FAO Fisheries Report No. 734 **FIIT/R734 (En)**

ISSN 0429-9337

Report of the

REGIONAL WORKSHOP ON APPROACHES TO REDUCING SHRIMP TRAWL BYCATCH IN THE WESTERN INDIAN OCEAN

Mombasa, Kenya, 13–15 April 2003

Copies of FAO publications can be requested from:
Sales and Marketing Group
Informatio Division
FAO
Viale delle Terme di Caracalla
00100 Rome, Italy
E-mail: publications-sales@fao.org
Fax: (+39) 06 57053360

Report of the

REGIONAL WORKSHOP ON APPROACHES TO REDUCING SHRIMP TRAWL BYCATCH IN THE WESTERN INDIAN OCEAN

Mombasa, Kenya, 13–15 April 2003

Edited by

S.T. Fennessy
Oceanographic Research Institute
Durban, Republic of South Africa

G.K. Mwatha
Kenya Marine and Fisheries Research Institute
Mombasa, Kenya

and

W. Thiele
Fishery Technology Service
FAO Fisheries Department
Rome, Italy

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2004

ISBN 92-5-105120-8

PREPARATION OF THIS DOCUMENT

This is the report of the Regional Workshop on Approaches to Reducing Shrimp Trawl Bycatch in the Western Indian Ocean, held in Mombasa, Kenya, from 13 to 15 April 2003.

Fennessy, S.T.; Mwatha, G.K.; Thiele, W. (eds.)
Report of the Regional Workshop on Approaches to Reducing Shrimp Trawl Bycatch in the Western Indian Ocean. Mombasa, Kenya, 13–15 April 2003.
FAO Fisheries Report. No. 734. Rome, FAO. 2004. 49p.

ABSTRACT

The workshop was jointly organized by the FAO Fishery Industries Division, the Marine and Fisheries Research Institute (KMFRI) in Mombasa (Kenya) and the Oceanographic Research Institute (ORI) in Durban (South Africa), and was hosted by KMFRI.

Twenty-nine participants from five countries (Kenya, Madagascar, Mozambique, Nigeria and South Africa) attended the workshop. The participants presented national fisheries administrations, non-governmental organizations and scientific institutions.

During the workshop, the participants discussed existing bycatch policy and legislation, the state of bycatch knowledge and impacts of bycatch, as well as methods for reducing bycatch or improving bycatch utilization in their respective countries.

The participants recommended the use of bycatch reduction devices (BRDs) in the region, to harmonize the data collection between the countries and the improved utilization of bycatch.

Full address of editors:

S.T. Fennessy, Oceanographic Research Institute, PO Box 10712, Marine Parade 4056
Durban, Republic of South Africa

G.K. Mwatha, Kenya Marine and Fisheries Research Institute, PO Box 81651
Mombasa, Kenya

W. Thiele, Fishery Technology Service, FAO Fisheries Department
Viale delle Terme di Caracalla, 00100 Rome, Italy

Distribution:

Participants at the Workshop
FAO Regional and Subregional Officers
FAO Fisheries Department
FAO Quota Mailing List

CONTENTS

Page

PART I

PART II

PART I

BACKGROUND TO THE WORKSHOP

The Global Environment Facility (GEF)/United Nations Environment Programme (UNEP)/The Food and Agriculture Organization of the United Nations (FAO) programme on "*Reduction of environmental impact from tropical shrimp trawling, through the introduction of bycatch reduction technologies and change of management*" commenced in 2002. This present main-phase project has been developed by FAO under a preparatory-phase activity funded from a PDF Block B grant supported by GEF/UNEP, through a process where government-appointed National Coordinators from 13 countries agreed with the executing agency (FAO) on a common approach to a series of national baseline studies. These baseline studies were executed under the supervision of the respective National Coordinators and involved a wide consultative process with most of the stakeholders having an interest in shrimp exploitation (including fishermen, shrimp-trawler owners, fishery authorities, fish processors and traders, shrimp-fisheries experts/researchers), and to a certain extent, the local communities which somehow benefit from the wealth resulting from shrimp exploitation. Initially, invitations to several countries with substantial shrimp fisheries were issued, followed by a National Coordinators workshop (March, 1999) and four regional workshops in 1999 and 2000 (FAO, 1999; FAO, 2000). Currently, thirteen countries from four regions (Latin America/Caribbean, Asia, the Near East and West Africa) are now participating in the main phase of the project. (Source: UNEP project document EP/GLO/201/GEF). Although representatives from three East African countries (Mozambique, Kenya and the United Republic of Tanzania) attended the National Coordinators workshop and/or the African regional workshop in Nigeria (December, 1999), these countries were for several reasons not participating in the current phase of the project.

Together with Madagascar and South Africa, these Western Indian Ocean (WIO) countries catch in the region of 24 000 tonnes of shallow water penaeid shrimps per annum, ranging from 200 tonnes per annum in South Africa to 11 500 tonnes per annum in Madagascar (FAO Fisheries Statistics – capture production volumes). The target species are mainly *Penaeus indicus* and *Metapenaeus monoceros*. As with shrimp fisheries elsewhere, there is a substantial and varied bycatch, and as with the target species, many of the bycatch species are common to all five countries. Estimates of bycatch range from about 800 tonnes per annum (Fennessy, 1994a) to about 20 000 tonnes per annum in Mozambique (calculated from figures in Magane, Sousa and Pacule, 1998). Most of the bycatch is discarded. There is frequently conflict between the trawling and artisanal sectors (Bwathondi and Mwaya, 1984; FAO, 2000; van der Elst and Govender, 2001; Mwatha, unpublished data). The main cause of the conflict is primarily due to loss of livelihood rather than poverty, which is often near-endemic in many coastal communities. In South Africa, user-conflict with the commercial line-fishing sector also exists (Fennessy, 1994b). The conflict with other fisheries sectors is both direct (e.g. damage to artisanal nets by trawlers; bycatch of trawlers comprises species which are valuable to other sectors) and indirect (e.g. by trawlers modifying habitats or altering predator-prey interactions).

Approaches to resolving the trawl bycatch problem have varied from country to country. All of these WIO countries have some estimates of composition and quantities of bycatch, and most have undertaken trials of one or more of the following bycatch reduction devices: grid separators (Mahika, 1992; Isaksen and Larsen, 1993); Turtle Excluder Devices (TEDs; Wamukoya and Salm, 1998; Gove, Pacule and Goncalves, 2001; Mueni and Mwangi, 2001; Mwatha, unpublished); square mesh panels (Fennessy, 2002). Other approaches include the setting up of systems to make the discarded catch available to coastal communities (e.g. Jensen, 1985), and setting spatial and/or temporal limits on trawling (e.g. Fennessy, 1994a).

The lack of a regional initiative aimed at addressing shrimp trawl bycatch issues prompted the hosting of this regional workshop on shrimp trawl bycatch in the WIO. The meeting was therefore held against the backdrop of raising concerns of high levels of fish discards associated with shrimp trawling in the world and in the WIO in particular.

OVERVIEW OF THE WORKSHOP

The workshop was jointly organized by the Fisheries Department of FAO, the Kenya Marine and Fisheries Research Institute (KMFRI) in Mombasa (Kenya) and the Oceanographic Research Institute (ORI) in Durban (South Africa), and was hosted by KMFRI. Twenty-nine participants from five countries attended the Workshop. ***The list of participants is attached in Appendix 1.***

During the workshop, participants were expected to discuss existing bycatch policy and legislation, the state of bycatch knowledge and impacts of bycatch, as well as methods for reducing bycatch or improving bycatch utilization in their respective countries.

Specifically the main objectives of the workshop were to:

- review baseline studies on bycatch and bycatch reduction in five Western Indian Ocean countries, including estimation of bycatch and discard rates;
- review baseline studies on bycatch and bycatch reduction in five Western Indian Ocean countries, including estimation of bycatch and discard rates;
- identify the specific bycatch problem in each country and develop suggestions how to solve it;
- promote and encourage the use of bycatch reduction technology in existing fishing gears;
- promote cooperation between countries in shrimp trawl bycatch research;
- discuss the development of a regional programme on the introduction of bycatch reduction technologies in shrimp trawls and measures for increased utilization of bycatch.

The expected outputs of the meeting were:

- A report documenting the current state of knowledge of shrimp trawl bycatch in the five countries.
- Increased knowledge about different types of bycatch reduction technologies and approaches to improve the utilization of bycatch.
- Proposals for the development of a regional programme on shrimp trawl bycatch in the western Indian Ocean.

WELCOME AND INTRODUCTIONS

The meeting was initially addressed by Dr Sean Fennessy from the Oceanographic Research Institute (ORI) in Durban, South Africa. He gave background information on the developments leading to the hosting of this important workshop. In particular, he referred to previous discussions between ORI and KMFRI around the problems of shrimp trawl bycatch in their respective countries, and how these discussions led to the development of a proposal to hold this workshop, under the auspices of the GEF/UNEP/FAO programme. He noted with appreciation the enthusiasm the regional countries had in supporting the proposal to convene this workshop. This interest was manifested in the excellent attendance at the workshop, although the non-attendance of a Tanzanian representative was noted with disappointment.

Dr Wilfried Thiele from the Fisheries Department of FAO in Rome gave the introductory remarks (see below). He explained that FAO has identified the discarding of fish associated with commercial shrimp fisheries as a priority area that requires urgent intervention. Dr Thiele emphasized that FAO is dedicated to promoting responsible fishing practices by supporting and promoting initiatives that address the negative impacts associated with fishing. To achieve effective management of fisheries resources, cooperation between countries is very important. FAO is also consciously aware that research and the development of appropriate technologies require substantial financial and human resources that are quite limited, especially in developing countries. As a result, technology

development tends to be restricted to those countries with strong economies. It is for this reason that research aimed at developing efficient and practical technological solutions to shrimp trawl bycatch has been very limited in most developing countries and in the WIO region in particular.

To address the problem of tropical shrimp trawl bycatch, FAO initiated the GEF-funded project which aims to reduce the environmental impacts from tropical shrimp trawling, through the introduction of bycatch reduction technologies and change of management strategies. It is unfortunate that none of the Western Indian Ocean countries were participating in the GEF shrimp trawl bycatch project, and Dr Thiele expressed the hope that the participants of this workshop would come up with recommendations on ways in which the donor community, including FAO, could assist WIO countries to address the problems associated with shrimp trawl bycatch to achieve long term solutions. He was therefore delighted to be involved in the organization of this regional workshop whose main agenda is to bring together regional experts to exchange ideas and to come up with clear and practical ways of addressing the problems associated with shrimp trawler bycatch Dr Thiele indicated that he expected the workshop participants to come up with clear recommendations on the way forward and to come up with tangible projects which could attract donor support, and to also explore ways of involving other countries interested in this initiative.

In his opening remarks, Dr J.M. Kazungu, the Director of the Kenya Marine and Fisheries Research Institute, thanked FAO for financially supporting the organization of the workshop. He noted with appreciation the attendance of experts in research and management from the region and from other parts of the world. He also emphasized that the workshop participants should deliberate on important issues related to shrimp trawl bycatch and come up with clear recommendations on how to address this problem for the better management of this important resource. He officially opened the workshop and wished the participants fruitful deliberations and an enjoyable stay in Mombasa.

APPENDIX 1

Agenda

Day 1: Sunday 13 April 2003

Chair: Sean Fennessy/Gerald K. Mwatha

09:30	Registration	
10:00	Welcome and introduction	
10:15	Background and history of the GEF/UNEP/FAO programme on reduction of environmental impacts of tropical shrimp trawling	W. Thiele
10:45	The GEF/UNEP/FAO project in Nigeria	J.C. Ogbonna
11:00	Objectives of Meeting	S. Fennessy and W.Thiele
11:30	Country status report: National policies/legislation for bycatch (15 minutes each, including questions)	
	• Kenya	G. V. Monor
	• Madagascar	O. Andriamiseza (Ms)
	• Mozambique	F.V.A.Bomba
	• South Africa	J. Groeneveld
	• Summary	Chairman
13:00	Country status report: Summary of bycatch research (maximum 30 minutes each, including questions)	
	• Mozambique	B. de Sousa P. (Ms)
	• Kenya	G.K. Mwatha
	• Madagascar	G. Rabarison
	• South Africa	S. Fennessy
	• Summary	Chairman
16:00	Discussion on gaps in bycatch policy and the way forward: harmonization of information/data collection, gaps and the way forward	

Day 2: Monday 14 April 2003

Chair: Narriman Jiddawi/Frans Teutscher

09:00	Country status report: Impacts of bycatch (maximum: 30 minutes each, including questions)	
	• Kenya	E.N. Fondo (Ms) and J. Ochiewo
	• Madagascar	G. Rabarison
	• Mozambique	D.Z. Gove
	• South Africa	S. Fennessy
	• Summary	Chairman

Day 2: Monday 14 April 2003 (cont.)

11:30	Country status report: Methods to reduce bycatch (20 minutes each, including questions)	
	• South Africa	S. Fennessy
	• Mozambique	D.Z. Gove
	• Madagascar	O. Andriamiseza (Ms)
12:00	Utilization of by-catch	
	• Utilization of shrimp by-catch	F. Teutscher
	• Utilization of low value fish by processing	P.M. Oduor
15:00	General discussions on problems identified in each session, suggestions for resolving them; the way forward	W. Thiele
17:00	Closing of Workshop	

Day 3: Tuesday 15 April 2003

08:00 Whole day field trip (Day coordinator: Mwatha/Mueni)

APPENDIX 2

List of participants

KENYA

ALI Mohammed
Coordinator : Coastal & Marine Programmes
National Env. Mgt. Authority
POBox 67839
NAIROBI
Tel.: 254-2-67839
E-mail: biofish@africaonline.co.ke

BASTA Paolo
Director
BASTA & Sons Ltd
PO Box 80782
MOMBASA
Tel: 254 11 476128
Mobile: 0733 910396
E-mail: paolo.Basta@hotmail.com

ESPOSITO Giuseppe
Operations in Charge
Trawler Operator
East African Seafood LT
PO Box 40268
MOMBASA
Tel.: 254 11 311091/225221
Mobile: 0722 774328
E-mail: Giuseppe@alphakenya.com

FONDO Esther N.
Research Officer
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-4
E-mail: efondo@kmfri.co.ke

KIMANI Edward N.
Research Officer
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-4
Mobile: 0722670037
E-mail: ekimani@kmfri.co.ke

MONOR Godfrey V.
Assistant Director of Fisheries
Fisheries Department
PO Box 90423
MOMBASA
Tel.: 041 315904
Mobile: 0733 705634
E-mail: monorgv@yahoo.com

MORAGWA Gladys
Research Officer
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-4
E-mail: gokemwa@kmfri.co.ke

MUENI Elizabeth
Fisheries Officer
Fisheries Department
PO Box 90423
MOMBASA
Tel.: 254 11 315904
Mobile: 0722 326826
E-mail: emuenibf@yahoo.com

MWATHA Gerald K.
Research Officer
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-5
Mobile: 0722596211
E-mail: gmwatha@kmfri.co.ke

NTHEKETHA Nicholas M.
Fisheries Officer
Fisheries Department
PO Box 12
MALINDI
Tel.: 042 31687
Mobile: 0733739981
E-mail: fisheries@swiftmalindi.com

NZUKI Simons
Conservationist
KESCOM
PO Box 82144
MOMBASA
Tel.:011-312744
Mobile: 0733-610222
E-mail: Suzuki@yahoo.com

OCHIEWO Jacob
Socio-Economist
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-4
Mobile: 0733 804395
E-mail: jochiewo@kmfri.co.ke

ODUOR Peter M. Odote
Research Officer
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 475151-4
Mobile: 0733526230
E-mail: podote@kmfri.co.ke

PARAZZI Nicky
Watamu Turtle Watch/Local Ocean)
PO Box 125
WATAMU
Tel.: 0122-32118
E-mail: wtwkenya@swiftmalindi.com

RUWA Renison K, Dr
Deputy Director
Kenya Marine and Fisheries Research Institute
PO Box 81651
MOMBASA
Tel.: 254 11 471435
Mobile: 0733700572
E-mail: kruwa@kmfri.co.ke

