
learned

DNAP demonstrate a strong profile towards good management. However, it is important to realise that in the case of Mozambique, this comes from a strong history of donor support.

Positive signs are that all the right mechanisms are there to control effort, and actions have been taken without political interference.

Industry reluctance to endorse BRDs and TEDs is a worrying issue. Species appear to be on the verge of ecosystem cascades, and there are considerable concerns about turtle and elasmobranch interactions. The imposition of the TED programme (as per USA and Australian examples) should have been supported with a heavy emphasis on training.

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A.7 Suriname

Feature	Description
Target species	Atlantic seabob (<i>Xiphopenaeus kroyeri</i>) <i>Penaeid shrimp</i> (known locally, and in the text below, as marine or Atlantic shrimp)
Byproduct	Bangamry (<i>Macrodon ancylodon</i>), Rockhead (<i>Larimus breviceps</i>)
Shrimp dependency	1:0.4 (71%) seabob. Atlantic not known
Management authority	Suriname Fisheries Department
Fishing zone	
Fleet segments	In 2010 20 vessels licensed to catch seabob in Suriname, and 31 marine shrimp vessels.
Management methods	<p>TEDs since 1999, and BRDs in the process of introduction. Suriname implemented VMS for all marine shrimp and seabob vessels. Input management measures are in use in the shrimp trawl sector, and represent the main method of fisheries management, and are tied to licence conditions. These measures include restrictions on:</p> <ul style="list-style-type: none"> • Licensing, coupled with days at sea restrictions • Maximum engine size • Demarcation zones for specific fisheries based on fishing depth (Suriname's seabob fleet is prevented from fishing within the 10 fathom (18m) contour, and the marine shrimp from inshore of the 30m contour) <p>There is no robust data to determine whether the existing fleet licences (31 in the marine shrimp sector and 20 in the seabob sector, following recent reductions in order to be precautionary) represent overcapitalization or not, and so no basis at the present time on which to justify any additional reductions in existing licence numbers</p> <p>Licence conditions for marine shrimp vessels already include a minimum landing size for marine shrimp. However, given the current state of knowledge, it is considered too early to consider quota management or other forms of output management</p>
History	<p>Seabob in 1996. Commercial <i>penaeid</i> fisheries commenced in the 1960s. Since the late 1990s the CARICOM Caribbean Regional Fisheries Mechanism (CRFM) has convened an annual joint meeting of local and international fishery scientists is tasked with working up available data for the purpose of providing stock management advice.</p>
Management Plan	<p>Policy intent: <i>To manage, regulate and promote the sustainable utilisation of the country's fishery resources for the benefit and safety of all stakeholders in the sector and the nation as a whole.</i></p> <p>There is a draft fisheries management plan from 2000, but this was never formally adopted, and more recently a draft seabob management plan has been developed jointly by industry and the government and is awaiting formal ratification. Management of the marine shrimp sector is less advanced.</p>
Bycatch work plans	None
Key features	<p>On balance, industry practice is largely left to the good practice and self-constraint of the industry operators. It is evident that both the industry and government in Suriname are likely to be more responsive to industry-initiated developments than is the case in Guyana.</p> <p>The industry holds substantial accurate and detailed data records on the evolution of this</p>

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fishery through its pack-out records.

Suriname has a tight inspection regime on landing, along with VMS (Guyana has neither). It is also noted that some seabob shrimp trawl sector companies in Suriname are currently supporting (and paying for) MCS activities through the provision of fishing vessels to act as marine platforms for surveillance activities by the Ministry of Defense, and through regular reporting of illegal vessel sightings.

To date there has been very little, if any, sharing of information between fisheries departments in Suriname, Guyana, and French Guiana.

The government of Suriname has signed up to FAO's regional bycatch reduction programme.

The use of TEDs is routinely checked by Fishery Department staff in Suriname (but no equivalent controls are in place in Guyana). WWF Guianas is also particularly active in promoting the conservation of turtles – through awareness raising programmes, and promotion of improved practice to artisanal and industrial fishermen.

Problems

The draft seabob management plan contains a HCR, but the marine shrimp sector has no such mechanism in place and is overall far less well organized/managed.

No formal stock assessment has been undertaken for either fishery.

MCS activities are poorly planned and not based on risk assessment (of key times, locations, operators, etc)

The 2004 CRFM workshop, using 2003 data from both Suriname and Guyana, recommended that fishing effort should be reduced from an average of 335 vessel-days per month (average of 14 days per vessel per month – 3,500 kg of seabob per vessel day) to 210 days for the Suriname fleet (9 days per vessel per month), and reduced from 1,0382 (average of 12 days per vessel per month – 1,320 kg of seabob per vessel day) to 900 vessel-days per month for the Guyanese fleet (also 9 days per vessel per month).

Over the last twenty years, FAO and other international development agencies have been working to build and strengthen fisheries management capacity throughout the region, including Suriname and Guyana. Such efforts have yielded some steady improvement, but such gains have often been undermined by high turnover in staffing and inadequate budgets

Consultation processes are in place and there is evidence of their effectiveness (notably in the introduction of a closed season), but the quality of information on which decisions are made is poor, and the transparency of decision-making can be questioned.

Lessons learned

No formal management system in place: the importance of integrating stock assessment with structural and effort control, and integrating these into HCRs should be emphasized.


More stringent use of HCRs is required as a mechanism to protect gravid females, and in the absence of other effort limits, to control effort.

Strengthening of Government capacity is needed.

Marked-based incentives, such as the ongoing MSC assessment process for the seabob fishery, have proven to be a significant catalyst of change for the better.

