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RESULTS AND CONCLUSIONS OF THE PROJECT "ECOSYSTEM APPROACHES FOR FISHERIES MANAGEMENT IN THE BENGUELA CURRENT LARGE MARINE ECOSYSTEM"

BCLME
Benguela Current Large Marine Ecosystem Programme

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PREPARATION OF THIS DOCUMENT

This document reports on the final results and conclusions of the Benguela Current Large Marine Ecosystem (BCLME) project LMR/EAF/03/01 "Ecosystem approaches for fisheries management in the BCLME". The project was jointly implemented by BCLME and FAO with the full participation of the management agencies of the three countries: Instituto Nacional de Investigação Pesqueira (Angola), Ministry of Fisheries and Marine Resources (Namibia) and the Department of Environmental Affairs and Tourism (South Africa). The primary objective of the project has been to investigate the feasibility of ecosystem approach to fisheries (EAF) management in the BCLME region through examining the existing issues, problems and needs related to EAF, and considering different management options to achieve sustainable management of the resources at an ecosystem level. The report summarizes and complements four earlier reports produced by the project:

- Report of the First Regional Workshop, Windhoek, Namibia, 21–24 September 2004. Project LMR/EAF/03/01 Report No. 1. Rome, FAO. 92p.
- The Annual Report January–December 2005. Project LMR/EAF/03/01 Report No. 2. Rome, FAO. 238p.
- Report of the Second Regional Workshop, Luanda, Angola, 20–24 March 2006. Project LMR/EAF/03/01 Report No. 3. Rome, FAO. 61p.
- Report of the Third Regional Workshop, Cape Town, South Africa, 30 October–3 November 2006. Project LMR/EAF/03/01 Report No. 4. Rome, FAO. 225p.

The project has involved a large number of people from government agencies, the fishery sector, conservation, non-governmental organizations (NGOs) and others from the three countries all of whom are acknowledged for their valuable contributions to the project and this report. Grateful thanks is also given to the members of the BCLME Secretariat for their support throughout the project, in particular Mick O'Toole, Hashali Hamukuaya, Moses Maurihungirire and Frikkie Botes for excellent support and encouragement throughout the project. Thuliswa Nkomana and Tokello Poho (Marine and Coastal Management, South Africa [MCM]) are also thanked for their logistic and administrative support. Samantha Petersen (World Wide Fund for Nature, South Africa [WWF]) made valuable contributions in helping to facilitate several of the Risk Assessment for Sustainable Fisheries (RASF) Workshops. Cassandra de Young, Tony Charles, Theo Stewart, Alison Joubert and Barbara Patterson are thanked for preparing very useful and informative reviews for the Third Regional Workshop, and Theo Stewart also for his advice on the statistical aspects of the benefit-cost analyses.

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ABSTRACT

This report provides the final results and conclusions of the Benguela Current Large Marine Ecosystem (BCLME) project LMR/EAF/03/01 "Ecosystem approaches for fisheries management in the BCLME". The project set out to examine the feasibility of implementing an ecosystem approach to fisheries (EAF) in the Benguela Current Large Marine Ecosystem which extends from east of Port Elizabeth, South Africa, to Angola's Cabinda province in the north. The project, a cooperative effort by BCLME, the management agencies of the three countries and FAO, started in January 2004 and ended in December 2006. The main objective of the project has been to investigate the feasibility of EAF management in the BCLME region through examining the existing issues, problems and needs related to EAF, and considering different management options to achieve sustainable management of the resources at an ecosystem level. The approach followed was to focus on ten of the major fisheries in the three countries. The project used a structured and participatory approach, attempting to engage the range of stakeholders in the countries, in order to identify and prioritize the gaps in the existing, largely conventional, approaches to fisheries management and to describe potential management actions necessary to address those gaps. In a similarly participatory approach, preliminary estimates of the costs and benefits (positive and negative impacts) of those actions specifically related to implementation of EAF have been made. The costs and benefits were evaluated for each of the broad objectives identified for each fishery. The detailed results, including potential management actions and their costs and benefits, are still preliminary but the issues and the broad management needs and possible actions that have been identified are highly informative. The process that has been developed provides a valuable framework for future refinement and implementation of EAF. The project also considered the applicability of a number of tools and activities that would be important for effective progress in implementation of EAF, in particular methods for improved decision-making, incentives to encourage implementation, institutional requirements and research needs.

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LIST OF ACRONYMS

ACAP	Agreement on the Conservation of Albatrosses and Petrels
AIDS	Acquired immunodeficiency syndrome
BCA	Benefit-cost analysis
BCC	Benguela Current Commission
BCLME	Benguela Current Large Marine Ecosystem
BCW	Benefit cost workshops
BEE	Black economic empowerment
BENEFIT	Benguela Environment Fisheries Interaction and Training programme
BEP	Benguela Ecology Programme
BMSY	The biomass at which a stock will, on average, produce the maximum sustainable yield
BRD	Bycatch reduction devices
CAF	Consultative Advisory Forum
CBO	Community-based Organization
CPUE	Catch per unit effort
CUFES	Continuous underway fish egg sampling
DEAT	Department of Environmental Affairs and Tourism [South Africa]
DSS	Decision-support system
EAF	Ecosystem approach to fisheries
ERA	Environmental risk assessment
ESD	Ecologically sustainable development
EwE	Ecopath with Ecosim
FIMS	Fishery Independent Monitoring Surveys
GDP	Gross domestic product
GEF	Global Environment Facility
GIS	Geographic information systems
GTZ	German Agency for Technical Cooperation
HIV	Human immunodeficiency virus
IBCC	Interim Benguela Current Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IMEWG	Integrative Marine Ecology Working Group
INIP	Instituto Nacional de Investigação Pesqueira [Angola]
IUU	Illegal, unreported and unregulated fishing
LTRAMP	Long Term Rights Allocation Management Process
MCDA	Multicriteria decision analysis
MCDM	Multiple criteria decision making
MCM	Marine and Coastal Management, South Africa
MCS	Monitoring, control and surveillance
MFMR	Ministry of Fisheries and Marine Resources [Namibia]
MLRA	Marine Living Resources Act
MPA	Marine Protected Areas
MSC	Marine Stewardship Council
MSY	Maximum sustainable yield
NGOs	Non-governmental organizations

NORAD	Norwegian Agency for Development Cooperation
NPOA	National plan of action
NTG	National Task Groups
OMP	Operational Management Procedure
PCU	Programme Coordinating Unit
PDI	Previously disadvantaged individuals
RASF	Risk assessment for sustainable fisheries
RFMO	Regional Fishery Management Organizations
RMWG	Resource Management Working Group
SADC	Southern African Development Community
SAP	Strategic Action Programme
SEAFO	South East Atlantic Fisheries Organization
SME	Small and Medium Enterprises
SSA	Single species approaches
SWG	Scientific Working Group
TAC	Total allowable catches
TAE	Total allowable effort
TETA	Transport Education and Training Authority
TROM	Target resource-oriented management
UNDP	United Nations Development Programme
VMS	Vessel monitoring systems
WCRL	West Coast rock lobster
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

This document reports on the final results and conclusions of the BCLME project LMR/EAF/03/01 "Ecosystem approaches for fisheries management in the Benguela Current Large Marine Ecosystem". The project has been a cooperative effort by BCLME, the management agencies of Angola, Namibia and South Africa, and FAO. It started in January 2004 and was completed in December 2006. The project was seen as a core activity within the BCLME Programme. Its primary objective has been to investigate the feasibility of EAF management in the BCLME region through examining the existing issues, problems and needs related to EAF and considering different management options to achieve sustainable management of the resources at an ecosystem level (Chapter 1).

Ideally EAF should be implemented across all fishery activities in combination with the implementation of an ecosystem approach to managing all other human uses and impacts. In practice this is rarely possible and it is more common and feasible for an ecosystem approach to be implemented incrementally according to opportunities and crises. Conventional fisheries management, focusing on target species, is well established in all the BCLME countries and, in accordance with an incremental approach, it was considered most effective to use the major fisheries as the starting point for the project, rather than to attempt to encompass all fisheries and related uses in the BCLME in this feasibility study. The following ten fisheries were included in the study (Chapter 2).

Angola:	demersal trawl (finfish); demersal trawl (deep-water shrimps); small pelagics; and artisanal fisheries.
Namibia:	hakes (trawl and longline); midwater trawl for horse mackerel; and purse seine fishery (sardine and juvenile horse mackerel).
South Africa:	hake (trawl and longline); small pelagics; and West Coast rock lobster.

(a) Investigating the feasibility of EAF

While EAF has been globally accepted as the appropriate framework for marine capture fisheries (e.g. the Reykjavik Declaration and the World Summit on Sustainable Development Plan of Implementation), the exact meaning of EAF and what it entails is still a confusing topic for many and there is still much debate on the subject. EAF has been defined by FAO (2003) as:

> "An Ecosystem Approach to Fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries."

The approach used in this project to clarify the concept and implementation of EAF within the context of the BCLME was to start by examining the strategies currently being used for management in each fishery considered and any problems or concerns that were not being satisfactorily addressed by the existing management strategy, within the wider context of the ecosystem and other users of it. Any factors beyond the mandate or control of the fishery managers that were impacting on the fishery were also considered. All of these factors were then prioritized and potential management actions to resolve the problems were identified. The overall goal of this process was to identify where the current management systems may have been failing to prevent or adequately control impacts that threaten the sustainability of

the fishery itself, impact on other stakeholders, both within the fishery sector and outside it, or that may threaten the long term sustainability and productivity of the ecosystem and its resources.

The process consisted of the following steps (Appendix).

(a) Reviews (the so-called target resource-oriented management [TROM] reviews) of the major fisheries in the BCLME region, their ecological, economic and social characteristics, and the strengths and weaknesses of the existing single-species management approaches. These reviews provided input into the next step of issue identification.
(b) Issue identification: i.e. identification of all issues of concern in the fisheries, within the context of EAF, that were not being satisfactorily addressed under the existing management strategies and systems.
(c) Risk assessment: the issues identified under point (b) were prioritized by assessment of their relative risk (consequence x likelihood).
(d) Performance reports were prepared for each issue of moderate or higher priority, as indicated by the risk assessment. The performance reports outlined an appropriate management response to resolve, or mitigate, the issue.
(e) For the purposes of examining the feasibility of EAF, the issues that were a direct consequence of implementation of EAF (as opposed to those arising from single-species or target-species management) were then aggregated into groups in which they could potentially be addressed by a common management measure or set of management measures.
(f) The performance reports for all issues in a group were amalgamated and revised to produce a single performance report for each group, including one or more feasible management actions to address each group.
(g) Benefit-cost analyses were undertaken for the issues considered to arise and require action as a result of adoption of EAF. These analyses consisted of:
    - identifying the broad objectives for the fishery against which costs and benefits needed to be evaluated;
    - performing preliminary evaluations, based on expert opinion, of the benefits and costs (in relation to each broad objective) of alternative management responses for each group of issues.

The results from this process provide an assessment of the feasibility of implementing EAF in the fisheries that were considered.

(b) The issues and priorities

(i) National

Seven workshops on "risk assessment for sustainable fisheries" (RASF) were held by the project to identify and prioritize the issues in the 10 fisheries being considered. The number of issues identified for each ranged from 20 in the Angolan artisanal fishery to 96 in the South African hake fishery, with a median number of approximately 70 issues per fishery (Chapter 3). Not all of these issues were considered to be of high or extreme priority, but the number that were does give cause for concern and demonstrate the urgent need for the countries to move forward rapidly in implementation of EAF. The percentage of issues that were considered to be high or extreme ranged from 23 percent in the South African small

pelagics fishery to 66 percent in the Angolan small pelagics fishery. In part, these figures reflect the perspectives and composition of the group of participants and their interpretations of risk. They should not therefore be used for comparison between fisheries but do reflect a large number of problems that are not being adequately addressed by existing management approaches in each. It should be noted that the issues with moderate risk values should also be examined carefully and considered for possible action where necessary.

The types of issues identified varied considerably from fishery to fishery, particularly in relation to ecosystem well-being. In all cases, many of the issues reflected problems in the existing single-species approaches to management, including insufficient knowledge of abundance and life-history characteristics, uncertainties about stock structure and distribution, and problems associated with high natural variability in target species. Arguably the most important ecological issues that could be considered as EAF "add-ons" were related to bycatches, including of species of importance to other fisheries, species of conservation concern and other species perhaps of less direct importance to humans but significant components of the ecosystem. The lack of good knowledge of and concerns about the impact of bottom fishing gear on benthic habitat was also an important theme across the three countries. There were also concerns about damage to habitats considered to be important to species survival and ecosystem functioning. There were a number of high priority issues related to human well-being and governance which showed considerable similarity across all fisheries.

Recommendation**:** The Benguela Current Commission (BCC) and the responsible authorities in each country should examine the lists of issues and priorities, as well as the draft Performance Reports, from all the RASF workshops, re-evaluate them as necessary, with full stakeholder participation and the best available scientific information, and act with urgency on the higher priority issues. While each these vary from fishery to fishery, the following may justify particular attention:

- bycatch issues across commercially and ecologically important species as well as species of conservation concern;
- ensuring aqequate protection of critical habitat from damage by fishing or other human activities;
- addressing the vulnerability of coastal communities arising from their high level of dependence on fishing and fish products;
- improving governance, in particular through efforts to improve capacity for research and management and by improving consultation with stakeholders and co-management.

(ii) Regional

As would be expected in the BCLME, there are several stocks and species that are shared between two or all three of the coastal States and that therefore require coordinated and cooperative approaches in management of activities affecting them. These species and stocks include some of commercial importance such as the hakes, sardine, horse mackerels and deep-sea crab, as well as species of conservation concern such as a number of seabirds, turtles, deep-sea sharks and others.

Some of the major regional issues identified at the RASF and benefit-cost analysis (BCA) workshops included (Chapter 4):

- the need for Namibia and South Africa to cooperate in research and management of the deep-water hake *Merluccius paradoxus*;
- the need for Angola and Namibia to cooperate in research and management of the sardine *Sardinops sagax* stock shared between those countries;
- the need for the BCC to identify any other priority species to be addressed at a regional level and the action or actions required;
- BCC should also give consideration to addressing regional environmental issues such as monitoring and mitigating the impacts of red tides, low oxygen events and other large scale environmental events and anomalies;
- BCC may also have a role to play in monitoring pollution from, amongst others, land-based activities, oil and gas exploration and extraction and offshore mining, and addressing their impacts on fisheries.

It will be essential for the BCC, informed and advised by its Ecosystem Advisory Committee, to take cognisance of the high priority regional issues identified at the RASF workshops, to re-evaluate them in full consultation with stakeholders as necessary, and to take appropriate action to remedy them.

Recommendation**:** The BCC and its associated Ecosystem Advisory Committee should move ahead rapidly in fulfilling their mandates and take due note of the relevant issues identified in this project, in particular those summarized in Chapters 3 and 4 of this report.

(c) Options for EAF management action

In most cases it would be possible to identify a number of different management options that could resolve or help to resolve each of the priority issues identified in the project. In deciding which one of these alternative options would be most effective, it is necessary to consider the advantages and disadvantages of each for the different objectives being pursued in the fishery. The BCA workshops were intended to develop and demonstrate a process for achieving this.

The process that was established consisted of the following steps for each of the fisheries considered:

- setting the broad objectives;
- identifying and aggregating the EAF issues into groups that could be addressed by the same management measures;
- identifying alternative and complementary measures to address each group of issues;
- assessing the costs and benefits (standardized measures of the advantages and disadvantages) across the set of broad objectives.

The final step, which was not done in the project, would be to identify and implement the set of management measures that has the optimal aggregated costs and benefits, taking into account the agreed weightings of the broad objectives.

An essential step in the process was to agree on the broad objectives for each fishery, where the broad objectives should encompass the operational objectives and values of the full set of stakeholders. The groups of issues, broad objectives and proposed management responses for all the fisheries agreed on in the BCA workshops are found in Chapter 5. They provide a useful starting point for beginning the implementation of EAF but will need to be reviewed, in consultation with the full set of stakeholders, before they can be considered to be final. It will

also be necessary for decision-makers to rank the objectives in order of priority and to assign weightings to each of them, according to their relative importance for the fishery.
Management solutions in which all objectives are equally met and all the different stakeholders fully satisfied will rarely if ever be possible but this trial exercise demonstrated that there are alternative solutions to many of the problems. With rigorous planning, informed by the best available science and other information and with participation by the affected stakeholders, management responses should be identified that minimize the costs and maximize the benefits across all objectives for the priority issues.

Recommendation**:** Even in those fisheries in the BCLME region where some EAF operational objectives are being addressed by management, the current management measures and strategies have tended to be developed in disjointed and often reactive ways. As a result, the RASF workshops identified many gaps and conflicts between different objectives in the same fishery and between fisheries. The national fisheries agencies and the BCC should adopt a coordinated and holistic approach in the development of management strategies that recognize and reconcile, as far as possible, the conflicting goals of all stakeholders, including those within and those outside the fishery sector. A formal, transparent and participatory analysis of the costs and benefits of alternative measures, as demonstrated in the project, should underlie the choice of these strategies.

(d) Potential use of simulation models

Implementation of EAF should proceed on the basis of the best available information. Good decisions can be made in the absence of scientifically-based quantitative models, provided the extent of uncertainty is taken into account through application of a precautionary approach. However, more rigorous and reliable information will generally allow more benefits to be obtained from a resource or ecosystem for a given level of risk than would otherwise be possible. In this regard, suitable, validated ecosystem models can contribute important information to support decision-making, complementary to information provided from the available single-species stock assessment models. Capacity for and application of different types of ecosystem mathematical models is well developed in fisheries science in Namibia and South Africa (see Chapter 6) and there is growing attention to their potential use to advise and inform management, particularly in relation to strategic matters (i.e. broad and longer-term) rather than in shorter-term tactical management. Angola is beginning to develop capacity in this regard too.

A problem throughout the region for development and application of ecosystem models is the poor availability of economic and social data.

Recommendation: Ecosystem models, of different types, can make an important contribution to informing management and policy for the implementation of EAF. The BCLME countries, and the BCC, should encourage the development of capacity in ecosystem modelling and the appropriate use of such skills and models in planning and implementing EAF.

(e) Indicators for EAF

The best indicators to use will depend on the particular characteristics of each case, including the capacity of the management authority. They will also be dependent on the operational objectives for the fishery or ecosystem as a whole. Any indicators applied in management should adhere to the six principles described in Chapter 7.

In addition to selecting suitable indicators, meaningful reference points also need to be selected as either targets for which management should strive or limits that management needs to avoid crossing. In general, it is preferable to use a suite of indicators to guide management action as no single indicator is likely to be completely reliable or to reflect the full set of operational objectives.

Recommendation**:** Reliable and informative indicators are essential for management to track what is happening in the system of interest and to adjust the management measures, as necessary, to achieve the desired objectives. They also facilitate objective and transparent decision-making. The national management agencies and the BCC should ensure that:

- a suite of suitable indicators, consistent with the principles listed above, and associated reference points are identified for the range of goals and activities under their mandates;
- the data necessary to track these indicators is systematically collected and analysed;
- management decisions take into account the status of and trends in the indicators in relation to their reference points.

(f) States of ecosystems

There is uncertainty and controversy about what defines the "state" of an ecosystem and therefore when, and whether, an ecosystem can be defined as changing or having changed state. Nevertheless, the detailed structure (e.g. the relative abundances and distribution of different species) and functioning of ecosystems are dynamic and can change substantially on different time scales, as has occurred in the northern Benguela ecosystem within approximately the last decade (see Chapter 8).

Management, and those dependent on the ecosystem including its fishery resources, need to be able to respond to such changes with a minimum of negative impacts on either human or ecosystem well-being. Adaptive management is necessary to allow for changes in managing human impacts in response to changes in the ecosystem and human uses of it. Governments should work with the fishery sector to ensure that those dependent on fishing for their livelihoods are not highly vulnerable to such change. Strategies to reduce vulnerability include ensuring that fishing capacity is commensurate with the long-term productivity of the resource, ensuring suitable diversification in livelihoods, and the availability of alternative livelihoods for those that cannot be accommodated in a fishery when the "state" of the ecosystem changes.

Recommendation: All fishery stakeholders including managers, fishery groups, conservation groups and others need to recognize that the Benguela Current ecosystem is inherently variable and that abundances and productivity of constituent populations can change substantially on a range of time scales. Human dependence and management of human impacts on the ecosystem must be able to adjust to these changes. While existing management approaches in a number of the fisheries include some measure of flexibility, the national management agencies and the BCC should strengthen this where necessary, including through consideration of developing improved forecasting capacity. Governments and potentially affected stakeholders need to work together to minimize the vulnerability of stakeholders to inevitable changes in the ecosystem, including abundance and productivity of important fishery resources.

(g) Options for strengthening the decision-making process

Under EAF it is clear that decision making in fisheries management needs to address widely divergent desires and needs and the likely conflicting values and goals of the different stakeholders. Effective decision making involves seeking solutions, in the form of management responses, that satisfy all those values and goals to the greatest extent possible. Multiple criteria decision-making (MCDM) aims to assist decision-makers to identify such solutions and has developed a range of different tools and approaches to facilitate this (Chapter 9). These tools could make an important contribution to improved decision-making in the region and should be encouraged.

The project concluded that management decisions were often made in a haphazard and unstructured way in fisheries in the BCLME countries. Transparency and participatory management and decision-making need to be improved urgently in the BCLME region if national and regional policies and objectives for fisheries in the region are to be obtained.

Recommendation: Decision-making in fisheries management in the BCLME countries is frequently opaque and unstructured. This is likely to lead to sub-optimal decisions and wide-spread dissatisfaction with decisions made in this way, leading to conflict and lower levels of compliance. The national fisheries agencies and the BCC must take steps to ensure that decision-making is transparent, participatory and arrives at optimal solutions. MCDM techniques have a critical role to play in achieving this and should become a formal and routine component of decision-making in fisheries management in the region.

(h) Potential incentives for facilitating EAF

Incentives can be considered as "any factor that affects individual choice of action" (Chapter 10). They can be either coercive or encouraging, for example economic incentives can include fines for unacceptable practices, or rewards such as market accessibility, for adhering to rules. Incentives can be classified as: legal; institutional; economic (including market-based); and social.

Some specific applications and considerations for using incentives to facilitate the implementation of EAF in the region included: improved communication between stakeholders, policy makers and management; making scientific information available as a basis for negotiation with stakeholders; co-management; ecolabelling; allocation of long-term user rights; and alternative livelihoods in cases where fishing capacity needs to be permanently reduced.

Recommendation**:** It is recognized that while incentives are being used to encourage compliance and responsible fishing in the region, the full range of possible incentives and their potential contribution as a management tool in the implementation of EAF has not been formally and explicitly evaluated. It is therefore recommended that the options for making better use of incentives in fisheries be further investigated in the context of EAF in the BCLME.

(i) Institutional arrangements for implementation of EAF

The over-riding institutional problem for all three countries was insufficient capacity (Chapter 11). This problem was already considered to be affecting the ability of the fisheries

management agencies to fulfil their responsibilities. Lack of capacity was considered to be particularly serious in relation to research and management but also extended to other services such as policy, economics and social sciences.

Other institutional priorities that were identified by project participants included:

- the need to develop resource management structures that involve the main stakeholders and that include co-management;
- improved communication with stakeholders outside the fishery sector but impacting fisheries (e.g. the oil and offshore mining industries) and government departments responsible for those activities;
- increased capacity to sustain long-term ecosystem monitoring, the deployment of scientific observers and improved data management;
- improvement of surveillance and compliance in Angola, as well as addressing access rights relating specifically to artisanal fisheries.

Notwithstanding these needs, the project concluded that the current problems with capacity should not preclude progress in implementation of EAF measures.

Recommendations**:**

(a) At present, the absence of adequate capacity, and declining capacity in Namibia and South Africa, is seriously threatening the ability of all three countries to implement effectively even the current predominantly single-species approaches. The shortage is more critical in the context of the broader requirements of EAF. The BCLME countries need to give urgent attention to retaining existing capacity and strengthening overall capacity in their fisheries management agencies, particularly but not exclusively in research and management.
(b) Co-management as well as improved liaison with other stakeholders impacting the marine ecosystem, and the relevant government departments is necessary for effective fisheries management.
(c) Countries will need to address the implementation of EAF seriously, including through the BCC, and this will require additional institutional changes as summarized above.

(j) Research needs

The three BCLME countries have identified lengthy and far-reaching lists of research needs at national and regional level (Chapter 12). These lists need to be evaluated and priorities set. The countries should examine opportunities for research cooperation at the bilateral and regional levels in order to reduce costs and achieve greater efficiency, including in the purchase and use of research vessels.

There is an urgent need for greater cooperation with social scientists and economists in fisheries research and management. This communication failure is not only one-sided and human scientists also need to take the initiative and become more directly involved at management level in fisheries.