MADAGASCAR

ANDRIAMISEZA Olga
Control and Statistics
Ministry of Fisheries
ANTANANARIVO
Tel.: 22 40650
Mobile: 032 0408211
E-mail: cspmadag@dts.mg
: olgamiseza@hotmail.com

RABARISON Guy
Researcher
CNRE
Cite 67 Ha N˚393
ANTANANARIVO
E-mail: cnre@dts.mg

MOZAMBIQUE

BOMBA Francisco Victor A.
National Deputy Director
Ministry of Fisheries – Mozambique
PO Box 1723
MAPUTO
Tel.: 258 300961
E-mail: bomba@mozpesca.org

DE SOUSA Barbara Palha
Fisheries Biologist
IIP
Mao Tse Tung Av. 389
MAPUTO
Tel.: 258 1 990307
Office: 258 82 882586
E-mail: bsousa@mozpesca.org

GOVE Domingos Z.
Advisor
Center For Sustainable Development of Coastal Zones
PO Box 66
PREAIA DE XAI-XAI GAZA
Tel.: 258 02235004
Mobile: 082307528
E-mail: cdscoastal@teledata.mz

FAO

HARRIS Aubrey
Senior Fisheries Officer
FAO Subregional Office for Southern and East Africa
PO Box 3730
HARARE
ZIMBABWE
Tel.: 263 4 253693
E-mail: Aubrey.harris@fao.org

TEUTSCHER Frans
FAO Consultant
Via Ragoli 61
ROME 00124
ITALY
Tel.: 39065090178
E-mail: md1186@mclink.it

THIELE Wilfried, Dr
Senior Fishery Industry Officer
FAO Fisheries Department
Viale delle Terme de caracalle
ROME 00100
ITALY
Tel.: 390657055836
E-mail : Wilfried.Thiele@fao.org

PART II

REDUCTION OF ENVIRONMENTAL IMPACTS FROM TROPICAL SHRIMP TRAWLING THROUGH THE INTRODUCTION OF BYCATCH REDUCTION TECHNOLOGIES AND CHANGE OF MANAGEMENT

Wilfried Thiele, FAO, Rome

Background

The UNGA, during its fifty-third session, urged "States, relevant international organizations and regional and sub-regional fisheries management organizations and arrangements to take action, including through assistance to developing countries, to reduce bycatch, fish discards and post-harvest losses consistent with international law and relevant international instruments, including the Code of Conduct for Responsible Fisheries" (Resolution A/RES/53/33).

The GEF Operational Programme "Integrated Land and Water Multiple Focal Area" lists as an expected outcome "the reduction of stress to the international water environment in selected parts of all five development regions across the globe through participating countries making changes in their sectoral policies, making critical investments, developing necessary programs and collaborating jointly in implementing ... water resources protection measures."

One source of stress on the marine environment which is of growing international concern is the impact from capture fisheries, hence the need to develop, promote and implement environmentally-sound technology and practices in the marine fisheries sector, so as to prevent loss of biodiversity and habitat degradation.

The GEF project on "Reduction of Environmental Impacts from Tropical Shrimp Trawling, through the Introduction of Bycatch Reduction Technologies and Change of Management" is a main-phase five year project, starting in mid-2002. The following countries are participating in the project; Cameroon, Colombia, Costa Rica, Cuba, Indonesia, Iran, Mexico, Nigeria, Philippines, Venezuela, Trinidad and Tobago, Bahrain and the Southeast Asian Fisheries Development Center (SEAFDEC). UNEP is the implementing agency and FAO acts as executing agency.

Expected outputs

Four principal results are expected from the Project. These are:

- adoption of bycatch reduction devices by national and regional shrimp-trawling fisheries;
- improved management of shrimp-trawl fisheries;
- increased cooperation among countries in research on, and management of, their shrimp (and fish) resources;
- better understanding of the interactions between shrimp-trawl fishing gear and the environment.

National activities

To achieve the above, the **main national activities will include** an assessment of the impacts of the present shrimp trawling production systems on the environment. This will involve:

- collection of more precise data on catch composition;
- assessment of present and potential economic value of bycatch and discards;

- consideration of the introduction of alternative fishing methods and management measures;
- development and/or adoption of bycatch reduction technologies;
- fishing experiments with BRDs on commercial trawlers;
- introduction of successful BRDs which are developed on a larger scale through training and extension, extensive information campaigns, etc.

Regional activities

To expand activities to other participating countries in the region, the coverage of studies, assessments, experimental fishing activities and commercial trials through joint activities under the lead of the first group of participating countries. Countries included here:

- Bahrain (Near East/Gulfs; but not GEF funded);
- Cameroon (West Africa/Gulf of Guinea);
- Colombia (Pacific);
- Cuba (Caribbean);
- Trinidad and Tobago (Caribbean**).**

Global activities

These will involve mainly the FAO activities, which will include;

- Coordination and management of the project;
- Production of guidelines and information material on sustainable shrimp fishing technologies, including:
    - electronic publication on shrimp fishing methods;
    - inventory of bycatch reduction devices (BRDs);
    - inventory of legal and policy frameworks for sustainable shrimp fisheries;
    - directory of experts and institutions experienced in shrimp fisheries;
    - collation and distribution of regular annual reports (prepared by the participating countries and other collaborating institutions) about progress in their shrimp fisheries (effort, catches, bycatch problems, technology, management, etc.).

WORKSHOP AGENDA ITEM 1: NATIONAL POLICIES AND LEGISLATION FOR BYCATCH

KENYA

National fisheries policy and bycatch legislation in Kenya
Godfrey Monor, Fisheries Department, Mombasa

In Kenya, commercial shallow water shrimp trawling began in the mid–1970s after the exploratory fishing surveys identified the prawn stocks within the Malindi-Ungwana Bay complex. This is part of Kenya's coastline with the widest continental shelf, suitable prawn trawling grounds and high prawn concentrations. Over time, the number of trawlers fishing in this area has varied greatly between five and 20 each year. However, not all the licensed trawlers are actively engaged in prawn trawling. For example, in 2000, out of the 12 licensed trawlers only six were fishing. Despite the fact that fishing effort has greatly varied, the total annual average catch has not exceeded 400 tonnes (Anon., 2001). In the last decade, the average annual landing has been 334 and 640 tonnes of prawns and fish respectively (Anon., 1999).

In Kenya, the Department of Fisheries is charged with the responsibility of managing the fisheries resources. The strategy of the Fisheries Department is to maximize the production, exploitation and utilization of the fisheries resources of the country on a sustainable basis for the social economic benefit of the Kenyan people. The Fisheries Department is mandated to formulate and issue national fisheries policies and guidelines for the sustainable management and exploitation of the national fisheries resources.

There is no formal policy in Kenya regarding bycatch. However the Fisheries Department is in the process of developing a national fisheries policy. In the absence of a national policy on bycatch, the government encourages the utilization of fish bycatch as food so as to meet the national food requirement. In Kenya, the following legislation is related to bycatch:

- Trawling is only allowed beyond five nautical miles from the shore (Fisheries act cap 378, regulation 43). This regulation was supposed to minimize the conflicts between the semi-industrial prawn trawlers and the local/artisanal fishermen. However, this legislation was not backed by any scientific information. There are relatively poor stocks of prawns beyond the five nautical miles limit and as a consequence prawn trawlers commonly trawl within the five nautical miles band resulting in very many conflicts. The compliance with this legislation is therefore very low. The Government is in the process of reviewing this legislation and detailed research is currently being undertaken to determine the distribution of prawn stocks within the Malindi-Ungwana Bay area. Information gathered from this research will guide in the formulation of a new legislative regime.
- The Kenyan Government issued a notice in the Kenya Gazette (Gazette Notice No. 7565 of 31/10/2001) which requires all prawn trawlers to use the Turtle Excluder Devices at all times while trawling in the Kenya territorial waters. However so far the compliance is very poor due to the poor performance of the available TEDs and weak enforcement mechanisms.
- In the Kenya Gazette (Gazette Notice No. 7565 of 31/10/2001); the Government has also gazetted a closed season for trawling from November to March. This has been identified as the breeding season for prawns and this legislation is intended to safeguard the breeding of prawns. Implementation has been enforced and compliance is expected to improve.

Together with the above management measures by the Department, introduction of other bycatch reduction devices together with Turtle Excluder Devices (TEDs) is encouraged. Utilization of the fish as food and encouraging establishment of fishmeal plants are yet other ways towards reducing the large amounts.

MADAGASCAR

Policy and legislation on bycatch in Madagascar
Olga Andriamiseza, Ministry of Fisheries, Antananarivo

In Madagascar, shallow water shrimps are principally exploited by the industrial trawl fishery and the artisanal trawl fishery. However, there are also traditional fishermen who catch shrimps using simple and traditional methods. The industrial fishery uses boats of more than 50 horsepower, while the artisanal fishery operates with boats fitted with outboard engines of less than 50 horsepower. The total number of industrial trawlers is limited to 72, of which 15 are fishing deep water shrimp. The artisanal fishermen also collect shrimps from the traditional fishermen.

In Madagascar, prawn trawling is carried out in well-demarcated zones, with clear limitations on catch and effort in each zone. The permissible catch and fishing effort for each zone is given in the table below.

Zone	Permissible catch (tonnes/year)	Maximum number of industrial trawlers (>50 horsepower)	Maximum number of artisanal trawlers (< 50 horsepower)
A	**1 600**	**8**	**36**
B	**2 300**	**10**	**-**
C	**2 500**	**48**	**-**
D	**5 00**	**6**	**-**
Total	**6 900**	**72**	**36**

(a) In Madagascar, there is no definite policy on shrimp bycatch. The specific objectives and policy of the Fisheries Department are:

- to satisfy local protein requirements;
- to fight against poverty;
- to create employment;
- to consider trawler bycatch as additional supplies of food fish (food security);
- to promote increased landings, processing and marketing of the bycatch, by dialogue and consultation with the fishing industry and also by improving control;
- to develop cold storage facilities on land;
- to take considerations of social and environmental impacts and have proper communication between industry, administration and research.

The general policies on bycatch utilization encourage the trawlers to retain the bycatch which will be sold in the market for human consumption. Threatened species recognized under international conventions are also protected, and Madagascar also follows the FAO Code of Conduct for Responsible Fisheries. Trawling is restricted to areas greater than two nautical miles from the coast. Like in the other countries, e.g. Kenya, this legislation was implemented without any scientific basis. There is a closed season between November and February to safeguard the breeding season of shrimps. To minimize the amount of discards, a new decree (200–415 of June 2000) requires the fish companies to land a ratio of 1 kg fish to 2 kg shrimp. Previously, the companies were required to land equal quantities of fish and shrimp. This requirement is cumbersome to implement and consequently compliance is very poor. An economic observatory was recently set up to analyse the companies' performance in reaching the specific objectives of the sector.

MOZAMBIQUE

Shrimp bycatch policy in Mozambique
Francisco Bomba, Ministry of Fisheries, Maputo

Mozambique is located on the east coast of Africa, with a coastline of 2 700 km stretching from the mouth of the Rovuma River in the north to Ponta de Ouro in the south. The population of Mozambique is 17 million increasing at two percent per annum (Anon.). Mozambique's long coastline and its marine resources support fisheries which are of high importance to the people of Mozambique in terms of food and economic activity - some 80 000 Mozambicans are mainly occupied with fisheries related activities, while coastal communities all along the 2 700 km coastline rely on fisheries as their main economic activity.

The economy is based on agriculture, and exports are dominated by agricultural products (cashews, cotton, sugar, copra, citrus, coconuts and timber) and fisheries. Prawns constituted the main commodity exported in 2001, with a value of US$ 85 million, while the annual value of all exported fish products was US$ 130 million. Aluminium and hydroelectric power are expected to contribute significantly to export earnings since the installation of the Mozal aluminium smelter (2000), and new

or restored electricity lines connecting the Cabora Bassa Dam to the South African and Zimbabwean electricity markets. The fishery sector is divided into three categories; 1) The artisanal fisheries of coastal communities along the coastline and in inland waters, which produce both for subsistence and commercial sale; 2) The semi-industrial fisheries by intermediate size boats (10–20 m in length), mainly involved in shallow water marine shrimp fisheries and the kapenta fisheries in Cahora Bassa – these provide for local consumption and export; and 3) The industrial fisheries with larger vessels (> 20 m), fishing for shallow water shrimp and resources in deeper waters, mainly for export.

It is estimated that artisanal fisheries land some 70 000 tonnes per year. The semi-industrial fleet lands 11 500 tonnes of which shallow water shrimp contributes 1 500 tonnes and kapenta in Cabora Bassa contributes 9 000 tonnes. In 2001 the industrial fleet of 80 vessels licensed in Mozambique landed 10 000 tonnes of which 9 000 tonnes were shallow water shrimp. The shallow water shrimp fisheries are in commercial terms by far the most important with an export of 9 000 tonnes worth US$ 85 million in 2001. Additionally, a fleet of 113 foreign vessels exploit tuna under license agreements, with catches amounting to 3 000 tonnes in 2001.

The most important commercially exploited stocks, including shallow water shrimp and deep water lobster, have been assessed to be highly or fully exploited, while some resources including large and small pelagic fishes and demersal fishes in some areas seem to be lightly or not exploited. Apart from providing food security, the artisanal fisheries serve also as a buffer for economic activity for people who are losing opportunities in other sectors. This may be an important contribution to the overall economy in slump periods but may also lead to longer term impoverishment in coastal communities if a net influx of people to coastal fisheries becomes more than just a temporary feature. The semi-industrial fleet, the industrial fleet and the artisanal fisheries all exploit the same stock to some extent. The general objectives of the Mozambican Fisheries Policy are (Anon., 1996):

For artisanal fisheries

- To improve the supply of fish on the local market.
- To improve the living conditions for people in the fisheries communities through increased exploitation on a sustainable basis of fish resources accessible to them.

For semi-industrial fisheries

- To contribute to the increase of foreign revenues and increase the supply to internal markets.
- To contribute significantly to the increase of export products, to the local consumption and also to improve the living conditions of fisheries communities, in a sustainable use of the resources, and in the improvement of profits generated from the respective vessels.

For industrial fisheries

- To contribute significantly to stabilizing the national economy through an increase in net foreign exchange revenue.
- On a sustainable basis improve the profitability of the utilization of the fishing resources.

According to the national policy in Mozambique, the Government encourages the trawling companies to offload the highest quantity of bycatch possible. Taking into account the importance of the shrimp resources in the Mozambican economy, strong management measures have been established for sustainable exploitation of this resource. The main measures are:

- closed season of three months;
- control of mesh size of the nets (55 mm);

- annually quotas for each vessel;
- limitation of number of vessels;
- closed fishery (no more entries);
- no industrial trawlers are allowed to trawl in water less than 10 m deep and less than one nautical mile from the coast.

At the moment the Government has put into practice management measures that require the companies to offload an annual quantity of bycatch of at least double the shrimp quota for each vessel. The Ministry of Fisheries in Mozambique, the Government entity responsible for the fisheries sector, allocates shrimp quotas and the corresponding bycatch per company on an annual basis, and subsequently collects the fees based on the shrimp quotas and the retained bycatch.

The Ministry of Fisheries has to enforce the use of bycatch. The measures that have been taken until now are not effective. Some of the reasons for this include fear of theft from vessels and fears of disrupting this extremely important source of foreign revenue. Taking into account the needs for food of Mozambican people, efforts to reduce their impoverishment, and the over-exploitation of most common fish resources in recent years, we have to change our attitude and think about ways to solve bycatch problems. There is wastage occurring in high value fisheries resources. This misuse is undertaken for economic reasons by a minor group of companies and, while people are starving, should be considered morally wrong and needs to be solved. Administrative measures have to be put forward in a strong way, including use of devices for excluding bycatch. Mozambique is currently developing a fisheries policy and a bycatch policy will be included in this.