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A.8 Arafura Sea and Mareoke, Papua, Indonesia

Feature	Description
Target species	Banana shrimp (<i>P.indicus</i> , <i>P.merguensis</i>) 35.1%; tiger shrimp (<i>P.semisulcatus</i>) 23.6 %; Endeavour (<i>Metapaneus ensis</i>) 23.2%.
Byproduct	Flounder, rays, giant threadfin, scad, squid, octopus, Selaroides, snapper, fringed scale sardinella
Shrimp dependency	1:8-15 (8%)
Management authority	MMAF
Fishing Zone	 <p>The map shows the Arafura Sea and Mareoke region in Papua, Indonesia. It includes labels for various provinces such as Irian Jaya, West Irian, and Central Irian. Key locations like Sorong, Ambon, and Jayapura are marked. The Arafura Sea is highlighted in blue, and the Mareoke Sea is highlighted in red. The map also shows the Indonesian archipelago and the surrounding waters.</p>
Fleet segments	90 domestic industrial trawlers in the Arafura sea (and Mareoke), from 50-> 200 GT. These are based in Sorong , Mareoke, and Ambon. 200 additional foreign boats fishing under access agreements. However, details of the agreements are unclear.
Management methods	Open access, but more recent emphasis on reducing the numbers through non-renewal of licenses for bad practice/non compliance. TAC set at 17,200 t. Companies receive allocations based on vessel GTs. Trawling is permitted in waters deeper than 10 m. Presidential Decree No 1, 1975 25 mm minimum mesh size. Fisheries Decree No. IK.010/S3.80.75/1982 requires that trawlers in the Arafura area deploy TEDs, and Fisheries Decree No. 868/Kpts/IK.340/ II/2000 requires that a BRD be installed on the body of the trawl. Trawlable area is the eastern part of 130° longitude line and beyond 10 meter of isobath line (Presidential Decree No. 85 of 1982). Trawling has also just been permitted in East Kalimantan. All gear should be < 350GT (Ministry of Agriculture Decree No. 392 of 1999). Observers are required by Law (for trawlers), but insufficient in number. Around 20 in total.
History	1975: First shrimp trawl management measures introduced. 1982: Trawling for shrimp is restricted to the Arafura Sea (Eastern Indonesia), and outside 10 n miles in this zone. 1999: TACs introduced. 2000: TED and BRDs made compulsory.
Management Plan	No management plan in place.
Bycatch work plans	There are no workplans. Very little observer coverage, 20 observers for 1,000 trawlers.
Key features	Shrimp fishing is conducted throughout the year, July-December in the Arafura Sea (banana shrimps), and is the months of January/February in adjacent Mareoke (Tiger shrimps). However, there is no closed season. Trawl ban was initiated in most areas in 1982, but generally circumvented, which includes some allowance for foreign vessel activity.

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Licensing and registration mechanisms are weak, and subject to political interference. Presently, no new licensed vessels allowed.

Illegal activity and poor statistical / data collection. HPPI members cooperate, but this is 30% of the sector (90 of 300 vessels). There does not appear to be any formal reporting procedure for licensed foreign vessels.

Decreasing trend in shrimp CPUE in recent years. Catch/vessel/day has decreased from 300–350 kg per day two decades ago to the present 250–300 kg.

Arafura Sea stock is over-exploited and fishery should be reduced to around 50% of 1993 levels. The average size of the fish and shrimp are smaller and smaller.

Increase in fuel price caused a 25% reduction in effort between 2008 and 2009. The main casualties being foreign owned vessels fishing under access agreements (BRPL).

High discard level of industrial shrimp trawlers in the Arafura Sea. Bycatch dependencies increased from 1:10 to 1:15/20, 60% is discarded. 500,000 t fish caught from shrimp trawl from 35,000 t.

Very large number of non trawl vessels active in other parts of the archipelago – shrimp nets, Danish seine, beach seine, drifting gill net, trammel net, stowed net. These fish inside the 10 m isobath.

TAC system (Fisheries Decree No. 995/1999) is not supported by robust scientific analysis, and there is only partial recording of the uptake.

Stock assessment is qualitative, and based on 80% BLim. Last stock assessment undertaken in 2001, but CPUE changes measured annually.

Biological impacts of industrial bycatch is significant.

Some appropriate measures to mitigate bycatch problems (mesh sizes, more appropriate BED).

Enforcement is intermittent.

Non-target species include: pelagic fish, demersal, cephalopods, sharks and rays. Evidence that small shrimp are caught.

National companies pay wage dividends for larger prawns, and use try nets pre-fishery to ensure larger prawns are caught, but some trawl companies still pay crew remuneration from fish sales. The feedback though is that discards/most other retained species (except squid) are seen as a nuisance.

Turtle interactions reduced because of the application of TEDs.

Fuel subsidy removal for industrial boats combined with an open access system has resulted in the collapse of some fisheries in the country. This policy has resulted in bringing many fishing companies to the brink of failure, especially those operating vessels larger than 30 GT in the Arafura Sea. The operational fleet is reported to have fallen to around dedicated shrimp 90 trawlers, but with some companies only operating at 75% capacity.

Conflicting administrative responsibilities in licensing (offshore under national jurisdiction, inshore under Provincial and District).

At Provincial level, the main management objective appears to be the generation of government revenue and, to a lesser extent, mitigation of conflict.

MMAF applies a licensing system to domestic and foreign trawlers with fees, but fees are absorbed by the Ministry of Finance and not transferred to control or research.

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Many of the problems in the management of fisheries in the country relate to enforcement difficulties, and lack of finance to deploy resources.

Recognition of what needs to be done, much positive aspirations, but little political will to implement.

Governance

MAFF responsible for management decision making. The laws are in place but there is no implementation. The ability to implement is hampered by lack of human and financial resources, and political interference. A National Committee for Fish Stock Assessment exists and TACs and individual company quotas are set each year. The scientific basis for the assessment relies on a stock assessment in 2001, along with CPUE data collated from a limited number of fishing companies (HPPI members). MAF has very limited means of checking the landings data, with 20 observers allocated to 1,000 trawlers in the region. The Government has an increased focus on co-management, but there is questionable ability as to co-responsibility of a large number of trawler companies.

DKP Provinsi is responsible for artisanal vessels operating inside 12 n.miles. This organisation advocates a system of open access which allows for more and more vessels entering inshore fisheries. DKP Provinsi has a stronger focus on license revenue collation.

The Association of Indonesian Shrimp Catching Companies is responsible for 30% of the trawler sector. Its membership represents 90 vessels, or the original participants. The fishery has since expanded to 200 trawlers (mostly foreign). HPPI is responsible for the dissemination of regulations to its members, and converses with Government. However, there is no formal structure, and HPPI would support the creation of a management committee. The organization advocates a policy of license control and seasonal closures as a means to restrict effort.

Currently, four Sorong-based companies conducted shrimp fishing with trawls. The companies are: PT. WIFI (Western Irian Fishing Industries), PT. DBU (Dwi Bina Utama), PT. AKFE (Alfa Kurnia Fish Enterprise), PT. IMPD (Irian Marine Product Development).