Recommendations:

(a) Research capacity is severely limited in the region. It is therefore essential that, even while building capacity, the countries ensure that higher priority research questions are being addressed. The lists of research needs provided in Chapter 12, evaluated in conjunction with the results of the RASF workshops, provide a useful starting point for countries to review and prioritize their research requirements for implementation of EAF.
(b) Countries need to give serious attention to boosting liaison with and capacity in social and economic research.
(c) Countries, and the BCC, need to ensure that they implement, where not already being done, and maintain long-term monitoring of indicator variables to provide effective feed-back on key ecosystem states and functions.
(d) Existing capacity for quality control, storage and processing of data and information is inadequate and needs to be strengthened as a top priority.

1. INTRODUCTION

The Benguela Current ecosystem stretches along the southwest Atlantic coast of Africa from central Angola through Namibia to the south coast of South Africa, bounded by the Angola-Benguela Front in the north and the Agulhas Current in the south (from between roughly 14° and 17°S to between 36° and 37°S). As such, it covers the west coast of South Africa, the entire Namibian coast, and southern Angola to an extent depending on the position of the Angola-Benguela front (Figure 1.1).

The ecosystem is a highly productive one in terms of primary production and fisheries resources. It is also very complex in its oceanographic features (Figure 1.1), trophic structure and human activities such as mining, oil extraction and fishing. All of these human enterprises impact upon the biodiversity and health of the ecosystem but also have important social and economic significance, providing jobs and incomes for the three developing countries. For the living marine resources to be managed sustainably and the social and economic benefits to be maintained, it is therefore essential that their dynamics should be adequately understood and that the countries should implement management strategies that preserve ecosystem health and minimize the risk of overexploitation (Cochrane *et al.*, 2004; Roux and Shannon, 2004; Shannon *et al.*, 2004).

The region has long been a leader in ecosystem-based marine science. In 1991, a multi-disciplinary and multi-institutional research programme named the Benguela Ecology Programme (BEP) was initiated (Moloney *et al.*, 2004). The programme integrated physical, chemical and biological oceanography, ecosystem modelling, fisheries biology and stock assessment approaches. This approach was intended to provide scientific support for management initiatives that addressed the ecosystem in a more holistic way than was typically the case in single-species approaches. By 1986 good progress had been made in this research and published in a seminal symposium volume (Payne, Gulland and Brink, 1987) that was followed by two similar volumes (Payne *et al.*, 1992; Pillar *et al.*, 1998). Subsequently, as the defeat of apartheid opened up the way for regional cooperation, in the mid-1990s the countries of the region realized that there was an enormous opportunity for improved understanding of the whole Benguela ecosystem by pooling resources across boundaries and tackling these issues on an ecosystem-wide basis. This led to the establishment of a new marine science programme in 1996, the Benguela Environment Fisheries Interaction and Training programme (BENEFIT). The programme was initiated and funded by Angola, Namibia and South Africa and strongly supported by Germany (through the German Agency for Technical Cooperation [GTZ]) and Norway (through the Norwegian Agency for Development Cooperation [NORAD]). The programme has been highly successful and has led to further advances in the understanding of linkages between resources and the environment and in capacity-building in these areas.

Subsequently, the three countries, in collaboration with the Global Environment Facility (GEF), developed an integrated cross-sectoral programme to address transboundary human impacts on the ecosystem, namely the Benguela Current Large Marine Ecosystem Programme (BCLME). This Programme was developed between 1997 and 2001 and was formally launched in 2002. It considers the human impacts across all sectors but focuses mainly on transboundary fisheries and management actions that will contribute to ensuring sustainable economic benefits for the region. The BCLME Steering Committee responded to the growing interest in adopting ecosystem approaches to management of natural resource use by

commissioning a project specifically intended to address the implementation of an ecosystem approach to fisheries management. In view of the global leadership of FAO in developing and implementing an ecosystem approach to fisheries (EAF), the Organization was approached to assist in the design of the project and to lead it. The successful completion of the project has allowed fisheries managers in the three countries to develop an approach and consider appropriate practical measures to deal with managing fisheries in a way that leads to sustainable use of fishery resources while also ensuring that impacts of fisheries on the ecosystem as a whole do not compromise its structure and functioning. This approach is required not only within national areas of jurisdiction but also at a regional scale, particularly where shared fish and invertebrate stocks are exploited across borders. This report describes the methods, results and conclusions arising from this project.

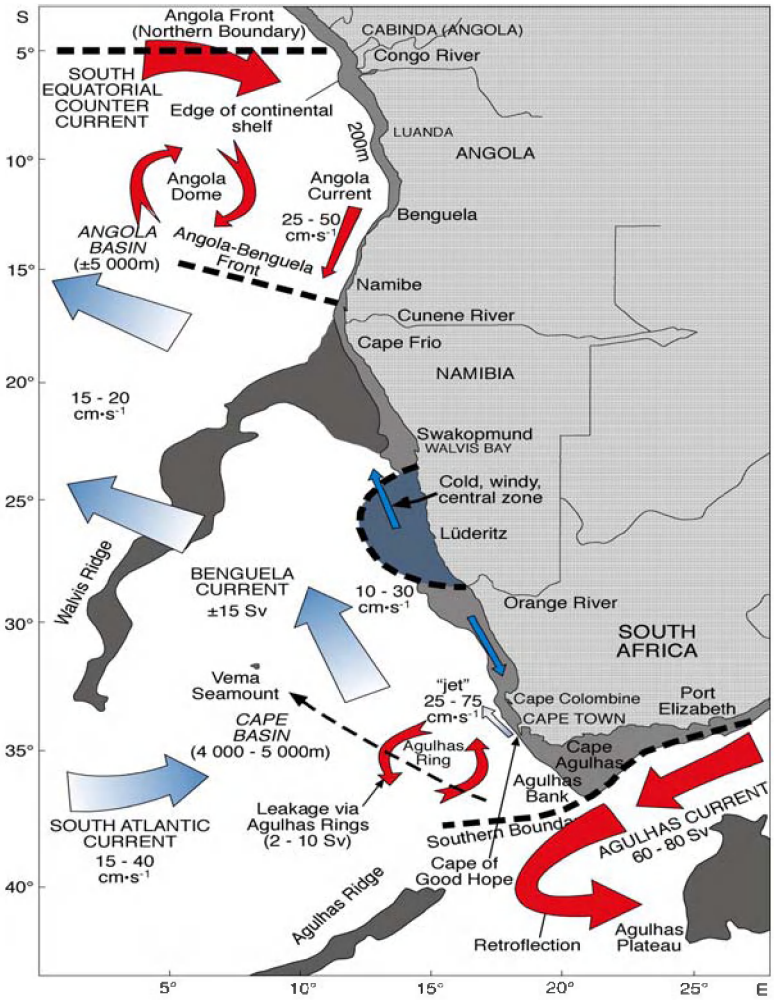


Figure 1.1. The boundaries, major currents and physical features of the Benguela Current large marine ecosystem

During the developmental phase of the BCLME, there was an early realization that better understanding of the dynamics of the ecosystem and improved approaches in its management would only be effective in achieving the goals and expectations of the region if they enjoyed political support at the highest level. In addition, progress would only be possible if policy-makers and managers utilized and acted upon the information being generated by the scientists. In order to provide the institutional structure necessary for these conditions to be met, the main output of the Strategic Action Programme of the BCLME has been to establish a formal Commission which will allow managers to access information on the status of

resources and the ecosystem as a whole, agree on sustainable levels of utilization and reduction of negative impacts. The Benguela Current Commission (BCC) was formally initiated in February 2007 with the signing of an Interim Agreement by the three countries and will allow managers to advise their governments on these matters. It is hoped that by the end of the second phase of the BCLME Programme (2008–2012), a fully integrated BCC will have been developed and signed with a legally binding Convention that will set terms over which total allowable catches (TACs) and other management measures for transboundary resources will be negotiated bilaterally within the Commission between the neighbouring countries and outcomes will be enforced by the Commission.

1.1 Terms of reference of the BCLME project on EAF

The main objective of the project reported on here has been to investigate the feasibility of EAF management in the BCLME region through examining the existing issues, problems and needs related to EAF, and developing different management options to achieve sustainable management of the resources at an ecosystem level. Its scope included the following:

(a) a review of all major TROM commercial fisheries from an ecosystem perspective;
(b) evaluation of the consequences of continuing with TROM approaches to the fisheries;
(c) analyse the benefits and costs of implementing EAF and present them to managers and decision makers;
(d) propose operational goals and objectives to implement EAF;
(e) identify management measures and rules to achieve the best results within an EAF;
(f) liaise with managers and decision makers to formulate preliminary management plans for EAF at national and regional levels;
(g) develop improved techniques and approaches to strengthen the decision-making process;
(h) identify useful ecosystem indicators and their application to characterize ecosystem states, changes and functioning;
(i) identify research needs for improved EAF;
(j) propose incentive measures to facilitate the implementation of EAF;
(k) recommend appropriate institutional arrangements for successful implementation of EAF, and
(l) inform stakeholders of project results.

2. THE FISHERIES INCLUDED IN THE STUDY

2.1 Reviews of current fisheries management approaches

The project Terms of Reference specified the need to "Liaise with the government scientists responsible for single-species monitoring and assessment to review the current target-resource oriented management (TROM), from an ecosystem perspective, for each major commercial fishery in the BCLME".

The TROM reviews were undertaken largely by reviewing the available literature, both formal and informal. Separate reviews were undertaken for each of the fisheries shown in Table 2.1 and each included a description of the distribution and biology of the target species, the current status of the stocks, and the fishing methods and social and economic importance of the fishery. The effectiveness of management and the interactions of the fishery were evaluated including:

- effectiveness of the current management measures in relation to the fishery itself, including their effectiveness in ensuring sustainable utilization;
- associated impacts, including significance and risk of each impact on the ecosystem structure and/or function, on habitats or on the populations of associated species and on associated biological diversity and productivity;
- problems being experienced in the fishery with respect to compliance and monitoring, and any complaints or dissatisfaction amongst fishers and rights holders;
- details of direct interactions with other fisheries e.g. competing for the same target species, target species taken as bycatch in another fishery, etc;
- information on the nature and extent of bycatch (capture of non-target species) and extent of discards (the proportion of the catch not landed) and unobserved fishing mortality (i.e. sources of mortality other than those mentioned above);
- the effects of supply and use of bait;
- impacts on recognized protected, endangered or threatened species and management objectives in terms of impact identification and avoidance/reduction on these species;
- details of direct interactions with the ecosystem (impact on sea bottom, pollution caused by fishery and effects of coastal zone development or land-based pollution);
- physical impacts on habitat: gear and gear lost during fishing operations, e.g. ghost fishing.

Reports for the fisheries listed in Table 2.1 have been completed. The results of the reviews provided background information for the subsequent issue identification and risk analysis and the reports are being published and distributed as project reports.

2.2 Fisheries included in the study

2.2.1 Angola

Fisheries represent the third main economic sector in Angola, following the oil and mining (diamond) industries. The estimated rate of fish consumption in coastal areas is between 14 and 17 kg/per habitant/year and it is estimated that one third of animal protein comes from fish.

Table 2.1. Fisheries for which TROM reviews were undertaken

Angola	Namibia	South Africa
Demersal trawl fishery (finfish and deep-water shrimps)	Hakes, *Merluccius paradoxus*: demersal trawl and longline	Hake (*M. paradoxus* and *M. capensis*) – trawl and longline fisheries
Small pelagic fisheries *Sardinella* spp., *Sardinops sagax, Trachurus capensis, T trecae* and other species	Horse mackerel, *T. trachurus capensis* (midwater trawl and purse seine)	Small pelagic (purse seine) fishery (inclusive of anchovy *Engraulis encrasicolus* and Sardine *Sardinops sagax)*
	Sardine, *Sardinops sagax* (purse seine)	Squid (Jig) fishery for *Loligo vulgaris reynaudii*
	Rock lobster, *Jasus llandii*	West Coast rock lobster fishery (inshore shallow-water trap fishery)
	Deep-sea crab, *Chaceon maritae*	South Coast rock lobster fishery (offshore deep-water trap fishery)
	Seals, *Arctocephalus pusillus*	Abalone, *Haliotus midae*, fishery (diving)
		Midwater trawl fishery for horse mackerel, *Trachurus trachurus capensis*
		Traditional linefish (coastal shore and sea-based multispecies)
		Kwazulu Natal prawn fishery (offshore trawl)
		Large pelagics – offshore longline and pole fisheries for albacore and other tunas as well as shark

The Government of Angola has adopted a number of objectives to be achieved over the next decade within the fisheries sector to:

- guarantee rational exploration of the aquatic biological resources inside the limits of biological sustainability and to protect the aquatic environment;
- legislate to protect aquatic biological resources and to guarantee their application;
- create enabling mechanisms and financial and fiscal conditions;
- promote training, capacity building and development of expertise in the fishery sector;
- promote improvement of the economic infrastructure and social basis of the sector;
- promote development of the artisanal fishery;
- promote development of the industrial productive fisheries sector;
- promote development of aquaculture;
- promote development of salt production;
- promote a reliable supply of fishery products to the population;
- maximize benefits from responsible use of living aquatic resources.

The above objectives are fully consistent with the implementation of an ecosystem approach. While development of the sector is encouraged to provide benefits to the Angolan population, it is explicitly stated in the policy that biologically viable limits should be respected and the marine environment protected.

The Angolan EEZ can be subdivided into three main areas: the northern, central and southern areas. The southern area extends from approximately Namibe to the Cunene River and is by far the most productive.

Angolan industrial fisheries have a long history dating back to the early 1950s when total catches already exceeded 300 000 tonnes. After a decline in 1960, the production increased and reached nearly 600 000 tonnes in 1972. At present, total catches are estimated to be around 280 000 tonnes.

The small pelagic industry is the largest with respect to volumes, landing 80 percent of the total fish catches of the country. The main species comprise round sardinella (*Sardinella aurita*), the flat sardinella (*Sardinella maderensis*), Cunene horse mackerel (*Trachurus trecae*), Cape horse mackerel *(Trachurus capensis*) and the South African sardine (*Sardinops sagax*). Resource assessment in 2002 indicated that, of the major pelagic species, the sardinellas were not fully exploited, while the horse mackerel stocks had reached a critical state, requiring immediate decisions concerning future allowable levels of exploitation. The South African sardine, considered to be shared with Namibia, was also estimated to be depleted. Small pelagic resources are exploited by a fleet of 104 purse seiners, 17 pelagic trawlers, and by the small-scale sector.

Drastic management measures have recently being taken to favour recovery of the overexploited pelagic resources and particularly of horse mackerel. These include banning pelagic trawl fishing all along the coast and any type of trawling in the southern region (13° to 17° S).

The demersal fisheries are usually classified into three main categories, i.e. the industrial trawl fishery for deep-water shrimp, the industrial bottom trawl fishery for demersal fish and the artisanal sector which fishes for demersal fish with gillnets and handlines. There is also a small fishery for deep-water crab *Chaceon maritae*, operating with crab pots off southern Angola.

The main targets of the deep-water shrimp trawl fishery are *A. varidens* and *P. longirostris*. The fleet operates between about 200 and 800 m depth, along the whole coast north of 12° S. Total deep-water shrimp catches were about 9 000 tonnes in the 1980s while they have fluctuated between about 3 000 and 6 000 tonnes during the last decade (K. Kilongo *et al.*, in preparation).

The industrial bottom trawl fishery for demersal fish operates along the whole coast, with a fleet exceeding 60 large industrial trawlers. It operates mostly on the continental shelf, at depths shallower than 200 m, catching a mix of demersal fish, including commercial groups such as seabreams (Sparidae), croakers (Sciaenidae), hakes (*Merluccius* spp.), cephalopods, grunts (Haemulidae) and groupers (Serranidae). Because of their abundance (more than 40 percent of the demersal landings) and their commercial value, seabreams represent the most important fish group. This fleet also lands large quantities of horse mackerel, *T. trecae* and *T. capensis*. Because of this bycatch, bottom trawling has been banned in the southern

region. Overall trends in demersal landings showed a peak immediately after independence (1975), followed by a marked decline in the following years. Data for the last decade indicate lower levels of landings as compared to the historical, post-independence landings, with a marked increase during the last three years, with total catches above 100 000 tonnes. This increase seems to be mostly due to increased landings in the artisanal fishery that exploits demersal fish all along the coast with a wide range of vessels, from small wooden canoes to modern motorized fibreglass vessels. The gear used for demersal resources is mostly handlines, with an increasing number of gillnets.

The brief overview above shows that Angola has to face important challenges to be able to meet the goal of biological sustainability.

2.2.2 Namibia

Hake fishery

Hake (*M. capensis* and *M. paradoxus*) is an important commercial resource for Namibia, both in terms of revenue earnings and employment. In 2003, hake products were worth N$2.9 billion and more than 9 000 Namibians were employed in the fishery.

The two species of hake occur on the shelf and upper slope in Namibian waters. *M. capensis* occurs at depths between 100 and 350 m, while *M. paradoxus* occurs mainly at depths of 300 and 500 m. The spawning biomass of the two hake species was estimated at 1.3 million tonnes in 2004. The current state of the hake stock gives a "fishing down" (B^{sp}_{2004}/B^{0}) level of a median value of 34 percent. The maximum sustainable yield (MSY) is estimated to be 45 percent of the pristine biomass level.

Three types of vessels, freezer trawlers, wet fish trawlers and longliners, operate in the hake fishery. More than 90 percent of hake is currently landed by the freezer and wet fish trawlers, with the rest being landed by longliners. More than half the processing is conducted ashore. Eighty-five percent of the hake products are exported to European markets, 13 percent is marketed in southern Africa and only 2 percent is consumed locally.

Purse seine fishery for small pelagics

The purse seine fishery in Namibia is based largely on pilchard (*Sardinops sagax)* and juvenile Cape horse mackerel (*T. capensis)*, and to a lesser extent on anchovy *Engraulis encrasicolus* and other small pelagic species. The fishery commenced soon after the Second World War when there was a great demand for canned fish. Pilchard landings increased rapidly from 0.02 million tonnes in the 1950s to a maximum of 1.4 million tonnes in 1968. There was then a sharp decrease to less than 0.03 million tonnes in 1971, followed by a slight increase for a few years before a sudden collapse in the late 1970s. By 1990, when acoustic surveys were first carried out, the stock was estimated at roughly 700 000 tonnes and continued to decrease through the 1990s with a very low estimate in 1996 of only a few thousand tonnes. In 2001, 2006 and 2007 similarly low stock biomasses were observed with at least one of the two annual surveys returning a zero biomass estimate. Though varying in abundance, the stock remains in a critical state. These collapses are attributed mainly to overfishing and environmental perturbations.

In the past, the fleet operated mainly in the vicinity of Walvis Bay, however now the fish are also caught further north of the port, as far as Cape Frio in some years. Before the mid-1970s, a fleet of purse seiners targeted the same sardine stock in southern Angola. Since the mid-1990s, some fishing has again taken place there. The fishery has been conducted almost entirely from the port of Walvis Bay but for a limited period during the 1960s and early 1970s, it also operated out of Luderitz and from sea-going processing plants (Butterworth, 1983). The sea-going plants, converted ex-whaling, factory ships, were supplied by 27 catcher boats fishing the same stock as the land-based purse seiners but operating further than 12 nautical miles from the coast. Refrigerated seawater boats using 28 mm nets have been employed since 1979 and have been responsible for most of the pilchard catch since 1980.

Midwater trawl fishery

This fishery is the largest contributor by volume to the Namibian fishing industry and targets primarily Cape horse mackerel (*T. capensis)*. The fleet was dominated by various eastern block countries from the 1960s to the 1980s. During the 1990s, after independence, the fishery underwent structural changes and it is currently mainly composed of the Russian fleet registered in Namibia but still operated by a foreign crew. The fleet size has decreased since independence from 57 to 17 in 2001 and consists of 22 vessels at present. The midwater fishery operates using trawls within the water column to catch schools of adult horse mackerel. The fish are mainly frozen whole round horse mackerel. Fishmeal, oil and in some cases dried fish and fillets were also produced.

Over the years, landings have fluctuated with low catches reported in the early 1960s, increasing in the 1970s and the highest catches of almost 600 000 tonnes were reported in the early 1980s. Since the 1990s, landings have been, on average, 300 000 tonnes per year. Catch rates have steadily decreased since the early 1990s mainly due to lower fish abundances.

The horse mackerel resource is managed through a quota allocation method whereby a combined assessment is carried out and a TAC is set for the resource after scientific recommendations are given to management. Since 1999, the quota allocation to the midwater fishery has been about 86 percent of the TAC.

For both the pelagic and midwater fleets there is no specific season and fishing in both fleets starts in January and ends in December of each year, on condition that restrictions are adhered to on areas, size, depth and bycatch. The midwater fleet is restricted to operate outside the 200 m bottom depth contour line. This restriction was imposed to avoid trawling in nursery areas as well as to prevent high bycatches of juvenile hake and pilchards. A minimum mesh size of 60 mm is allowed for the midwater fleet and a size restriction of 17 cm total length or greater is applied. Within the depths allowed, the fleet is required to leave a fishing area if a catch by weight comprises of more than 5 percent of hake or pilchard and/or horse mackerel less than 17 cm total length per haul.

2.2.3 South Africa

Demersal hake fishery

The deep-sea trawl fishery (also referred to as offshore trawl) for hake commenced in the early twentieth century. Overfishing by foreign fishers occurred in the 1960s and 1970s and resulted in stock decline and overexploitation. Consolidation and stock rebuilding commenced from the late 1970s. Initially the deep-sea hake trawl sector comprised of only a few pioneer companies. However, the proportion of TAC of these companies was systematically reduced from 1994 and many new entrants were introduced to the fishery. The deep-sea trawl fishery targets both hake species.

The hake fishery is predominantly an export-driven revenue operation with most of the fresh and value-added products destined for Spain, United States of America, Australia and other parts of Europe. There is a small local market (<20 percent of products sold locally).

The hake deep-sea trawl fishery sustains about 8 800 direct jobs along South Africa's west and south-east Cape coasts. The market value of the landed catch is approximately ZAR1.4 billion annually.

The inshore trawl fishery commenced in the 1970s. A global quota management system was applied to the sector in 1978 (Olympic system), and in 1982 individual quotas were introduced. The fishery is relatively stable and comprises companies mostly associated with deep-sea trawl operators. The fishery consists mostly of smaller vessels (than the deep-sea vessels) with strict control of boat size and power (effort limitation). The inshore trawl fishery targets the south coast *Merluccius capensis* stock. The fleet is split between hake-directed (with a sole bycatch) and sole (*Austroglossus capensis*) directed (with a hake bycatch). The inshore fishery takes a significantly higher diversity of bycatch species than does the offshore sector.

The inshore trawl fishery sustains some 1 100 direct jobs. The market value of catch landed is approximately ZAR16 million annually.

The demersal longline-hake fishery commenced with an experimental phase from 1994 to 1997 with the introduction of full commercial fishing from 1998. Fishing is somewhat irregular and driven by resource availability and market demand. Hake longliners are mostly small vessels (<30 m) and operations are labour-intensive with little value-adding of product.

The hake longline fishery generates some 3 600 permanent jobs and a further 3 200 part-time jobs. The total value of fish landed in the hake longline fishery is estimated to be worth more than ZAR130 million per year.

The handline-hake fishery originated in 1990 as an expansion of the linefish fishery (a handline fishery using small boats). The sub-sector expanded rapidly, driven by the availability of shallow-water hake stocks close to shore (<100 m water depth) and international demand for fresh hake. The total allowable effort (TAE) currently limits the number of crew and vessels that could target hake using a handline to 130 vessels and 785 crew. The hake handline fishery operates out of small fishing harbours and slipways along the Southern and Eastern Cape coasts, as far north as Port Alfred. The handline fishery,

like the hake longline fishery, lands prime quality hake for export to Europe. The fishery operates in inshore waters targeting shallow water hake, *M. capensis*.

Small pelagics fishery

The small pelagics fishery dates back to the late 1940s when a fleet of privately owned purse seine vessels began targeting sardine and horse mackerel. In 1953 an annual maximum catch limit of 270 000 tonnes was set but was never enforced. As a result, catches regularly exceeded this figure. By 1961, the maximum limit was repealed. In 1962, more than 410 000 tonnes of sardine were landed, but by 1966, the catch had dropped to 100 000 tonnes. The fleet then started targeting anchovy, using nets with a smaller mesh size. In 1987 anchovy catches peaked at 600 000 tonnes, but catches declined thereafter and in 1996 only 40 000 tonnes of anchovy were landed. Anchovy and sardine catches have subsequently increased, with landings of both species averaging around 250 000 tonnes each over the past five years. The fishery is currently managed in terms of an Operational Management Procedure (OMP) that sets annual TACs for anchovy and sardine. In terms of catch volumes, the small pelagic fishery remains the largest in South Africa. It is the second most important in terms of value. This fishery's management procedure is the most complex of the commercial fisheries. Two species are the main targets, namely sardine (*Sardinops sagax)* and anchovy (*Engraulis encrasicolus)*, with associated bycatch species being red-eye round herring (*Etrumeus whiteheadii*) and Cape horse-mackerel (*Trachurus trachurus capensis*). Sardines are canned for human consumption while anchovy and most of the bycatch species are reduced to fishmeal, fish oil and fish paste. Small pelagic targeting occurs inshore, primarily along the Western Cape's west and south coasts (anchovy and sardine) and the Eastern Cape coast (sardine). The pelagic fleet consists of just over 100 wooden, glass-reinforced plastic and steel hulled purse-seine vessels, ranging in length from 15 to 30 m. The industry employs approximately 7 800 people. Of these, 5 300 are employed on a permanent basis and 2 500 on a seasonal basis. The average annual income of sea-going workers is ZAR94 000 – the highest in the fishing industry. Ninety-five percent of workers in this fishery are historically disadvantaged people. The value of fish landed is presently approximately ZAR800 million per year. Most of the catch is processed in eight fishmeal plants, six canning factories and more than 40 bait packing facilities.