REPUBLIC OF SOUTH AFRICA

Bycatch policy and legislation in South Africa
Johan Groeneveld, Marine and Coastal Management, Cape Town

South Africa subscribes to the principles embodied in the FAO Code of Conduct for Responsible Fisheries, part of the preamble of which states:

“Selective and environmentally safe fishing gear and practices should be further developed and applied, to the extent practicable, in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems and protect fish quality”.

Some of these principles are covered by the South African Marine Living Resources Act No 18 of 1998, the introduction to which includes the following statement:

“To provide for the conservation of the marine ecosystem, the long-term sustainable utilization of marine living resources and the orderly access to exploitation, utilization and protection of certain marine living resources; and for these purposes to provide for the exercise of control over marine living resources in a fair and equitable manner to the benefit of all the citizens of South Africa; and to provide for matters connected herewith”

The following objectives and principles of this Act (Chapter 1 [2]) are relevant to the issue of target and bycatch species:

- the need to achieve optimum utilization and ecologically sustainable development of marine living resources;
- the need to conserve marine living resources for both present and future generations;
- the need to apply precautionary approaches in respect of management and development of marine living resources;
- the need to protect the ecosystem as a whole, including species not targeted for exploitation;

- the need to preserve marine biodiversity.

A definition of bycatch is provided in the regulations in terms of the Marine Living Resources Act: "Bycatch" is any species landed in addition to a target species for which a permit has been issued.

There are numerous regulations that have been promulgated in terms of the Act:

- Chapter 1: Administrative matters
- Chapter 2: Rights of access, other rights, permits and licences
- Chapter 3: Closed seasons and closed areas
- Chapter 4: Use of gear
- Chapter 5: Species restrictions
- Chapter 6: Mariculture
- Chapter 7: Landing, transportation, delivery, receipt, processing and marketing of fish and fish products
- Chapter 8: Compliance control
- Chapter 9: Other provisions

Specific regulations that are used to control bycatch of all fisheries in South Africa include:

- prohibited species
- closed seasons
- closed areas
- gear limitations (nets and mesh sizes; attachments to trawlnets);
- size and mass limits
- landing, transportation, delivery, receipt, processing and marketing of fish and fish products

Specific regulations or permit conditions relevant to bycatch in the South African prawn trawl fishery include:

- Any spotted grunter (*Pomadasys commersonii*) caught may not be sold.
- Closed seasons and areas: "Fishing is prohibited on the Tugela Bank…from November to February".
- Gear limitations: "The mesh size on trawlnets may not be less than 50 mm, measured centre knot to centre knot".
- Only five trawlers are allowed within seven nautical miles of the coast at any one time.

These regulations were introduced in order to:

- protect *P. commersonii;*
- protect juvenile fish – mainly squaretail kob *Argyrosomus thorpei;*
- allow for the escape of very small fish and crustaceans.

Levels of discarded bycatch remain unacceptably high (Figure 1) and contrary to policy.

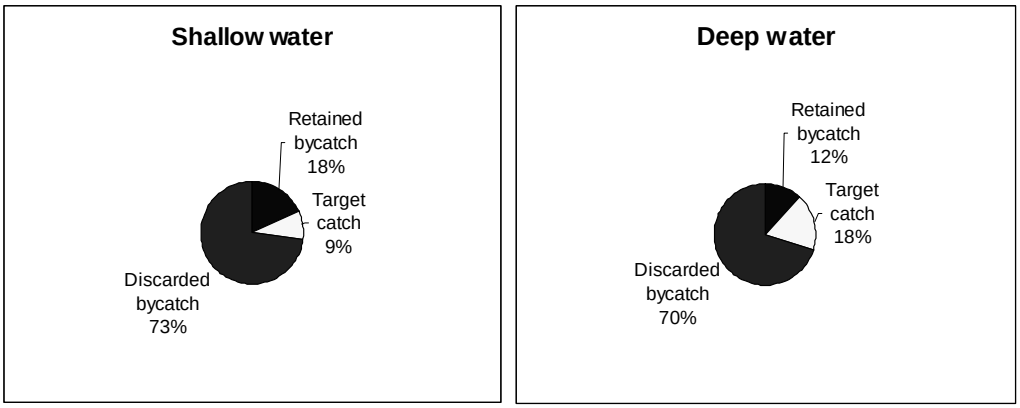

Figure 1: Composition of prawn trawl catches in South Africa (Fennessy and Groeneveld, 1997).

However, there is a need for research before regulation. In this regard, a long-term observer programme started in 2002, which aims for 15 to 20 percent coverage of all trawls. The programme:

- collects data on retained and discarded bycatch and target species;
- focuses on discarded bycatch;.
- collects samples for further analysis in the laboratory;

Discarded bycatch are identified and quantified (by numbers and mass) at sea. A key (field guide) for species identification at sea has been developed for the fishery.

Further initiatives to reduce discarded bycatch in the prawn trawl fishery include:

- trials with bycatch reduction devices (BRDs) to take place in 2003;
- policy to address bycatch and discarding by demersal trawlers in early stages of development.

These initiatives will, in the near future, provide a scientific basis for the management of bycatch in the South African prawn trawl fishery.

WORKSHOP AGENDA ITEM 2: UTILIZATION OF BYCATCH

Utilization of shrimp bycatch
Frans Teutscher, ex-staff member, FAO Fish Utilization and Marketing Service

Introduction

Bycatch utilization is an important aspect of shrimp trawl fisheries and their management. However, bycatch can be reduced but cannot be eliminated. With present selectivity technology and management the reduction may not be more than some 30 percent at most, hence in the most favourable case the average global bycatch: shrimp ratio may be reduced from around 6:1 to around 4:1 and a trawler's daily bycatch could perhaps be reduced from around three tonnes to two tonnes. Utilization of unavoidable bycatch helps to reduce discards, adds to the income of trawler and crew, increases low-cost food supplies, creates employment and income on shore, reduces pollution, and it reduces conflict between industrial and artisanal fishermen. In fact most of the bycatch in shrimp fisheries can nowadays be considered as secondary target catch with shrimp as the primary target catch.

The introduction of selective fishing gear and selective fishing methods reduces these socio-economic benefits and therefore it is important to compensate by improving the utilization of the unavoidable bycatch. Bycatch utilization is in line with the Code of Conduct for Responsible Fisheries because it promotes maximum socio-economic benefit of fish catches for local populations. However, quantities caught and utilized must stay well within the limits of sustainability, and therefore fishermen must follow instructions from fisheries managers with respect to catches of fish of certain species and sizes, in particular juveniles, and with respect to time and place of fishing activities.

Scientists and managers need to know all characteristics of the bycatch. This may include quantities, species, sizes, season, location, and time caught, etc. These characteristics need to be assessed regularly and it is only on the basis of these data that management including development can be pursued. The data should therefore be entered in a database to facilitate analysis.

In addition, data are required on the socio-economic aspects of the bycatch, including:

- present and potential loss of commercial species;
- present and potential contribution of bycatch to incomes of trawler and crew;
- marketability of bycatch by species and size;
- facilities onboard;
- arrangements and practices for transfer of the bycatch to shore; and
- the utilization of the products.

Socio-economic studies are usually included in the work plan of the GEF project, but practical research and development of markets for bycatch products is not included. This is however included in the FAO Regular Programme where the Fish Utilization and Marketing Service (FIIU) of FAO is responsible for promoting the utilization of low-value catches such as bycatch and small pelagics. In East Africa FIIU has assisted national institutions in Mozambique, Madagascar, Tanzania and Kenya to promote bycatch utilization. This has been done through studies, reports, projects, meetings, and publications. The last activity was together with KMFRI Mombasa through a Letter of Agreement between FAO and KMFRI. Probably Gerald Mwatha will report on the study but I would like to call your attention to the fact that such studies do not need to cost a lot of money and that it can help a lot to collect information, organize stakeholder consultations and help in designing fisheries policy, including management and development. FIIU collaborates with the GEF project on bycatch utilization aspects and to some extent this meeting can be regarded as a spin-off from the FIIU-KMFRI collaboration.

Reasons for bycatch utilization

In line with the objectives of the GEF project and the Code of Conduct for Responsible Fisheries there are two reasons for utilization of bycatch:

I. *An environmental reason*: the main drive being to protect resources and environment through a reduction of discards. Discarded bycatch may affect the ecosystem and cause pollution of water and beaches.

II. *A socio-economic reason:*
    - There is need to contribute to the economic performance of the shrimp trawler. Bycatch is often a secondary target contributing to the income of boat owner and crew, in particular on smaller boats without freezing facilities.
    - To contribute to food security, income generation and employment. The effect on poverty reduction and food security can be significant if the bycatch is allowed to

enter the traditional food systems in poor coastal areas. In some countries bycatch is used in school feeding programmes.

- Utilization of bycatch ultimately contributes to conflict resolution between artisanal fishermen and shrimp trawlers. While artisanal fisheries communities are affected by damages caused by trawlers, they benefit from access to the bycatch. Stakeholder consultations between the two groups, under supervision by fishery departments, are useful tools not only in conflict management but also in other aspects of fisheries management.

- Bycatch has the potential of polluting water and beaches. This has the potential of scaring tourists away, while traditional artisanal fish processing and marketing has a folkloristic interest for tourists. Therefore the elimination of discarding and the utilization of bycatch in traditional food systems can promote tourism.

- Utilization of bycatch can promote and sustain trade. Consumers in shrimp importing countries are becoming aware and concerned about environmental and social impacts of fisheries. Application of responsible fishing and responsible fish utilization is a wise strategy to sustain and promote trade. Traceability of fishery products should also be considered in this context.

Reasons against bycatch utilization

Owners and operators of freezer trawlers are often not interested in the possible revenues from bycatch or in the needs of crews or coastal populations. This seems to be the case of joint venture operations, in particular when trawlers make long trips of several months. Reasons brought forward against bycatch utilization include the following:

I. Theft of shrimp by the crew and other high-value species such as beche-de-mer to the coastal communities.

   Comment: It happens and trawler owners know it but usually prefer to ignore it and don't want to discuss it. However, it would be better for all stakeholders, including the trawler owners, to openly discuss it. It does not occur on smaller trawlers where the captain is also the owner of the boat and therefore has good control over what happens at sea.

II. No space, capacity or time for bycatch. The crew time and facilities onboard are fully occupied by trawling operations and by the shrimp.

   Comment: Indeed, shrimp trawlers are not designed to take care of low-value bycatch, but in some cases, such as recently in French Guyana, new boats may be designed with storage capacity for commercial bycatch. Perhaps it is time to rethink the design of shrimp trawlers. In other cases such as in Thailand, Cuba and Madagascar, special vessels collect both the shrimp and the bycatch at sea. And in many countries small coastal craft approach the trawlers at sea and bycatch is transferred to these vessels.

III. Quality assurance considerations; there is the argument that bycatch utilization would not be permissible for sanitary reasons. Import regulations such as those of the European Union require that food safety systems in exporting countries are equivalent to their own. This would imply that shrimp should only be handled by a trained and sanitarily controlled crew.

   Comment: Such an argument is false as the EU does not (yet?) include such a requirement. However, normal good handling procedures must be applied including cleaning of the deck immediately after sorting, and storing the bycatch separately from the shrimps.

IV. It would be an incentive to catch more small fish and juveniles. The income derived from low-value. bycatch may deter fishermen from applying selective fishing technologies and management measures.

Comment: This should be managed and controlled by fisheries managers and by the companies themselves.

Examples of bycatch utilization systems

The following are some bycatch utilization systems in some selected countries:

Madagascar

In Madagascar, bycatch must be landed by law, at least 1 kg for each kg shrimp. Fresh bycatch is thus made available to coastal communities in remote areas and frozen bycatch is marketed in urban areas. In other remote areas people in small canoes scoop up discarded bycatch from the water surface. The fish enters the traditional food chain as salted, dried or smoked fish and is sold in rural and urban markets. The PNB Company in Nosy Be has an active community bycatch programme. This is the same company that collaborated with a FAO project on bycatch utilization in 1994.

Mozambique

In Mozambique, fresh unchilled bycatch is kept in heaps on the deck of the trawler. It is collected at sea by coastal communities using non-motorized small boats or canoes. The fish enters the traditional food chain: it is salted, dried or smoked in the villages and sold in rural and urban markets.

Central America

Fresh bycatch without ice is collected at sea by moralleros (bycatch collectors) using small motorized boats.

Cameroon, Nigeria and Tanzania

Selected bycatch is chilled in plastic sacks on board the trawler and collected at sea by small motorized boats and canoes. The fish enters the traditional food chain: it is salted, dried or smoked in the villages and sold in rural and urban markets.

Guyana, Suriname and Mexico

Selected bycatch is frozen in bags on board the trawler, landed in port, and marketed in urban markets through cold chains, often as low-cost fish.

Cuba

Bycatch is iced on board the trawler, landed at special collection points along the coasts from where it is collected by semi-industrial vessels. It is then landed in port and industrially processed to frozen mince, frozen fish burgers. The collector vessel also collects the shrimp catch. Trash fish is not iced, but it is also collected (by a different vessel) and then used for fishmeal.

Thailand

Shrimp bycatch is iced on board the trawler in plastic containers of 80 kg capacity that are collected at sea by a specialized vessel. The bycatch is landed in port and industrially processed to fish balls, surimi, fish sauce and fishmeal.

Trinidad

Bycatch is used to produce products for school feeding programmes.

KENYA (1)

Utilization and the socio-economic impacts of bycatch in Kenya
Jacob Ochiewo, KMFRI, Mombasa

The fishery of Malindi-Ungwana Bay in the northern Kenya coast is open access, and there are two types of fisheries in this area. The artisanal fishery depends on traditional fishing vessels, simple fishing gears and fish for subsistence, while the shrimp trawling fishery is semi-industrial. The shrimps are mostly exported while the finfish caught is sold in the local markets. Both the artisanal fishery and the semi-industrial shrimp industry aim to maximize output to improve profit.

In Kenya, part of the bycatch is retained and sold by the trawl companies in the local market, particularly fish of high commercial value. Table 1 shows the trend in catches of shrimps and retained fish in Malindi-Ungwana Bay semi-industrial shrimp fishery for the last five years, with an increase in the amount of valuable fish being retained. Between 60 and 70 percent of the total fish bycatch is discarded at sea. This normally consists of small-sized fishes, juvenile fish and shrimps, other edible crustaceans, rays and sharks. Most of the discarded fish comprises species that are valued by the artisanal fishing units and consumers. The prevailing demand in the market for these species clearly expresses the consumers' willingness to pay for discards. However, fish discarding is still being practised by the shrimp trawlers mainly due to the following reasons:

- The trawlers have limited storage facilities on board. They prefer to maximize storage of shrimps in order to maximize profits.
- There is no policy framework and clear legislation to compel the industry to either store bycatch or facilitate the collection of discards at sea by the artisanal fishermen. Most of the bycatch is therefore discarded at sea.
- The discards fetch very low prices in the local markets and therefore there is no profit motivation for trawlers to store the bycatch.

Table 1. Annual catches from the semi-industrial shrimp fishery in Kenya.

YEAR	TOTAL CATCH (kg)	SHRIMP (tonnes)	VALUABLE FISH (tonnes)	PERCENT VALUABLE FISH
2002	1049.6	495.3	554.3	52.8
2001	950.9	454.1	496.8	52.2
2000	712.4	399.7	312.6	43.9
1999	736.6	429.3	307.3	41.7
1998	858.3	587.4	270.9	31.6

However, the true social and environmental costs of bycatch are not reflected in the market. The social and economic impacts of bycatch are intertwined, and the bycatch has both negative and positive impacts. On the negative side, survey results in 2001 show that increased bycatch has led to decreased economic returns to local artisanal fishermen (KMFRI, unpublished data). The artisanal fishery has experienced declining catch per unit effort which the artisanal fishermen have attributed to the negative impacts of trawling on bycatch, fishing grounds, fish breeding sizes and destruction of the benthic habitat. As a consequence, heightened conflicts between the fisheries sectors have resulted. Decrease in catch per effort unit in the artisanal fishery has resulted in an increase in poverty and a decline in the ability of many fishing households to meet their basic needs. The prevailing scarcity of fish has led to changes in consumption habits. Some species that form the bulk of the bycatch such as the wolf herring and ribbonfish are now delicacies in many coastal households.