Strategic partnerships

UNEP/GEF/FAO and Southeast Asian Fisheries Development Centre (SEAFDEC) has developed Juvenile and Trash Excluder Device (JTED)

Problems

Fleet expanded threefold since 1980. Overfishing with declining CPUE and increased reliance on bycatch species.

Foreign fishing largely unregulated.

Some crews receive income from the bycatch, which reduces incentive for greater selectivity.

Acceptance of the need to manage, but no political will to implement.

No restrictions on the numbers of artisanal boats entering the fishery, and differences in provincial and national policy goals.

Centralized administration, too remote from fishing and subject to political interference.

Inadequate resources allocated to stock assessment.

Inadequate resources allocated to management, and control and data validation.

Weak formal management / stakeholder dialogue in place.

Some discussion on processing (mechanized conversion of trash fish to surimi).

Lessons learned

Need for increasing resources for management, research and compliance.

Focus on effort reduction programmes, limited entry licensing and effort control through seasonal closures and other associated measures (eg gear SFRs) required.

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Improved focus on gear selectivity. Weight of the gear and bycatch exclusion.

Business structure that rewards crews through bycatch retention reduces selectivity, so need to focus on other business drivers, e.g. fuel savings.

Improved observer presence to ensure implementation of bycatch exclusion devices, bycatch and catch recording.

The need for training in gear application, possibly by education from observers.

Improved data collection methods to gain information on by- catch and related problems, as well to monitor bycatch management measures.

Greater integration of stakeholders into management planning and means to prevent political interference, i.e. adoption of performance indicators, and peer review process.

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A.9 Kerala and Orissa shrimp fisheries, India

Feature	Description
Target species	Kadal shrimp (<i>Mtopenaeus dobsoni</i>), west coast Kiddi shrimp (<i>Parapenaeopsis stylifera</i>), west coast Kuruma shrimp (<i>Marsupenaeus japonicus</i>), ^w West coast Indian shrimp/Red legged banana prawn (<i>F. indicus</i>), west coast Grooved tiger prawn (<i>Penaeus semisulcatus</i>) east coast.
Byproduct	15 species identified for stock assessment purposes. New development into deepwater shrimp fishing. Ribbon fish, pomfrets, silver bellies, croaker, threadfins, soles but up to 400 species caught.
Shrimp dependency	25% East coast. 7% West coast.
Management authority	Maritime States Fisheries Departments under the concerned State ministry and the Ministry of Agriculture under the Union government.
Fleet segments	29,000 shrimp trawlers, Mostly artisanal/semi-industrial, 85-150 hp, 12-17m.
Management methods	Closed seasons West coast 47 days, June-August; East coast 47 days April-may. 7 month closure of selected turtle corridors in Orissa. Fishery demarcation zones: No trawling inside 12 n.miles, but Orissa condones trawlers operating between 5 n.miles and 12 n.miles. Minimum mesh size of 35 mm, but 10-15 mm used. MPAs, but established largely around islands or areas of high biodiversity. Protected species including syngnathids, sponges, 10 species of shark, but largely found in coastal habitats. Compulsory use of TEDs in Orissa. No BRDs presently applied, and to be introduced under amendments to the Fisheries Act, supported by participatory management processes.
History	1897 Indian Fisheries Act. 1972 Wildlife (Protection) Act 1972. 1978 MFR (Reg) Bill. 1980 Maritime States enabled. Marine Zones of India Act 1981. Several review committees, especially in reviewing the case for closed seasons. Recommendations made but never taken up by National Government, refer to a further committees. 2009/2010 Marine Fisheries Regulation and Management Act (currently in consultation phase) incorporating ecosystem approach to fisheries management and clarifying roles of National and State Government.
Management Plan	Management plans exist but are not implemented. Management committees constituted by scientists from the research and technology institute, academics advise the maritime States Fisheries Departments on the management plans for improvement of the fisheries. Management reference points are provided for establishing limits as thresholds but not applied. Consultation with stakeholders is very limited.
Governance	State fisheries responsible up to 12 n.miles. National, responsible for outside 12 n miles. Vessels over 30m also fall under the responsibility of the National Ministry. Authority for artisanal vessels, though fishing outside 12 n miles, is delegated to the State Ministry.
Bycatch work plans	WWF / Central Institute of Fisheries Technology and Shrimp Trawlers Association working in participatory design of TEDs in Orissa. CIFT developing several BRDs for application to suite fisher specific needs. These include

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Key features	<p>Juvenile Fish Excluder/shrimp sorting device, Hard BRDs (Rectangular Grid BRD, Fisheye BRD, Oval BRD) and Soft Reduction devices (Radial Escapement Device, Sieve Net BRD, Separator Panel BRD and Bigeye BRD).</p> <p>Four maritime zones. Main shrimp trawl regions are NW (31%), SW (36%) and NE (13%).</p> <p>Open access regime, but fleet stabilized now with a policy of taking out old boats (> 20 years), and some confiscations when caught inside seasonal closed areas.</p> <p>Effort has also stabilized as a result of the closed seasons.</p> <p>CPUE declining. Total fish catch was 80 kg/hour in 1980s, now 30 kg/hour. Shrimp constitute 7% (west coast) to 25% (east coast), of total catch. These ratios (shrimp %) have remained constant throughout.</p> <p>Shrimp stocks, whilst overexploited (0.6 to 0.75 BMSY), 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.</p> <p>Some species compositions affected significantly as a result of heavy bycatch of juvenile (trash fish) eg., catfish, silver bellies, pomfret, croakers, gastropods, molluscs threadfins and other whitefish.</p> <p>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%). Some adaptations occurred to gears by a minority of multi-day trawling, and greater use of try nets and alternative semi-pelagic fishing gears (60 mm) to target finfish. These boats also focus on specific shrimp seasons, as and when catch rates are higher.</p> <p>Boats increasingly switching gears as a result of target species – shrimp or finfish. Finfish nets have larger mesh sizes, but still retain some shrimp. Semi-pelagic gear also being used.</p> <p>The average % juvenile trash fish is around 15%, but income from juvenile trash fish less than 2%. Hence, the need for heavy focus on reduction of juvenile fish bycatch.</p> <p>Shrimp Trawlers Association agrees focus on bycatch reduction (Gujarat). Members now reducing trawl times to 1 to 1.5 hours, some adoption of square meshed panels in the cod end (60 mm upper net for fish) and 20 mm in the lower net. Square meshed panels reduce resistance from the net, reduce sorting, results in improved shrimp and fish quality, and some minor savings in fuel costs.</p> <p>Some recruitment overfishing inshore throughout coastal area as a result of other gears deployed by coastal fishers eg., mini trawls, stake nets and bag nets have high catches of juvenile shrimp. Contribution to recruitment overfishing also from semi-industrial boats illegally fishing in inshore waters. These boats are targeting shrimp and pomfrets.</p> <p>Benthic interactions have impacted heavily on gastropods, bivalves etc. Some respite during the closed season, and evidence of fairly rapid recovery.</p> <p>Ecosystem impacts are also of major concern. Trophic dependences have been severely affected as total fishery catch increases.</p> <p>The area hosts the largest Olive Ridley's turtle rookery in the world with migration across the shrimp trawling areas.</p> <p>Existing adaptation of TEDs has resulted in fish losses of around 5-7%, and 0.2% loss in shrimp catch. Turtle catches and large sharks eliminated from catch. However, only 3,000 TEDs introduced (to around 10% of the fleet). TEDs are provided free to the industry, funded by Marine Products Export and Development Authority (MPEDA). The programme supports the training of fishers. 120 sessions have been held to date, attended by 25-100 fishers per session.</p> <p>Some heavy juvenile fish hot-spots are presently being identified to avoid heavy bycatches.</p> <p>Fuel price subsidy (3%).</p>
Problems	<p>CPUE continually falling.</p> <p>Heavy bycatch of juveniles impacting on whitefish species, with resulting decline in biomass.</p>