West Coast rock lobster fishery

West Coast rock lobster (*Jasus lalandii)* are distributed from just north of Walvis Bay, Namibia, to near east London on the east coast of South Africa. Commercial exploitation started in the nineteenth century and expanded in the early twentieth century, eventually levelling off at about 10 000 tonnes from 1950 to 1965. Since 1965, the utilization of the stock declined almost continuously to a minimum of 1 500 tonnes in 1995/1996. Since then the TAC has stabilized and increased. Currently the stock is at about 6 percent of the pre-exploited levels. There are three main sectors: full commercial, limited commercial (small scale), and recreational.

About 1 300 seasonal and full-time employees are involved in the commercial catching segment. The processing component is comprised of approximately 19 factories with over 2 800 employees. South Africa supplies less than 2 percent of the world's total lobster market demand and foreign earnings in 2002 amounted to approximately ZAR200 million. Between 1992 and 1999 an average of about 52 000 recreational permits was sold each year.

3. NATIONAL EAF ISSUES AND PRIORITIES

The Risk Assessment for Sustainable Fisheries (RASF) Workshops

Issue identification and risk assessments were undertaken through the risk assessment for sustainable fisheries (RASF) workshops held for each fishery in each country during the course of 2005. The methods used are outlined in Appendix and are based on the methods developed by the "ecologically sustainable development" (ESD) initiative undertaken in a number of Australian Federal fisheries (Fletcher *et al.*, 2002) and adopted in the FAO technical guidelines for implementation of EAF (FAO, 2003; 2005). The results are described in detail in the Appendices of the Annual Report: January–December 2005 (BCLME, 2006). At differing levels of detail and coverage, they have also been reported in Cochrane, Augustyn and O'Toole (2007), Nel *et al.* (2007) and Shannon *et al.* (2006).

RASF workshops were held in Angola at the Instituto Nacional de Investigação Pesqueira (INIP) in November 2005 for the pelagic fishery, the demersal trawl fishery (finfish and deep-water shrimp), and for the small-scale fishery using gillnets and beach seine nets. In Namibia, the RASF workshops were held to address the three main Namibian fisheries sectors: the hake trawl (4–7 April 2005); long-line fisheries and the sardine and horse mackerel, purse-seine and midwater trawl fisheries (26–30 September 2005). A range of stakeholders from managers, to scientists and non-governmental organizations (NGOs) attended those workshops. In South Africa, RASF workshops were conducted from 10 to 12 May 2005 for each of three South African fishing sectors, namely small pelagics, hake and West Coast rock lobster and included a range of stakeholders. Follow-up workshops were held in South Africa from 31 May to 3 June to complete the work.

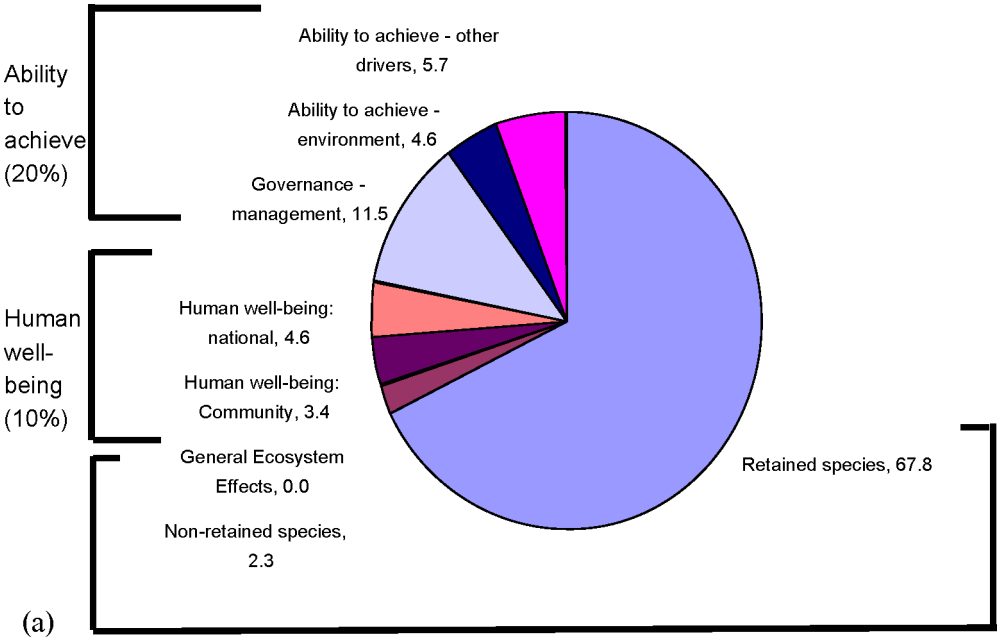
Results of the RASF Workshops

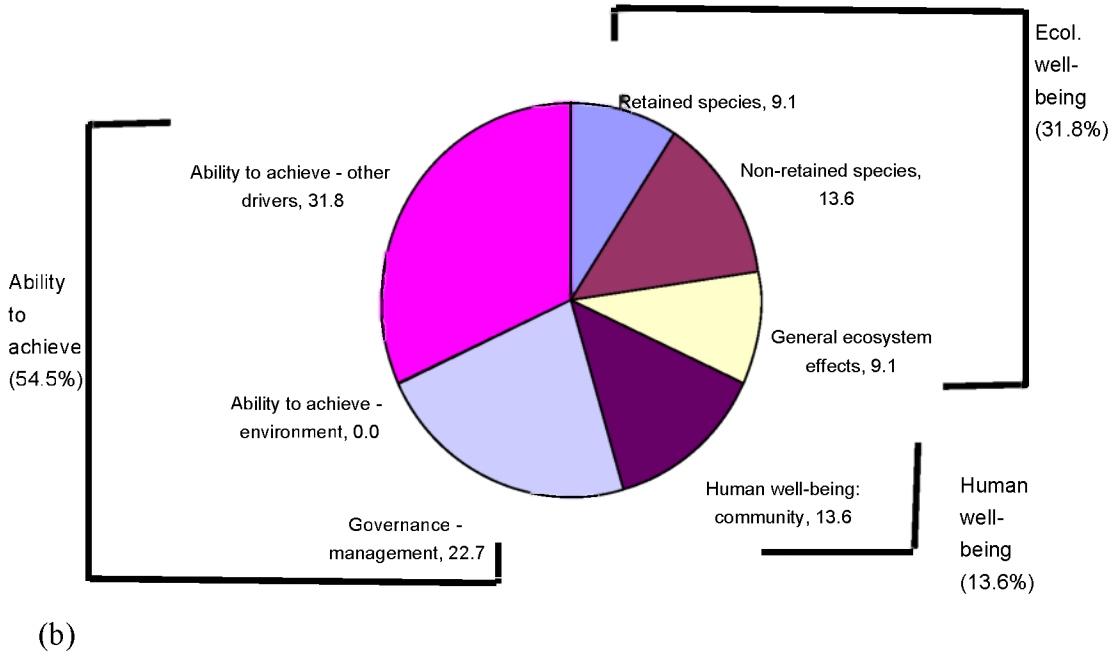
3.1 Angola

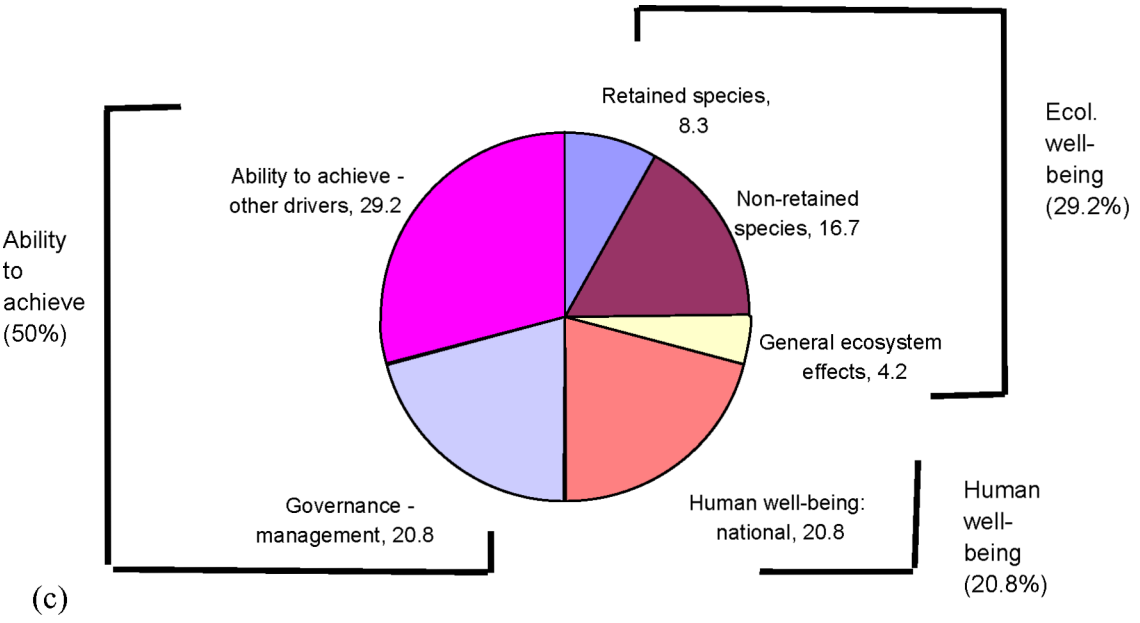
3.1.1 Identification of issues

The full lists of issues for each of the four fisheries are provided in Table 3.1 below. The higher number of issues identified for the pelagic fishery probably reflects the fact that this "operational unit" includes various types of fisheries (pelagic trawl, purse seine and artisanal fishery) while the second group subdivided the demersal fishery into its main components. Combining the three demersal categories, the total number of demersal issues was 66.

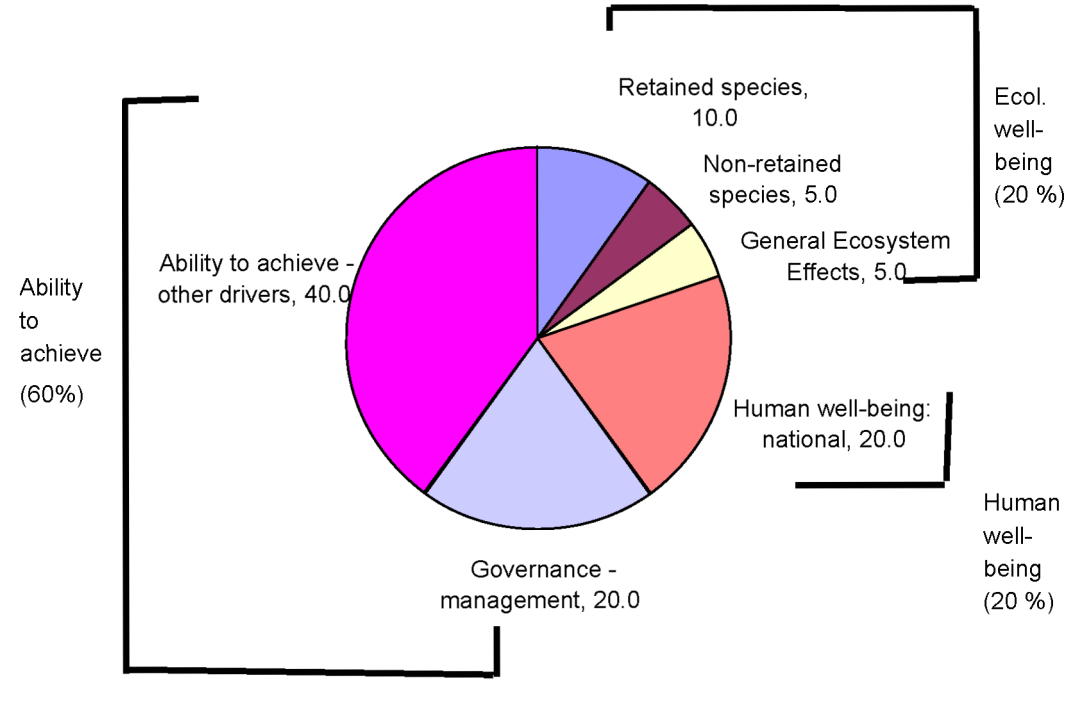
Figures 3.1 (a-d) shows how the issues were distributed among the various components and categories. There are important differences in the relative percentages, particularly between the pelagic fishery (Figure 3.1a) and the three demersal fisheries. In the former, most of the issues (about 68 percent) identified belong to the component "Ecological well-being" while in the demersal fisheries the highest percentage of issues fall within the "ability to achieve" component. This result may be due to a number of factors, including the composition of the two working groups and the taxonomic detail which each of the two groups considered appropriate for the fisheries they were addressing. In the case of the pelagic fishery, the group considered it necessary and feasible to examine each of the major target species separately, whereas the demersal group decided that it was more appropriate to aggregate the species for assessment of those fisheries.


Ability to achieve (20%)
Human well-being (10%)
Ability to achieve - other drivers, 5.7
Ability to achieve - environment, 4.6
Governance - management, 11.5
Human well-being: national, 4.6
Human well-being: Community, 3.4
General Ecosystem Effects, 0.0
Non-retained species, 2.3
Retained species, 67.8
(a)
Ecological well-being (70%)


Ecol. well-being (31.8%)
Human well-being (13.6%)
Ability to achieve (54.5%)
Retained species, 9.1
Non-retained species, 13.6
General ecosystem effects, 9.1
Human well-being: community, 13.6
Governance - management, 22.7
Ability to achieve - environment, 0.0
Ability to achieve - other drivers, 31.8
(b)



(c)



(d)

Figure 3.1. Percentages of issues that were identified within each component and category: (a) Pelagic fishery; (b) demersal trawl fishery (fish); (c) bottom trawl fishery (deep-water shrimp) and (d) artisanal fishery targeting demersal fish

3.1.2 The major issues

Ecological well-being

Most of the issues that were identified as having high priority in the pelagic group, and applying to all commercial species, were issues that would be considered also under a conventional fisheries management framework (Table 3.1). These included the improvement of fishery statistics, the recognition that all pelagic stocks are shared with neighbouring countries, and the limited information about the amount and type of bycatch. An issue that encompasses broader ecosystem impacts was the interactions between the pelagic resources and other fisheries such as the banda banda fishery (a small-scale fishery utilizing a fine-meshed beach seine) that impacts juveniles in shallow coastal waters. This was considered to be a particularly high risk to the sustainability of exploited pelagic species. This activity is considered to have been increasing and may explain some of the important decreases in the biomass of horse mackerel.

Trophic interactions did not appear as a priority in any of the fisheries.

Shark bycatches were considered an important issue in most fisheries. Specific to the demersal trawl fishery were the possible impacts of trawls on bottom substrate and associated fauna.

Human well-being

The poor working conditions of women in the processing industry (salt/drying) was stressed as an important issue with high risk level in the pelagic fishery. Overall poor infrastructure in the fishery sector, lack of facilitation in the creation of cooperatives, and low salaries were all affecting human well-being at the community and national levels.

Ability to achieve

Allocation of fishing rights, collection of reliable fishery data, inadequate monitoring and control systems and the lack of management plans for the species exploited were all considered as major governance issues.

The oil exploitation activities were also regarded as imposing a high risk for all the fisheries, both the industrial fisheries, because of the possible impact on resources, and the small-scale fisheries, because of the impact on resources and on coastal environments.

3.1.3 Angola: conclusions

The results of this workshop represent an important step in the introduction of EAF to Angola's fisheries management. The workshop participants successfully identified key issues in the pelagic and demersal fisheries and were able to prioritize these through a semi-quantitative risk assessment exercise.

It should be noted, however, that this is a feasibility study. With the limited time available, this workshop was intended to, and did, produce provisional results and reports. These will need to be completed and revised where necessary to ensure that they are sources of accurate and reliable advice to the decision-makers. Future work should include the following:

1. Review and revision, where necessary, of the issue lists with participation of representatives of important stakeholder groups that were missing at the workshop

(including the industry, representatives of small-scale fisheries, conservation agencies or groups, managers and administrators at the national and regional levels). In addition, the presence of representatives of the energy sector and of the ministry of environment will be important.

2. Review and revision, where necessary, of the risk values across all components of the hierarchical trees, in both the pelagic and the demersal groups.
3. The performance reports need to be completed and the sections already completed would benefit from review and possible revision, all preferably with participation of relevant ministry officials and with the industry so that proposed actions are as meaningful as possible.

Notwithstanding the need for strengthening of the results, the list of issues can already be a valuable reference for improving present fisheries management by addressing some of the priority issues identified.

Table 3.1. Issues and risk values for the fisheries of Angola
Complete list of issues raised for: (a) small pelagic fishery; (b) demersal trawl fishery (fish); (c) demersal trawl fishery (deep-water shrimp) and (d) artisanal fishery targeting demersal fish. The scores reflect: consequence, i.e. the severity should the issue not be resolved (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.).

(a) Small pelagic fishery

	Issues	Cons	Like	Risk
Retained species				
	1. Fishing activity taking place in nearshore areas	4	6	24
	2. Utilization of nets with very small meshes (banda banda)	4	6	24
	3. Utilization of high value species for fishmeal	4	6	24
Sardinella aurita	4. Biomass estimation methods	1	6	6
	5. Low resolution of fishery statistics	3	6	18
	6. Licence allocation to purse seiners	3	2	6
	7. Uncertainty as regards growth parameters	3	6	18
	8. Shared resource	4	4	16
	9. Impact of small-scale fisheries (banda banda)	5	6	30
Sardinella maderensis	10. Biomass estimation methods	1	6	6
	11. Low resolution of fishery statistics	3	6	18
	12. Licence allocation to purse seiners	3	2	6
	13. Uncertainty as regards growth parameters	3	6	18
	14. Shared resource	4	4	16
	15. Impact of small-scale fisheries (banda banda)	5	6	30
Trachurus trecae	16. Stock status	5	6	30
	17. Size composition of the stock	5	6	30
	18. Studies on fish behaviour	2	4	8
	19. Fishery statistics	3	6	18
	20. Shared resource	4	4	16
	21. Stock identification	3	5	15
	22. Impact of small-scale fisheries (banda banda)	5	6	30
Trachurus capensis	23. Size composition of the stock	5	6	30
	24 Studies on fish behaviour	3	5	15
	25. Fishery statistics	3	6	18

	Issues	Cons	Like	Risk
	26. Shared resource	4	4	16
	27. Stock identification	4	5	20
Sardinops sagax	28. Stock status	4	6	24
	29. Size composition of the stock	4	6	24
	30. Fishery statistics	4	6	24
	31. Studies on fish behaviour	3	5	15
	32. Shared resource	4	6	24
	33. Stock identification	3	5	15
Scomber japonicus	34. Biomass estimation not available	5	5	25
	35. Poor fishery statistics	5	6	30
	36. Impact of small-scale fisheries (banda banda)	4	6	24
	37. Shared resource	2	4	8
	38. Limited knowledge of the species biology	3	4	12
Carapau	39. Impact of bottom trawl fishery on species abundance	4	6	24
	40. Impact of small-scale fishery on the horse mackerel fishery	3	5	15
Sardinellas	41. Impact of artisanal fishery on sardinella fishery	3	5	15
By-product species				
Selene dorsalis	42. Poor knowledge on abundance	2	2	4
	43. Poor knowledge on biology	2	2	4
	44. Poor fishery statistics	2	2	4
	45. If caught, this species is retained	0	1	0
Trichiurus lepturus	46. Poor knowledge on abundance	2	2	4
	47. Poor knowledge on biology	2	2	4
	48. Poor fishery statistics	2	2	4
	49. If caught, this species is retained	0	1	0
Decapterus rhoncus	50. Poor knowledge on abundance	2	2	4
	51. Poor knowledge on biology	2	2	4
	52. Poor fishery statistics (often recorded as horse mackerel)	4	6	24
Brachideuterus auritus	53. Biomass estimation based on trawl surveys	0	1	0
	54. Poor information on the biology	2	2	4
	55. Difficulty in identifying this species acoustically	3	3	9
Seals	56. Consumed if caught	0	1	0
Dolphins	57. Consumed if caught	0	1	0
Sharks	58. Fins and stomachs are exported	3	5	15
	59. Consumed if caught			0
Myctophidae	60. Discarded	0	1	0
Round herring	61. Discarded	0	1	0
Human well-being: Community				
Sardinellas and carapau	62. The manner in which landings are handled and processed	3	5	15
	63. The conditions of women involved in the industry producing dry-salted fish are not good	4	5	20
	64. Repeat of 63	4	5	20
Human well-being: national				
	65. Inland communities prefer to consume small pelagic fish	2	4	8
	66. The provinces of Benguela and Namibe absorb most of labour	4	5	20

Issues	Cons	Like	Risk
67. A large part of the families depend on small-scale or semi-industrial fisheries	4	5	20
68. Feed most of the "informal" market	5	5	25
Governance – management	4	6	24
69. Allocation of fishing rights	4	6	24
70. Lack of incentives for small-scale companies	1	1	1
71. Monitoring and control system inadequate	4	6	24
72. Database not functioning well	4	5	20
73. Lack of management plans for all species	4	5	20
74. Fisheries management lacks capacity in bio-economics	2	2	4
75. Inadequate application of information technology (Internet)	1	1	1
76. Open access in small-scale fisheries	4	5	20
77. Maintain open access in small-scale fisheries, but develop a control system	4	5	20
78. Improve communication between scientists, managers and the industry	4	5	20
Ability to achieve – environment			
79. Oil exploitation areas seem to represent a barrier to the distribution of sardinella	4	5	20
80. Climate anomalies affecting recruitment	4	5	20
81. Climate anomalies affect fish availability	4	5	20
82. Seasonal migrations, particularly in the case of shared stocks	4	5	20
Ability to achieve – other drivers			
83. Reduced life expectancy of fishermen due to alcohol abuse	4	4	16
84. New generations are not interested in fishing	4	4	16
85. Large part of fishermen are illiterate	4	4	16
86. Need to redevelop infrastructure (roads, bridges, etc.)	5	5	25
87. Increasing fuel prices	4	6	24

(b) Demersal trawl fishery (fish)

Issues	Cons	Like	Risk
Retained species			
1. Demersal resources are overexploited and further decline is expected if no management measures are taken	3	3	9
2. Low selectivity of fishing gear (too small meshes) for demersal long-lived species	4	4	16
Non-retained species			
3. Lack of information	2	4	8
4. Incidental catch of sea turtles	4	4	16
5. Incidental catch of sharks	4	4	16
General ecosystem effects			
6. Impact of bottom trawling on bottom substrate	4	5	20
7. Changes in community structure	2	4	8

	Issues	Cons	Like	Risk
Human well-being: community				
	8. Lack of training and of specialized Angolan man power	3	4	12
	9. Lack of processing plants and job opportunities	3	4	12
	10. Low salaries	4	5	20
Governance – management				
	11. Poor MCS	3	3	9
	12. Lack of models and indicators for multispecies assessments	4	5	20
	13. Insufficient institutional and financial support to the industrial fisheries and the national boat owners	3	4	12
	14. Inadequate system for collection of fishery statistics	3	3	9
	15. Conflicts between small-scale and industrial fisheries (violation of regulations as regards fishing zones)	3	3	9
Ability to achieve – environment				
	16. The increasing oil exploitation is in conflict with the development of the industrial fisheries	4	4	16
Ability to achieve – other drivers				
	17. Reduced life expectancy of fishermen due to alcohol abuse	3	3	9
	18. New generations are not interested in fishing	3	3	9
	19. Large part of fishermen are illiterate	3	4	12
	20. Need to redevelop infrastructure (roads, bridges, etc.)	4	4	16
	21. Increasing fuel prices	4	4	16
	22. Fluctuations in export taxes and in fuel costs	4	4	16

(c) Demersal trawl fishery (deep-water shrimp)

	Issues	Cons	Like	Risk
Retained species				
Aristeus varidens, Parapeneus longirostris	1. Shrimp resources are overexploited, the situation is expected to further deteriorate if appropriate management measures are not put in place	3	3	9
	2. Overexploitation = the resource is reduced to very low levels			
Non-retained species				
Merluccius polli, Dentex angolensis, Dentex macrophthalmus, Brotula barbata, Illex coindetii	3. Record amount and type of bycatch and consider this information when giving licences.	3	4	12
	4. Species of low commercial value are discarded	3	4	12
	5. Gear selectivity (mesh size)	4	4	16
	6. Incidental bycatch of vulnerable species (sharks, sofia, etc.)	4	4	16
General ecosystem effects				
	7. Impacts of trawling on bottom substrate	4	2	8
	8. Changes in community composition	2	4	8

Issues	Cons	Like	Risk
Human well-being: community			
9. Lack of training and of specialized Angolan manpower	3	4	12
10. Lack of processing plants and job opportunities	3	4	12
11. Lack of initiatives to improve utilization of discards	3	3	9
12. Lack of exposure of Angolans to international competition	3	4	12
13. Low salaries	4	5	20
Governance – management			
14. Implementation, control and monitoring of management measures	3	3	9
15. Poor institutional and financial support to the industrial fisheries and to national boat owners	3	4	12
16. Inadequate system for collection of fishery statistics	3	3	9
17. Lack of detailed action plans	3	4	12
18. Inadequate stakeholder participation	4	4	16
Ability to achieve – environment			
19. The increasing oil exploitation is in conflict with the development of the industrial fisheries	4	4	16
Ability to achieve – other drivers			
20. Reduced life expectancy of fishermen due to alcohol abuse	3	3	9
21. New generation is not interested in fishing	3	3	9
22. Large part of fishermen are illiterate	3	4	12
23. Need to redevelop infrastructure (roads, bridges, etc.)	3	4	12
24. Increasing fuel prices	4	4	16
25. Fluctuations in export taxes and in fuel costs	4	4	16

(d) Artisanal fishery targeting demersal fish

Issues	Cons	Like	Risk
Retained species (*Dentex macrophthalmus, Arius parkii, Pseudotolithus typus, P. senegalensis, Charcharinus* sp., *Galeiodes decadactylus*, etc.)			
1. Possible overexploitation	3	4	12
2. Unreliable fishery statistics	3	4	12
Non-retained species			
3. Incidental catch of vulnerable species (sharks, sea turtles, etc.)	4	4	16
General ecosystem effects			
4. Ghost fishing	4	3	12
Human well-being: community			
5. Lack of incentives to create cooperatives	4	5	20
6. Development of processing plants and job creation	4	4	16
7. Low salaries	4	5	20
8. Lack of distribution networks	4	4	16
Governance – management			
9. Implementation, control and monitoring of management measures	4	4	16

Issues	Cons	Like	Risk
10. Poor institutional and financial support to small-scale fisheries	3	4	12
11. Inadequate system for collection of fishery statistics at the national level	3	4	12
12. Open access nature of small-scale fisheries	4	5	20
Ability to achieve – environment			
13. Pressure on coastal ecosystems (destruction of mangroves, etc.)	4	4	12
14. Pollution resulting from oil exploitation activities	4	5	20
Ability to achieve – other drivers			
15. Reduced life expectancy of fishermen due to alcohol abuse	3	3	9
16. New generation is not interested in fishing	3	3	9
17. Large part of fishermen are illiterate	3	4	12
18. Need to redevelop infrastructure (roads, bridges, etc.)	4	4	16
19. Fluctuations in export taxes and in fuel costs	4	4	16
20. Lack of a management plan for small-scale fisheries	4	4	16

3.2. Namibia hake fishery

3.2.1 Identification of issues

A total of 74 issues were identified. Most of the identified issues fell within the "ecological well-being" (50 percent) and "ability to achieve" (41 percent) categories (Figure 3.2). Only 9 percent of identified issues were from the "human well-being" category. While this may reflect the composition of the group that participated in this exercise, it may also simply reflect that there are fewer "human well-being" issues, but those may potentially be of greater importance (see below).