Indeed, even the cooking technology has changed to accommodate those species which require special cooking methods.

On the positive side, the bycatch from shrimp trawlers has created employment opportunities for many coastal dwellers. From 2000, the shrimp trawlers started retaining more bycatch which has landed on the consumer's table, thereby augmenting protein requirements. Retained bycatch has actually been contributing to the country's GDP.

Apart from the people employed by the shrimp trawling firms to handle and sell bycatch, there are approximately 500 fishmongers in Mombasa who depend solely on bycatch. The number of fishmongers who depend on bycatch in Malindi is yet to be estimated. These fishmongers support some 3 000 dependants.

There is need to minimize discards. Edible fish should all be landed where it can reach the consumer. The fishing techniques are the main contributors to bycatch. Therefore, shrimp trawling technology should be improved to reduce the amount of bycatch. Reduction of bycatch will have positive ecological impacts and conflicts between the stakeholders will also be minimized.

KENYA (2)

Improved utilization of some low value fish in Kenya
Peter Odour, KMFRI, Mombasa

In the last decade, annual fish production in Kenya was approximately 180 000 tonnes. Of this, coastal fisheries accounted for about 10 000 tonnes and the prawn fishery 350 tonnes. Wastage (discards) from the prawn fishery was estimated at 1 800 tonnes per year. The consumption of fish in Kenya could be more than doubled if presently unused fish resources were brought into the human food chain. Solar dryers and low cost extruders can be exploited as one way of preserving and or processing fish mince, and used to develop some ready to eat shelf-stable products in combination with locally available staple cereals like maize, wheat, millet and other starch sources like pumpkins and cassava (Bala, 2000; Bala and Manol, 2002). An ongoing project in Kenya funded by the European Union aims at improving the utilization of low value fish including waste products by producing extruded and dried products of high nutritional and organoleptic quality in Kenya in combination with staple foods.

The parameters initially analysed were nutritional composition with emphasis on protein content, microbial characterization, fatty acid profile and oxidation during shelf storage of dried products of selected low value fish. The fish species studied included *Tachysurus feliceps* (Mapanga) and *Trichiurus lepturus* (Catfish), and the results are presented in this report.

Nutritional properties

The chemical composition of fish varies, depending on species, environment, sex and season (Huss, 1995). The protein level for the two species studied is between 20 percent and 21 percent. Protein levels for most fish range between 16 percent and 21 percent (FAO, 1995). The fish are therefore suitable for human utilization.

Microbiological analysis

Post-mortem events after fish evisceration can cause sensory deterioration, autolytic increases, microbial proliferation, rancidity development and physical changes that consequently reduce product quality.

The initial aerobic plate count of *T. feliceps* on skin, gut, gills was 450 cfu/10g, 90 cfu/10g and 360 cfu/10g respectively, while the Total Coliform Count (TCC) was 90 cfu/10g for skin-on fillets and 81

cfu/10g for gills. For *T. lepturus* the APC was 360 cfu/100g for skin-on fillets, 2700 cfu/10g in the gut and 648 cfu/10g for gills. Micro-organisms are found on all the outer regions (skin and gills) and in the intestines of newly-caught fish. The number of bacteria varies enormously, with ranges of 10^2 – 10^7 cfu/cm^2on the skin being considered as normal. The gills and intestines both contain between 10^3 and 10^9 cfu/g. The levels of bacteria seen in this case study are reasonable and within normal ranges. The levels of coliforms could be due to handling of the fish during processing. Studies on ambient storage with emphasis on bacterial counts, total volatile bases, and organoleptic quality score indicated that the maximum possible storage time was about 4 hr. This is important to know as post-harvest quality of fishery products has been a concern since it directly impacts on consumer satisfaction and knowledge of initial freshness is crucial as procurement conditions do vary. Both microbial and chemical changes occurring over time result in a loss of freshness followed by development of undesirable aromas and flavours (Huss, 1988).

Further biochemical characterization/chemical changes

Attempts made to study fat oxidation and microbiological changes of minced fish flesh in the solar dryer indicated that the temperature conditions in the solar dryer of up to 50ºC did not allow for bacterial growth. TBARS and PV however increased in the initial stages then declined. This is probably in line with the mechanism of lipid oxidation which involves initiation, propagation and termination phases (Icekson *et al.*, 1998; Frankel, 1991). Within a 15 day period, the shelf-keeping quality of a fish protein concentrate prepared by solar drying showed no significant difference ($p<0.05$) when ethanol was used as dehydrating, further defatting or deodorizing agent. The fish protein concentrate will be used to fortify the selected staple cereals.

Preliminary conclusions:

- Spoilage/rejection of all the fish occurred after about 4 hours.
- Protein levels were within ranges reported generally for fish. TVB, Microbial counts and the sensory scores show some similar trends and are useful for freshness tests. *T. lepturus* has a wider range of HUFA's than *T. feliceps*.
- TBAR levels in solar dried fish show more definite patterns than PV. Therefore TBARS can be used as indicators of oxidation in dried fish.

MADAGASCAR

Utilization of bycatch in Madagascar
Guy Rabarison (CNRE) & Olga Andriamiseza (Ministry of Fisheries), Antananarivo

The following table summarizes studies or initiatives related to the utilization of bycatch in Madagascar.

PROJECT/ STUDIES WORKSHOP	AUTHOR/ ORGANIZATION	PERIOD	INFORMATION COLLECTED	OBSERVATIONS
Biological studies (Nosy be, Mahajanga)	G. RABARISON N. RAVELOSON	1984-86	a) Catches, discards assessment b) Species composition c) Stomach content	
Biological studies	CNRO	1987-89	More detailed bycatch assessment	

PROJECT/ STUDIES WORKSHOP	AUTHOR/ ORGANIZATION	PERIOD	INFORMATION COLLECTED	OBSERVATIONS
Valorisation du poisson d'accompagnement de la pêche crevettière malgache	J.ROULLOT	1989	a) Situation of fisheries in Madagascar (fleet, catch, trading, fishing effort, etc.) b) Testing selective trawls c) Species composition of bycatch	Proposition to feed aquaculture species and to enhance breeding using bycatch
Shrimp trawler bycatch	H.N.RAVELOSON	1990	a) Constraint of rational exploitation b) Technical and economical situation c) Proposition for bycatch development	Proposition to carry out technical feasibility studies of treatment on board
Utilization of bycatch	FAO J.ROULLOT M.RAKOTONDRASOA	1993-1994	a) Situation of bycatch in the world and in Madagascar b) Species composition of bycatch c) Categories of bycatch fish and quantity unloaded in each zone d) Variation of catch (day/night). e) Demonstration of collecting bycatch at sea by appropriate boat, and subsequent processing and marketing	18 000-20 000 tonnes of bycatch are discarded in Madagascar 4 600 tonnes first choice 19 300 tonnes second choice 10 500 tonnes for animal feeding Not applied by private operators
Utilization of bycatch from shrimp trawlers (international workshop, Nosy be Madagascar)	FAO, UNDP and Malagasy government	1995	a) Information on bycatch utilization in different countries b) Conclusions and some recommendations about government policies on bycatch and collaboration between government and fleet owners in coastal countries	Participants : Benin, Cameroon, Cuba, Gambia, Guinea, Nigeria, Madagascar, Mozambique, Suriname, Tanzania, Thailand, United Kingdom (with info from India), Vietnam

PROJECT/ STUDIES WORKSHOP	AUTHOR/ ORGANIZATION	PERIOD	INFORMATION COLLECTED	OBSERVATIONS
Project on best use of bycatch	OFCF (Overseas Fisheries Cooperation Foundation) Japan cooperation with Malagasy government	1997-2000	a) Promotion of bycatch marketing by giving material for storage and transport b) Training of fishermen and sellers c) Promotion bycatch consumption (testing a new process) d) Processing (smoked, dried, etc.)	
Bycatch in Mahajanga	ANDRIAMIZARA, C. (participation in national shrimp workshop)	1998	a) Information from three fishing companies working in Mahajanga b) Species composition, ratio of shrimp/fish c) Bycatch marketing (price, destination, etc.)	
Project on developing bycatch storage	JICA Japanese cooperation with Malagasy government	2002	a) Feasibility studies (information about society and bycatch at Mahajanga) b) Gift of cold storage unit (900 m^3, 300 t, -20°C) and means of transport	Storage on land is one solution to improve quality and quantity of bycatch. Need collaboration between administration and fleet owners. Status of unit is private but it belongs to the fisheries administration

MOZAMBIQUE

Utilization of bycatch in Mozambique
Francisco Bomba, Ministry of Fisheries, Maputo

The Mozambican shallow water shrimp fisheries are in commercial terms by far the most important, with an export of 9 000 tonnes worth US$85 million during 2001. Table 1 shows the shrimp catch by sector in recent years. As shown in the table the highest catches recorded within this period were in 2001, due to the special environmental conditions in 2000, the previous year (rain and others).

Table 1: Shallow water shrimp catches (tonnes) by trawl sector in Mozambique

Year	Industrial vessels	Semi-industrial vessels	Total
1998	7 172	976	8 148
1999	6 971	1 474	8 445
2000	7 419	1 721	9 140
2001	7 595	1 566	9 161
2002	7 285	1 550	8 835
Total	36 442	7 287	43 729

All vessels in the semi-industrial fleet (using ice) land the bycatch either as frozen or as sun dried products. Most of the companies using semi-industrial vessels have processing plants where the bycatch is sold. The artisanal fishermen use and/or sell the entire bycatch fresh, sun-dried or salted. In comparison, this fishery produced more bycatch under the centralized government planning system than under the market economy system. Table 2 shows the bycatch records in the database of the Ministry of Fisheries. The figures show the lack of information for the period 1988-1995.

Table 2: bycatch quantities (tonnes) landed by trawl sector

Year	Industrial vessels	Semi-industrial vessels	Total
1998	803	556	1 359
1999	554	444	9 98
2000	560	480	1 040
2001	658	354	1 012
2002	840	599	1 439
Total	3 415	2 433	5 848

The most critical aspects in the utilization of bycatch are:

- Lack of statistical records on the use of bycatch;
- Absence of strong measures against companies not obeying the government efforts to increase utilization of bycatch.

Not all companies have been enthusiastic in supporting government policy to land twice as much bycatch as shrimp. Particularly the companies using industrial vessels in the shrimp fishery have argued strongly and persistently that the freezing capacity on board the vessels is too small for the total catch. Since shrimp is the most valuable species in the catches, the companies prefer to use the freezers only to preserve shrimp.

The collection of bycatch in the shrimp fisheries in Mozambique is not a new phenomenon. Since the early sixties, artisanal fishermen, using dugout canoes, have collected bycatch in the high seas, through exchange of fruits and other products, with shrimp crew members of industrial vessels. Since 1982, the collection of bycatch began on an experimental basis in the northern province of Nampula using small motorized boats. The positive results of these activities were then replicated in other areas of the country. However, administrative and logistic constraints blocked the initiative and further development was interrupted. Later the fisheries sector designed a project based on the experiences gained in the experimental phase. The project was financed by the Danish Government, through DANIDA, and was implemented from 1988 to 1995. The main objective of the project was to improve the supply of food (cheap animal protein) to the poorest of the Mozambican people, through collection, processing and marketing of bycatch obtained from industrial trawlers in the shrimp fishery.

The annual bycatch in the country was estimated to be approximately 40 000 tonnes, from which the project aimed to collect 50 percent per year for human consumption. However, according to the development of the activities, the project only managed to collect 3 175 tonnes of bycatch per year, or 635 tonnes from each of a total of five collection points. Many constraints affected the implementation of the project, including:

- Technical (in the design of the motorized boats)
- Administrative (changes in the social-political system)
- Logistics

The project ceased after the defined project period, but the activities as such continued, as the collection of bycatch became a routine activity amongst artisanal fishermen. However, due to logistic

problems such as limited maintenance of the engines, the fishermen continued with improved canoes and not motorized boats. As a conclusion the project found that the use of motorized boats in the collection of bycatch was very costly, and that canoes traditionally equipped with sails were the most appropriate (and economically adequate) method for the collection of bycatch. The number of canoes collecting bycatch has increased in later years because of the general increase in prices for fishing gear in Mozambique, coupled with the increase in unemployment, and because of a low degree of investment in the artisanal sub-sector. At the moment 809 canoes are involved in the collection of bycatch from the industrial fishery. According to records from 1996, the annual volume of the bycatch collection is estimated to be in the order of 7.5 - 8 000 tonnes (IDPPE, 1996).

At the moment, the Ministry of Fisheries has launched a new project called “Project for Raising the Value of Catches of the Artisanal Fishermen and the bycatch of Shrimp”. The project is funded by the Japanese Government and aims to improve the living conditions for people in the fishing communities. The idea is to support fishermen, processors and vendors to increase their revenues by improving the quality of the products caught and the bycatch collected. As the project is still in an early stage, no figures on catches or the quantity of bycatch collected is recorded within this project.

SECTOR REPRESENTATIVE PERSPECTIVE

The Kenyan trawling sector's perspective on bycatch utilization
Basta Paolo, Basta & Sons, Mombasa.

Trawler operators in Kenya admitted that bycatch and discarding of fish occurs in the prawn fishery. While some of the trawlers have adequate storage facilities, others have very limited storage facilities. Due to limited storage facilities and the need to maximize profits, discarding becomes unavoidable. However, of late there have been some efforts to minimize the amount of discard in order to minimize the conflicts arising due to the act of discarding. Currently, more of the bycatch is being stored and marketed by the trawler operators.

Trawlers in Kenya are reluctant to make bycatch freely available to fishermen. There have been several proposals to allow the local fishermen to collect the bycatch at sea but the trawler owners are opposed to this arrangement because of two prime considerations. First, the trawler operators feel that if this is allowed to take place, there is a high possibility that the crew may sell prawns and high quality fish to the artisanal fishermen, leading to loss of catch. Secondly, the trawlers have safety concerns if the operations are allowed to take place in the sea.

On marketing of the bycatch in the area where it is caught, e.g. Malindi, the trawlers reason that this would result in an overflow of the fish in the local markets and this would cause direct competition between the trawler operators and the artisanal fishermen. The argument is that if marketing of the bycatch is carried out in the local markets, it would most likely cause fish prices to plummet causing artisanal fishermen to make losses in their fish products. Due to these considerations, the trawler operators prefer marketing the bycatch in Mombasa, where there is a bigger market and higher demand for fish. The fish dealers in Malindi are therefore forced to travel to Mombasa, a distance of 120 km, to purchase trawl fish bycatch.

WORKSHOP AGENDA ITEM 3: STATE OF BYCATCH KNOWLEDGE

NIGERIA

The GEF/UNEP/FAO programme in Nigeria
James Ogbonna, Federal Department of Fisheries, Abuja

Introduction

Nigeria has a long coastline of about 850 km, lying mainly from the Niger-Delta to the border with the Republic of Cameroon. Industrial shrimp activities are limited mainly to the Southeast. Shrimp trawling in Nigeria began in the 1960s. Currently a total of 167 trawlers are licensed to trawl for prawns. The annual prawn production is about 12 000 tonnes of which 8 000 tonnes is exported. The Nigeria shrimp trawling industry is associated with a significant amount of discards and bycatch. The discards consist mainly of small sized fishes and juveniles of commercially important fish species. In the prawn trawl fishery, fish and prawns comprise 75 percent and 25 percent of the total catch respectively

Policy and legislation on shrimp bycatch

The Sea Fisheries Decree No.71 of 1992 requires that all shrimp trawl codends should not exceed 44 mm mesh size. The law also prohibits the dumping of edible seafood in the territorial waters. The law also recommends that the ratio of fish:prawns should be maintained at 75:25. In practice this is never maintained and more fish, relative to prawns is caught. Currently no technology is employed to reduce the capture of juvenile/adult finfish in shrimp trawls. However, in compliance with the Code of Conduct for Responsible Fishing (CCRF), and in order to make the Nigerian shrimp product acceptable in the American market, Turtle Excluder Devices (TEDs) are already installed in the shrimp vessels operating in Nigeria's territorial waters. One fishing company had voluntarily employed the same type of trawls with 60 mm cod mesh size and they report landings of premium fish and less discards. Data from this exercise have not been analysed independently.