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	<p>Fishers reluctant to lose any catch.</p> <p>Benthic interactions causing problems for some assemblages.</p> <p>Ministry of Agriculture heavily influenced by politicians and trade unions, with the result that there is little action taken in implementing HCRs. Expert Committees (17 since 1980) are created at national level and state level, but no actions are taken. Membership of these committees is exclusive, i.e. limited fisher stakeholder involvement and no NGOs. Committee reports consistently recommend a buy-back policy to central Government.</p> <p>Some proposals to produce surimi machines to optimize trash fish.</p>
Lessons learned	<p>Need for a strong centralised fishery act with decentralised powers, but removal of political influences, and creation of a Management (stakeholder) Committee that can implement rules without interference. There is a need for much focus on participatory management, and linking the outputs of the core institutions to fishers.</p> <p>50% reduction in effort required (CMFRI advice to Kerala State Fisheries Department).</p> <p>Some extension or revision of closed seasons, especially as a means of supporting effort reduction.</p> <p>Strengthening of enforcement capacity within Departments to implement control systems.</p> <p>Rapid introduction of TEDs.</p> <p>Elimination of trash fish catches is essential. BRDs to be made mandatory, with focus on separating out fish from shrimp, either within the trawl or with a focus on two distinct gears, i.e. shrimp bottom trawl and semi-pelagic trawl.</p> <p>Introduction of gear SFRs to prevent expansion in fishing effort.</p>

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Key features	The Vietnamese fishery sector is occasionally heavily subsidised: Fuel payments equate to US\$ 900 – US\$ 2,400/ year for < 40 hp to > 90 hp (2008). This equated to 10-15% of fuel costs per annum. Subsidies are also paid to conversion to larger vessels and larger sized engines > 90 hp, to promote offshore fishing.
Governance issues	Policies and their implementation concentrate on social aspects (employment) and maximize production rather than any focus on species sustainability and environmental management. The stated focus is that <i>Fishing communities are very poor so the government should support them in the short run so that they can conserve fish resources for the long run.</i> Enforcement of management measures is not applied, and the management measures are ignored.
Strategic partnerships	Danida are active in the development of co-management initiatives, but little advance appears to have been made towards commercial fisheries initiatives. The MARD focus remains heavily on production increases despite an apparent MoU with MSC.
Problems	No control on access. The government has been subsidised for offshore fishing fleet (engine>90 HP). As a result, fishing effort has been increasing and heavily overexploiting coastal areas (due to scarce fish resources offshore). Management measures ineffective and no progress towards other alternatives – closed seasons, restrictive entry licensing. No bycatch reduction with significant impact on other species, including TEPs. No TEDs/BRDs in operation, mesh size at the cod-end are smaller than regulated and hence the ratio of juvenile and trash fish in the catches is high. 0.5-10 sea turtles caught per trawler / annum. The market for trash fish is a major driver.
Lessons learned	A revision of fishery-specific objectives that will focus on species sustainability and avoidance of trophic cascades. The strategic importance of trash fish should be clearly examined. The need for a limited entry licensing system and a significant reduction in fishing effort. Elimination of capacity as opposed to deflecting it to offshore waters. Weak compliance will ensure that effort remains in inshore waters resulting in continuing conflict and juvenile over fishing. DARD implementing management plans in consultation with stakeholders, but illustrating clear and positive drivers for change as a result of the above measures. Introducing educational system for fishers focussing on bycatch reduction and positive business drivers.

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A.11 Industrial shrimp trawl, Nigeria