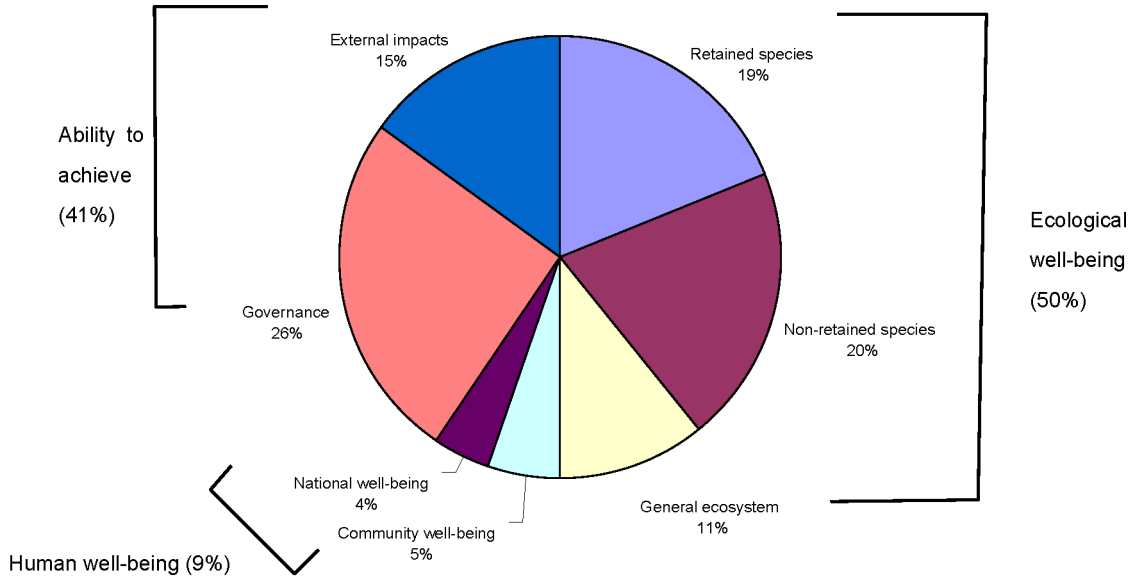


Figure 3.2 Percentages of issues that were identified within each RASF component and category in the Namibia hake fishery

3.2.2 The major issues

The full set of issues is listed in Table 3.2. These issues are briefly discussed within each of the risk categories.

Extreme risk issues

Thirteen issues received an "extreme" risk rating. This risk category was dominated by issues from the "governance" component. At the very core of this was the lack of an approved management plan that reconciled conflicting objectives in an integrative manner and was bound by management reference points. Implementation was also considered by workshop participants to be hampered by inadequate resources. This included allocation of appropriate budgets and facilities as well as the inability to attract and retain highly qualified human resources. Problems with data capture procedures as well as slow revision of legislation were also identified.

The fact that the living standards of the fishing community and fishery service providers were linked to the state of the fishery and of the stock were identified as issues that required careful management consideration. High levels of unskilled labour and lack of training and development opportunities within industry structures were also considered to need attention.

Interestingly, only two issues from the "ecological well-being" category were considered to be of "extreme" risk. The first relates to the bycatch (or incidental mortality) of threatened seabirds in both longline and trawl operations. The second was the potential impact of the bycatch of monkfish within the hake fishery on the sustainability of the monkfish fishery.

International economic factors such as fuel prices and exchange rates as well as local health issues such as the human immunodeficiency virus (HIV) and the acquired immunodeficiency syndrome (AIDS) were amongst the extreme risk "external impacts" that could inhibit the fishery attaining its objectives.

High risk issues

Fifteen issues received a "high" risk rating. Issues under this category were dominated by issues from the "ecological well-being" category. Issues included concerns that the present biomass of *Merluccius* sp. is lower than it should be and that current fishing mortality could be contributing to this. There were also concerns about the effect of the low selectivity of trawls may be having on the size structure of the stock. The lack of a bycatch plan or other informed management of several major fish bycatch species (e.g. kingkilp and sole) as well as damage to benthic fish communities (especially rattails) and crustaceans were also considered to be of "high" risk to this fishery.

An important issue from the "general ecosystem" component was the effects of biomass removal on trophic structure and ecosystem functioning.

Issues relating to "governance" that fell into the "high" risk category were mainly concerned with the restructuring and development of the industry in order to increase local benefits (Namibianization). The need for wider representation from NGOs, civil society and other stakeholders in decision making bodies (e.g. council and working groups) was given a high risk rating.

Within the "human well-being" category, the economic dependence of coastal towns on the hake fishery as well as the effect the fishery has on national employment were considered to be high risk.

Moderate risk issues

Twenty seven issues were rated as "moderate" risk (Table 3.2). This risk category was once again dominated by issues from the "ecological well-being" category.

Issues under "retained species" revolved around impacts on size structure of the stock, high variability and uncertainty in stocks, shared stocks with South Africa, and the combined management for the two *Merluccius* sp. "non-retained species" involved the bycatch of sharks and skates, as well soaking of gannets in macerated offal discharge, and shooting of bull Cape fur seals. Damage by trawling to benthic biota and habitats was raised under "general ecosystem impacts".

"Governance" issues revolved mostly around compliance issues such as vessel monitoring systems (VMS), inadequate penalties, real-time reporting, and poor observer coverage on smaller vessels. The need for a transboundary management regime was also raised here.

3.2.3 Namibia hake fishery: conclusions

Table 3.2 can be used as a detailed checklist against which a management plan or strategy for this fishery can be appraised and provides suggested performance limits, data requirements and management responses. At this stage these actions are merely the outputs of the workshop and do not enjoy any formal status, however, this does form an excellent basis for further formalization. It is strongly suggested that this report is reviewed in such a detailed manner.

Table 3.2. Issues and risk values for the Namibia hake fishery. The scores reflect: consequence, i.e. the severity should the issue not be resolved (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.).

	Issues	Cons	Like	Risk
Ecological well-being				
Retained species				
Primary species				
1	The *M. paradoxus* stock is shared with South Africa; Namibia on its own cannot ensure that it achieves its objectives	3	3	9
2	The *M. capensis* stock is shared with South Africa; Namibia on its own cannot ensure that it achieves its objectives	1	1	1
3	Abundance: present biomass is lower than it should be. Stock rebuilding is necessary.	3	6	18
4	High variability and uncertainty in abundance and estimates of the stocks	3	4	12
5	Current fishing mortality may be contributing to low abundance of *M. paradoxus*	2	5	10
6	Current fishing mortality may be contributing to low abundance of *M. capensis*	3	5	15
7	Bycatch in the horse mackerel midwater trawl fishery might be contributing disproportionately to low abundance	1	4	4
8	The longline fishery is affecting the natural size structure by catching larger fish. This is leading to a negative impact on the viability of the population	3	4	12
9	The low selectivity of the trawl fishery affects the natural size structure of the *M. paradoxus* stock leading to a negative impact on the viability of the population	3	5	15
10	The low selectivity of the trawl fishery affects the natural size structure of the *M. capensis* stock leading to a negative impact on the viability of the population	2	4	8

	Issues	Cons	Like	Risk
11	Combined management of the two species may lead to undesirable impacts on one or both species	3	4	12
12	Fishing activity reduces or changes geographical distribution of the species	1	2	2
By-product species				
13	No management or bycatch plan is in place to ensure the sustainability of the following bycatch species: angelfish, kingklip, dentex, jacopever, sole, alfonsino, squid (especially kingklip and sole).	3	5	15
14	The hake fishery may be negatively impacting the sustainable use of monkfish	4	6	24
15	The hake fishery may be negatively impacting the sustainable use of horse mackerel and orange roughy	1	5	5
Non-retained species				
Capture				
Threatened or protected species				
16	Bycatch of seabirds may be negatively impacting the viability of 13 species of albatross and petrel plus Cape gannet *Morus capensis*	4	6	24
17	Bycatch of sharks may be negatively impacting the viability of species of threatened shark, e.g. blue and mako sharks (note: a targeted fishery for mako sharks exists)	1	2	2
18	Bycatch of sharks may be negatively impacting the viability of 3 endemic (Benguela) species (puffadder shy shark *Haploblpharus edwardsii*, St Joseph's *Callorhincus capensis* and white-spotted *M. palumbes* sharks)	2	6	12
19	Bycatch of skates may be negatively impacting the viability of 3 endemic (Benguela) species (Slime *Raja pullopunctata*, Munchkin *R. caudaspinosa* and Yellowspot Skate *R. wallacai*)	2	6	12
20	Fishery catches dolphin species that are protected under Namibian legislation	1	2	2
Other species				0
21	The fishery impacts the population of seals	1	4	4
22	The fishery impacts the populations and structure of the benthic fish community (predominantly rat tails)	3	5	15
23	The fishery impacts the population of crustaceans	3	5	15
24	The fishery impacts the populations of jellyfish	1	1	1
25	The fishery impacts the population of other sharks and skates (not currently classified as threatened or specifically protected	3	4	12
Direct interaction but no capture				
26	Change in behaviour and population dynamics (foraging and distribution driven by supplementation of diet) of seals – offal management; ingestion of pollution	1	5	5
27	Change in behaviour and population dynamics (foraging and distribution driven by supplementation of diet) of seabirds – offal management; ingestion of pollution	3	6	18
28	Maceration/release of offal leads to "soaking" of Cape Gannets	2	4	8
29	Shooting of bull seals impacts population dynamics e.g. sex bias or age structure	2	5	10

	Issues	Cons	Like	Risk
General ecosystem impacts				
Broader environment				
Pollution issues				
30	Seabirds become entangled or ingest plastics and persistent materials dumped from fishing vessels	1	6	6
31	Seals become entangled or ingest plastics and persistent materials dumped from fishing vessels	0	6	0
32	Seabirds become oiled from small chronic spills and deliberate disposal of oil and fuel at sea from fishing vessels	2	6	12
Substrate quality				
33	Trawling causes physical damage to benthic habitat	2	4	8
Impacts on the biological community				
34	Removal of biomass (hake and other caught species) may alter the trophic structure and functioning of the ecosystem	3	5	15
35	Damage to sensitive benthic biota	2	4	8
36	Cetaceans and seals and other species become entangled in lost trawl and longline gear	1	6	6
37	Seabirds become entangled in lost trawl and longline gear	1	5	5
Human well-being				
Community well-being				
Industry community				
38	Income and living standards of the fishing communities are linked with profitability of fishery and health of the resource	4	6	24
39	High levels of unskilled labour and inadequate training opportunities within the industry structure result in uneven distribution of income and fringe benefits and possibility of labour unrest	4	5	20
Dependent communities				
40	Any negative impacts on the industry will be reflected in service providers and equipment suppliers	4	5	20
41	The economic well-being of fishing harbour towns (Walvis Bay and Luderitz) are linked to the profitability of fishery and health of the resource	3	5	15
National well-being				
42	Fishing activity makes a substantial contribution to the gross domestic product (GDP) and any downturn in profitability will have a negative impact	3	4	12
43	Downturn in stock will result in less fish available for local consumption and/or higher local prices	0	2	0
44	Any downturn in the hake fishery will have an effect on national unemployment rate	3	5	15
Ability to achieve				
Governance				
Management				
45	Lack of an approved management plan including reconciled objectives based on an integrated approach with reference points	4	6	24
46	Working groups need clear terms of reference	2	6	12
47	A need for improved transparency in the management of resources	2	6	12
Compliance				
48	VMS is still not in place	3	4	12

	Issues	Cons	Like	Risk
49	Penalties for transgressions are not adequate	3	4	12
50	Need for real-time reporting and overcatching of quota	4	3	12
51	Lack of observer coverage on smaller vessels (while observers do not have an enforcement function, their presence increases compliance)	2	4	8
	Information			
52	Inadequate and incomplete recording, capture and storage	4	6	24
	Resources			
53	Problems with attracting and retaining qualified and experienced staff	4	6	24
54	Inadequate research budget leading to insufficient services and facilities	4	6	24
	Inter-agency cooperation			
55	Poor cooperation/interaction between stakeholders (observer agency, industry, directorates, Department of Marine Affairs, NGOs)	3	2	6
	Legal framework			
56	Regular updating of legislation (e.g. NPOA – sharks adopted, but has not filtered down into legislation)	4	6	24
57	Establishment of transboundary management regime for shared hake stock(s)	2	4	8
	Access rights			
58	Need for capacity and development in joint venture agreements in order to achieve desired outcomes (economic empowerment)	4	4	16
59	Need for implementation of transparency in quota transferability	4	4	16
60	Problems with the current allocation system result in a failure to meet the policy standard of strengthening the Namibianization of the fishing sector	4	4	16
	Consultation			
61	The lack of wider representative participation in council and working groups, e.g. public interests, conservation groups, NGOs	4	4	16
62	Improved communication to the general public	2	3	6
	Industry			
63	The absence of an industry code of conduct may disadvantage Namibia's fisheries in the light of global pressure and trends for responsible fisheries	3	2	6
External impacts				
	The environment			
64	The stock is under the influence of climatic and oceanographic factors that management has no control over but that influence its availability to the industry and the stock dynamics. This leads to variability and uncertainty.	3	6	18
65	Human induced changes outside the hake fishery also have a direct influence on the viability and productivity of the stock, e.g. mining (substrate, turbidity, pollution), pollution, other fisheries, oil exploration	2	3	6
66	Climate change (global warming) affects factors in Issue 64 (which received a higher score) which will have widespread implications	3	4	12
67	Trophic impact induced by other fisheries (e.g. overfishing of other stocks – prey and predators)	4	5	20

	Issues	Cons	Like	Risk
	Social			
68	Human health (e.g. AIDs) will affect the work force	4	6	24
69	The profitability of the fishery is at the mercy of global eating habits (developed countries)	4	3	12
70	There are a number of social factors that affect the profitability of the fishery such as cheap labour, education, and population distribution	2	4	8
71	The national political climate affects foreign and local investment	3	3	9
72	There are a number of international factors that affect the profitability of the fishery, e.g. fuel price, exchange rates, import taxes, foreign subsidies and competition with other markets	4	6	24
	Economic			
73	Export standards can influence access to foreign markets (e.g. EU regulations, ecolabelling)	2	4	8
74	There are a number of local factors that affect the profitability of the fishery such as taxes and lack of infrastructure	1	4	4

3.3 Namibia purse seine fishery

3.3.1 Identification of issues

A total of 66 issues were identified for this fishery. Most of the identified issues fell within the "retained species" component (30 percent). The "governance" component was responsible for 23 percent of issues while "human well-being" and "external impacts" both accounted for 15 percent of issues each. The "general ecosystem" component accounted for 12 percent of the issues, but very few issues were identified in the "non-retained species" component (Figure 3.3).

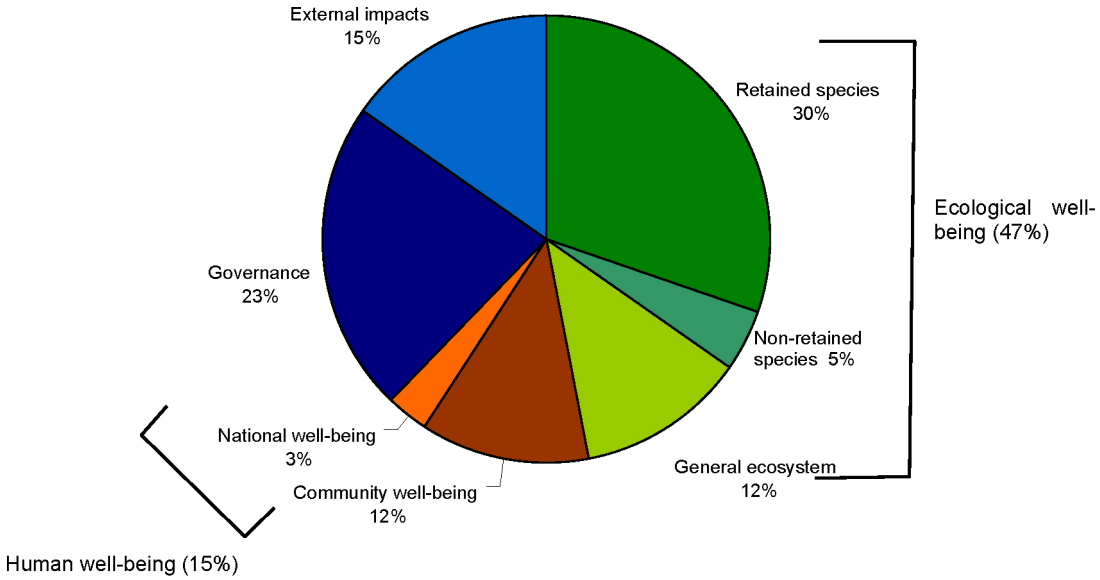


Figure 3.3. Percentages of issues that were identified within each RASF component and category in the Namibia purse seine fishery

3.3.2 The major issues

The full set of issues is listed in Table 3.3. The discussion in this section cannot cover each of the issues and so will merely highlight some of the main issues and themes under each of the main components.

Ecological well-being

The current low abundances of several target species were of concern. Pilchard abundance is considered to be critically low and the size and age structure of the stock has changed. The low anchovy stock was also considered to be a moderate risk. Transboundary sharing of stocks also posed considerable risk for the management of this fishery (pilchard and horse mackerel – shared with Angola; anchovy – potentially shared with South Africa).

The impact that fishing has had on decreasing food availability for certain predators that have not been able to adapt to changes in the ecosystem (e.g. gannets and penguins) was considered to be an extreme risk, as was the fact that overfishing may have resulted in long term changes in the trophic structure of the ecosystem. These long-term changes may also be partially responsible for environmental events such as sulphur eruptions and low oxygen events.

Human well-being

Historically this fishery was the highest employer in Namibia but is currently operating on the edge of commercial viability. Fluctuations in the TAC were considered as an extreme risk to the livelihoods of the fishing community and industry felt that a TAC of below 20 000 tonnes could close the fishery permanently and this could have consequent knock-on effects on dependent industries. Above the 20 000-tonne TAC mark, it appeared variability in resource availability (rather than the actual amount) seemed to be the most important risk as this made long term planning very difficult and inhibited investment in the sector. The poor present economic situation of this fishing sector has resulted in some very specific social and economic problems such as the inability of certain companies to afford basic employee benefits such as medical insurance.

Governance

The highest risk to this fishery is the fact that currently social and economic demands conflict with sustainability of the stocks. This was compounded by the lack of reliable economic data and a management plan with reconciled objectives.

At an international level the lack of cooperation and information sharing on stock management with Angola was seen as an extreme risk.

A number of governance issues relating to transparent and participatory decision making were also identified. These include narrow representation on the Advisory Council, lack of review and appraisal of management procedures, and poor communication with the general public and lack of involvement of organized civil society groups and NGOs in decision making.

There also appeared to be poor communication between different government ministries involved in aspects of the fishery as well as poor communication between different directorates within the Ministry.

Annual variability in the TAC also posed a medium term economic risk through loss of previously secure and reliable overseas markets.

External impacts

The effects of long term climate change as well as short term climatic anomalies posed extreme and high risks to this fishery. Political climate and fuel prices were of most concern within the set of other external issues, while the effects of HIV AIDS and currency exchange rates were also of high and moderate concern.

3.3.3 Namibia purse seine fishery: conclusions

The most striking feature of this fishery that consistently appeared throughout the workshop was the apparent low abundance and variability in the biomass of the target species. From a social and economic point of view it was felt that the variability of the TAC was the most difficult to deal with and that a stable and more conservative TAC was more desirable than a highly fluctuating TAC. This should also be seen in light of the need to rebuild the stock. The workshop therefore pointed out that a conservative and relatively stable fishing regime that allowed the fishery to remain economically viable, but that allowed years of good recruitment to escape heavy fishing mortality, would be the best strategy to meet both the social and economic needs and those of rebuilding the stock to its former potential.

The second significant feature of this fishery appears to be the keystone trophic position occupied by the target species. This has led to changes in conservation status of dependent species as well as possible long term changes in the trophic structure of the ecosystem. These factors need to be considered explicitly in the management of this fishery. Conservation targets need to be set for dependent predators and incorporated into management practices. There is also an urgent need for a research focus around understanding the key factors that could have led to the current trophic structure of the ecosystem and factors that are causing the persistence of the present state.

Finally, this fishery was previously the largest employer in the fisheries sector, and it is therefore not surprising that the current depressed state of the stock is leading to significant social and economic concerns. A strategy is needed that protects current fisheries investments and jobs and yet allows the stock to rebuild to its former levels. Clear and transparent management plans that seek to reconcile social, economic and sustainability issues will also greatly add to the better management of this fishery.

Table 3.3. Issues and risk values for the Namibia small pelagics fishery. The scores reflect: consequence i.e. the severity should the issue not be corrected for (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.).