Bycatch utilization

The bycatch comprising adult and juvenile finfish of commercial value is usually sold to fishmongers who in turn retail them at the various marketing outlets. Some of the bycatch, usually juveniles, are also sold at sea by some unscrupulous vessel captains/crews or at the numerous fishing markets of the coastal/riverine communities. From an economic point of view the level of bycatch and discard generated is on the increase. There is also an expanding market for the trash fish at the numerous fishing communities due to the existing high demand for fish. The effect of bycatch on the recruitment vis-à-vis species diversity has not been properly researched.

The GEF/UNEP/FAO programme in Nigeria

From 1999, Nigeria has been participating in the GEF/UNEP/FAO shrimp fisheries project. The focus of this project is the reduction of the environmental impacts of shrimp trawling through the use of Bycatch Reduction Technologies and change in fisheries management regimes. The project is being implemented in two phases viz:

(a) Preparatory phase
(b) Implementation phase (main phase)

Project preparatory phase

This phase consists mainly of wide consultations with all stakeholders and that was after Nigeria had indicated that the problem of bycatch existed and needed to be reduced. Apart from consultations, sensitization/interactive sessions were held with people in the bycatch (discard) trade. There was a lot of anxiety expressed by both traders and fishers over alternative means of making money if the quantum of bycatch was reduced. The project was easily accepted by the stakeholders due to the following factors/issues:

- Trash fish marketers/crew were afraid of losing the lucrative fish bycatch business;
- Marketers/middlemen, especially those engaged in transshipment were eager to cash in on the trash fish business;
- Nigeria's large population creates consumer pressure for trash fish and therefore the market for trash fish is readily available;
- The sound management of the trawl fishery and utilization of the trash fish was going to contribute positively to the government strategy on poverty alleviation and food security;
- The stakeholders were unanimous about the non-sustainability of the current method of shrimp operations and the need to employ new tested mitigating technologies to reduce bycatch (trash).

At the end of the preparatory phase, an international workshop was held in Lagos with participants drawn from many parts of tropical Africa but with focal points from Cameroon, Tanzania and Nigeria. At the end of the workshop a general work outline/framework was agreed upon which was later reviewed, developed and approved as the shrimp fisheries project

Project implementation

In the approved project, the Federal Department of Fisheries (FDF) of Nigeria, as laid out in a Letter of Agreement, will undertake to implement the following subprojects:

- Improved routine shore-based collection of fisheries statistics (particularly from the shrimp trawler fleet). This includes data on fishing effort, fishing capacity, landing of shrimp, valuable fish, bycatch, etc over an annual cycle.
- Collection through an onboard observer/sampling programme of precise detailed data on actual effort and catches by industrial shrimping.
- Initiation of a campaign for the widespread introduction of appropriate bycatch reduction technologies in the industrial shrimp trawler fleet.
- The compiling of existing fisheries legislation, regulations plus measures for ongoing MCS of shrimp trawlers fisheries.

Under a different letter of agreement, the Nigeria Institute for Oceanography and Marine Research (NIOMR), the marine research arm of the Federal Ministry of Agriculture, is to undertake the following in collaboration with the Republic of Cameroon:

- The design and implementation of a socio-economic survey of the shrimp-trawl fisheries and the trading of their bycatch.
- The development/adaptation of appropriate bycatch reduction technologies for the Nigerian and Cameroonian shrimp-trawl fleets.
- The construction of prototype BRDs for testing in the commercial shrimp trawls fisheries.
- The implementation of a training/outreach session for some commercial fishermen from Nigeria and Cameroon in the construction and operation of these prototypes.

Project achievements

A draft data collection format for the fishery has been developed by the FDF awaiting the ratification of the project steering committee.

- The draft format for the socio-economic survey is nearing completion.
- The Honorable Minister of Agriculture recently approved the review of the sea fisheries act. The composition of the review committee cuts across many disciplines. Nominations are being received from different relevant establishments for the initiation of the review committee. After working internally, the draft paper produced would be reviewed together with the Republic of Cameroon.
- The Letter of Agreement for the implementation of the FDF component of the project in Nigeria has been signed. A dedicated bank account has also been opened. NIOMR is working on the second Letter of Agreement

At the end of the project it is hoped that all shrimp vessels will be employing the adopted bycatch reduction devices. There is close collaboration between Nigeria and the Republic of Cameroon in the implementation of the project.

Constraints

The major impediment to the actual initiation of the project has been funds. The inaugural meeting which precedes the actual project commencement is currently awaiting the release of funds.

KENYA

Gerald Mwatha, KMFRI, Mombasa

Due to bathymetrical, ecological and other environmental factors, the Malindi-Ungwana Bay is the area with the highest concentrations of shallow water prawns within Kenyan marine waters. Shallow water prawns are also found in the mangrove inlets. Mostly they are found in the mangrove inlets up to sub-adult stage while adult prawns are commercially caught by trawlers in the Malindi-Ungwana Bay area. In the mangrove creeks, prawn fishing is mainly at subsistence level and peaks during the rainy season. In the Malindi–Ungwana bay, the prawn fishery ha developed as a commercial fishery since the mid-1970s. Trawlers of various sizes carry out bottom prawn trawling all year round. Over time, the number of trawlers fishing in this area has varied greatly between 5 and 20 each year. However, not all the licensed trawlers are actively engaged in prawn trawling. For example, in 2000, out of the 12 licensed trawlers only 6 were fishing. In the last decade, the average annual landings from prawn trawlers have averaged 334 and 640 tonnes of prawns and fish respectively (Anon, 1999).

There have been limited efforts to quantify or qualify the amount of bycatch associated with prawn trawling activities since commercial prawn trawling began in the Malindi-Ungwana Bay area. Monitoring of the bycatch is also lacking. However, there is some available information on the quantity of high quality fish retained by the trawlers. Figure 1 shows the annual landings of prawns and fish by the prawn industry over the years.

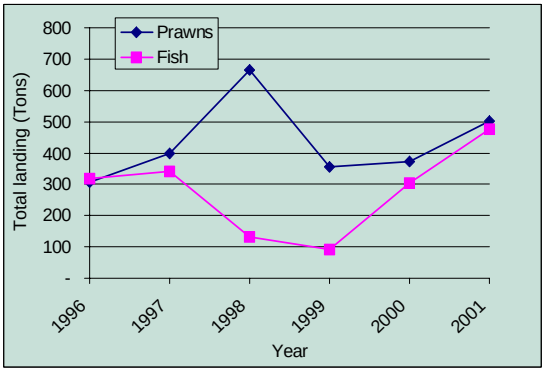

Figure 1: Annual landings of prawns and fish by the semi-industrial prawn trawlers operating in Malindi-Ungwana Bay area (Data from SECO and Alpha fishing companies).

A short evaluation on the impact of trawling on turtle mortality was carried out in 1997 (Mueni, KMFRI, unpublished data). The survey showed that prawn trawling in Kenya has a bycatch of about 70-80 percent bycatch in weight, which includes juveniles of commercial fish species and other marine organisms that include endangered species like sea turtles.

To address the persistent complaint by the artisanal fishermen about the high amount of bycatch generated by the prawn trawlers, among other concerns, the government banned prawn trawling in 2000 to allow for detailed scientific research to be carried out in order to gather correct information and make recommendations on the appropriate management intervention. During the same period, the Food and Agriculture Organization funded a research project to quantify and qualify the amount of bycatch associated with semi-industrial prawn trawling in Kenya. This research work was carried out over a period of one year (2001 to 2003) by the Kenya Marine and Fisheries Research Institute in collaboration with several organizations and stakeholders (Mwatha, KMFRI, unpublished). From this study, it was established that the ratio of total bycatch to prawns is 7:1. On average, each trawler discards about 1.5 tonnes per day. Small sized fish are the most commonly discarded fish in this fishery.

Between 25 and 30 percent (in weight) of the total fish discarded is made up of juveniles of commercially important fish species (Fig. 2). Sciaenidae (especially *Otolithes ruber* Malindi herring, and *Johnius* sp.) and *Pomadasys* sp are the main fish discarded in this category. At larger sizes (>20cm) the same species are retained. Figure 2 shows the spatial distribution of commercially important fish species in Malindi-Ungwana Bay.

Fish discarding has brought to the fore bitter conflicts between the artisanal and the semi-industrial sectors of the fishery. The artisanal fishermen argue that the decline in fish catches is due to the destruction of fish habitats by the trawlers. They also view the discarding of fish as a real case of food wastage and they would like to see it eliminated or reduced. The Fisheries Department, Kenya Marine and Fisheries Research institute and other stakeholders are holding regular consultative meetings to address the problems associated with prawn trawl bycatch, explore new opportunities and build consensus among the interested groups. Further detailed evaluation and monitoring of the bycatch is to be undertaken.

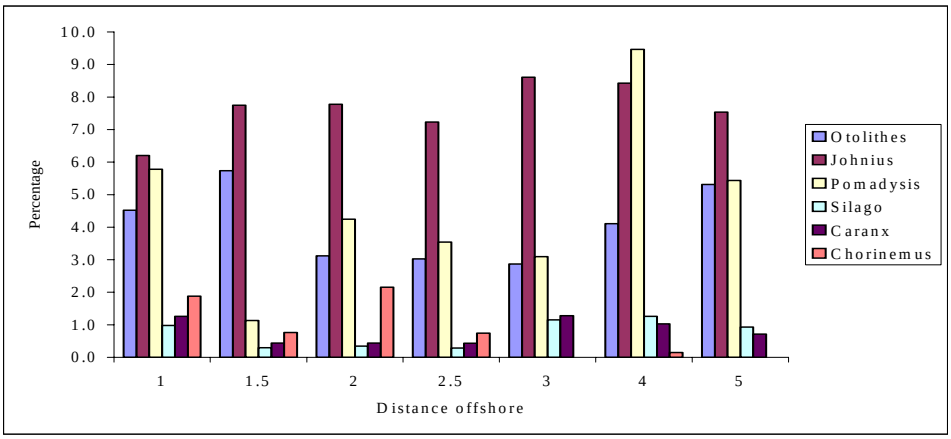

Figure 2: Temporal distribution of commercially important fish species discarded by prawn trawlers in the Malindi-Ungwana Bay area.

MADAGASCAR

Guy Rabarison, CNRE, Antananarivo

This is a brief review of bycatch composition studies done by the former French Oceanographic Centre (ORSTOM) and the National Oceanographic Research Centre (CNRO) at Nosy-bé (Madagascar). The first study was conducted in 1964 in the Ambaro Bay, the most important shrimp fishing ground in the northwest of Madagascar. The aim of the work was to make a survey of benthic resources of the Bay, both shrimp and fishes. The results presented here concern only the information on fish assemblages as bycatch in the trawl fishery. The second study was carried out by CNRO in 1984/85 and was aimed at assessing the importance of bycatch of the industrial shrimp fishery in the northern part, namely Ambaro Bay, Ampasindava Bay and Mahajanga Bay which was named Zone I, Zone II and Zone III in the fishery regulation at that time. Both surveys were done with the research vessel of the Centre.

The survey done in 1964/1965 with the R/V VAUBAN resulted in a description of the fish population on the shrimp fishing ground in Ambaro Bay - northwest of Madagascar (reported in Chabane and Plante, in Cah. ORSTOM, 1964). Two types of substrata were identified, sea grass and muddy-sand bottom. Main families found in sea grass habitats were Lethrinidae, Lutjanidae, Siganidae and Serranidae, while in muddy/sand habitats, Leiognathidae, Gerridae, Mullidae, Clupeidae and Theraponidae dominated. During 1984 and 1985, a preliminary assesment of industrial shrimp trawl bycatch was done by CNRO using R/V TELONIFY. A qualitative and quantitative evaluation was carried out.

Table 1: Sampling with the research vessel B/R TELONIFY

	Number of trawls		
Fishing ground	Dry Season	Wet Season	total
Zone I	17	48	65
Zone II	9	14	23
Zone III	38	75	113
Total	64	137	201

According to the species occurring in the local market, species were classified in two categories: commercial fish (P1) and trash fish (P2). In these groups, species were sorted as dominant (more than 30 percent of positive trawls) secondary (between 30 and 10 percent of positive trawls) and accidental (less than 10 percent of positive trawls).

Table 2: Main species composition (only top four species in each category listed)

Species	Percent positive trawls	Species	Percent positive trawls
(i) Commercial fish		**1) Trash fish**	
(ii) Dominant species		(iii) Dominant species	
(iv) Upeneus sulphureus	62	*1) Leiognathus bindus*	40
Nemipterus delagoe	61	*Gazza minuta*	38
Leiognathus equula	53	*Polynemus sextarius*	35
Pomadasys hasta	51	*Secutor insidiator*	32
Secondary species	40	Secondary species	
2) Upeneus bensasi	29	*3) Apogon quadrifasciatus*	22
Pomadasys maculatus	29	*Pelates quadrilineatus*	15
Drepane punctata	22	*Arelia bilineata*	15
Johnius belengeri	22	*Pseudobalistes flavimarginatus*	20
Accidental species		Accidental species	
4) Chorynemus lysan	8	*5) Hilsa kelee*	10
Sphyraena barracuda	6	*Chirocentrus dorab*	10
Acanthopagrus berda	5	*Apogonicthys quecketta*	9
Formio niger	5	*Stolephorus heterolobus*	5

Overall species composition in weight was also calculated from 201 trawls (137 in wet season and 64 in dry season).

Table 3: Main fish species in bycatch (by weight)

Species	Percent in weight
(v) Leiognathus equula	12.4
Gerres punctatus	7.5
Upeneus sulphureus	6.7
Pellates quadrilineatus	5.8
Therapons theraps	5.5

Estimations of catch rates (kg/hr) of commercial fish (P1) and trash fish (P2) in the 3 zones are given in table 4.

Table 4: Catch rate (kg/h) of bycatch fish species

	Commercial Fish (P1)			Trash Fish (P2)		
	Dry Season			Wet Season		
	P1	P2	Total	P1	P2	Total
ZoneI	60.5	174.6	235.1	14.1	48.6	62.7
Zone II	20.8	84.5	105.3	27	60	87
Zone III	18.2	34.9	53.1	42.2	74.2	116.4
Total	99.5	294	393.5	83.3	182.8	266.1

The ratio of commercial fish over total bycatch, for zone I, II and III are given in table 5.

Table 5: Ratio of commercial fish to total bycatch P1 / (P1+P2)

	Wet	Dry
Zone I	0.165	0.349
Zone II	0.315	0.278
Zone III	0.406	0.324
Total	0.272	0.325

The relation of bycatch to total catch i.e. shrimp and fishes, varies between 0.858 during the dry season and 0.356 during wet season. Based on this relationship, the biomass of bycatch for 1984 was estimated at 2 221 tonnes. Discarding is about 20 000 - 30 000 tonnes per year (not included in global marine catch statistics). Only 3 000 - 4 000 tonnes are landed and sold for consumption by the population.

MOZAMBIQUE

Barbara Sousa, Instituto de Investigaçao Pesqueira, Maputo

Mozambique is located on the eastern coast of southern Africa between 10°27´ and 26°2´S latitude and 30°12 ´E and 40°51´E longitude. The Mozambique coastline is 2 700 km long and is characterized by a wide diversity of habitats including sandy beaches, sand dunes, coral reefs, estuarine systems, bays, mangroves and seagrass beds, which offer good conditions for marine animals, such as marine mammals and sea turtles. Total population in 1994 was estimated to be 16.6 million inhabitants (World Bank, 1995). The majority of the population is rural (approximately 76 percent) and the remaining 24 percent live in urban areas (provincial capitals). As a result of the civil war, a large part of the population resettled along the coast and is dependent on marine resources.