Feature	Description
Target species	<i>Penaeus notalis</i> in deeper (15-60 m) and mainly <i>Parapenaeosis atlantica</i> in shallower water (7-15 m). As reported for Cameroon the non-native giant prawn <i>Penaeus monodon</i> is increasing in abundance.
Byproduct	Croakers (Sciaenidae); soles (Cynoglossidae); silver fish/hairtails (Trichiuridae); big eye grunts (Haemulidae); barracudas (Sphyraenidae), snappers (Lutjanidae); catfish (Ariidae)
Shrimp dependency	1:9 (11%).
Management authority	Federal Department of Fisheries (FDF).
Fleet segments	156 vessels for inshore shrimping; 33 for inshore fishing. 35 000 artisanal fishermen. The shrimp trawlers belong to 15 fishing companies.
Management methods	Open access, but restrictions e.g. in size of a shrimp trawler to less than 23.2-m length overall and 130 GT. BRDs and TEDs applied and implemented. Three BRD options given: square mesh window (SMW); square mesh codend (SMC); 90 degree or gentle codend. Currently more than 80% of the shrimp trawl nets carry one BRD. 44 mm cod end mesh size. No trawling with 5 n.miles. 70% bycatch restriction. A regulation concerning minimum fish sizes for sale. The use of TEDs on shrimp trawl nets has been a requirement since September 1996.
History	
Management Plan	No management is applied. The ecosystem management approach is about to be introduced.
Bycatch work plans	UNEP/GEF/FAO implementation programme on bycatch reduction, but no formal management plan in place.
Key features	Overcapacity of the trawl fleet. Declining stocks are very pronounced and prominent. Traditional small-scale fishing gear catches large quantities of prawn <i>Nematopalaemon hastatus</i> within 5 n.miles. Small meshes applied, long trawl times leading to heavy bycatch and fuel inefficiencies. GEF/UNEP/FAO supported initiatives in BRD and TED in shrimp trawl nets. Companies also introduce cruise targets i.e. 10-12 tonnes of shrimp and 17-25 tonnes; Fish caught in excess of this is passed to the crew. Crew remuneration is low (US\$20/month) and crew are paid from the sale of bycatch which runs counter to the bycatch initiative. Bycatch trades provide jobs along the chain to the consumers especially in the rural communities and also support the need for food security. Export expansion grant is given to augment cost of operation. It has promoted the urge to earn more foreign currency in export trades in shrimps. One of the major/priority projects of the Research Institute is the conduct of deep-sea resources survey. This is with a view to promote diversification from inshore waters.
Governance	Nigerian Institute for Oceanography and Marine Research (NIOMR) responsible for effective marine research and gives data/information for policy formulation. Federal Department of Fisheries (FDF) is the administrative arm for policy and enforcement. Nigerian Trawlers Owners' Association (NITOA), an umbrella association of licensed fishing companies, is a major stakeholder in the Fishing Industry. Economic and social support strategies, as well as sustainability form part of Government

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objectives. Economic and social interests tend to outweigh environmental considerations in implementation.

There is a high level of Government/industry interaction but no formal management council.

Implementation/enforcement is a joint responsibility of FDF, NIOMR, Navy, Customs & Immigration Services of the Federal Govt. Most checks on land, inadequately equipped MCS e.g. no patrol craft.

BRDs are not expected and do not remove bycatch completely. However the volume of bycatch is reduced. Bycatch is sold at sea to augment the relatively low crew remuneration. (FDF has zero tolerance for non compliance in the usage of both TED and BRDs; bycatch trade is not dependent on non-application of the devices).

Non compliance issues relate to trawling inside 5 n.miles and non compliance with the cod end mesh size.

Strategic partnerships GEF/UNEP/FAO Bycatch reduction programme has improved awareness among all the stakeholders for drastic reduction in bycatch.

Proposed harmonisation of regional management measures – Cameroon.

Problems No system of effort control.

No closed seasons.

High number of conflicts between coastal and industrial fishermen, with frequent incursions into no trawls zones by industrial vessels.

Ecosystem issues exacerbated by indiscriminate dumping of refuse and nylon bags which end up in the coastal waters.

Lessons learned Management planning incorporating the ecosystem approach to fisheries management making allowances for effort reduction through initiatives such as closed seasons.

A stronger emphasis on gear selectivity and implementation of BRDs.

Educating fishing companies towards positive business drivers.

A stronger compliance system linked to established demarcation zones.

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A.12 French Guiana

Feature	Description
Target species	<i>Penaeid shrimp</i>
Byproduct	n/a
Shrimp dependency	30%.
Management authority	CRPMEM (French Guiana Regional Fisheries Committee). Maritime Affaires also involved with formulation of policy.
Fleet segments	23 boats of 24 meters. Twin rig built in Florida average age 20 years old. Principal companies are: UNIFIEPECH company, and ABCHEE and Fils fishing company.
Management methods	45mm (based on a study by IFREMER in 2004 to determine best size to retain market sizes and release juveniles). Use of Trash and Turtle Excluder Device (TTEDs). Closed area less than 30m depth for trawling. No closed seasons. Use of Neptune doors that reduce drag and are not as impacting on the benthos. 1/3 of boats actively use this and the others have ordered the gear. Without the TTED it would be impossible to use these doors since they are lighter and therefore more affected by the volume of catch in the bag. TTED eliminates all large items that cause drag and amplifies the selectivity of the bag (aka Sting Rays). Use of restricted licensing. 53 licences available. Restrictions on fishing gear in the form of 2 *22m trawls Per boat. Compulsory landing of bycatch - all catch unloaded at Larivot dock. TAC of 4108 tons. Also a fish bycatch restriction of 2kg per day per crew. Restrictions on the transfer of licences for replacement vessels.
History	Has been government support for scrapping. Has been considerable decline in vessel numbers over the years.
Management Plan	Not specifically but very wide range of management methods in places.
Bycatch work plans	Considerable amounts of historical research and ongoing work on bycatch reductions.
Key features	Well managed fishery, and well resourced as French Guiana is a department of France. Controls at sea show that TTED is being used and is proving effective. With a 25-40% bycatch reduction according to rigorous testing using ICES protocol for the testing of towed gears. And observed reduction ranging from 15% to 90%. Re subsidies - Tax free fuel but still more expensive than many other places in the world. No more subsidies for boat building. Subsidy of 1€ per kilo exported to EU to cope with the distance of the market. Research is conducted by IFREMER on: <ul style="list-style-type: none"> - Catches (logbooks, landings); - Bycatch rates of fish sold; - Discards; - Shrimp/fish sizes; - Ecosystem status; - Compliance levels with regulations; - Spawning stock biomass; and

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- Ecosystem modelling.