	Issues	Cons	Like	Risk
	Retained species			
1	Pilchard stock is shared with Angola	3	6	18
2	Pilchard: distribution of shoals has become more patchy (effect of decreasing abundance)	3	5	15
3	Pilchard abundance is critically low	3	6	18
4	Pilchard: size and age structure has changed (Fish are much smaller and no more fish older than 3 years)	3	6	18
5	Pilchard: variability in recruitment is not well understood	3	6	18
6	Pilchard: discarding of fish with jellyfish (in the bottom of net)	1	3	3
7	Pilchard: unusually high and unknown natural mortality	3	6	18
8	Anchovy abundance is low	2	6	12
9	Anchovy stock is potentially shared with South Africa	2	4	8
10	Anchovy stock is shared with Angola	1	1	1
11	Anchovy: variability in recruitment is not well understood	3	6	18
12	Horse mackerel stock is shared with Angola	3	6	18
13	Horse mackerel: fishing of juveniles has unknown effect on recruitment	3	4	12
14	Horse mackerel: variability in recruitment is not well understood	3	6	18
15	Round herring: little known about this species (life history, ecology, distribution, etc.)	2	6	12
16	Gobies: little known about this species (life history, ecology, etc.)	3	6	18
17	Chub mackerel: Little known about this species (life history, ecology, distribution, etc.)	1	6	6
18	Snoek: little known about impact on the population	1	6	6
19	Snoek: stock identity unknown (not known if shared with SA and Angola)	1	4	4
20	Kob, steenbras and other linefish are being caught	3	2	6
	Non-retained			
21	Gannets are occasionally caught in nets	0	2	0
22	Seals are killed in nets	0	6	0
23	Jellyfish are caught	0	6	0
	General ecosystem impacts			
24	Removal of grazers leads to accumulation of plankton biomass possibly leading to sulphur eruptions and low oxygen events	4	4	16
25	Removal of small pelagics may have led to the increase in goby, jellyfish, etc., abundance and distribution (and other possible trophic impacts)	4	4	16
26	Decreased food availability for predators (gannets, penguins – species unable to make switch to gobies)	4	6	24
27	Decreased food availability for predators able to make switch to alternate prey (seals, sharks, hake, snoek, etc.)	2	6	12
28	Overfishing may have led to long term change in the trophic structure (possibly an alternate stable state)	5	4	20
29	Seals benefit from fishing activities	1	6	6
30	Seabirds (mainly gannets and gulls) benefit from fishing activities	1	6	6
31	Impacts of factory effluents	1	5	5

	Issues	Cons	Like	Risk
	Human well-being			
32	Recent decrease in numbers of jobs available – including recent closures of canneries (but fishery still has high potential for future)	3	4	12
33	Threat of TAC <20 000 tonnes could close the fishery permanently	4	5	20
34	Variability in resource availability makes planning difficult, low security, low investor confidence	3	6	18
35	Changes in TAC affect income and loss of livelihood for workers' dependents	4	6	24
36	Medical insurance and other employer benefits are no longer available/affordable for the majority of sea-going personnel	2	6	12
37	Collapse of fishery could result in large scale knock-on effects on dependent service providers and retailers (engineering companies, transport, shipping repairs, provisions, fuel, etc.) in Walvis Bay and Swakopmund	2	5	10
38	Knock on effects on the rural areas from which migrant labour is drawn	2	5	10
39	Fish meal smell affects tourism potential	1	4	4
40	Historically this fishery was a large contributor to National GDP (large potential for future)	3	6	18
41	Historically this fishery was the largest employer (large potential for future especially for Namibians)	4	6	24
	Governance			
42	Lack of an approved management plan that includes reconciled objectives	4	5	20
43	Social and economic demands conflict with sustainability	4	6	24
44	Lack of cooperation and information sharing with Angola on the management of shared stocks and inconsistent national application of rules for fishing on same stock	4	6	24
45	Lack of economic information for decision making	3	6	18
46	Research budget has got smaller with catches (drawn from levies) – leads to less research vessel availability	3	6	18
47	Lack of sufficient cooperation within the Ministry (between different Directorates)	2	6	12
48	Insufficient cooperation between scientists of South Africa, Namibia and Angola	1	6	6
49	Lack of communication between Ministries (Transport, Fisheries, Labour, Finance)	3	5	15
50	Lack of specific labour regulations for seagoing staff	2	6	12
51	Narrow representation on the Advisory Council and working groups (no labour, civil society, fisheries specific, etc.)	3	6	18
52	Poor communication with the general public (including transparency in decision making)	2	6	12
53	Lack of external review and appraisal of management procedures	3	6	18
54	Lack of newly trained skilled labour	2	5	10
55	Loss of markets due to variability in TAC	3	6	18
56	Civil society and NGOs are poorly organized and represented in fisheries matters, mainly due to a lack of information and communication by management	2	6	12
	External impacts			
57	Long-term climate change – effect unknown but major	5	4	20
58	Short term climatic anomalies (Benguela niños) affect all population parameters	4	6	24

	Issues	Cons	Like	Risk
59	Localized anomalies (sulphide eruptions, low oxygen events, etc.)	2	6	12
60	Shipping pollution	1	4	4
61	Mineral and gas exploration and mining (Kudu oil fields and southern Angola)	2	3	6
62	Development of harbour at Cape Frio (increased shipping traffic could disturb spawning)	3	2	6
63	HIV AIDS impacts the workforce	3	6	18
64	Political environment	4	6	24
65	Exchange rate	2	6	12
66	Fuel prices	4	6	24

3.4 Namibia midwater trawl fishery

3.4.1 Identification of issues

A total of 54 issues were identified for this fishery. The "governance" component accounted for highest proportion of issues (31 percent), whilst the "external impacts" and "retained species" components were responsible for 20 percent and 19 percent of issues respectively. "non-retained species" and "general ecosystem" components both accounted for 11 percent of issues. Interestingly, only 8 percent of issues related to "human well-being" (Figure 3.4).

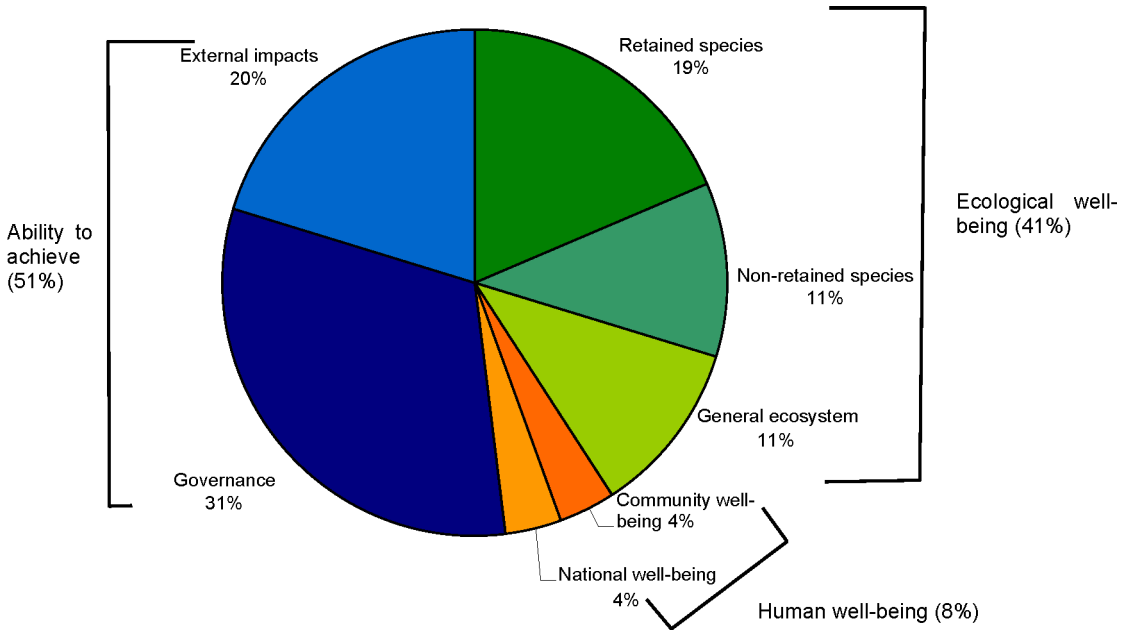


Figure 3.4. Percentages of issues that were identified within each RASF component and category in the Namibia midwater trawl fishery

3.4.2 The major issues

The full list of issues is provided in Table 3.4. The discussion in this section cannot cover each of the issues and so will merely highlight some of the main issues and themes under each of the main components.

Ecological well-being

Concern was raised about the variability in the estimates of the biomass of horse mackerel and that there was a lack of confidence in certain parameters in the population model. Added to this is the concern that the size structure has changed towards smaller fish, a phenomenon characteristic of heavily fished populations. For several non-target species, little is known about their biology, status and the potential impact of this fishery on populations. Catches of juvenile hake in this fishery are not accounted for in the hake population models and could also be contributing to low abundances of hake.

Bycatches of threatened species of shark and seabirds were also considered to be of moderate risk. There was also concern that little is known about the trophic role of horse mackerel and the impacts of fishing on the ecosystem structure. Despite this, horse mackerel has become a major forage fish for several top predators. Concern was also raised about the potential impacts of fishing within the 200 m contour. It was felt that this could impact on the horse mackerel stock as well as having wider ecosystem impacts (e.g. through bycatch of pilchard).

In terms of pollution, it was felt that the fact that these vessels rebunkered at sea posed a pollution risk. This fishery is also the largest fleet in Namibian waters and as such posed a general marine litter problem.

Human well-being

Not many Namibians are employed in this fishery and those that are, are mostly unskilled. However, this fishery contributes significantly to food security in Namibia and in West Africa. Poor management of this fishery could thus have significant effects on food security.

Governance

The lack of an approved management plan with reconciled objectives poses a significant problem to the management of this fishery. This is compounded by the fact that fines imposed by inspectors are not an adequate deterrent. Certain rights holders were also guilty of overcatching their quota.

Several issues relating to transparent and participatory governance were also raised. These included: no representation of this industry on the Minister's Advisory Council (despite the economic importance of the fishery); there is a lack of external review of management practices; a lack of transparency and record of decisions; and a lack of organized NGO participation.

Industry was also concerned about the impact of the 200 m depth exclusion zone was having on the economics of this fishery. It was felt the stock straddles this contour, and industry felt that they would like to be given the opportunity to scientifically test the positive and negative effects of fishing within this zone. Industry also felt that there were many misconceptions about the impacts and benefits of this fishery to Namibia.

Lack of information sharing and cooperation with Angola on management of horse mackerel was also seen as a problem.

External impacts

High fuel prices and the impacts of exchange rate fluctuations were deemed an extreme risk to this fishery, whilst both short term variability as well as long term environmental changes were considered to be a high risk.

There was concern about the impact of competition with the purse seine fishery that was targeting the species. Limited markets within Africa and the fact that there was a preference for horse mackerel from other countries was also of concern.

3.4.3 Namibia midwater trawl fishery: conclusions

Overall it appeared that the horse mackerel stock was in reasonably good condition allowing the Namibia midwater trawl fishery to continue to make a significant contribution to the national economy of Namibia and food security in parts of Africa. However, from an ecosystem perspective little was known about the trophic position of horse mackerel in the ecosystem and the dependence of certain predators on it. Furthermore, the impact of this fishery on several bycatch species has not been quantified; not least on several species of sharks and seabirds that have a threatened conservation status. Research is needed to elucidate these ecosystem impacts and relationships. This will more than likely require alternative funding sources and/or other collaboration.

Although this fishery is a consistently high contributor to the national economy, its transformation to Namibian crew (particularly in skilled positions) is still behind schedule and more needs to be done to ensure that this fishery maximizes its social contribution in terms of employment to Namibians.

In terms of governance, the most pressing need is to develop a widely acceptable management plan and management practices that are regularly assessed and peer reviewed. Several issues pertaining to good participatory and transparent governance also need to be resolved.

A very specific management issue that needs to be resolved is the justification for the 200 m depth contour regulation. The workshop encouraged scientists and the industry to work together to gain more information that will inform this regulation and its justification.

Table 3.4. Issues and risk values for the Namibian midwater trawl fishery. The scores reflect: consequence i.e. the severity should the issue not be corrected for (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.).

	Issues	Cons	Like	Risk
	Ecological well-being			
	Retained species			
1	Cape horse mackerel: stocks of both species (Cape and Kunene) that are shared with southern Angola could lead to overexploitation	2	3	6
2	Cape horse mackerel: stock is potentially shared with South Africa – could lead to overexploitation	1	2	2
3	Cape horse mackerel: bulk of catches are taken from a small area (where the species is concentrated) in comparison with the wider distribution of the species as a whole	3	4	12

	Issues	Cons	Like	Risk
4	Cape horse mackerel: estimates of current biomass are highly variable (confidence in certain parameters for model is limited and uncertainty around survey results)	3	6	18
5	Cape horse mackerel: size has decreased significantly and fish are maturing earlier	3	6	18
6	Kunene horse mackerel: composition not adequately reflected in sampling (lack of knowledge on species identification, difficult to identify when smaller)	0	6	0
7	Juvenile hake: may be contributing to low abundances (this is not accounted for in hake models)	2	4	8
8	Species and size composition of catch of small fish (going to fish meal) may not be accurately recorded and not accounted for	1	5	5
9	Pilchard: can potentially contribute to mortality	3	2	6
10	Dentex, angelfish, snoek, jacopever, squid, dories, mackerel, ribbonfish: very little is known about the biology and potential impacts	3	6	18
	Non-retained species			
11	Small cetaceans are caught	1	5	5
12	Sharks are caught	2	5	10
13	Seabirds are caught	2	5	10
14	Seals are caught	1	6	6
15	Jellyfish are caught	0	6	0
16	Sunfish are caught	1	6	6
	General ecosystem			
17	Little known about the trophic role of horse mackerel (e.g. trophic relationship with hake and pelagics) and how fishing impacts this relationship (e.g. changes in size, distribution and biomass)	3	5	15
18	Horse mackerel has become a major forage fish for top predators (seals, seabirds (gannets, penguins), large pelagic and demersal fish) and little is known about how fishing impacts this relationship (e.g. changes in size, distribution and biomass)	3	5	15
19	Bycatch mortality may have ecosystem impacts in itself	3	5	15
20	Impact of relaxing the 200 m depth exclusion on the ecosystem and horse mackerel stock	3	5	15
21	Compliance with waste and litter regulations (largest fishing vessels in our fleets)	2	5	10
22	Fuel bunkering inside the EEZ	3	3	9
	Human well-being			
23	Not a large number of Namibians employed in this industry and these are mainly unskilled	2	5	10
24	Large number of dependent service providers (cold storage, shipping agents, transport, stevedoring, health, launch, port costs, etc.)	3	2	6
25	Contribution to government in levies and other fishing fees is N$60M, also large contributor to Social Responsibility projects	3	2	6
26	Contributes to food security in Namibia and Africa	4	2	8
27	Horse mackerel fishery contributes significantly to the National GDP	3	2	6

	Issues	Cons	Like	Risk
	Governance			
28	Lack of an approved management plan (for midwater trawl fishery but also for horse mackerel as a whole) with reconciled objectives	3	6	18
29	Information sharing with Angola needs to be improved for Kunene horse mackerel	0	6	0
30	Information sharing with Angola needs to be improved for Cape horse mackerel	2	5	10
31	Impact of not relaxing 200 m contour on the industry	3	4	12
32	Non-compliance with the depth (200 m) contour (VMS needs to be in place to assist in compliance)	3	2	6
33	Overcatching by certain right holders	3	4	12
34	Fines imposed by inspectors are not an effective deterrent	3	6	18
35	Research resources perceived not to be adequate by the industry	3	4	12
36	Budget not adequate for broader ecological research	3	6	18
37	Issues general to government departments: availability and retention of skilled personnel; poor training and career development plans; research budgets are limiting (equipment, ship time, etc.).	2	6	12
38	No direct representation from this industry on the Advisory Council	3	6	18
39	Misconceptions on the impact of this fishery and its benefits to Namibia	2	6	12
40	Lack of transparency in decision making and no clear record of decisions	2	6	12
41	Lack of regular external review and appraisal of management and research	3	6	18
42	Lack of specific labour regulations for seagoing staff	1	6	6
43	Lack of skilled Namibian labour	3	6	18
44	Need for responsible NGOs and civil society to be well organized and better represented in fisheries matters	2	6	12
	External impacts			
45	Effect of environmental variability on recruitment and other population parameters (recruitment very poorly understood)	3	5	15
46	Potential long-term impacts of climate change	3	4	12
47	Levels of competition and interaction between midwater and purse seine fishery targeting horse mackerel	2	6	12
48	Shipping pollution	1	5	5
49	Oil and gas exploration and mining	1	5	5
50	Harbour development at Cape Frio (shipping disturbance of spawning grounds and reduction in local abundance)	3	2	6
51	HIV AIDS impact on workforce	2	6	12
52	Political environment	2	3	6
53	Fluctuations in the exchange rate	4	5	20
54	Fuel price	5	6	30
55	Limited markets (to Africa mainly) and market preference for horse mackerel from other countries	2	6	12

3.5 South Africa demersal hake fishery

3.5.1 Identification of issues

A total of 96 issues was identified for this fishery (Table 3.5). The "ecological well-being" and "ability to achieve" components each accounted for 44 percent of the issues, leaving only 12 percent of the issues under the "human well-being" component. "governance" issues accounted for 34 percent of all issues (Figure 3.5).

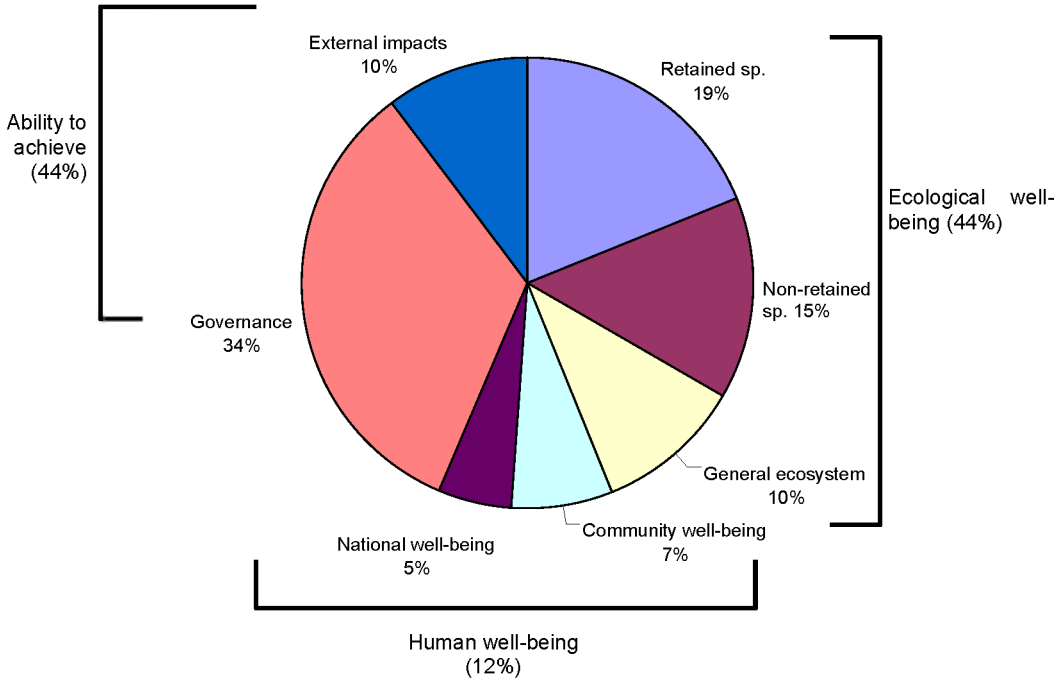


Figure 3.5. Percentages of issues that were identified within each RASF component and category in the South African demersal hake trawl fishery

3.5.2 The major issues

The full list of issues is shown in Table 3.5. The discussion in this section cannot cover each of the issues and so will merely highlight some of the main issues and themes under each of the main components.

Ecological well-being

The impact of fishing on the size structure of *M. capensis*, especially the removal of larger size classes, was rated as the issue of highest risk to the ecological well-being of this fishery. Various issues relating to management under uncertainty were raised as high priority issues. These related to uncertainty about natural mortality, variability in recruitment, migration patterns and the proportions of each hake species in the total catch. There is also uncertainty and disagreement on the status of the *M. capensis* stock, due to the model predictions not matching research survey findings. There was also concern that the level of discarding (presumably due to "high grading") is being underestimated. This fishery also impacts stocks

of several commercial species, such as kingklip, monk, snoek and others, by means of bycatch.

The death and injury of threatened seabirds colliding and interacting with trawl gear as well as the bycatch of protected linefish species (such as silver and dusky kob), and shark species such as *Galeorhinus* and *Mustelus* in the inshore trawl fishery were of concern.

The impact of trawls on the benthic habitat and biota was the subject of much debate. This impact was considered to be a "high" risk to this fishery, although some participants felt that this issue was of greater concern and fell in the "extreme" risk category. Other "general ecosystem" issues were related to impacts of the removal of a top predator from the ecosystem without an obvious replacement, as well as a change in behaviour of seabirds due to availability of offal.

Human well-being

The lack of baseline social and economic data was seen as the basis of many human well-being problems and was rated as being of "extreme" risk to the fishery. The overdependence of certain coastal communities on the demersal fishery and the vulnerability of dependent business enterprises to the fate of the hake stock are also seen as a risk to the objectives of this fishery. Disagreement on the social and economic trade-offs between the longline and trawl fisheries was also of concern.

It was recognized that, at a regional scale (Western and Eastern Cape), the demersal hake trawl sector is a key employer and a significant contributor to the regional economy. As such, a downturn in the fishery could have negative social and economic impacts at the regional scale.

Governance

Inadequate research and management capacity as well as loss of institutional knowledge was of great concern to the management of this fishery.

The lack of a Resource Management Working Group (RMWG) and poor communication with industry bodies and stakeholders was raised as being of particular concern. The lack of NGO involvement in the RMWGs and Scientific Working Groups (SWGs) was also raised.

Several data collection and processing issues were identified. Amongst the most important were the fact that catch data are not available for real time response and the fact that fisheries observer data had not been properly analyzed and reconciled with catch per unit effort (CPUE) data. Furthermore, technological and effort creep were not incorporated in CPUE analyses.

Conflict between the fishing sectors was recognized as an issue; along with the fact that the lack of Marine Stewardship Council (MSC) certification of the longline and handline fisheries is hampering the effectiveness of the certification of the trawl fishery. Inadequate communications and coordination between government departments was also noted.

External impacts

The most important external impact was deemed to be the effects of global climatic change. As with other fisheries, global economic parameters such as fuel price and foreign exchange rates are important. A significant and very specific issue highlighted for this fishery was the fact that size-related price differentials act as an incentive for fishers to try and target a specific size class, which in turn leads to high-grading and discarding. Drug abuse in the small boat sector was also highlighted.

3.5.3 South Africa demersal hake fishery: conclusions

These workshop outputs provide an excellent platform from which to implement an ecosystem approach in the demersal hake trawl fishery. The workshop participants were successful in identifying a comprehensive list of issues and, through very active debate, prioritizing these issues in terms of their risk to the fishery.

Ideally, a RMWG would be best placed to start implementing the outcomes of this workshop. Unfortunately, the lack of an effectively functioning RMWG was also identified as one of the major shortfalls of this fishery. It was therefore suggested by the workshop participants that a small working group be constituted under the BCLME-EAF project that can meet at regular intervals to discuss and facilitate the implementation of some of the management recommendations that were made in this document. It is envisaged that this working group could also form the nucleus of the RMWG, when these become established.