Shallow water shrimp occur in the Sofala bank area which is located in the central part of Mozambique, between the latitudes 16°00´S and 21°00´S, at depths ranging from 7 to 70 m. Shallow water shrimp are widely distributed along the coast mainly in mangrove areas where shrimp juveniles grow. Bottom conditions are generally good for trawling but, north of 17°30´S, the continental shelf is very narrow with fringing corals forming a chain of small islands, which makes trawling difficult. South of 19°30´S, at depths between 40 and 100 m, the corals still present a problem, but trawling can be conducted with caution. (Palha de Sousa, 1996; Fig.1). This resource is exploited by industrial, semi-industrial and artisanal fisheries.

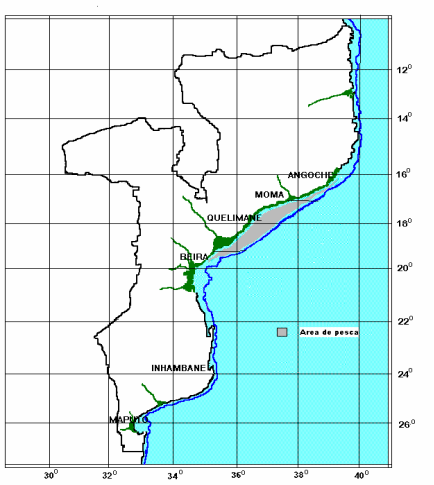

Figure 1: Map of Mozambique and the main trawling grounds

The shallow water shrimp fishery started in 1964 on the Sofala Bank, with a foreign fleet. Until 1973, the national industrial fleet operated between Angoche port and Pebane. From 1974 onwards some trawlers selected Quelimane as a base harbour and fishing area was extended to the Zambezi river delta. During 2001, 80 industrial and freezer semi-industrial vessels representing several companies were licensed to conduct this fishery. All vessels are outrigger trawlers but the boat characteristics such as length, engine horsepower, gross tonnage and number of nets vary among companies. In Beira Bay, 25 ice semi-industrial vessels also operated in the same year (Palha de Sousa *et al*., 2002).

In 2001, the catch of the industrial fishery (including the freezer semi-industrial vessels) was 8 751 tonnes and for the ice semi-industrial fishery was 218 tonnes (Palha de Sousa *et al*., 2002). The fishery targets different species of shallow water shrimp such as: *Penaeus indicus* (white shrimp); *Metapenaeus monoceros* (brown shrimp); *Penaeus japonicus* (flower shrimp); *Penaeus latisulcatus* (marfil shrimp) and *Penaeus mondon* (tiger shrimp). White and brown shrimp comprise about 70 to 80 percent of total shrimp catches (Palha de Sousa, Schultz and Pacule, 1996). During most of the fishing trip, the shrimp bycatch is discarded. The most valuable fish are sorted and frozen and part of the bycatch may be collected by artisanal fishermen for human consumption (fresh or dried). By catch annual estimates from 1993 to 1996 varied from 21 000 to 29 000 tonnes per annum (Schultz, 1997). Research on shallow water shrimp bycatch started with an ongoing sea sampling programme on board the shrimp trawlers in 1984. Also during shallow water shrimp research surveys, data on bycatch is collected, processed and analysed. Since 1984, data were collected on board to determine the relationship between shrimp and bycatch, and information was also collected from landings to establish species composition and biological characteristics of the main species (Palha de Sousa and Schultz, 1987; Schultz, 1997). From 2000 onwards, data were also collected from the artisanal fishery in Zambézia province. The shrimp species composition is the same in this fishery.

Bycatch comprises about 80 percent of the total catches (Table 1). The most abundant families/groups are Sciaenidae, Trichiuridae, Brachyura (crabs), Engraulidae, Haemulidae and Synodontidae, and the most abundant species include *Otolithes ruber* (tigertooth croaker), *Johnius amblycephalus* (bellfish), *Johnius dussumieri* (bearded croaker), *Trichiurus lepturus* (largehead hairtail), *Arius dussumieri* (blacktip sea catfish), *Pellona ditchela* (indian pellona), *Thryssa vitrirostris* (orangemouth thryssa) and *Pomadasys maculatum* (saddle grunt).

Table 1: Annual percentage of bycatch from 2000 to 2002 (Palha de Sousa and Baltazar, 2002)

Year/month	J	F	M	A	M	J	J	A	S	O	N	D	Total
2000			53	51									52
2001								80	85				82
2002						79		87	79				81

Catch composition varies depending on the area trawled, and catches may be clean or may include different degrees of mud, sponges, algae, etc. Fig. 2 shows fish catch composition by family for 2000 and 2001.

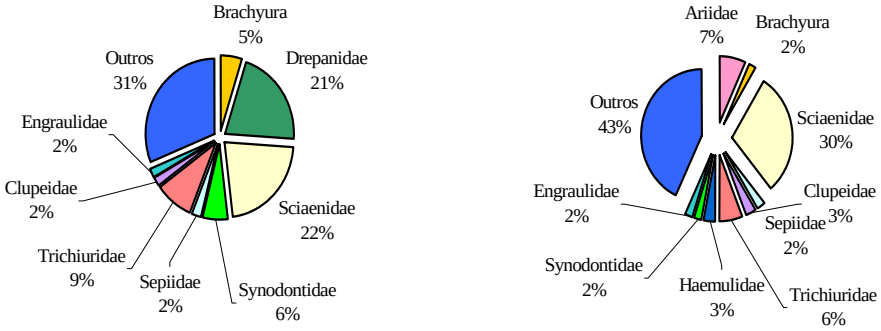

Figure 2: Main catch composition of fish for 2000 (left) and 2001 (right) (Palha de Sousa and Baltazar, 2002).

SOUTH AFRICA

Sean Fennessy, Oceanographic Research Institute, Durban

The South African prawn trawl fishery is relatively small, catching about 300 tonnes of target species per annum, with a value of about $ 1 million. There are shallow (< 50 m) and deep (> 100 m) water components, and the fishery is managed by means of input controls, i.e. there are no quotas. It is a wasteful fishery, with about 1 000 tonnes of discards per annum.

The deep water component currently has about four vessels operating, and catches about 250 tonnes of pink prawns (*Haliporoides triarthrus*), crabs (*Chaceon mcphersoni*), rock lobster (*Palinurus delagoae*) and langoustines (*Metanephrops mozambicus*) per annum (Fennessy and Groeneveld, 1997). There is a retained bycatch of about 30 tonnes per annum, mostly comprising fish and cephalopods, and a discarded bycatch of about 1 000 tonnes. The composition of the discards is not well known, although the fish component is dominated by greeneyes (*Chlorophthalmus punctatus*), coffin fish (*Chaunax pictus*) and rattails (Family Macrouridae) (Fennessy and Groeneveld, 1997). The shallow water fishery comprises four trawlers, targets penaeid prawns (mostly *Penaeus indicus* and *Metapenaeus monoceros*) and catches about 100 tonnes per annum (Fennessy, 1993). The retained bycatch (mostly fish and cephalopods) is about 25 tonnes per annum and the discarded bycatch is diverse, but mostly consists of fish and crustaceans, and is about 400 tonnes per annum (Fennessy, 1994a; Fennessy, 1994b). The fish component of the bycatch mostly consists of *Otolithes ruber*, *Johnius dussumieri*, *Johnius amblycephalus*, *Trichiurus lepturus* and *Thryssa vitrirostris* (Fennessy, Villacasting and Field, 1994).

Data on deep water and shallow water retained bycatch has been collected since 1985 (based on skipper's logbooks), while research on the shallow discards was conducted from 1989-1992 (Fennessy, Villacastin and Field, 1994; Fennessy, 1994a; Fennessy, 1994b; Fennessy, 1995). Investigation into shallow water bycatch reduction was undertaken in 2000 (Fennessy, 2002) and further work is planned in 2003, while investigation into the rationale behind the duration of the shallow water trawling season is currently being conducted. Additionally, observers from the local management agency (Marine and Coastal Management) have been undertaking trips on trawlers since 2002.

WORKSHOP AGENDA ITEM 4: KNOWLEDGE OF IMPACTS OF BYCATCH

Impacts of shrimp trawl bycatch in Australia
Aubrey Harris, FAO regional office, Harare

Introduction

The Australian northern prawn fishery opened in 1963 as a result of a detailed survey undertaken by Ian Munro. The fish community structure in northern Australia is typical of the Indo-Pacific prawn grounds in that there is high species diversity and small sized fish species dominate the fish population. The fishery catches between 10 000 to 12 000 tonnes of prawns annually. The tiger prawns are fished during the night while the night fishing primarily targets the white banana prawn. High rates of discards are associated with the prawn fishery. Most of the finfishes are discarded.

Long-term ecological effects on bycatch

To elucidate the long term ecological effects on shrimp bycatch a study was carried out in the same area to compare the catches prior to the commencement of the trawl fishery and over the next 20 years after the commencement of the fishery. Initially, sampling was carried out over a two years period to get a measure of the annual variability. In the experimental design, sampling was carried out using identical prawn trawls (florida flyers), same month, same trawl position, same time (day/night) and the same species/taxa identification.

The abundance of 82 fish taxa (species, families, groups) was studied over the 20 years period. A total of 52 fish taxa representing 63 percent of the total fish taxa studied showed no change, 18 fish taxa (22 percent) showed a decrease in abundance, while 12 taxa (15 percent) showed an increase in abundance. There was no change in overall species richness.

Species that increased		**Species that decreased**	
Sardines	Clupeidae	Scrpionfishes	Scorpaenidae
Anchovies	Engraulidae	Flatheads	Platycephalidae
Grunter	Theraponidae	Bulleyes	Priacanthidae
Sharks	Carcharhinidae	Dollarfish	Leiognathidae
Halfbeaks	Hemiramphidae	Butterfly breams	Nemipteridae
Remoras	Echeneidae	Tripodfish	Triacanthidae
		Dragonets	Callionymidae
		Flatfish	Bothidae
		Pigfish	Monocanthidae
		Pufferfish	Tetraodontidae

The change in fish abundance may be due to the following factors:

- The increase or decrease in fish abundance could be explained by the position of the fish in the water column. Benthic dwelling fish decreased in abundance while the semi-demersal fish species increased in abundance.
- The changes could also be related to the fishing effect of prawn trawls and the use of discards as a source of food. The bottom trawl disturbed the demersal fish species more, leading to a decrease in abundance. The discards contributed significantly to the food source of the pelagic fishes leading to the increase in their abundances.
- Natural changes in sediment were implicated in the observed changes.
- A pronounced change in the diurnal abundance in the fish community may have contributed to the observed changes.

In this study, it was observed that long term impacts of trawling include:

- A change in fish composition over time. The change in composition may either have negative or positive implications. The values of the society involved in the utilization of the resource will determine the changes will be viewed.
- Species of particular concern, e.g. those that are long-lived, have low fecundity and of restricted distribution/habitat may be impacted more by trawling.
- There was no evidence of any loss in species richness, especially that of fish.

Long-term impacts of trawling on species of special concern

In the 1980s there were serious conflicts related to turtle mortality in the Australian northern prawn fishery. Conservationists claimed that the trawl fishery caught at least one to five turtles per trawl shot, a claim which was disputed by the trawl operators. To come up with factual information, a study was commissioned to gather information on the extent of turtle mortality caused by the trawl fishery. The information was gathered from scientific trawl surveys, from observers on board trawling vessels and from monitoring by trained fisher volunteers.

Results from the survey indicated that:

- One turtle is caught every three to four days of trawling. The trawl fishery accounted for only one to three percent of the turtle mortality depending on species.
- Catch rate of turtles depends on depth, time of the year and location of trawling.
- The condition on capture of the turtle was related to duration of trawl. There were no dead turtles in trawls of 30 minutes and in trawls of about three hours, 18 percent of the turtles caught were dead while 11 percent were in a comatose state.
- There were five species of turtles in the trawling ground.
- The trawl catch results were used to estimate the size of turtle populations and the information assisted in tracing the migration of some of the juveniles.

Conclusions

There was a debate whether the observed turtle mortality from trawling activities accounted for the observed decrease in some Australian turtle populations. It was however acknowledged that other activities account for significant proportion of the turtle mortality. These activities include the following:

- Traditional harvesting by indigenous people;
- Destruction of beaches, erosion, coastal development;

- Predation of eggs by foxes;
- Ingestion of floating debris;
- Boat strikes;
- Disease.

The study concluded that trawling for prawns was not the major source of mortality on turtles but the above activities contribute significantly to mortalities of turtles. However, there is need for increased efforts to reduce all forms of human induced mortality on turtles, particularly the loggerhead.

To reduce turtle mortality from the trawl industry, TEDs were adopted across the Northern prawn fishery in 2000. The adoption of TEDs in the trawl fishery was led by the industry itself. As a result, there is total compliance and the industry keeps documented history of the catch before and after use of TEDs to demonstrate their contribution to resolving the turtle issue.

KENYA

Ecological impacts of trawling on substrate and invertebrates in Kenya. A case study in Malindi-Ungwana Ba.
Esther Fondo, KMFRI, Mombasa

Any fishing gear that is towed over the seabed will disturb the sediment and the resident community to some degree. Fishing affects the seabed habitat worldwide on the continental shelf. These impacts are patchily distributed according to the spatial and temporal variation in fishing effort that results from trawling. As a consequence, the frequency and intensity of fishing disturbance varies among different habitat types. Different fishing methodologies vary in the degree to which they affect the seabed. Comparative studies of areas of the seabed that have experienced different levels of fishing activity demonstrate that chronic fishing disturbance leads to the removal of high biomass species that are composed mostly of emergent seabed organisms, thus lowering productivity. Conversely, scavengers and small-bodied organisms such as polychaete worms dominate heavily fished areas.

The resuspension, transport and subsequent deposition of sediment may affect the settlement and feeding of the biota in other areas. Sediment resuspension as a result of bottom trawling will have a variety of effects including: release of nutrients held in the sediment; exposure of anoxic layers; release of contaminants; increase in BOD; smothering of feeding and respiratory organs. The effects of trawling on the substrate and invertebrates may have the following implications:

- reduced topographic complexity therefore reducing habitat complexity and species diversity;
- removal of high biomass species leading to lowered productivity;
- removal of predators that control bio-engineering organisms;
- change in predator-prey relationships leading to shifts in food web structure;
- alteration of benthic community structure ;
- small-bodied organisms such as polychaete worms dominate;
- resuspension of upper sediments leading to remobilization of contaminants and fine particulate matter;
- unstable sediment systems and destabilized chemical fluxes;
- resuspension, transport and subsequent deposition of sediment may affect the settlement and feeding of the biota in other areas.

Between June 2001 and June 2002, a study was carried out to gather baseline data on the impacts of commercial trawling on the benthic habitat of the Malindi-Ungwana Bay prawn trawling grounds. Preliminary results showed that the community structure was characterized by low species diversity

and abundance. The benthic community was composed of various feeding groups which included predators (carnivorous), detritivores, scavengers, filter feeders, suckers and parasites. However, the dominant feeding groups were the predators (39 percent) and detritivores (34 percent). The low species diversity; dominance of the benthic community by predators, detritivores and the absence of suspension feeders may be an indication of changes in the benthic structure and reduced structural complexity in the bay due to the impacts of bottom trawling.

MADAGASCAR

Impacts of bycatch in Madagscar
Guy Rabarison (CNRE) and Olga Andriamiseza (Ministry of Fisheries), Antananarivo

Little is known on the impacts of bycatch on ecological or economical aspects. During the period 1980-1990, the only studies conducted on shrimp bycatch were those of CNRO (1988, 1989) and the FAO project (SWIOP, 1989). Effects of shrimp trawling on bycatch population (fish and invertebrates) are not documented in Madagascar. Information collected during the course of other projects shows that:

- In fishing grounds with high fishing effort levels, size reduction in fish species is noted.
- Traditional fishermen complain that their catch and catch rate have dramatically declined in trawling areas.
- Periodically, conflicts between shrimp trawlers and traditional fishermen using fixed traps (valakira) take place on the northwest coast.
- Some proliferation of sea urchins has been noted in the west part of Madagascar.
- There is very limited experience with turtle excluder device (TED) and other bycatch excluder devices. Some experimental work has been conducted by the shrimp society, but results are not available.