Governance	<p>The TTED was made mandatory by the industry through the CRPMEM (French Guiana Regional Fisheries Committee).</p> <p>The French Marines, and The Maritime Affaires enforce regulations.</p> <p>As a department of France, the waters of the French Guiana are technically part of EC waters and fall under EC regulations.</p>
Strategic partnerships	<p>Industry contributes boat time to research on by-catch reduction and resource health.</p> <p>Industry and NGOs working together.</p>
Problems	<p>Used to be a problem during the months of August and September when boats want to follow the resource inshore within the 30 meters zone. Since 3 years ago, boats stop fishing during this period and stay in the harbour so as not to get reprimanded and ticketed by the marines responsible for controlling the zone.</p>
Lessons learned	<p>Key role of research and partnerships in improving management.</p>

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APPENDIX B: OTHER COUNTRY DATA

Region	Asia Pacific			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
Thailand	77,364			
Malaysia	41,000	4026 trawlers Zone B: 2714 Zone C: 1054 Zone C2: 258	No trawl zone inside 5 n.miles from the coastline. Zone B, which is 5-12 n. miles allows vessels between 20-40 GRT. Zone C, 12-30 n.miles, is between 40-70 GRT. Zone C2 is beyond 30 n.miles to EEZ, with vessels beyond 70GRT. Cod-end mesh size according to the Fisheries Act is 38mm, but enforcement is lacking.	40% of Malaysian landings comprise trash fish. Incidences of shrimp trawlers encroaching into the coastal zone for the resources.
Philippines	45,599	445 trawlers: 276 (3.1-20 GT), 165 (21-150 GT), 4 (150 GT +)		Discard rates are unknown, but are likely to be relatively small as there is a market for most captured fish. MCS very weak.
Bangladesh	3,444	45 industrial trawlers	Shrimp trawlers range in length from 20.5 to 44.5 m. These vessels use outriggers and operate two to four nets at a time, using modern shrimp trawl nets with the cod-end having a mesh size of 45 mm and a headrope length of 15-35 m. Shrimp trawlers must land finfish which must exceed 30% of the total catch. Licensed vessels must land fishing in designated ports and in the presence of a DoF officer.	Trawl fishing has officially been restricted from operating within the 40m depth contour. However, they have been found to be operating in depths as low as 10m, in order to catch brood shrimps for hatcheries. The CPUE of shrimp (kg/day/shrimp trawler) has steadily decreased since the early 1990s. High levels of discarded finfish were reported, reaching up to 35,000t, approximately 70% of the fish bycatch. MCS focuses primarily on the trawl fisheries.

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Region	Asia Pacific			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
			<p>Declaration of marine reserve in the Middle Ground and South Patches of the Bay of Bengal.</p> <p>No catch can be discarded (except marine turtles).</p> <p>All trawlers must use a Trawler Excluder Device (TED) during trawling</p> <p>Suspension of trawler ban in waters <40 m from 10 April 2007 to 21 August 2007.</p>	
Cambodia	1,163	1,500 trawlers in four municipalities. Two groups 30 hp, and 20 m	<p>Open access.</p> <p>The basic fisheries law prohibits trawling between the shore and the 20-m isobath (up to 10 km offshore).</p> <p>Mesh sizes (non gazetted are 40-50 mm).</p> <p>150 trawlers (mainly from Thailand) are licensed to fish in the offshore “overlap zones”.</p>	<p>Few legal instruments, no legal mechanism in the fisheries law for limiting fish catches or fishing effort.</p> <p>Illegal fishing in coastal waters.</p> <p>Damage to sea grass beds.</p> <p>Trash fish is a major bycatch issue; trash fish (for fertilizer), fish and squid could be considered together with shrimp as an actual target of trawling. The proportion of trash fish in the trawl catch is increasing.</p> <p>Trawl interactions with turtles and TEDs not practical because of the small size of the vessel.</p> <p>Shrimp gill netters targeting larger prawns.</p> <p>Paucity in biological data, no enforcement.</p> <p>Shift in fishing gears towards more modern and efficient methods, decreasing CPUE 20 kg – 5 kg per night).</p>

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Region	Asia Pacific			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
				<p>Poor enforcement.</p> <p>Significant quantity of unregulated fishing effort from Thailand.</p> <p>Regulatory authorities reluctant to prevent trawling inside 20 m isobath despite constant pressure from other artisanal fishers.</p>
Papua New Guinea	1,008	15	<p>A total of 8 nationally owned prawn companies operate in the Gulf of Papua prawn fishery, and other in PNG Torres Strait fishery.</p> <p>50 - 60 % consist of the banana prawn (<i>Penaeus merguensis</i>, <i>P. indicus</i>), 10 -15% tiger prawns (<i>Penaeus monodon</i>, <i>Penaeus semisulcatus</i>), 15 - 20% endeavour prawns (<i>Metapenaeus ensis</i>, <i>M. endeavouri</i>, and <i>M. demani</i>).</p> <p>Most vessels are twin-rigged with 12 fathoms (24 m) (footrope), except 3 vessels that are quad-rigged. Aggregate head rope (with mesh attached) for the main nets exceeds 60 m and 1 (one) try net exceeds 6 m head line.</p> <p>The duration per main net shot is 4 hours</p> <p>The trawl grounds from Iokea to Cape Blackwood shall be closed from 1December to 31 March.</p> <p>Mesh size 50 mm, fish escape panel at the neck of the cod-end, consisting of 1 m wide panel of net of 50 mm.</p>	

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Region	Americas			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
Brazil	34,416			
Venezuela	11,174	351 trawlers	Turtles Excluder Devices applied. The fishing grounds are demarcated into zones with a portion of the fleets authorized to fish in each of them.	The trawl fishery is a combined fishery for shrimp, molluscs and fish. Shrimp component represents between 2.5 and 6% of the general catch. Of the additional catch, 30-35% is normally landed, the remaining 60-65% (mainly fish, with an estimated 80% of juveniles from species of commercial interest) is discarded.
Panama	6,642			Shrimp fisheries have discard rates in excess of 80 %.
French Guiana	2,883			Shrimp fisheries have discard rates in excess of 80 %.
Colombia	2,755	Pacific coast operates 115 vessels, mainly small boats, 70% of them operating in coastal areas. Approx 20 m vessels on Atlantic coast, plus other seabob trawlers		shrimp resources are over-exploited. Bycatch 7.5:1, 14,664 tons of incidental catch (out of which many juveniles) (Pacific). Bycatch in the Atlantic 4:1. Bycatch sales used as a bonus to pay crew.
Costa Rica	2,319	73 trawlers ("Florida type" with outriggers)	Turtle Excluder Device (TED) is mandatory in shallower waters less than 80 fathoms. Vessel Monitoring System (VMS).	Bycatch 7.5:1. 80% finfish discarded. High discard rates, particularly of juveniles and overfishing.
Cuba	1,361	51 fishing vessels	Shrimp fishing grounds are well demarcated and there are fishing closures during recruitment seasons and other regulations exist for reducing fishing effort and the	Bycatch 5.5:1. Significant changes made as a result of the UNEP initiative. BRDs now mandatory. Historically, 22% of the non-shrimp catch are landed for human