Table 3.5. Issues and risk values for the South Africa demersal hake fishery.
The scores reflect: consequence, i.e. the severity should the issue not be corrected for (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.). MLRA = Marine Living Resources Act, CAF = Consultative Advisory Forum

	Issues	Cons	Like	Risk
Ecological well-being				
	Retained species			
1	Both hake species: changes in distribution	2	4	8
2	Both hake species: fishing mortality is underestimated due to discarding and survival after escapement	3	6	18
3	Both hake species: uncertainty about the estimation of natural mortality (predation and cannibalism)	3	6	18
4	Both hake species: uncertainty about longshore, offshore and vertical migration in the water column.	2	4	8
5	Both hake species: uncertainty about variability in recruitment	3	6	18
6	Both hake species: basic knowledge of the life-history strategy is not well understood	3	5	15
7	Both hake species: uncertainty about the proportions of each hake species in total catch	3	6	18
8	*M. paradoxus*: stocks are shared between Namibia and South Africa	3	6	18
9	*M. paradoxus*: stock status is below the biomass at which a stock will, on average, produce the maximum sustainable yield (BMSY)	3	6	18
10	*M. capensis*: stocks are shared with Namibia	3	3	9
11	*M. capensis*: uncertainty and disagreement as to the status of the stock – model projections do not match commercial and research survey findings	3	4	12

	Issues	Cons	Like	Risk
12	*M. capensis*: size structure may have been affected by fishing – the additional effect of removing more large hake	4	6	24
13	*M. capensis*: size structure may have been affected by fishing – Continued impact of fishing on small hake	3	6	18
14	*M. capensis*: increase in parasites which could affect fecundity and marketing	3	2	6
15	Monk, kingklip stocks are overexploited	4	4	16
16	Snoek stock is being impacted	2	4	8
17	Lack of understanding and quantification of the impact on linefish (kob, white stumpnose, etc.)	1	6	6
18	Impact on other commercial species (skates, rays, gurnards, sharks, jacopever, john dory, angel fish, bellman, chokka, etc.)	2	6	12
	Non-retained species			
19	Seals (protected species) are killed in trawling operations	1	6	6
20	Threatened species of seabirds (also protected) caught/injured/killed in longline operations	2	6	12
21	Threatened species of seabirds (also protected) caught/injured/killed by trawling	3	6	18
22	There is directed catch of seabirds in the handline fishery for the pot	1	5	5
23	Mortality of *Galeorhinus* and *Mustelus* in the longline fishery (these species are commercially harvested)	1	6	6
24	Mortality of *Galeorhinus* and *Mustelus* in the inshore trawl fishery (these species are commercially harvested)	2	6	12
25	Mortality of all other threatened sharks in longline and trawl	2	6	12
26	Bycatch of wreckfish	3	3	9
27	Bycatch of "protected" linefish (in MLRA) on soft ground available to the inshore trawling – silver kob, dusky kob, etc.	3	6	18
28	Bycatch of "protected" linefish (in MLRA) on hard ground	2	1	2
29	Bycatch of other benthic species that have been recorded in the trawl catch	1	6	6
30	Bycatch of other sharks, rays and skates (not threatened but not assessed)	2	6	12
31	Shooting of seals interacting with gear	0	6	0
32	Potential soaking of gannets from fish meal factory vessels	1	2	2
	General ecosystem			
33	Trophic effects of removing a proportion of a high level predator, with no obvious replacement species	4	3	12
34	Removal of predators may have an effect on the abundance of smaller pelagic species and mesopelagics	4	3	12
35	Change in size structure of hake leads to a switch in prey preference	3	3	9
36	Ghost fishing by net fragments	1	2	2
37	Hake are a component of the diet of marine mammals and other top predators (seals, swordfish [possible], snoek)	1	6	6
38	Impact of trawls on the benthic habitat and biota	3	6	18
39	Distribution patterns and behaviour of seabirds are being affected by the availability of offal	2	6	12
40	Seals benefit from offal discards	1	6	6
41	General pollution associated with fishing vessels and harbour activity is considered across all fisheries			0
42	Disturbance of sediments may change water chemistry (oxygen)	0	5	0
Human well-being				
	Community well-being			
43	Social and economic/welfare effect of trade-offs between longline and trawl fisheries	3	3	9

	Issues	Cons	Like	Risk
44	There is a lack of baseline social and economic information	5	6	30
45	Overdependence on demersal fishery in certain coastal communities	3	5	15
46	Safety at sea is a problem	1	6	6
47	There is a lack of business skills and entrepreneurship in optimal use and processing	1	6	6
48	A downturn in the fishery will have a negative impact on businesses that provide gear supply, boat repairs in highly dependent communities in Saldanha Bay, St Francis, St Helena, Mossel Bay, Hout Bay and Kalk Bay	3	5	15
49	A downturn in the fishery will have a negative impact on businesses that provide gear supply, boat repairs in Cape Town and Port Elizabeth	2	5	10
	National well-being			
50	The impact of a downturn in this fishery on the national economy	1	4	4
51	The impact of a downturn in this fishery on the regional economy (Western and Eastern Cape)	3	4	12
52	The impact of a downturn in this fishery on public wellness in terms of food supply	1	4	4
53	A downturn in the fishery will have a significant effect on employment in the Western and Eastern Cape	3	4	12
54	A large quantity of white stock fish is being imported into South Africa	1	6	6
Ability to achieve				
	Governance			
55	Larger number of rights-holders result in increased management complexity	2	5	10
56	Lack of effectiveness of present input and output controls	3	6	18
57	Conflict between sector users	2	6	12
58	Compliance is inadequately enforced – occasional examples are made but the coverage is low	3	3	9
59	Inspector coverage is inadequate and possibly biased geographically and per sector	2	6	12
60	There is no Resource Management Working Group	3	6	18
61	There are no formal or informal lines of communication with industry bodies and other stakeholders	3	6	18
62	Catch data are not available for real time response	3	6	18
63	Observer data have not been properly analysed or reconciled with catch records	3	6	18
64	Problems with the validity of scientific observer data in portraying the real picture	2	6	12
65	Technological and effort creep are not incorporated in the analysis of CPUE data and assessments	3	5	15
66	Inadequate age information	3	6	18
67	Inadequate research capacity and institutional knowledge	4	6	24
68	Lack of management capacity (no-one appointed to manage demersal fishery at present) and institutional knowledge	4	6	24
69	Inadequate coordination of research (nationally, regionally and internationally)	3	6	18
70	Inadequate communication with other government departments – specifically with Mineral and Energy Affairs or Petroleum Agency	2	6	12
71	Inadequate coordination with National Ports Authority with regard to facilities and services for fishing vessels	2	5	10
72	Allocation of possibly sub-viable quotas has complicated management	2	4	8

	Issues	Cons	Like	Risk
73	Cost involved in attaining transformation – both within the industry and for the Marine and Coastal Management (MCM) itself.	1	6	6
74	Insufficient flexibility in the current OMP to deal with exceptional circumstances	1	5	5
75	The MLRA needs to be revised; Consultative Advisory Forum (CAF) consultation	1	4	4
76	There is no current clear sector management policy.	3	1	3
77	There is no formal peer-review of management plans	1	6	6
78	Currently biodiversity audits for marine species are not being done	2	6	12
79	No institutional reviews of research and management	1	6	6
80	Lack of accessibility to records of decisions (minutes, etc.)	2	6	12
81	Lack of state of the environment reports	2	6	12
82	Criteria for representation on SWGs should be reviewed. Difficulties in weighting representation	1	6	6
83	Industry is not particularly interested in some broader management issues, focusing on direct issues	1	6	6
84	The fact that the longline and handline industry are not MSC certified hampers the certification of the trawl fishery	2	6	12
85	The requirements of the MSC are possibly beyond the abilities of management's resources (for those conditions that require MCM to play a role)	2	6	12
86	NGOs not involved in management and scientific working groups	3	6	18
	External impacts			
87	Anomalous climatic events affect availability and distribution	4	4	16
88	Effects of global warming and climate change	4	6	24
89	Spatial interaction between mining and fishing results in excluded areas for trawling	1	6	6
90	The debris from mining cutting fluids (oil and gas) and dredging (diamond) has an impact on re-suspension of sediments which affects habitat	1	4	4
91	Responsibility for rehabilitation of mined areas has been confused by changes in ownership of companies	2	6	12
92	General pollution from shipping	1	6	6
93	Impact of AIDS on the workforce	2	6	12
94	Impact of drug abuse on the workforce – particularly in the small boat sector	3	6	18
95	Global economic parameters such foreign exchange rates and fuel affect profitability	3	6	18
96	Size-related price differentials are an incentive for high grading	3	6	18

3.6. South Africa small pelagics fishery

3.6.1 Identification of issues

A total of 91 issues were identified for this fishery by the workshop participants (Table 3.6). Most issues (48 percent) fell within the ecological well-being component (see Figure 3.6). This is understandable given the unpredictable and fluctuating nature of the stocks as well as the pivotal position of the target species in our offshore ecosystems. Governance issues were also well represented (21 percent). Surprisingly human well-being issues were less well represented, given that this fishery is the highest employer (Figure 3.6).

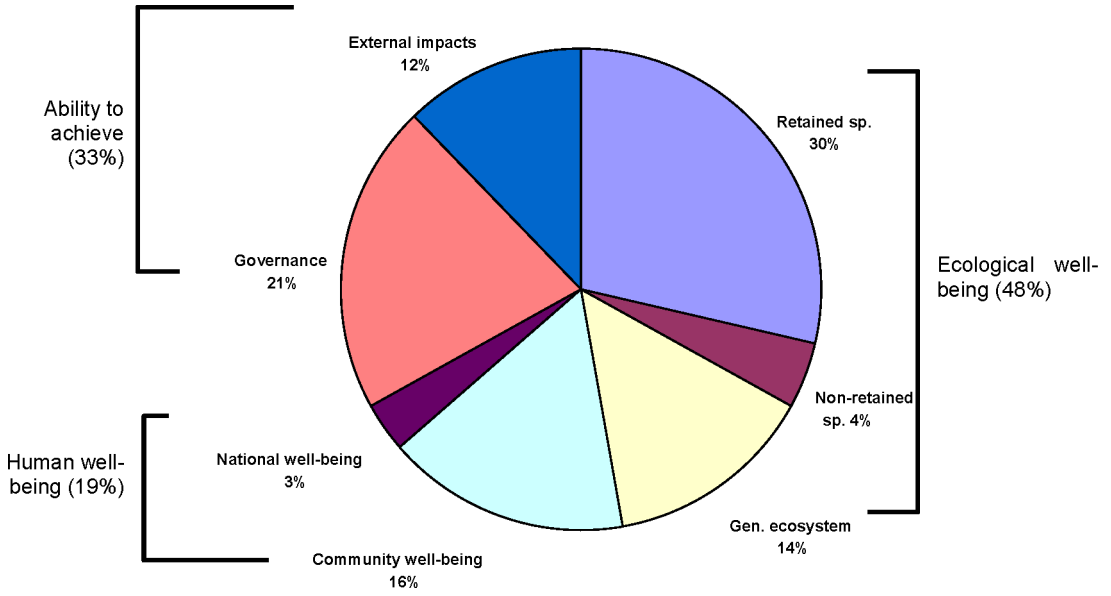


Figure 3.6 Percentages of issues that were identified within each RASF component and category in the South African small pelagics fishery

3.6.2 The major issues

The full list of issues is shown in Table 3.6. The discussion in this section cannot cover each of the issues and so will merely highlight some of the main issues and themes under each of the main components.

Ecological well-being

Only one issue under this component scored an "extreme" risk rating. This was the "impacts of removal of forage fish on land-based top predators (e.g. seabirds)", emphasizing the importance of these target species as food for top predators whose foraging options are restricted, while breeding on offshore islands. The impact of the removal of forage fish on other more mobile predators (e.g. cetaceans and predatory fish) was also of concern, but somewhat less than for the land-based predators.

Issues of "high" risk revolved mostly around perceived changes in distribution, size structure and growth rates of sardine, indicating the dynamic nature of this stock and the potential impacts of a long history of fishing it. Linked to this was the issue of poor understanding of decadal-scale fluctuations in abundance for all primary species. Discarding of small sized sardines in the anchovy fishery was also considered to be of high risk to the sustainability of the fishery.

Poor knowledge of the catch histories and the status of the horse mackerel stock were also deemed to be of high risk to the fishery. Other issues that were deemed to be of moderate concern included the directed catch of certain linefish species.

Human well-being

Most human well-being issues for this fishery revolved around the lack of understanding and unpredictable nature of decadal-scale fluctuations of stock abundances in this fishery. This

resulted in fluctuations in the profitability of the fishery and concomitant standard of living for fishers and highly dependent communities (such as St. Helena Bay, Gansbaai, Laaiplek and Lambert's Bay). Issues related to this central theme were all scored in the "extreme" risk category.

Concern was also raised about the fact that there was surplus capacity in the fishery and that the increase in numbers of rights holders has resulted in potentially sub-viable quotas.

It was also noted that this fishery was the highest employer and as such supported many decentralized rural communities. A downturn in the fishery could have an effect at the regional level in these rural areas.

Governance

The main governance issues revolved around the lack of a functional RMWG and that there was no statutory requirement for participatory decision making. This was compounded by poor communication with stakeholders and poor representation of stakeholders on RMWGs and the SWG.

The lack of resources (including staffing) for resource management and research was considered to be of "high" risk to the fishery. The potential use of input (effort) controls was considered to be of "moderate" risk.

External impacts

Once again the uncertainty about future trends in the stock abundances due to environmental influences was raised as an "extreme" risk. Other external impacts include exchange rates, fuel prices and climate change. Social impacts include AIDS and drug and alcohol abuse. Economic influences include market fluctuations and competition with soya.

3.6.3 South Africa small pelagics fishery: conclusions

These workshop outputs provide an excellent platform from which to implement an ecosystem approach in the small pelagics fishery. The workshop participants were successful in identifying a comprehensive list of issues and, through active debate, prioritizing these issues in terms of their risk to the fishery.

Ideally, a RMWG would be best placed to start implementing the outcomes of this workshop. Unfortunately, the lack of an effectively functioning RMWG was also identified as one of the major shortfalls of this fishery. It was therefore suggested by the workshop participants that a small working group be constituted under the BCLME EAF project that can meet at regular intervals to discuss and facilitate the implementation of some of the management recommendations that were made in this document. Such a working group would be constituted primarily (but not exclusively) from the participants of this workshop. It is envisaged that this working group could also form the nucleus of the RMWG, when these become established.

Table 3.6. Issues and risk values for the South African small pelagics fishery.
The scores reflect: consequence i.e. the severity should the issue not be corrected for (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.).

	Issues	Cons	Like	Risk
Ecological well-being				
	Retained species			
1	All primary species: lack of understanding about decadal-scale fluctuations in abundance for all species	2	6	12
2	All primary species: the fishery has caused genetic changes in the distribution of the fish	3	4	12
3	All primary species: concentration of fishing effort may have changed the distribution of fish (disturbance)	2	3	6
4	Sardine: changes in distribution of sardine – eastward shift and absence on the west coast	3	6	18
5	Sardine: size structure of commercial catches is skewed towards smaller fish – this appears to be caused by lack of availability to the industry and high TACs which encourage heavy fishing on smaller fish	3	6	18
6	Sardine: growth rate, gonad size and condition factor have all declined in recent years – suggest changes in productivity	3	6	18
7	Sardine: discard of small sardine in the sardine-directed fishery (if not canning size) – not quantified	2	6	12
8	Sardine: discard of small sardine in the anchovy-directed fishery - not quantified	3	6	18
9	Sardine being used for fish meal rather than leaving fish to grow to larger more valuable fish is resulting in suboptimal economic use	1	6	6
10	Sardine: potential for disease mortality	4	3	12
11	Sardine: possibility of separate spawning stocks	2	4	8
12	Sardine: life-history strategy is not well understood	2	6	12
13	Anchovy: discarded by sardine-directed operations	1	5	5
14	Anchovy: some signs of distributional shifts in spawning patterns from the western Agulhas Bank to the central and eastern bank	3	4	12
15	Anchovy: signs of reduced productivity – as evidenced by reduced fat content	3	4	12
16	Redeye: industry may expand to catching redeye as the resource has been identified as an underutilized one	2	4	8
17	Redeye: potential fishery may result in increased adult/large sardine bycatch	2	4	8
18	Redeye: lack of confidence in abundance estimates as current survey design does not incorporate full range of distribution	1	6	6
19	Redeye: life-history strategy is not well understood	2	6	12
20	Lantern fish and light fish: Insufficient estimates of abundance and distribution	1	5	5
21	Horse mackerel: impact of high mortality (catching and dumping) of juveniles on midwater and bottom trawl fisheries	1	6	6
22	Horse mackerel: insufficient knowledge, poor record of catches and poor stock assessment due to life history	3	6	18
23	Chub mackerel: stock abundance fluctuates – currently low, possibly correlated with sardine abundance	1	5	5
24	Linefish: illegal and directed catches (yellowtail, white steenbras, kob)	4	3	12
25	Incidental bycatch of snoek, gurnard, geelbek and other linefish – particularly with deeper nets in shallower-water	0	5	0

	Issues	Cons	Like	Risk
26	Bycatch of chokka squid	1	1	1
	Non-retained species			
27	Incidental bycatch of cetaceans	0	2	0
28	Bycatch of jellyfish	1	6	6
29	Bycatch of gobies	1	5	5
30	Incidental mortality of seals (protected species)	1	6	6
	General ecosystem			
31	Impact on the ecosystem of removing increased amounts of redeye if this fishery is expanded	2	5	10
32	Impacts on top predators through removal of fish by existing fishery (Bryde's whale, penguins, gannets, swift terns, line fish incl. hake, cormorants)	2	6	12
33	Impacts of removal of forage fish on species which are bound by land-based breeding colonies (e.g. seabirds)	4	6	24
34	Impacts on zooplankton and phytoplankton abundance (wasp-waist effect)	2	4	8
35	Seals benefit from fishing activity – artificial food concentration (or dead dumped fish) has resulted in increased seal populations resulting an imbalance in the predator suite	2	6	12
36	Discarding/dumping may cause localized anoxic effects	0	5	0
37	Seabirds possibly benefit from discarded dead fish while they float on the surface	1	5	5
38	Organic effluent discharged from factories in harbours and bays may cause localized eutrophication and de-oxygenation	4	2	8
39	Fishing activity might result in injection of nutrients in the water column (mainly from fish while in the net)	0	6	0
40	Impact of fishmeal production on air quality	1	6	6
41	Noise pollution from vessels and factories	1	6	6
42	Occasional incidences of fish-oil spilled by processing factories may cause oiling of birds	1	1	1
43	Vessels sheltering close to protected islands and breeding colonies may discard pieces of fishing gear, operational oil spills may occur	1	6	6
Human well-being				
	Community well-being			
44	Concerns about the high proportion of landed sardine catch that is reduced to fish meal	0	6	0
45	Lack of understanding about decadal-scale fluctuations in abundance for all species – in timing and levels and interactions between species (regime shifts, species alternations)	4	6	24
46	Small rights holders are running at a loss or ceasing operation under current price and exchange rate conditions, in spite of high TACs	2	5	10
47	Concern that increase in numbers of rights holders has resulted in potentially sub-viable quotas	2	5	10
48	Value-adding is sub-optimal	1	6	6
49	A number of west coast fishermen now find themselves based on the east coast as the fish have moved eastward (only sardine)	1	6	6
50	Safety at sea is a concern as it is a highly industrial fishery	1	6	6
51	During periods of high availability – factories tend to process their own catches ahead of those of smaller independent operators – could disadvantage small quota holders	1	5	5
52	Under current estimates there is surplus capacity in the fishery	4	3	12
53	Unhappiness about Namibian vessels being used to fish the South African TAC (happened on temporary basis)	0	6	0

	Issues	Cons	Like	Risk
54	Higher salaries and lifestyles resulting from higher catches, will not be maintained in the future when catches decline, including factory workers in St. Helena Bay, Gans Baai, Laaiplek and Lamberts Bay	4	6	24
55	More than 50 percent of the whole community in St Helena Bay, Laaiplek and Lamberts Bay are dependent on the pelagic fishing industry – as such are highly vulnerable to stock status	4	6	24
56	Factory workers in Hout Bay, Mossel Bay and Port Elizabeth are dependent on healthy stocks	1	6	6
57	Tourism around KZN sardine-run (lifestyle and seasonal economic benefits for lower income groups) dependent on sardines.	3	1	3
58	Tourism surrounding seabirds which are dependent on small pelagic fish e.g. Lamberts Bay, Simon's Town	3	4	12
	National well-being			
59	The effect of a collapse of the pelagic fishery on the national economy	1	4	4
60	A collapse of fishery would counteract national strategy of decentralization of employment opportunities	2	4	8
61	The sector is the biggest employer in the fishing industry (10 000)	1	4	4
Ability to achieve				
	Governance			
62	There are large delays in administration of permits	1	6	6
63	Legal disputes on the allocation procedure may result in temporary closure of the fishery	4	4	16
64	Need increased observer coverage of vessels at sea and scale monitors or inspectors at landing points	1	6	6
65	There is evidence of illegal dumping (compliance issue)	2	6	12
66	Quantity of landings has prompted the compliance directorate to investigate controlling the fishing effort because of problems of monitoring the landings (but this is contrary to the needs of the data requirements for assessment of the resource)	5	2	10
67	Need to quantify processing capabilities for assessing effort and capacity	1	4	4
68	Concern about target identification on acoustic surveys	4	1	4
69	Difficulties in accessing VMS data (within MCM)	2	4	8
70	Lack of resources (and inappropriate allocation within MCM) for resource management and research (staffing issues) – industry is concerned at the lack of skilled and experienced scientists in MCM	3	5	15
71	Potential conflict due to interference by large purse-seiners with line fishery when they come close inshore	0	6	0
72	The RMWGs are not functional but are considered as sectoral replacements for the CAF	3	6	18
73	There is no statutory requirement or structure for participatory decision making (including co-management)	3	6	18
74	There is a lack of follow-up reporting on management decisions taken	1	6	6
75	Interaction between scientists and new rights holders (esp. smaller rights holders) and industrial bodies is perceived to be suboptimal	1	2	2
76	A consulting company has been contracted to place observers on vessels – lack of communication with industry and formal documents identifying observers	1	2	2
77	Self policing of bycatch and closed areas – problem companies and skippers	1	2	2
78	Costs associated with complying with HACCP	3	6	18

	Issues	Cons	Like	Risk
79	Poor communication between MCM and NGOs and civil society	2	6	12
	External Impacts			
80	Poor representation of stakeholders on RMWG and SWG	2	6	12
81	Uncertainty about future trends in abundance (driven by environmental fluctuation) creates problems for industry planning	4	6	24
82	Effects of climate change on resource abundance and distribution are inadequately understood	3	6	18
83	Potential conflict with developing oil and gas industry	1	1	1
84	Impact of seals on fishing operations (damage gear, etc.)	1	6	6
85	Impact of AIDS on fishery workforce	3	6	18
86	Impact of drugs on fishery workforce	2	6	12
87	Impact of alcohol on fishery workforce	2	6	12
88	Impact of exchange rate on fishery viability	4	6	24
89	Impact of fuel price on fishery viability	4	6	24
90	Global market fluctuations affect fishery viability	3	6	18
91	Soya is competing with fishmeal	3	6	18

3.7 South Africa West Coast rock lobster fishery

3.7.1 Identification of issues

A total of 71 issues were identified by the workshop participants (Table 3.7). Most issues (42 percent) fell within the "governance" component (Figure 3.7), followed by "community" issues (21 percent). Relative to other fisheries this fishery appeared to have fewer "ecological well-being" issues (only 21 percent of all issues).

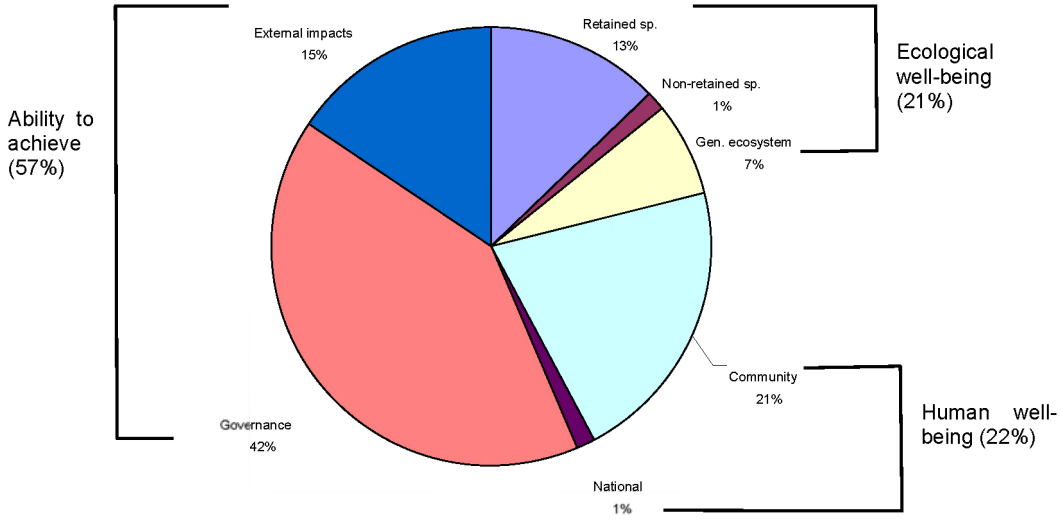


Figure 3.7. Percentages of issues that were identified within each RASF component and category in the South Africa West Coast rock lobster fishery

3.7.2 The major issues

The full list of issues is shown in Table 3.7. The discussion in this section cannot cover each of the issues and so will merely highlight some of the main issues and themes under each of the main components.

Ecological well-being

This fishery does not seem to be plagued with the number of "ecological well-being" risks that face many other fisheries. This is probably due to the selective nature of the gear and its low impact on benthic habitats.

"The trophic influences of rock lobster on urchins and abalone" was the only issue that was considered to be of extreme risk under the ecological well-being component. The slow somatic growth and the southward shift in the distribution were considered to be of high risk to the fishery. While it was noted that the stock was lower than desired levels, this was qualified by the fact that there have been recent signs of recovery.

Human well-being

Many of the community human well-being issues that are being faced by this fishery are related to the smaller operators. These include the lack of a coordinated marketing ability which will result in lower prices and profitability of small quota holders. In the past many of these small operators have also been allocated economically sub-viable quotas.

Another concern that emerged in several issues was the lack of business skills and capacity amongst the small-scale fishermen. It was felt that lack of capacity and resources could result in *bona fide* fishermen not being able to enter the fishery. This could lead to these fishers engaging in poaching activities. Furthermore, a lack of business skills and coordination amongst the small-scale fishers is hindering the effective transformation of the nearshore fishery. This appears to be leading to some frustration amongst small-scale operators over technicalities related to prices (e.g. water loss and over-the-scale compared to direct prices). Conflict between the three sectors involved in this fishery (full commercial, limited commercial and recreational) was also noted.

Finally, the social and economic importance of this fishery for small coastal towns on the west coast and south-western Cape was also noted. A downturn in this fishery could have severe consequences to these predominantly fishing villages.