SOUTH AFRICA

Impacts of bycatch in South African prawn trawl fisheries
Sean Fennessy, Oceanographic Research Institute, Durban.

There are no historical data for the deep water trawl fishery, and collection of observer data only commenced in 2002, although there are data on retained bycatch which have been collected (via skipper's logbooks) since 1985. Consequently it is not possible to determine whether there are ecological impacts by deep water trawlers because of the lack of detailed information. Based on the current knowledge of deep water bycatch composition (Fennessy and Groeneveld, 1997), there is no obvious impacts of the deep water prawn trawl fishery on other fisheries sectors.

In the shallow water fishery, there are user conflict impacts between trawlers and hook and line fishermen. The work by Fennessy (1994a) showed that trawlers were catching about 800 000 juvenile individuals of the sciaenid fish *Argyrosomus thorpei* per annum (mostly in January and February), while commercial hook and line fishermen were catching about 400 000 individuals of this species annually, albeit larger individuals. Per-recruit modelling demonstrated that the trawl catches were impacting on yield and spawning biomass of this species and, since about 1997, the shallow water Tugela Bank trawl fishery has been closed in January and February each year. The economic viability of the prawn fishery was also not good during these months, so it made economic sense not to trawl at this time and the trawlers had the possibility of trawling on the deep water grounds during these months. Good data is required to be able to undertake user conflict assessments of this type, specifically data on catch quantities, sizes of the relevant species caught by the different sectors, and information on age, growth and maturity of the relevant species. Currently, a similar assessment is underway for *Otolithes ruber*.

Regarding the potential for ecological impacts of shallow water trawling, there are historical data on catch composition from 1989 to 1993 and data is currently being collected by observers to enable comparisons to be made. Preliminary data from a relatively new trawl ground off St Lucia (Fennessy, 2002) indicates that trawlers cause substantial damage to organisms such as sea pens and echinoderms.

WORKSHOP AGENDA ITEM 5: METHODS TO REDUCE BYCATCH

MOZAMBIQUE (1)

Bycatch reduction in Mozambican prawn trawl fisheries
Domingos Gove, Centro Desenvolvimento Sustentavel, Maputo

Shrimp are one of the main sources of foreign income to Mozambique, and most of the catches are made on the Sofala Bank (Anon., 1979; GTA, 1990). In Mozambique, bycatch comprises about 70 percent of total catch, and, although several species of turtles occur in Mozambique (Hughes 1973; Gove and Magane, 1996), there is nothing known about the impacts of turtles caught in the bycatch of prawn trawling (Magane, Sousa and Pacule, 1998). Studies in the United States in the 1980s, however, showed that prawn trawling was a major source of turtle mortality, and the National Marine Fisheries Service (NMFS) began investigations of turtle excluder devices (TEDs). TEDs were shown to reduce catches of turtles, as well as reducing bycatch by up to 40 percent, without reducing prawn catches. Catch sorting times were also reduced, and hence prawn quality and value were improved. Trawler fuel consumption was also reduced.

TEDs have not been used in Africa, despite the fact that a regional training course on their design and use was held in Malindi in 1997 (Wamukoya and Salm, 1998). There is a tendency for them to be used in the western world, but not elsewhere – possibly because of a lack of information and few demonstrations of their application. An experiment testing the use of TEDs in Mozambique was undertaken in 2001 (Gove *et al*., 2001). The objectives were to determine the numbers of turtles caught by trawlers, and to test the effect of TEDs on: bycatch (including turtles), prawn catches, catch sorting time and prawn quality. Trawler captains and fishing authorities were interviewed, and onboard testing was conducted in August and November on the southern Sofala Bank. The TED was obtained from the NMFS, but had to be modified to fit in the local gear.

Based on interviews with trawler captains and scaling up by total fleet effort, it was estimated that 1 932–5 436 turtles were caught by trawlers (semi-industrial and indsutrial) per year, mostly in summer. This was considered a substantial source of mortality for turtles in Mozambique. The onboard experiments showed that the TEDs did not reduce prawn catches or bycatch, although catches of large elasmobranchs and rocks were reduced. The catch sorting time was not affected by using a TED, and prawn quality and value was improved.

It was recommended that the report describing the experiment and its results should be distributed to the stakeholders, combined with seminars on the experiment. It was also recommended that legislation be introduced that requires trawlers to use TEDs, and that catches by trawlers with TEDs be certified. Similar studies and follow-up experiments need to be undertaken throughout the region.

MOZAMBIQUE (2)

Bycatch reduction in Mozambican prawn trawl fisheries
Barbara Palha de Sousa, Instituto de Investigacao Pesqueira, Maputo

In 1993, over a 15 day period, experiments with a 0.9 m x 1.5 m aluminium grid in the aft and top section of a shallow prawn trawl were undertaken on the fishing grounds for shallow water shrimps

along the coast of Mozambique. For the most abundant species (white and brown prawn), the grid gave a better size selection (more small shrimps were excluded from the catches) compared to an experimental codend with 60 mm mesh size. The best results were obtained with a grid with 14 mm bar distance and when the grid had an angle of attack close to 33 degrees.

The fish bycatch was normally between two and four times the weight of shrimps caught, and the catches contained mainly species with a maximum length of 25–30 cm. As an overall result the exclusion of fish by weight through the 60 mm codend was much higher (83 percent) than for any grid version tested (36.4 percent to 76 percent). The size selection on fish was sharper with grids compared to the 60 mm codend. The results were preliminary due to the short test period and the small number of hauls using 54 mm and the experimental 60 mm codends (Isaksen and Larsen, 1993).

In 1995, following the recommendation from the 1993 grid experiments, further experiments were undertaken with the "top-grid" system with a 14 mm bar spacing to further understand the effect of the grids. The results showed that 60 mm codends gave very clean catches retaining the biggest tigertooth croaker (*Otolithes ruber*) and bearded croaker (*Johnius dussumieri*). With the 54 mm codend, smaller sizes and greater numbers of the same species were retained. As for the 1993 experiments, the grid had a very good separation of Indian pellona (*Pellona ditchela*) and orangemouth thryssa (*Thryssa vitrirostris*).

As with the results for the TED experiment descibed by Gove in this report, further testing is required before use of the grids is implemented.

SOUTH AFRICA

Bycatch reduction in South African prawn trawl fisheries
Sean Fennessy, Oceanographic Research Institute, Durban

The discarded bycatch of the prawn trawl fishery mostly consists of small, low value fish species (Fennessy, 1993). Increased utilization of the discards is unlikely because the fishery is economically marginal, and increasing the amount of retained bycatch that is packed would increase packaging costs without adding much value to the landed catch. It is also not known whether increased harvesting of the bycatch would be sustainable and whether there would be ecological or fisheries impacts. Consequently, I do not believe that increased use of the discarded prawn trawl bycatch is likely in South Africa. Instead, I suggest that the current discarded catch should be reduced by means of bycatch reduction devices (BRDs).

During September 2000, I investigated the effects of a square mesh panel on the bycatch of a twin net boom trawler operating on the Tugela Bank shallow water prawn grounds. The panel was inserted in the codend of one trawlnet while the other net served as a control. The objectives of the study were to reduce the bycatch, but without reducing the prawn catch. Catches of prawns, retained bycatch and discards in panel and non-panel trawls were compared. The panel was successful in reducing overall discarded catch quantities, without reducing prawn catches (Table 1). In fact, on 10 occasions, prawn catches in the panel trawl were greater than in the non-panel trawl. Catches of retained fish (mostly *O. ruber*) were reduced in the panel trawl. Other retained catch categories (crabs, cuttlefish) did not appear to be affected by the insertion of a panel. Differences in catch rates of discarded fishes appeared to be species specific, with catches of *J. amblycephalus, O. ruber* and *P. olivaceum* being lower in the panel trawls. For *A. thorpei* and *P. sextarius*), differences in catches between panel and non-panel trawls were not apparent.

Table 1: Numbers of Tugela Bank trawls incorporating a square mesh panel, with catch quantities either greater than, less than or equal to a non-panel (standard) trawl.

Catch category	Panel > non-panel	Panel < non-panel	Panel = non-panel
Prawns (weight)	10	5	2
Crates of discarded catch	3	13	3
Retained fish (no.)	3	15	1
Retained crabs (no.)	8	9	2
Retained cuttlefish (no.)	8	6	5
A. thorpei (no.)	5	6	0
A. nibe (no.)	4	4	3
J. amblycephalus (no.)	2	9	0
J. dussumieri (no.)	4	7	0
O. ruber (no.)	2	9	0
P. olivaceum (no.)	2	9	0
P. sextarius (no.)	4	4	3

Catch rates of discards and retained fishes were significantly higher in trawls without a square-mesh panel, while prawn catches by weight were not affected (Figure 1). Mean catch rates of the main discarded fish species were all lower in trawls with a panel and, in the case of three species, significantly so.

It was anticipated that the size distributions of fishes caught in panel and non-panel trawls would be different, because of the potentially greater ability of smaller fish to escape through the panel relative to larger fish. However, this does not appear to be the case, as there was not much difference in size. The panel therefore appeared to permit the escape of all sizes of the most common fishes encountered. This contention is supported by the much reduced catch rates of retained fishes in panel trawls on the Tugela Bank. Most retained fish were *O. ruber* that, despite being much larger than discarded *O. ruber*, were still able to escape through the square mesh, largely accounting for reduced catches of the retained fish component in panel trawls.

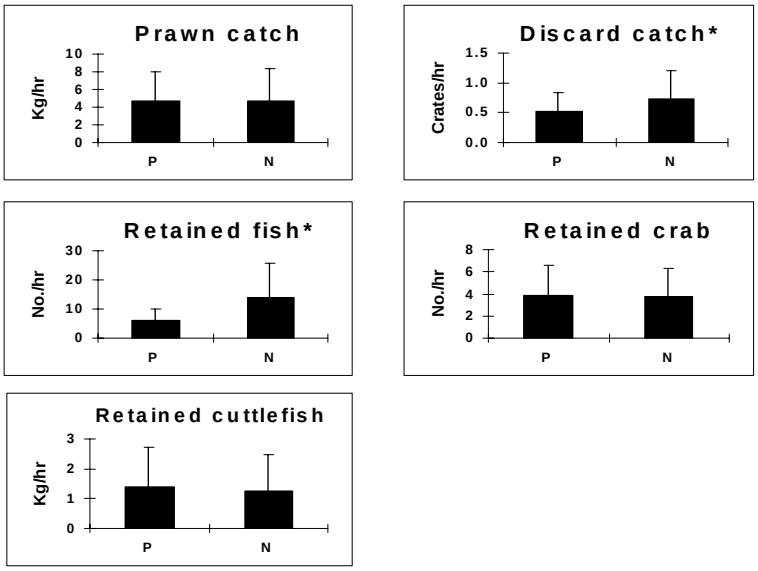

Figure 1: Comparison of mean catch rates (plus one standard deviation) by panel and non-panel prawn trawls on the Tugela Bank. P = Panel, N = Non-panel; an asterisk* indicates a significant difference (Wilcoxon paired signed-rank test: P < 0.05).

The results of this work show that the square-mesh panel holds considerable potential for the reduction of fish bycatch in the South African prawn trawl fishery. However, several aspects need further investigation. Firstly, the panel needs to be tested during the main prawn season, i.e. when prawn catches are greatest (April to June), in order to determine whether prawn catches will be compromized beyond the viability of the fishery. Secondly, variances associated with the mean catch rates are high, so greater numbers of replicates are required. Thirdly, the square-mesh panel that was used in this investigation does not allow the release of larger fishes such as *P. commersonnii*, sharks or rays. The importance of individual species' behaviour is indicated by the differential catch rates of some fishes relative to others.

Although implementation of legislation requiring South African prawn trawlers to utilize square-mesh panels is feasible, based on these results, it is apparent that additional experimental work is required to optimize the application of bycatch reduction devices. However, such research is also dependent on the cooperation of the industry and the availability of suitable vessels.

SUMMARY OF DISCUSSIONS FOLLOWING EACH AGENDA ITEM

Legislation/policy

It is very important to be explicit about the criteria being used to categorize fisheries and define bycatch in each country, i.e. traditional vs artisanal fisheries, industrial vs. semi-industrial fisheries, bycatch for human consumption vs. bycatch for discarding.

Although the bycatch policy frameworks are vague in some countries, there have been attempts to reduce bycatch. It was very apparent that the measures being taken to reduce bycatch are at different stages of development. Maximization of bycatch utilization is a key focus in Kenya, Madagascar and Mozambique due to the needs of poverty and food security. South Africa's focus is more comprehensive up to the ecosystem level and is already at the experimental stage of BRDs. Some countries are in the process of re-formulating their fisheries policy, and specific bycatch policies should be included. It is also apparent that enforcement of legislation is lacking in some countries.

There were notable differences between countries on the legislation regarding minimum allowable trawling distances from the shore. These were attributed to specific factors in each country:

- South Africa: The proposed 1.5 nautical mile regulation was not scientifically based. Conflicts have arisen with regard to safety issues (trawlers being beached), discards washing up on the shore and complaints by beach users of trawlers operating too near the beach.
- Kenya: The basis for the five nautical mile regulation was to reduce user conflicts and to safeguard the interests of small/artisanal fishermen. Kenya is however in the process of scientific research on this issue.
- Madagascar: Trawling is restricted to beyond two nautical miles, with no scientific basis.
- Mozambique: The restrictions are categorized according to depth to protect species (i.e. shallow vs. deep-water species). Industrial vessels are restricted from trawling in waters less than 10 m deep and may not trawl within one nautical mile of the shore, except in north of Mozambique where industrial vessels are restricted to beyond three nautical miles due to a political decision to reduce user conflicts arising between artisanal and industrial fishermen.

Utilization

There are various difficulties being experienced in utilizing bycatch among the countries. Trawler operators may be reluctant to land bycatch or to allow for the collection of bycatch at sea due to fear of theft, the lack of storage facilities on board and the high costs of collecting bycatch at sea. Consultations with all stakeholders of the fishing industry such as those recently conducted in Kenya should be prioritized.

There is a need to improve administrative measures concerning bycatch utilization. Currently, enforcement of bycatch:target catch quota systems in Mozambique and Madagascar is very low. One way of tackling this is to improve the cold storage facilities on land. The Japanese Government plans to fund such a project in Madagascar. This is a good example of how key investors are contributing to the development of infrastructure for the collection of bycatch at sea.

Knowledge of bycatch

It was noted that there is no formal monitoring system in the countries apart from South Africa and Mozambique. Madagascar and Mozambique have a good history of steps to address the bycatch problem through various projects, but this has not been continuous. The continuity of monitoring activities is affected by staff changes, poor information management, and poor accessibility to information. The GEF project could assist in this.

Long-term ecological monitoring on impacts of trawling should be undertaken; however this is a difficult issue due to the element of experimental design. For example, to detect ecological changes due to trawling, there is a need to sample pristine shrimp trawl grounds, i.e. before trawling commences, for comparison with exploited areas. This was a limitation in the Kenyan study since no previous research had been conducted. Long-term research is the factual basis needed for making policy decisions and should be promoted. The need to set baseline monitoring programmes in place regionally was identified as a priority. To be cost-effective, it was recommended that monitoring should be done in time spans of three to four years according to the needs of each country.

Information can be obtained through scientific trawl surveys, observer vessels and monitoring using trained volunteers. Identification of bycatch species is also a main concern which can be tackled using bycatch identification keys such as the one developed by South Africa.

Bycatch reduction

TEDs are being used in some countries (Kenya, Mozambique and Nigeria). It was noted that steps are needed to effectively introduce and transfer TED/BRD technology to the countries. However the trawling companies need to be convinced first to use the devices since various problems have been experienced in compliance with TED legislation. The high compliance with TED usage in Australia was achieved through a long-term process after the fishery was overexploited and trawlers chose to comply rather than lose a percentage of their prawn catch. TED compliance was very low in Kenya due to problems with gears getting blocked and destroyed. The blockage of gears was also experienced in Mozambique; however modifications were made to the gear to overcome this. A mechanism used in Mexico and Costa Rica to reduce blockage is by reducing the trawling time. It was noted that seasonal and/or spatial closure of the trawling grounds could also result in a reduction of bycatch.