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Region	Americas			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
			protection of areas with a known high density of juveniles or large quantities of small size fish.	consumption, the rest is reduced to fishmeal or silage. Shrimp bycatch is sold at receiving centres at sea when fishermen take multi-day trips, and are fishing away from shore (Clucas 1997). This allows the bycatch to be sorted on-board and sold for human, as well as for use as animal feed. Fishers were given monetary incentives to exceed prearranged quantities and qualities of bycatch on a daily basis.
Trinidad and Tobago	830 t, 37% artisanal, 13% semi-industrial and 50% industrial	84 artisanal trawlers, 9 semi-industrial trawlers 21 industrial trawlers	<p>Most vessels operating in the coastal waters of Trinidad and Tobago trawl both day and night, artisanal vessels, 1.8 and 18 m, semi-industrial, 9 and 41.4 m, industrial, 9-77m.</p> <p>Restricted access to industrial and semi-industrial fisheries.</p> <p>Trawling is prohibited on the east coast of Trinidad and within 12 n.miles of the coast of Tobago.</p> <p>Artisanal trawlers are permitted to operate outside one nautical mile from the coast; Semi-industrial trawlers are permitted in depths of six fathoms (1 fathom, 1.83 m) or more; and industrial trawlers are permitted in depths of 10 fathoms, 18 m.</p> <p>The stretched mesh size of the codend of the trawl net must be no smaller than approximately 7.5 cm when trawling for fish and approximately 3.5 cm for shrimp.</p> <p>Use of TEDs is statutory for industrial and semi-industrial boats.</p>	<p>High incidental juvenile fish catch (90%) associated with artisanal shrimp trawling. This causes major areas of conflict with non shrimp fishers. Larger industrial or semi-industrial trawlers normally keep around 40 % of their bycatch on board. Shrimp: Bycatch = 1:1. Shrimp value more than 4 x fish.</p> <p>Semi-industrial and artisanal vessels deliberately target juvenile shrimp.</p> <p>Fully or overexploited condition of shrimp stocks and overcapitalization in the trawl fishery.</p> <p>The use of TEDs on the semi-industrial and industrial trawl fleets has not been well accepted by the industry.</p> <p>Capture of juvenile (pre spawning) shrimp.</p> <p>Low or negative profits in the fishery.</p> <p>Limited capacity to monitor compliance at sea.</p> <p>Limited catch data.</p> <p>Lack of political will and legal tools to do so.</p> <p>Strong emphasis on subsidies: Registered fishers or vessel owners receive Value Added Tax (VAT)</p>

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Region	Americas			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
				exemption on equipment, engine parts and new fishing vessels. Replacement vessels are eligible for 25 % subsidy subject to a maximum of US\$800. Registered vessel owners are also eligible to access subsidies on gasoline and oil, but these are minimal.

Region	Africa			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
Cameroon	9,595	65 vessels	Vessels mainly operated by "Time Charter" companies, a form of joint venture with foreign ownership. Two-boat trawling is increasing in shallow waters, targeting mainly fish. 25 mm mesh size currently used. Some consideration of a change to 35 mm (GEF).	The capture of juvenile food fish was a threat to sustainable exploitation of demersal fish resources. Violation of non trawl zones. Trawling in shallow waters created serious conflicts with artisanal fishers.
Senegal	4,300			Bycatch of fish, including juveniles. Some is sold for human consumption, but most discarded at sea. Conflicts between artisanal and trawl fisheries because of inshore activities.
Tanzania	1,795	20 vessels	Foreign owned outrigger shrimp trawlers. Trawling for shrimp in coastal waters. Tanzania is banned in December, January and February and night fishing (between 6 pm and 6 am) is prohibited.	Bycatch of fish, including juveniles. Some is sold for human consumption, but most discarded at sea. Conflicts between artisanal and trawl fisheries because of inshore activities. Violation of non trawl zones.
Ghana	1,282			Bycatch of fish, including juveniles. Some is sold for human consumption, but most discarded at sea. Conflicts between artisanal and trawl fisheries because of inshore activities.

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Region	Africa			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
				Violation of non trawl zones.
Kenya	392	4 industrial trawlers		strict monitoring regulations as well as a declining stock. 2:1 Fish:shrimp.
Gambia	363			Bycatch of fish, including juveniles. Some is sold for human consumption, but most discarded at sea. Conflicts between artisanal and trawl fisheries because of inshore activities.

Region	Middle East			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
Iran (Islamic Rep. of)	7,261	39 industrial trawlers (27 m and 750 hp) fishing with two trawls i.e. twin rig; 870 wooden dhows (16 m / 100-220 hp) (Dhows); 1 500 fibreglass boats of 7 m 25-45 / hp	Fishing season in each province is approximately six weeks, and opening and closing is based on the maturity and body length of shrimp and percentage (20%) of remaining stock.	The shrimp trawler catch composition consists of 10-17% shrimp, 10-25% small fish, 40-60% juvenile fish. The grid (Grid 80) became mandatory for industrial trawlers. Consequently, gear trials later focused on the artisanal fisheries, so far with mixed results, and these trials (using JTED, square mesh window, parallel ropes, and fisheye) are continuing. Aside from the legislation of BRD use, shrimp fisheries are also regulated through effort reduction (through buy-back of licences and gear swaps) and controls, research-based imposition of closed seasons and closed areas.
Kuwait	1,773	35 steel-hulled double-rigged Gulf of Mexico-type trawlers; 34 dhow trawlers	Limited entry. Specified 6 month fishing season 1 Sept to end of Jan/Feb, determined by stocks assessment, allied to a system of effort limitation. Protected areas (Kuwait Bay and the three	High level of effort and low CPUE seem to indicate that the stock has been overexploited since 1993. High discard rates. Bycatch actually landed is small, from 1.32 to 1.61 percent of the total bycatch caught; more than 98 percent of the bycatch is discarded. Bycatches include juveniles and adult finfish, sharks,

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Region	Middle East			
Country	Tonnage	Fleet characteristics	Management system	Problem issues
			<p>nautical mile coastal zone).</p> <p>Nominal stretched mesh size of 51 mm in the main body of the net and 45 mm in the codend. Typical net specifications are: 57.4-m headrope, 30.5-m footrope.</p> <p>Capacity reduced through buy-out scheme.</p> <p>Plans to introduce TEDs and BRDs within the next 2 years.</p>	<p>rays, crustaceans, sea snakes, turtles, soft corals, molluscs and echinoderms.</p> <p>Heavy reliance in subsidies which sustain profits.</p> <p>No incentives to use BRDs.</p>
Bahrain	1,738	335 traditional vessels (“banoush”), 5m – 25 m, towing only one trawl.	9 month fishing season.	Bycatch of finfish is problematic.
Oman	489		Only traditional fishing methods are allowed, mainly cast nets, involving 500-700 fibreglass boats. The fishing season is from 1 September to 31 December.	