Ability to achieve

As noted previously, the workshop participants identified a large number of issues related to the governance of this fishery. At the heart of the problem seems to be poor coordination between science and management within the Department of Environmental Affairs and Tourism (DEAT). Linked to this is poor participation of resource managers in the SWG and poor transparency and accountability feedback on decisions that depart from scientific advice. The lack of an effective RMWG is exacerbating this situation. This is hindering communications with stakeholders and any potential for co-management of this resource. Communications seems to be further hindered by the lack of effective representative structures for the small-scale and recreational sectors.

Poaching is a large problem in this fishery and is compounded by a lack of appropriate enforcement capacity. Understaffing and lack of social and economic expertise within MCM is also a problem.

External impacts on this fishery include fluctuating foreign exchange rates, fuel prices and a number of environmental factors.

3.7.3 Conclusions and the way forward

These workshop outputs provide an excellent platform from which to implement an ecosystem approach to the West Coast rock lobster fishery. The workshop participants were successful in identifying a comprehensive list of issues and through (often vigorous) debate prioritizing these issues in terms of their risk to the fishery.

As in the two other South African fisheries considered in the project, a RMWG would be best placed to start implementing the outcomes of this workshop. In the absence of an effectively functioning RMWG, a small working group should be constituted under the BCLME EAF project that can meet at regular intervals to discuss and facilitate the implementation of some of the management recommendations that were made in this document. It is envisaged that this working group could also form the nucleus of the RMWG, when these become established.

Table 3.7. Issues and risk values for the West Coast rock lobster fishery.
The scores reflect: consequence i.e. the severity should the issue not be corrected for (Cons.); the likelihood of the issue occurring (Like.), the overall risk score (Risk = Cons. x Like.). CBOs = Community-based Organizations

	Issues	Cons	Like	Risk
Ecological well-being				
	Retained species			
1	WC rock lobster: somatic growth rate below historic average (esp. in areas 1–2)	3	6	18
2	WC rock lobster: shift in distribution to the south	3	6	18
3	WC rock lobster: current abundance is below the desired level	2	5	10
4	WC rock lobster: sex ratio skewed towards males	1	4	4
5	WC rock lobster: there is an lack of large females	3	5	15
6	WC rock lobster: the stock is shared with Namibia	1	6	6
7	WC rock lobster: variability in moult timing creates problems for monitoring and management	1	6	6
8	WC rock lobster: discarding results in physical damage to individuals	1	5	5
9	Bycatch of kingklip, octopus, hottentot and other linefish species	1	5	5
	Non-retained species			
10	Bycatch of 27 species, including cat sharks	2	5	10
	General Ecosystem			
11	Trophic influences on urchin/abalone	4	6	24
12	Ghost fishing of penguins	1	3	3
13	Discarding of netting during repairs can lead to entanglement of birds	1	4	4
14	Fishing gear causing damage to benthic biota: hard corals, bryozoans, sea fans	2	6	12
15	Discarding plastics that can lead to ingestion by and entanglement of birds	2	6	12

	Issues	Cons	Like	Risk
Human well-being				
	Community			
16	The three fishing sectors (limited commercial, full commercial, recreational) are competing for the same resource, leading to social and economic conflicts.	2	6	12
17	Conflicts caused by different prices paid to fishermen for over the-scale versus direct deals	2	6	12
18	Unhappiness amongst fishers because of problems with water loss before weighing, having impact on price (especially important for smaller operators)	3	6	18
19	A lack of coordinated marketing results in lower prices (fragmentation of industry)	4	6	24
20	Some quota holders have sub-viable quotas (influenced by exchange rates)	4	6	24
21	Lack of economic benefits of collecting walk-out lobsters	3	1	3
22	Concerns about incidence of work-related injuries – safety at sea	3	5	15
23	Problems related to maintaining employment in processing plants in remote areas	2	5	10
24	Fishermen excluded from access because of lack of capacity/insufficient resources to prepare applications, pay for licences	4	5	20
25	Exclusion of fishers is leading to poaching, that reduces TACs, lowers prices	3	5	15
26	Failure to fulfil transformation targets	2	1	2
27	Lack of capacity in business skills is hindering effective transformation (nearshore fishery)	3	5	15
28	Negative impacts on lobster fishery would create substantial hardship for large number of people between Saldanha Bay and Port Nolloth	2	3	6
29	Substantial number of people would be negatively impacted by closure of recreational fishery: dive operators, tourism industry, boat industry, service stations, restaurants, cafes	3	4	12
30	Negative impacts on lobster industry would have significant impacts on socio-economy of Western and Northern Cape	1	2	2
	National			
31	Collapse of rock lobster industry would remove important lifestyle component for the Western Cape	3	2	6
Ability to achieve				
	Governance			
32	RMWGs are not functioning effectively	4	6	24
33	Effective abolition of the CAF is hindering consultation	4	6	24
34	Lack of devolution of authority to appropriate local level	2	5	10
35	Lack of cooperation between scientific decisions and management implementation	5	6	30
36	Lack of participation by managers/administrators on SWGs	5	6	30
37	Lack of discussion, feedback, transparency, accountability, for departures by resource managers from scientific advice	5	6	30
38	Inadequate representation of social and economic staff at MCM	3	6	18
39	Inability to interact with recreational sector (no representative body)	2	5	10
40	No agreement on managing shared stock with Namibia	1	5	5
41	Exclusion of offshore sector from area east of Hangklip	1	6	6

	Issues	Cons	Like	Risk
42	Poaching is a substantial problem (500 tonnes compared 3 000 tonnes TAC)	4	6	24
43	Insufficient observer coverage on deck boats (with specific compliance duties)	3	5	15
44	Insufficient enforcement (inadequate numbers, salaries, cooperation between agencies)	4	6	24
45	"Sanctioned" poaching is allowed in diamond areas	1	6	6
46	Understaffing at MCM caused by radical failure to fill posts	4	6	24
47	Lack of capacity amongst previously disadvantaged sector to fill science/technical/management posts	3	6	18
48	Failure to cooperate adequately with Departments of Trade and Industry, Labour, Mineral and Energy Affairs	2	6	12
49	1 300 rights holders likely to compromise ability to monitor/control fishery effectively	4	5	20
50	Lack of provision for small-scale fishers in the MLRA	4	6	24
51	Dissatisfaction with allocation policy of not being allowed to have multiple permits	2	6	12
52	Communication difficulties between industry and managers/administrators on ad hoc issues during year	4	6	24
53	Inadequate implementation of co-management, failure to use Management Working Groups	4	6	24
54	Inappropriate means of communication results in target audience not being reached	2	5	10
55	Peer-review not obligatory part of management plans and OMPs	2	5	10
56	Currently biodiversity audits for marine species are not being done	3	5	15
57	Failure of diamond mining companies to address impacts on fisheries	2	3	6
58	Inadequate access for compliance officers to mining areas	1	4	4
59	Absence of representative structures for communities hinders effective communication and participation	3	5	15
60	Absence of watchdog NGOs and CBOs at community level is contributing to poaching, disappearance of funds, etc.	2	4	8
	External impacts			
61	Increased frequency of harmful algal blooms	5	3	15
62	Increased frequency and magnitude of low oxygen events and related walk-outs	5	3	15
63	Long-term climate change possibly causing eastward shift of lobster	3	5	15
64	Impact of environment on slow growth rate	4	6	24
65	Impact of mining: hydrogen sulphide eruption, sediment turnover, suspension particles, etc.	2	6	12
66	Problem with attitudes towards perceived human "rights" to harvest rather than responsibilities (driving force for poaching in many cases)	3	6	18
67	Market preference for smaller sizes (higher price) leads to discard of larger lobsters	3	2	6
68	Subsidies by other countries hindering market access affecting profitability	2	2	4
69	Exchange rate affects profitability	5	6	30
70	Fuel price impacts on profitability	4	6	24
71	Collection of pueruli for aquaculture may affect recruitment	2	3	6

4. REGIONAL ISSUES AND PRIORITIES

4.1 Overview of the Benguela Current Commission Interim Agreement

Since its inception in 2001, the BCLME Programme had allocated more than US$10 million in support of 98 scientific and economic research projects in the region by the end of 2006. The purpose of the BCLME Programme is for participating countries and their institutions sharing the Benguela Current Large Marine Ecosystem to have the understanding and capacity to utilize a more comprehensive ecosystem approach and to implement sustainable measures to address transboundary ecosystem related environmental concerns collaboratively.

At the onset of the BCLME, the littoral countries had agreed on a programme of actions (the Strategic Action Programme – SAP) aimed at achieving the integrated management of the ecosystem, including the creation of the Benguela Current Commission (BCC), and a vast array of local, national and regional actions. It was planned that the BCLME Programme would support the countries in this effort through the establishment of the Interim Benguela Current Commission (IBCC), the development of a series of assessments, surveys and plans, training and capacity building (the latter defined by the signatories of the SAP as of the "highest priority"), and the securing of additional financing.

With the support of the Global Environment Facility (GEF), which finances environmentally sustainable projects and its implementing agency, the United Nations Development Programme (UNDP), this collaborative effort has resulted in the Benguela Current Commission, the first of its kind in the world. The Commission was formally established when the Governments of South Africa and Namibia signed the Interim Agreement on 29 August 2006 in Cape Town and the government of Angola signed on 31 January 2007, allowing for their joint management of the Benguela Current's marine resources. The BCLME extends from east of Port Elizabeth and north to Angola's Cabinda province and the BCC is an institutional structure that will link the three countries in the management of the BCLME, one of richest and most productive marine ecosystems on earth. The three countries will collectively manage transboundary environmental issues such as shared fish stocks and will work together to mitigate the impacts of marine mining and oil and gas production on the marine environment.

A study conducted by fisheries economists from the University of British Columbia in 2004 had concluded that the net benefits of regional cooperative management are huge compared with the risk of non-cooperation. Some of the conclusions of that study included that the establishment of the BCC would:

- reduce wasteful use of shared stocks and increase catch potential of fisheries throughout the BCLME;
- allow stocks to grow to their fullest economic potential;
- incur modest costs (sustainable funding is available);
- require strong political commitment which is already present in the region.

This Interim Agreement of the BCC applies to the area of the Benguela Current Large Marine Ecosystem to the extent that it falls within the internal waters, territorial seas or exclusive economic zones of the Contracting Parties, as well as to all human activities, aircraft and vessels under the jurisdiction or control of the Contracting Party to the extent that these activities, or the operation of such aircraft or vessels result, or are likely to result, in adverse

impacts. The BCC will have links to the Southern African Development Community (SADC), the South East Atlantic Fisheries Organization (SEAFO) and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Some important features of the Interim Agreement include the following:

- The Contracting States shall use their best endeavours to bring into force by no later than 31 December 2012, a binding legal instrument that will establish a comprehensive framework to implement an ecosystem approach to conservation and development of the Benguela Current Large Marine Ecosystem.
- The BCC shall be funded by the Contracting Parties and donors. Unless otherwise agreed, the Contracting Parties shall contribute in equal proportions to the budget of the Commission.
- In the event of a dispute between Contracting Parties concerning the interpretation or implementation of this Interim Agreement, the Contracting Parties concerned shall seek a solution through negotiation. If the Contracting Parties concerned cannot settle the dispute through negotiation they shall agree in good faith on a dispute resolution procedure which may include jointly seeking mediation by a third party (which may be a Contracting Party that is not involved in the dispute).
- The Contracting Parties have entered into this Interim Agreement without prejudice to any claims that they may have in relation to the delimitation of their maritime boundaries and nothing in this Interim Agreement or done pursuant to it, shall be construed or interpreted as conduct on the part of a Contracting Party signifying that it either consents to, or disputes, a particular maritime boundary.

The full text of the Interim Agreement between the three BCLME countries, Angola, Namibia and South Africa on the establishment of the Benguela Current Commission is available from the BCLME Programme Coordinating Unit (PCU) in Windhoek, Namibia.

4.2 Issues raised at the Third Regional Workshop

It was noted that the functions of the Ecosystem Advisory Committee of the BCC include:

(a) to support decision-making by the Management Board, the Ministerial Conference and the Contracting Parties by providing them with the best available … information, and expert advice concerning the conservation and ecologically sustainable use and development of the BCLME;
(b) to build capacity … to generate and provide the information and expert advice referred to in (a) on a sustainable basis.

It will be essential for the Ecosystem Advisory Committee to be aware of the high priority regional issues and to advise the appropriate BCC institutions on how to address those issues. Some of the major regional issues that had came out of the RASF and benefit-cost analysis (BCA) workshops are summarized below.

In the case of deep-water hake *M. paradoxus*, the workshops in both Namibia and South Africa had emphasized the need to cooperate bilaterally in research and management. There had been consensus that such cooperation should proceed in a stepwise manner. The first step could be based on informal agreements and cooperation that included: a joint research

strategy and sharing of data for stock assessment; an attempt to control and balance effort across the sectors and countries; coordination in bycatch policies for bycatch species that were also shared, research into and protection of benthic substrate and habitat which otherwise could compromise recruitment and sustainable use of stock; and research into and appropriate action on external influences on the species including pollution on eggs and larvae. The second step would involve formal, binding agreements that addressed: a joint management strategy and administrative cycles (recognizing that allocations within each country would remain a national issue); effort control and bycatch policies and practices; data collection and an observer programme; compliance; and possibly efforts to coordinate marketing to maximize profit.

The RASF and BCA workshops in Angola and Namibia had also arrived at similar conclusions on the need for cooperation in management of the sardine *S. sagax* stock shared between those countries. The objective of joint management would be to coordinate and harmonize management of the stock in order to rebuild it and ensure optimal benefits were obtained from it. This would best be served through a bilateral agreement that included bilaterally agreed TACs; joint surveys using standardized methodology; sharing fishery statistics and other relevant information; and bilateral working groups involving the range of stakeholders.

Based on these examples and other outcomes from the project, the following important questions needed to be considered:

- What are the priority species and ecological issues for regional consideration?
- Where is the action required?
  - consultative structures (between or within countries);
  - management measures (TAC, effort control, etc.);
  - enforcement and surveillance;
  - monitoring;
  - management of or responses to ecosystem impacts (bycatch, habitat damage, environmental variability);
  - impacts of other human activities;
  - research.

The Third Regional Workshop developed the table below (Table 4.1) identifying the species and species groups that were recommended to the BCC for consideration for regional cooperation. In addition, it was agreed that the BCC should also give consideration to addressing regional environmental issues and providing a regional service in this regard. Environmental matters that are relevant to two or more countries include, for example, monitoring and mitigating the impacts of red tides, low oxygen events and other large scale environmental events and anomalies. The BCC could also encourage and perhaps facilitate monitoring for agreed ecosystem and environmental indicators and providing regular information on the state (or health) of the ecosystem and advising on its implications for fisheries and related activities. It may also be able to play a similar role in the monitoring of pollution from e.g. land-based activities, oil and gas exploration and extraction and offshore mining, considering and advising on their implications for fisheries (including health related aspects) as well as ensuring that the interests of the fisheries sector are taken into account in the development and management of the coastal zone and the EEZ as a whole.

Table 4.1. Species and species groups to be recommended to the BCC for regional consideration. Entries marked with two asterisks (**) are considered top priority and those with one asterisk (*) of middle priority.

Species	Technical matters	Assessments	Comments
Seabirds	** - Gear trials for exclusion gear. - Protection status for breeding sites. - Consideration of protection status for spp. by the Agreement on the Conservation of Albatrosses and Petrels (ACAP)	Endemic species status	There is a multinational MoU on monitoring endangered spp. In addition, the BCC should consider coordination of the National Plans of Action (NPOAs) on seabirds.
Tunas	*There may be a need for effort control within the context of ICCAT framework.		
Turtles	These are a global conservation concern. The BCC should give attention to any international commitments by BCLME states. There is a need to collect data on fisheries related mortality, including through the use of observers		Leatherback turtles are critically endangered. The BCC needs to give attention to any international obligations and commitments of its members. There are directed fisheries in all three BCLME states.
Pelagic sharks	There is a need for effort control within the context of ICCAT		
Hake		**Note was taken of the Benefit Workshop on shared hake stocks in May 2006, and the intentions for on-going attention to regional cooperation on these species were supported.	
i) impact of hake fishery on seabirds	**South Africa already has regulations covering gear exclusion and mitigation devices for seabirds in both the long-lining and trawl fisheries. Namibia should give attention to implementing similar measures.		
ii) bycatch of commercially important species in hake fishery	Snoek, kingklip and monk in South Africa and Namibia		These stocks may be shared between South Africa and Namibia, which would require a cooperative and coordinated approach to their management, including bycatches
Crab		**A joint Angola-Namibia working group has been established	Shared between Angola and Namibia. The BCC should ensure that the cooperative approach is maintained and strengthened where necessary.
Cunene and Cape horse mackerel		**A bilateral agreement is in place but, while Angola has a minimum size limit, Namibia does not, which is cause of concern	Shared between Angola and Namibia. The BCC should ensure that the cooperative approach is maintained and strengthened where necessary.
Sardine		**A joint Angola-Namibia working group has been established and transboundary surveys have been undertaken.	Shared between Angola and Namibia. The BCC should ensure that the cooperative approach is strengthened and extended to management.

Species	Technical matters	Assessments	Comments
Demersal sharks		Current knowledge of the status of the stocks is not adequate.	These species are impacted by many fisheries. The BCC should help to coordinate the implementation of NPOAs for the conservation and management of sharks.
Seals		*Joint assessment across the three countries is justified	
Dentex	**The species is taken as bycatch in the horse mackerel and hake fisheries.		It is a targeted fish in Angola and a retained bycatch species in Namibia. The BCC should give attention to optimizing its use between the two countries.

5. EVALUATING OPTIONS FOR EAF MANAGEMENT ACTION

INTRODUCTION

The primary objective of the project addressed in this volume was to investigate the feasibility of implementing EAF in the Benguela Current Large Marine Ecosystem. Simultaneous achievement of all desirable objectives within an ecosystem will rarely, if ever, be achievable and implementation of the approach therefore requires consideration of conflicting objectives and decisions on trade-offs between them. The purpose of the benefit-cost analyses (BCAs) undertaken by the project was to demonstrate and test a process for evaluating the positive and negative impacts, here referred to as benefits and costs, of different management actions across the range of desired objectives for the ecosystem. The goal of the process is to evaluate the consequences of different management actions for each of the broad objectives in order to provide decision-makers with the best available information to assist them in selecting the optimal set of management actions most likely to meet the agreed objectives for the full range of stakeholders.

The BCAs built on the lists of issues, priorities and draft Performance Reports developed during the RASF workshops and summarized in Chapter 3 and made use of the BCA methodology described in Section 4 of Appendix and summarized in Figure 5.1. Workshop participants therefore applied the RASF results and this methodology as the basic tools needed to assess the benefits and costs of each fishery. The process was consultative and included fisheries researchers, compliance and management personnel as well as representatives from the commercial fishing sectors under consideration. The BCA essentially required participants (managers, industry representatives, scientists, socio economists) to grade the perceived negative and positive impacts of the management measures identified in the Performance Reports as possible means of addressing particular EAF issues. The perceived benefits and costs were considered in terms of the broad objectives for the fishery which were identified from the policy goals for each fishery, as well as from consideration of other issues identified in the RASF workshops from which additional objectives could be identified. As described in Appendix, the benefits and costs were expressed in terms of the following scores, with costs expressed as a negative and benefits as a positive value:

Score	Criteria
0	Suggested management action will have a negligible benefit or cost towards achieving the Objective
1	Suggested management action is likely to have a small but noticeable impact towards achieving the Objective
2	Suggested management action will have a moderate benefit or cost towards achieving the Objective
3	Suggested management action will result in a major improvement (benefit) or will have a major negative (cost) impact towards achieving the Objective
4	Suggested management action will have an immediate and long-term benefit or will be unsustainable from the outset towards achieving the Objective

Management actions were scored for both their short-term (up to three years) and long-term (more than three years) impact on the broad objectives.[1] An example of a completed benefit cost table for one potential management action to address a group of issues is provided in Appendix of this volume (Table A3). The example was taken from the group addressing bycatch and gear issues in the artisanal fishery in Angola.

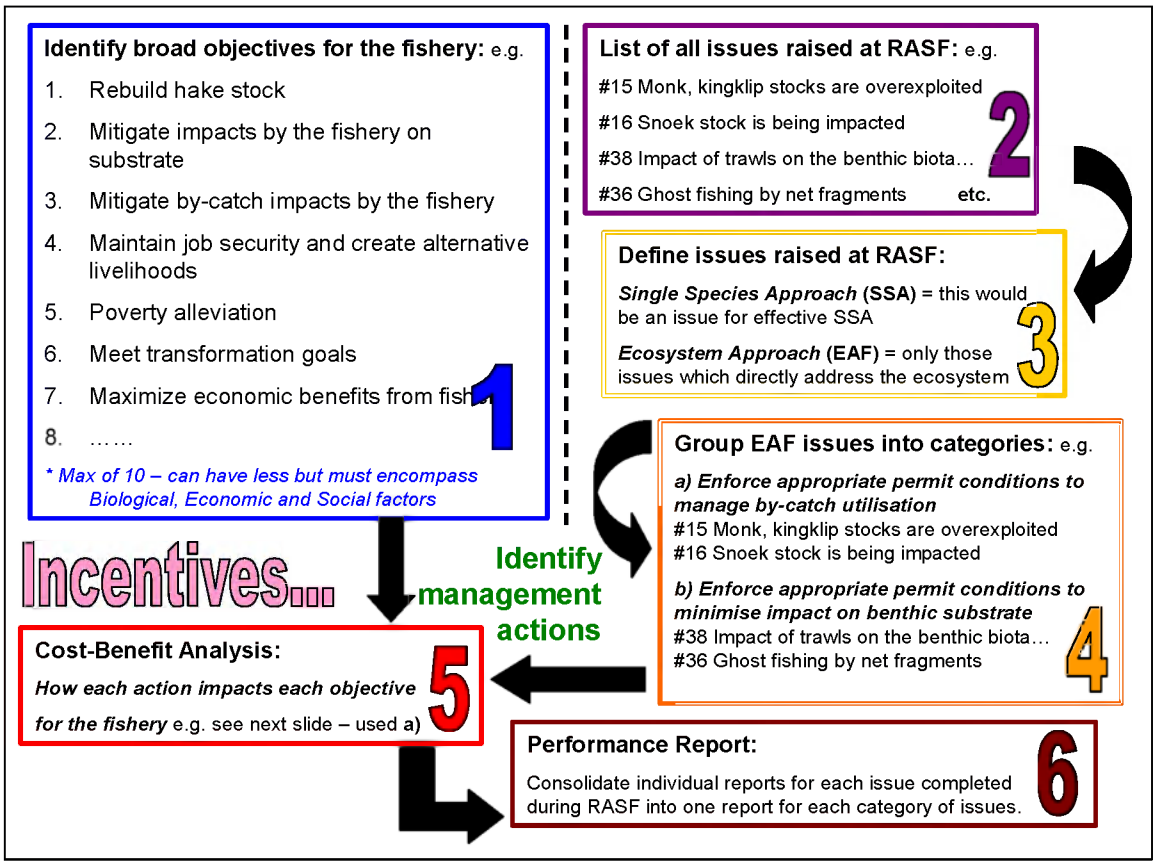


Figure 5.1. The process followed to estimate the positive and negative impacts (costs and benefits) of different management actions to address EAF issues of concern in each of the fisheries considered. The examples shown in the figure are from the South African hake fishery (see Appendix for more details)

[1] Note : The calculation of BCA ratios through averaging has to be applied consistently for ease of comparison between Objectives and Management Actions. The application of zeros and additive costs or benefits had to be applied carefully without duplicating the perceived relative benefit or cost between Objectives. For example, if a perceived benefit for a particular Management Action was rated "3" and if this benefit was deemed to have been adequately accommodated under the scoring of one Objective, it was not duplicated under another.

RESULTS

5.1 Angola

5.1.1 Artisanal fishery

The broad objectives for the fishery

- Maintain biomass of commercially important coastal fish species at optimal levels of productivity.
- Minimize impact of fishery on juvenile or undersized fish.
- Minimize impacts of fishery on threatened, protected or vulnerable species (turtles, cetaceans, seabirds).
- Minimize impact of fishery on coastal communities and ecosystems.
- Maintain or increase the supply of good-quality fish to the population.
- Contribute to poverty alleviation through the increase of opportunities for employment in the fisheries extractive sector and in small-scale fish processing in the coastal provinces.
- Increase equity in the distribution of employment and income among the regions of the country and in the coastal provinces.
- Maximize the contribution of the fishery to the national economy, and especially of the coastal provinces.

Benefit:cost ratios for possible management responses

The set of EAF issues for the artisanal fishery in Angola was subdivided into six groups: research, management and MCS, bycatch and gear, ecosystem impacts, social and economic issues, and pollution. The Groups consisted of between two and six issues each. A number of potential management actions or responses was identified to address each group and the estimated benefit:cost ratio for each possible response is shown in Figure 5.1.1.