The impact of artisanal fisheries on turtle survival is hard to resolve as it depends on specific cultural factors in each country. Most communities eat turtles or use them for other cultural practices. In Australia, indigenous people have rights to exploit turtles but are not allowed to sell them. Since there are no monetary gains to exploitation, sea turtle exploitation has been maintained at a sustainable level.

Socio-economics

- In most cases fishermen and trawlers use the same fishing grounds leading to conflicts. Fishermen attribute this to the decline in catches per capita. However the increased number of fishers also has an impact.
- Bycatch wastage on trawlers is high. There are no clear mechanisms in place to collect or avail the bycatch to the local communities. The amount of landed bycatch (where and when) is entirely dependent on the needs of the trawler industry.
- Currently there is a ready market for the bycatch in many countries. However the supply is erratic and the marketing channels are not well developed.
- Ways to maximize the use of the bycatch that has already been caught have been recommended. One way is via liaison with the private sector to devise strategies that enable discards to reach the market.
- The need for fishermen to seek alternative sources of livelihood was also raised

FINAL DISCUSSION SESSION

During the final session**,** several main themes which emerged from the workshop were noted. These themes are;

1. **Knowledge on the composition and quantification of the bycatch**

   It was noted that there are limited formal shrimp bycatch monitoring systems in the Western Indian Ocean countries apart from Madagascar and South Africa. Formal monitoring has only recently commenced in the form of observer programmes in South Africa. Madagascar and Mozambique have on several occasions tried to address the bycatch problem through projects, but the efforts have not been continuous. The continuity of these activities is normally affected by staff changes, poor information management and poor accessibility to information. Quantifying the impacts of trawling on the environment requires long-term studies which may be beyond the scope of programmes such as the GEF/UNEP/FAO project. The affected countries need to put in place long-term projects that will provide information to resolve the issues associated with shrimp trawling. e.g. the effect of trawling on the ecosystems. Alternatively, bycatch surveys could be undertaken at regular intervals, say five years, to provide the required information.

2. **Bycatch reduction**

   It was noted that the measures and efforts being taken to reduce bycatch are at different stages of development in each country. Poverty issues and food security for coastal communities, not the maintenance of ecosystem integrity, are the key issues which are driving bycatch reduction initiatives in Kenya, Madagascar and Mozambique. Initiatives to reduce bycatch in Kenya also focus on the reduction of the conflicts emanating from the acts of fish discarding. On the other hand, it could be argued that reduction of bycatch is not seen as a major requisite in Madagascar and Mozambique, given these countries' expressed desire to maximize the use of bycatch. However, countries that export shrimps have made attempts to introduce Turtle Excluder Devices in order to comply with United States' import requirements. South Africa’s focus is more comprehensive and considers the integrity of the ecosystem as well as impacts on other fisheries. The use of Bycatch Reduction Devices (BRDs) is already at the experimental stage in South Africa.

3. Utilization of bycatch and the socio-economic impacts of bycatch

There is a strong focus on this issue in Kenya, Mozambique and Madagascar. The latter two countries in particular are seeking to maximize the use of bycatch for poor coastal communities, and have initiated programmes to promote increased landing of bycatch.

Overlying these three themes is the issue of bycatch policy and legislation, which does not specifically form part of exisiting fisheries policies in the WIO, i.e. the policy framework for shrimp bycatch is not well defined and developed.

Workshop participants acknowledged that the interventions of agencies such as GEF and FAO in creating global projects on shrimp bycatch are very important. These projects go a long way in supporting efforts of developing countries to seek solutions to a common problem. In particular, the development of further FAO projects on shrimp bycatch in the Western Indian Ocean could assist in building on existing experience as well as developing capacity.

RECOMMENDATIONS

Two general comments:

- Stakeholder consultations are essential for reaching consensus and for solving various problems such as bycatch. The development of management plans for shrimp fisheries requires full participation of the stakeholders, and such initiatives need to be enhanced.
- Due to unforseen circumstances, there were no delegates from Tanzania attending this regional workshop. However, it was recommended that Tanzania should be included in the activities emanating from the recommendations.

OBSERVER SYSTEMS, DATA COLLECTION AND ANALYSIS

- The use of observer systems and the collection of good data are required for decision making. To harmonize data collection in the region, there is a need to organize a training workshop for observers. FAO could support such an initiative.
- The lack of resources and personnel to run observer systems hinders their full implementation. Implementation could be done on the same lines as in South Africa, where a private company is contracted to undertake onboard observations. The presence and payment of observers on board trawlers can be made a condition of the licence. Data collection and analysis can also be undertaken by using university students for under-graduate and post-graduate projects – this is a relatively cheap option and also builds capacity.
- The protocol for data collection should be harmonized between the countries. FAO has produced a manual for data collection and this can be used for the region, in addition to developing a central database.

TURTLE EXCLUDER DEVICES (TEDs) AND BYCATCH REDUCTION DEVICES (BRDs)

- Reduction of bycatch seems to be accepted in the region**.** Therefore the development and application of TEDs and BRDs should be seriously considered. FAO could consider supporting such a programme.
- There is need to have a common approach in addressing the issue of bycatch reduction, especially taking into consideration the achievements and experiences of countries in the region and elsewhere. Regional and/or national workshops/practical sessions can be organized to test and transfer the available technology.

SOCIO-ECONOMICS AND PRODUCT MARKETING

- Poverty alleviation and food security are key focusses in the WIO countries. The utilization of discards to alleviate food scarcity should be considered.
- Fishing communities have poor access to the bycatch. There is therefore a need to look into ways of improving the accessibility of the bycatch. A project aimed at making bycatch more accessible is desirable for the region.

FUNDING

- FAO in partnership with regional experts can initiate specific national and regional project proposals for funding. However, the regional experts must lead the way.
- Proposals on training workshops in data collecting and processing, and the developing and testing of TEDs/BRDs can also be supported by FAO when requested.
- Technical Cooperation Programmes (TCP of FAO) can be requested by regional groupings of countries. However, a minimum of three countries need to request support. The ceiling for TCP programmes is US$400 000. The proposals should be linked with regional frameworks, e.g. the Nairobi Convention

VOTE OF THANKS

The vote of thanks was given by Olga Andriamiseza who thanked FAO, KMFRI and all participants for a wonderful meeting.

BIBLIOGRAPHY CONSULTED

Anon. 1979. Country Statement on the Present Fishery Situation in Mozambique. In Report of the FAO/IOP Workshop on the Fisheries Resources of the Western Indian Ocean South of the Equator. IOFC/DEV/79/95, pp 63-68.

Anon. (Unpublished). A study of the Fisheries Sector in Mozambique. A report prepared for NORAD by the Norwegian College of Fisheries Science and Institute for Fisheries Management.

Anon. 1996. Fisheries Policy and Implementation Strategies, Ministry of Fisheries, Mozambique.

Anon. 1999. Annual fisheries statistics, Kenyan Fisheries Department. Unpublished report.

Anon. 2001. Report on the scientific information and conservation sub- committee – Prawn fishery in Kenya marine waters. KMFRI Unpublished report.

Anon. 2002. Current status of the trawl fishery of Malindi- Ungwana bay. KMFRI technical report.

Bala, B.K. 2000. Solar drying of fruits and fish. Rept. Dept. of farm power and machinery, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh.

Bala, B.K. & Mondol, M.R.A., 2001. Experimental Investigation on Solar Drying of Fish Using Solar Tunnel drying. Drying Technology 19 (2).427-436

Bwathondi, P.O.J & Mwaya, G. 1984. The fishery of crustacea and molluscs in Tanzania. In: Iversen, S.A. and Myklevoll, S. eds. Proceedings of the NORAD-Tanzania seminar to review the marine fish stocks and fisheries in Tanzania. Mbegani, 6-8 March 1984. Tanzania Fisheries Research Institute/NORAD/Institute of Marine Research (Bergen). pp. 19-28.

FAO. 1995. Quality and Quality Changes in Fresh Fish. FAO Fisheries Technical Paper No. 348

FAO. 1999. Report of the workshop of national co-ordinators of the GEF/UNEP/FAO project on the impact of reducing the impact of tropical shrimp trawling fisheries on living marine resources through the adoption of environmentally friendly techniques and practices. *FAO Fisheries Report* 605: 46 pp.

FAO. 2000. Report of the four GEF/UNEP/FAO regional workshops on reducing the impact of tropical shrimp trawl fisheries. *FAO Fisheries Report* 627: 40 pp.

Fennessy, S.T. 1993. A description and evaluation of the ichthyofaunal bycatch of the Tugela Bank prawn trawlers. MSc thesis, University of Natal, Durban. 104 pp.

Fennessy, S.T. 1994a. The impact of commercial prawn trawlers on linefish catches off the North coast of Natal. *South African Journal of Marine Science* 14:263-279.

Fennessy, S.T. 1994b. Incidental capture of elasmobranchs by commercial prawn trawlers on the Tugela Bank, Natal, South Africa. *South African Journal of Marine Science* 14:287-296.

Fennessy, S.T. 1995. Relative abundances of non-commercial crustaceans in the bycatch of Tugela Bank prawn trawlers off KwaZulu-Natal, South Africa. *Lammergeyer*. 43:1-5.

Fennessy, S.T. 2002. Preliminary investigation of a bycatch reduction device for the Tugela Bank prawn trawl fishery in KwaZulu-Natal. Oceanographic Research Institute Durban: 10p. (ORI Unpublished Report 203).

Fennessy, S.T. & Groeneveld, J.C. 1997. A review of the offshore trawl fishery for crustaceans on the east coast of South Africa. *Fisheries Management and Ecology*. 4(2): 135-147.

Fennessy, S.T., Villacastin, C. & Field, J.G. 1994. Distribution and seasonality of ichthyofauna associated with commercial prawn trawl catches on the Tugela Bank of Natal, South Africa. *Fisheries Research.* 20:263-282.

Frankel, E. N. 1991. Recent Advances in Lipid Oxidation-A Review. J. Sci. Food. Agric (495-510)

Gove, D. & Magane, S. 1996. The Status of Sea Turtle Conservation in Mozambique. UNEP Regional Seas Reports and Studies. N° 165, p. 89-94. Nairobi. Kenya.

Gove, D., Pacule, H. & Goncalves, M. 2001. The impact of Sofala Bank (central Mozambique) shallow water shrimp fishery on marine turtles and the effects of introducing TED (Turtle Excluder Device) on shrimp fishery. WWF, unpublished report. 23 pp.

GTA (Environmental Working Group). 1990. The Present Environmental Situation. NORAD/Mozambican National Environmental Commission, INPF. Maputo, Mozambique.

Hughes, G. 1973. Preliminary Report on the Sea Turtle and Dugongs of Moçambique. Veterinária de Moçambique. Vol. 4 N° 2, p. 45-62. Lourenço Marques.

Huss, H.H. 1988. Fresh Fish-Quality and Quality Changes: A Training Manual Prepared For The FAO/DANIDA Training Programme on Fish Technology And Quality Control. FAO/UN. Fisheries Series No.29.

Icekson, I., Vladmimir, D., Aizendorf, S. & Gelman, A. 1998. Lipid oxidation levels in different parts of the mackerel. *J. Aquatic. Food Prod. Technol*. Vol. 7. (2). 17-29.

IDPPE, 1996. Estudo sobre o impacto do Projecto da Recolha de Fauna Acompanhante do camarão. IDPPE, Unpublished report.

Isaksen, B. & Larsen, R. 1993. Size selectivity for shallow water shrimps by using a rigid metal grid in the aft and top section of the trawl. Unpublished report (Institute of Marine Research, Bergen and the College of Fishery Science, Tromso): 42 pp + 2 appendices.

Jensen, J.G. 1985. Recovery of bycatch from the shrimp fishery by the "Moma transfer" method. A review. In *Proceedings of the FAO expert consultation on fish technology in Africa. FAO Fisheries Report no. 329 (suppl.).* pp. 67-73.

Magane, S., Sousa, L. & Pacule, H. 1998. Summary of turtles and fisheries resources information for Mozambique. In: Wamukoya, G.M. and Salm, R.V. (eds.). Proceedings of the Western Indian Ocean Turtle Excluder Device (TED) training workshop. Mombasa, Kenya, 27-31 January 1997. IUCN. 30 pp.

Mahika, G.C. 1992. Bycatch reduction by rigid separator grids in Penaeid shrimp trawl fisheries: the case of Tanzania. Mphil thesis, University of Bergen,Norway. 53 pp.

Mueni, E. & Mwangi, J. 2001. A survey of the use of the Turtle Excluder Device (TED) in trawlers along the Kenyan coast. *KWS Technical Series*. 11 pp.

Mwatha G.K., 2002. The Malindi-Ungwana Bay fishery; Assessment of the prawn fishery, bycatch resource use conflicts and performance of the Turtle Excluder Device. Pg 44 – 65. KMFRI technical report.

Palha de Sousa, B. & Schultz, N. 1987. Análise da composição de capturas do Projecto Experimental dos barcos da R.D.A na Beira, de Outubro de 1984 a Setembro de 1986. Instituto Investigação Pesqueira. Boletim de divulgação 29: 33p.

Palha de Sousa, L., Schultz, N. & Pacule, H. 1996. Survey report of the shrimp trawling fisheries of Mozambique. Cooperative Research Network in the Asia and Indian Ocean Region on Selective Tropical Shrimp Trawling . 4 p

Palha de Sousa, B. & Baltazar, L. 2002. Composição específica das capturas e relação camarão fauna acompanhante durante 2001. Instituto Investigação Pesqueira. 8 pp.(unpublished report).

Palha de Sousa, L., Brito, A., Abdula, S. & Caputi, N. 2002. The industrial shallow water shrimp fishery at Sofala Bank in Mozambique. Instituto Nacional de Investigação Pesqueira. 55pp. (unpublished report).

Rabarison Andriamirado, G.A. & Raveloson Hasinarivo, N. 1988. Les captures secondaires dans la pêcherie de crevettes côtières à Madagascar : première estimation. Doc. N° 14 1988 CNRO. 39p.

Rabarison Andriamirado, G.A. 1986. Les captures secondaires et les rejets de la pêche à la crevette P*enaeus notialis* Perez-Farfante, au Sénégal : Régimes alimentaires et relations trophiques, Thèse Doct. 3ème Cycle, Univ. Bretagne occid. 2 vol. 118 et 142p.

Schultz, N. 1997. Capturas da fauna acompanhante na pescaria industrial de camarão no Banco de Sofala de 1993 a 1996. Instituto de Investigação Pesqueira. 23 pp.(unpublished report).

Van der Elst, R.P. & Govender, A. 2001. Mozambique fisheries (artisanal and linefish). Oceanographic Research Institute, Report on Research during the period April 2000 to March 2001. 92-93.

World Bank, 1995. Africa: A framework for integrated coast zone management. World Bank. Washington, DC. 139 pp.

Wamukoya, G.M. & Salm, R.V. (eds.). 1998. Proceedings of the Western Indian Ocean Turtle Excluder Device (TED) training workshop. Mombasa, Kenya, 27-31 January 1997. IUCN. 30 pp.

The wokshop was jointly organized by the FAO Fishery Industries Division, the Marine and Fisheries Research Institute (KMFRI) in Mombasa (Kenya) and the Oceanographic Research Institute in Durban (South Africa), and was hosted by KMFRI.

Twenty-nine participants from five countries (Kenya, Madagascar, Mozambique, Nigeria and South Africa) attended the workshop. The participants represented national fisheries administrations, non-governmental organizations and scientific institutions.

During the workshop, participants discussed existing bycatch policy and legislations, the state of bycatch knowledge and impacts of bycatch, as well as methods for reducing bycatch or improving bycatch utilization in their respective countries. The participants recommended the use of bycatch reduction devices (BRDs) in the region, to harmonize the data collection among the countries and the improved utilization of bycatch.

ISBN 92-5-105120-8 ISSN 0429-9337

9 789251 051207

TR/M/Y5362E/1/04.04/1600