APPENDIX C: REFERENCES

AFMA (2008), Program for Addressing Bycatch and Discarding in Commonwealth Fisheries: and Implementation Strategy, Australian Government.

BRPL (2005) Pengkakan stock ikan (Fish stock assessment Report), Indonesia

Brewer, D.T., Griffiths, S., Heales, D.S., Zhou, S., Tonks, M., Dell, Q., Taylor, B.T., Miller, M., Kuhnert, P., Keys, S., Whitelaw, W, W., Burke, A. and Raudzens, E. (2007). Design, trial and implementation of an integrated, long-term bycatch monitoring programme, road tested in the Northern Prawn Fishery. Final report, FRDC Project 2002/035. CSIRO, Cleveland

Bolger, J. (2000) Capacity Development: Why, what and how? CIDA. Occasional Series Vol. 1 No. 1

Boopendranath M.R., Pravin P., Gibin Kumar T.T., (2008) Bycatch reduction devices for selective shrimp trawling, ICAR A-hoc project. Central Institute of Fisheries technology, Cochin, India.

Caverivière A., Chaboud C., Rafalimana T. (2008), Institut de Recherche pour le Développement (IRD).

Cobalt Marine Resource Management (2009), Successful ecosystem based fisheries management in Australia's Northern Prawn Fishery, WWF-US.

CRFM (2004) Report of the Shrimp and Groundfish Workshops conducted in Guyana (November 2003), Belize (December 2003), Trinidad and Tobago (January 2004)

Dall, W., B.J. Hill, P.C. Rothlisberg and D.J. Sharples. (1990). The Biology of the Penaeidae. Academic Press. 489 pp.

Fry, G. (2009), Assessing the sustainability of the Northern Prawn Fishery bycatch from annual monitoring data, CSIRO, Cleveland

FAO (2000), Four GEF/UNEP/FAO Regional Workshops on Reducing the Impact of Tropical Shrimp Trawl Fisheries, FAO Fisheries Report 627

Gillette R (2008), Global Study of shrimp fisheries, FAO Fisheries Technical Paper, 475

Hermes, R. (2009), Terminal Evaluation of the UNEP/GEF Project, Reduction of Environmental Impact from Tropical Shrimp Trawling through the Introduction of Bycatch Reduction Technologies and Change of Management, Project Number UNEP GF/2731-02-4469 & GF/4030-02-04, FAO EP/GLO/201/GEF.

Hooper, G.E., Dixon, C.D., and Roberts, S.D., (2007) Spencer Gulf Prawn (*Melicertus laticulcatus*) Fishery Status Report. Report to PIRSA Fisheries. SARDI Aquatic Sciences Publication No.F2007/001094-1. SARDI Research Report Series No. 260

Gulf of Mexico Fishery Management Council,
<http://www.gulfbase.org/organization/view.php?oid=gomfmc>

Larcombe J., and Perks C. (2008), Northern Prawn Fishery. Status of Fish Stocks and Fisheries Managed by the Australian Government, BRS Fishery Status Reports 2008

Macfadyen G. and Huntington T. (2009), Review of potentially negative impacts on small-scale fisheries of market-based environmental sustainability requirements, Poseidon ARM Ltd, FAO, November 2009.

Marine Stewardship Council, Fisheries Assessment Methodology and Guidance to Certification Bodies Including Default Assessment Tree and Risk-Based Framework, 2010

A blueprint for sustainable tropical trawl fisheries

Milton, D., Fry, G.C. and Dell, Q (2009). Reducing impacts of trawling on protected sea snakes: bycatch reduction devices improve escapement and survival. *Amrine and Freshwater Research* 60.

Ministério das Pescas, Republica de Moçambique (2004-2008). *Relatório Annual*. Instituto de Investigação Pesqueira (IIP).

Ministry of Fisheries (2009), Management Plan for the Shrimp Fisheries of the Sofala Bank (PGC/BS) National Directorate of Fisheries Administration, Mozambique

Nance J.M. (2009), Gulf of Mexico Shrimp Fishery Stock Assessment Report, 2008, NMFS

NOAA Fisheries Service: <http://sero.nmfs.noaa.gov/sf/GulfShrimp.htm>

NPF Industry Pty Ltd: Northern Prawn fishery data summary, 2008,

PIRSA, Management Plan (September 2007) for the South Australia Spencer Gulf Fishery, Paper No 54, South Australia Fishery Management Series, PIRSA,
http://www.pir.sa.gov.au/fisheries/commercial_fishing/prawn_spencer_gulf_and_west_coast_fishery/management_plan

R. Rose, and T. Kompas, 2004. ABARE Report 04.12 *Management Options for the Australian Northern Prawn Fishery - an economic assessment:*
http://www.abareconomics.com/publications_html/fisheries/fisheries_04/er04_ntbn_prawn.pdf

Thanh V.N, 2006. Bioeconomic analysis of the shrimp trawl fishery in the Tonkin Gulf, Vietnam. Master thesis, Tromso University. (<http://www.ub.uit.no/munin/bitstream/10037/334/1/thesis.pdf>)

Thuy N. T. D. and Symington K. (2008), Sustaining Fisheries and Alleviating Poverty in Vietnam: A Socio-economic Review and Case Study, WWF Greater Mekong – Vietnam

Zacharin W, Dixon C and Smallridge M (2007) Towards self-management for the Western King Prawn Fishery in Spencer Gulf, South Australia, PIRSA,
http://www.sardi.sa.gov.au/fisheries/publications/2008_publications

<http://www.ccatexas.org/cca-texas-helps-complete-shrimp-license-buyback-program/>