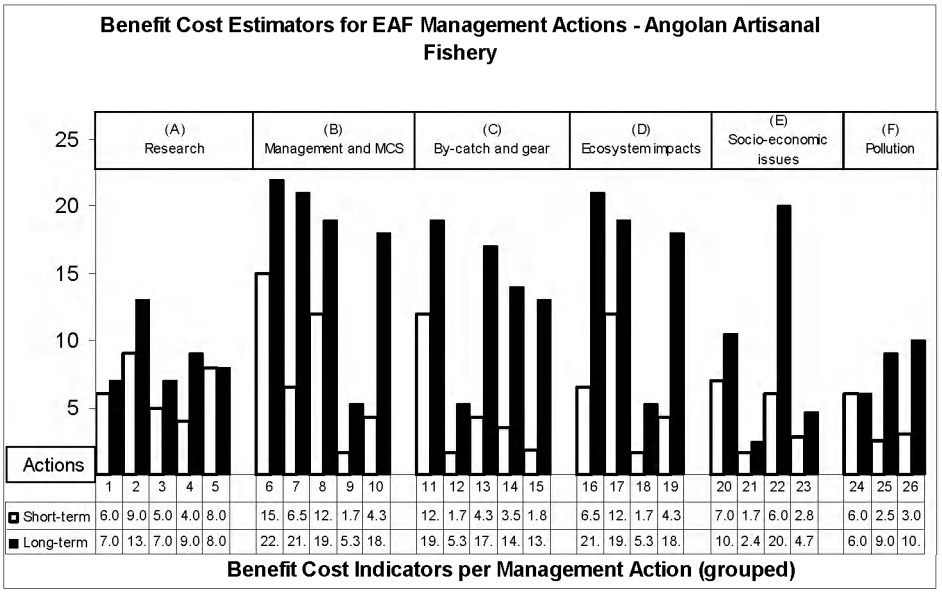


Figure 5.1.1. Benefit:cost ratios for possible management actions to address each of the groups of issues (A to F) identified for the Angolan artisanal fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
11: Lack of an efficient system for collection of national statistical data	12
2: Reliability of the system for collection of statistical data	12

(ii) Proposed management responses

Action 1 Develop and consolidate the database system to store and easily analyse the information
Action 2. Carry out studies of gear selectivity and efficiency for the gear used by artisanal fisheries
Action 3. Reinforce the National Biological Sampling Programme
Action 4. Improve the system for data collection, including the collection of catch and effort data for artisanal fisheries
Action 5. Carry out regular social and economic surveys

In the case of research needs, the primary concerns were about the lack of an efficient and reliable system for collection (and storage) of data but the response with the highest estimated long-term benefit:cost ratio was to carry out selectivity and efficiency studies on fishing gear. Overall, the estimated benefit:cost ratios were substantial, ranging from 4 to 9 in the short term and from 7 to 13 in the long term.

Group B: Management and MCS

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
12: Open access for artisanal fishery	20
20: Management plan for artisanal fishery	16
9: Monitoring, control and surveillance of management measures inefficient	16

(ii) Proposed management responses

Action 6. Restricted (licence-based) access to the artisanal fishery, with long-term licences for artisanal fisheries issued to fisher's cooperatives or local communities
Action 7. Co-management involving fisher's cooperatives and economic incentives
Action 8. Education, training and awareness programme
Action 9. Marine Protected Areas (MPAs) implemented in especially sensitive areas
Action 10. MCS system for artisanal fisheries reinforced

The open access nature of the artisanal fishery, the lack of a management plan and the need for improved MCS were the issues included in the category "Management and MCS". The proposed management responses with the highest benefit:cost ratios included the implementation of a limited access system, based on fisher's cooperatives or local communities as the licensed unit, and the introduction of co-management. These could be supplemented by education and training. The estimated benefit:cost ratios were very high, especially in the long term and, apart from the use of MPAs, all responses were considered to have benefit:cost ratios in the vicinity of 20 in the long term. In the case of MPAs, while the

aggregated benefits were high (10 in the short term and 16 in the long-term) there were concerns about the potential social and economic costs, particularly in the short term (see Table A3, Appendix).

Group C: Bycatch and gear

(i) EAF issues in order of priority and associated risk values
na = not assessed

Issues	Risk values
New1: Catch of juvenile fish by beach seines	na
3: Accidental bycatch of threatened, protected or vulnerable species.	16

(ii) Proposed management responses

Action 11. Education, training and awareness programme
Action 12. Marine Protected Areas (MPAs) implemented in especially sensitive areas
Action 13. MCS system for artisanal fisheries reinforced
Action 14. Minimum mesh size for beach seines
Action 15. Restrictions on gear types to use for different fisheries, encouraging the use of more selective gears (e.g. pots, longline and gillnets)

Three of the five management responses proposed to address the bycatch issues were the same as proposed for management and MCS, i.e. education and training, the use of MPAs and reinforcing the MCS system, and had similar or identical benefit:cost ratios. Again, with the exception of MPAs, all options had high long-term benefit:cost ratios which would be substantially smaller, but still beneficial, in the short term.

Group D: Ecosystem impacts

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
13: Impact on the coastal ecosystem; damage to mangroves, littering, etc.	12
4: Ghost fishing	12

(ii) Proposed management responses

Action 16. Co-management involving fisher's cooperatives and economic incentives
Action 17. Education, training and awareness programme
Action 18. Marine Protected Areas (MPAs) implemented in especially sensitive areas
Action 19. MCS system for artisanal fisheries reinforced

Only two issues were included within the "Ecosystem impacts" group. Again, education and training, the use of MPAs and strengthening MCS were identified as potential management responses, and co-management, which was proposed as useful for addressing the management and MCS issues, was the fourth management response. Benefit:cost ratios were the same for each response as had been estimated for preceding groups.

Group E: Social and economic issues

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
7: Low wages	20
18: Infrastructures (roads, bridges) are damaged and need rehabilitation	16
6: Lack of fish processing facilities and lack of jobs in the processing industry	16
17: The majority of fishers cannot read or write	12
15: Low life expectancy of fishers due to excess consumption of alcohol and tobacco	9
16: The new generations do not wish to participate in the activity	9

(ii) Proposed management responses

Action 20. Increase support to cooperatives of small-scale fishers
Action 21. Continue rehabilitation of existing infrastructures and building of new ones
Action 22. Training of fishers and fish processors in capture, seamanship and fish conservation/processing
Action 23. Dedicated extension service for artisanal fishing communities reinforced

The social and economic group included the largest number of issues within the artisanal fishery of Angola. These issues collectively reflected a group of fishers struggling with poverty and with poor facilities and infrastructure. Suitable training of fishers was seen as having the highest benefit:cost ratio in remedying these problems in the long term, followed by increased support to fishing cooperatives. In contrast, improvement of infrastructure and the formation of a dedicated extension service for artisanal fishers were considered likely to generate considerably lower benefit:cost ratios.

Group F: Pollution

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
14: Pollution from oil related activities	20

(ii) Proposed management responses

Action 24. Regular pollution monitoring programme functioning
Action 25. Early warning system for pollution events in place
Action 26. Regular fisheries products quality control inspections including monitoring of pollutants

The group Pollution included only one issue. Management responses for this covered pollution monitoring, an early warning system for pollution events and regular inspections of the quality of fishery products to detect the presence of pollutants.

5.1.2 Demersal crustacean fishery

The broad objectives for the fishery

- Restore biomass of commercially important deep-sea crustacean species to optimal levels of productivity.
- Maintain deep-sea demersal community structure in terms of size structure and species composition.
- Minimize bycatch of non-target species, including species that are targeted by other fisheries.
- Minimize impacts of bottom trawl fishery on threatened, protected or vulnerable species (sea turtles, sharks, marine mammals, other).
- Minimize impacts of bottom trawling on bottom substrate.
- To contribute to poverty alleviation through the increase of opportunities for employment in the fisheries extractive sector and in the fish processing industry in the coastal provinces.
- To promote the utilization for human consumption of unavoidable bycatch.
- Maximize long-term economic benefits from the fishery.
- Maximize the contribution of the fishery to the national economy, and especially of the coastal provinces.

Benefit:cost ratios for possible management responses

The EAF issues for the demersal crustacean fishery were subdivided into the same groups as for the artisanal fishery, apart from the pollution group which was considered not to be applicable to this fishery. The groups were: research, management and MCS, bycatch and gear, ecosystem impacts, and social and economic issues. A number of potential management actions or responses was identified to address each group and the estimated benefit:cost ratio for each possible response is shown in Figure 5.1.2.

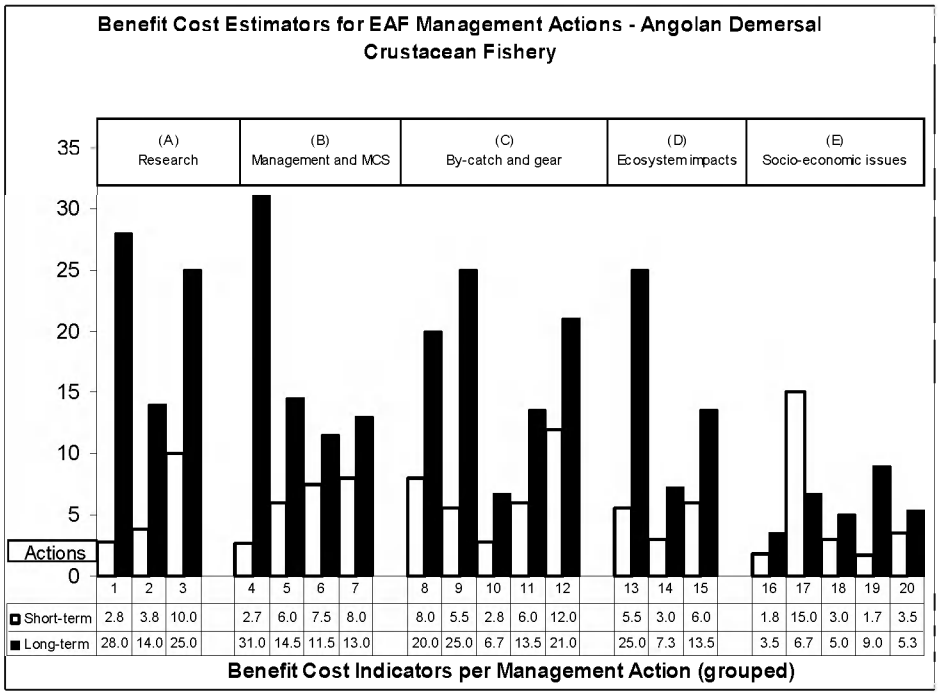


Figure 5.1.2. Benefit:cost ratios for possible management actions to address each of the groups of issues (A to E) identified for the Angolan demersal crustacean fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
16: System for collection of fisheries statistical information is inadequate	9
8: Changes in interspecific relations	8

(ii) Proposed management responses

Action 1. Carry out studies of gear selectivity and efficiency
Action 2. Improve the system for data collection
Action 3. Develop and consolidate the database system

Within the "research" issues, the greatest problems were being experienced in the collection of fisheries statistical information and two of the three management actions proposed were intended to address this, while the third management response recommended was to undertake research to improve the selectivity and efficiency of the fishing gear used. This third response was linked to the issues of bycatch and the impact of the fishing gear on bottom substrate, addressed separately under "bycatch and gear issues" and "ecosystem impacts". Collectively, the long-term benefit:cost ratios for all three responses were estimated to be high, ranging from 14 to 28.

Group B: Management and MCS

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
19: Growing oil exploration activity conflicts with the development of the fishing industry	16
18: Inadequate participation of all stakeholders of the fishing sector	16
3: Bycatch is not declared and does not show in the landing statistics	12
17: Lack of detailed management plans	12
14: Monitoring, control and surveillance of management measures inefficient	9

(ii) Proposed management responses

Action 4. Management plan with all major stakeholders
Action 5. Reinforce at-sea monitoring, control and surveillance
Action 6. Expanded inspection programme for commercial landings
Action 7. VMS system in place and expanded

The EAF issues included in the group "management and MCS" covered a range of problems that indicated some serious weaknesses in the existing management approaches and impacts from the oil industry The single greatest need, as indicated by the benefit:cost ratio, was considered to be the development of a management plan, with participation by all the major stakeholders, and to implement it.

Group C: Bycatch and gear issues

(i) EAF issues in order of priority and associated risk values
na = not assessed

Issues	Risk values
6: Accidental bycatch of threatened, protected or vulnerable species	16
5: Little selectivity of the fishing gear (mesh size)	16
4: Bycatch species of low commercial value are discarded	12
New 1: Large levels of bycatch in the deep-sea bottom trawl crustacean fishery	na

(ii) Proposed management responses

Action 8. Define bycatch limits per species/group of species
Action 9. Redefine closed areas for deep-sea crustacean bottom trawl fishery
Action 10. Compulsory use of bycatch reduction devices (BRDs), like the Nordmore grid
Action 11. Improvement of the at-sea MCS system
Action 12. Prohibition of dumping and discards

Four issues were included under the heading of "bycatch and gear issues" including one on species of conservation concern and another on discards. The underlying problem was the poor selectivity of the fishing gear being used. A number of potential management responses was suggested, including setting bycatch limits by species or species groups (which would require substantive scientific and enforcement support). The improvement of MCS at sea was also proposed, as well as the prohibition of discards, which would need to be accompanied by effective enforcement. The highest benefit:cost ratios were estimated to be, in descending

order, for redefining the closed areas applicable to the fishery (25), prohibition of discards (21) and a system of bycatch limits (20). Use of bycatch reduction devices was considered to have substantial benefits (aggregate benefits of 20) but there were concerns about the negative impacts of the use of the devices on the economic and social contributions from the fishery, which resulted in a long-term ratio of 6.7.

Group D: Ecosystem impacts

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
8: Impact of the gear on bottom substrate	8

(ii) Proposed management responses

Action 13. Redefine closed areas for deep-sea crustacean bottom trawl fishery
Action 14. Compulsory use of groundgear modifications to reduce bottom impact
Action 15. Improvement of the VMS system

Only one issue was listed under "ecosystem impacts": the possible impact of the gear on the bottom substrate. Two potential management solutions to this problem were proposed of which the system of closed areas was allocated a higher benefit:cost ratio (25). The improvement of the national VMS system was also proposed which would be complementary to an effective system of closed areas.

Group E: Social and economic issues

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
23: Infrastructures (roads, bridges) are damaged and need rehabilitation	12
9: Lack of specialized personnel	12
10: Lack of fish processing facilities and lack of jobs in the processing industry	12
22: The majority of fishers cannot read or write	12
11: Lack of a system for use of the discarded fish	9
21: The new generations do not wish to participate in the activity	9
20: Low life expectancy of fishers due to excess consumption of alcohol and tobacco	9

(ii) Proposed management responses

Action 16. Continue rehabilitation and building of support infrastructures
Action 17. Training of fishers, fish processors and managers
Action 18. Support to rehabilitation and modernization of fish processing facilities
Action 19. Expansion and reinforcement of fish quality inspections
Action 20. Support to producer's organizations

A wide range of different issues were included under the heading social and economic issues. The management responses that were proposed aimed to address these problems directly through the rehabilitation of infrastructure, including fish processing facilities, training of people in all roles relevant to the fishery and its management, and provision of support to producers' organizations. The biggest benefit:cost ratio, in the short-term, was considered to arise from training of the people involved, but there were concerns that, in the long-term, this

would lead to increased fishing effort and efficiency that would have negative impacts on both ecosystem and human objectives. This was a concern across all of the proposed management actions and, clearly, in this fishery it would be necessary to ensure the correct balance between access and fishing capacity, which would mean that as efficiency was improved, the benefits from the fishery would probably be accessible to fewer and fewer people. An appropriate balance would have to be sought.

5.1.3 Demersal finfish fishery

The broad objectives for the fishery

- Restore biomass of commercially important demersal species to optimal levels of productivity.
- Maintain demersal community structure in terms of size structure and species composition.
- Minimize impacts of bottom trawl fishery on threatened, protected or vulnerable species (sea turtles, sharks, marine mammals, other).
- Minimize impacts of bottom trawling on bottom substrate.
- To contribute to poverty alleviation through the increase of opportunities for employment in the fisheries extractive sector and in the fish processing industry in the coastal provinces.
- To promote the development of the industrial productive fisheries sector.
- To promote reliable supply of fish products to the population, at accessible prices.
- To promote equity in the distribution of employment and income among the regions of the country and in the coastal provinces.
- Maximize long-term economic benefits from the fishery.

Benefit:cost ratios for possible management responses

The EAF issues for the demersal finfish fishery were subdivided into the same five groups as for the demersal crustacean fishery: research, management and monitoring, control and surveillance (MCS), bycatch and gear, ecosystem impacts, and social and economic. A number of potential management actions or responses was identified to address each group and the estimated benefit:cost ratio for each possible response is shown in Figure 5.1.3.

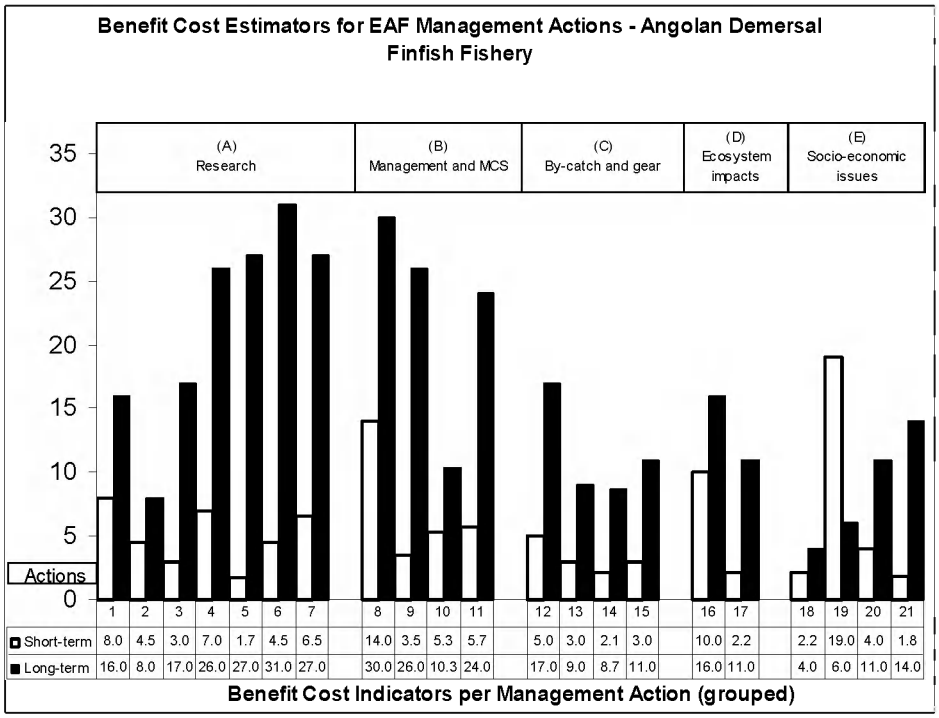


Figure 5.1.3. Benefit:cost ratios for possible management actions to address each of the groups of issues (A to E) identified for the Angolan demersal finfish fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
12: Adequate models and indicators for multispecies fisheries not available	20
14: System for collection of fisheries statistical information is inadequate	9
7: Changes in interspecific relations	8
3: Lack of information	8

(ii) Proposed management responses

Action 1. Improve database system
Action 2. Biological sampling programme and onboard scientific observer programme
Action 3. Joint and experimental surveys
Action 4. Indicators of ecosystem health
Action 5. Gear selectivity and efficiency
Action 6. Statistical data collection
Action 7. Regular social and economic surveys

Within the "research" group, the highest priority issue was the absence of models and indicators that would be practically feasible and reliable for use in this diverse, multispecies fishery. A substantial programme of strengthened research activities would be necessary to resolve these problems and seven potential, complementary management responses were proposed. Greatest benefit per unit cost (31) was anticipated for ensuring effective collection of statistical data, with high ratios also envisaged for developing and implementing a system

of indicators of "ecosystem health", undertaking regular social and economic surveys and research into improved gear selectivity and efficiency.

Group B: Management and MCS

(i) EAF issues in order of priority and associated risk values

na = not assessed

Issues	Risk values
16: Growing oil exploration affects the development of the fishing industry	16
1: Demersal fish stocks overexploited and community structure altered	9
11: Monitoring, control and surveillance of management measures inefficient	9
15: Conflict between industrial and artisanal fisheries	9
New 5: Demersal fish community shared with Congo and Gabon	na
New 3: Impacts of small-scale fisheries (including beach seines) on species targeted by the industrial fisheries	na
New 4: Stock of *Dentex macrophtalmus* shared with Namibia	na

(ii) Proposed management responses

Action 8. An appropriate management plan for the demersal finfish fishery, adopted by all main stakeholders
Action 9. Joint management of shared stocks with neighbouring countries
Action 10. Improvement of the MCS system, including the VMS system
Action 11. Prohibition of dumping and discards

A broad range of issues were included in the "Management and MCS" group. The key management responses to address these issues were seen as the participatory development and implementation of a suitable management plan, implementation of joint management approaches with neighbouring states and the effective prohibition of dumping and discards, all accompanied by improved MCS.

Group C: Bycatch and gear issues

(i) EAF issues in order of priority and associated risk values

na = not assessed

Issues	Risk values
5: Accidental bycatch of sharks	16
2: Use of non-selective fishing gear	16
4: Accidental bycatch of sea turtles	16
New 1: Bycatch of species that are targets in other fisheries: horse mackerel	na

(ii) Proposed management responses

Action 12. Define bycatch limits per species/group of species
Action 13. Redefine closed areas for finfish bottom trawl fishery
Action 14. Compulsory use of bycatch reduction devices (BRDs)
Action 15. Scientific observers on board all industrial fishing vessels

The category "bycatch and gear issues" included concerns about impacts on species of conservation concern and of species important to other fisheries, in particular horse mackerel.

Similar management responses were proposed for these problems as were proposed for the demersal crustacean fishery. Clearly the options being put forward could be complementary. The greatest benefit:cost ratios, in the short and long terms, were envisaged for the use of a system of bycatch limits for individual species or groups of species but it is recognized that such a system requires substantial scientific input, in order to determine suitable limits for each taxon, and also effective enforcement of the bycatch limits.

Group D: Ecosystem impacts

(i) EAF issues in order of priority and associated risk values

na = not assessed

Issues	Risk values
6: Impacts of bottom trawling on bottom substrate	20
New 2: Impacts of bottom trawling on species targeted by the artisanal fishery	na

(ii) Proposed management responses

Action 16. Sensitive demersal habitats closed to bottom trawl fishing
Action 17. Restrictions to gear, especially modifications of the groundgear, to reduce impact on bottom substrate

Two issues were listed within the group "ecosystem impacts". The potential management responses were similar to those proposed for the demersal crustacean fishery. A system of closed areas was considered to lead to high benefit:cost ratios in both the short and long term, while modifications to groundgear would also probably lead to good benefits per unit of cost in the longer term.

Group E: Social and economic issues

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
20: Infrastructures (roads, bridges) are damaged and need rehabilitation	16
8: Lack of specialized personnel	12
9: Lack of fish processing facilities and lack of jobs in the processing industry	12
19: The majority of fishers cannot read or write	12
17. Low life expectancy of fishers due to excess consumption of alcohol and tobacco	9
18: The new generations do not wish to participate in the activity	9

(ii) Proposed management responses

Action 18. Continue rehabilitation and building of new infrastructures, especially harbour facilities
Action 19. Training of fishers, fish processors and managers
Action 20. Support to rehabilitation and modernization of fish processing facilities
Action 21. Expansion and reinforcement of fish quality inspections

The issues included in the "social and economic issues" category were the same as for the demersal crustacean fishery apart from the issue "lack of a system for use of the discarded fish" which was considered not to be applicable to the finfish fishery. Similarly, the potential management responses were identical, apart from the exclusion of "support to producers'

associations" for the finfish fishery. As for the crustacean fishery, training of personnel throughout the sector was considered to be able to produce high benefit:cost ratios in the short-term but with the same concerns about the impacts of improvements in efficiency as were discussed for the crustacean fishery. The highest benefit:cost ratios in the long-term were anticipated from improving the fish processing facilities and the system of fish quality inspections. These two measures would lead to less wastage, higher quality of the products and therefore higher prices, and increased employment opportunities on land.

5.1.4 Pelagic fishery

The broad objectives for the fishery

- Restore biomass of commercially important small pelagic fish species to optimal levels of productivity.
- Minimize impacts of fishery on threatened, protected or vulnerable species (turtles, cetaceans, seabirds).
- Maintain or increase abundance of non-retained species.
- Maintain or increase the supply of good-quality fish to the population.
- To contribute to poverty alleviation through the increase of opportunities of employment in the fisheries extractive sector and in the fish processing industry in the coastal provinces.
- Increase equity in the distribution of employment and income among the regions of the country and in the coastal provinces.
- Maintain or increase the contribution of the fishery to the national economy, and especially of the coastal provinces.

Benefit:cost ratios for possible management responses

The EAF issues identified for the pelagic fishery were grouped into four categories: research, management and MCS, bycatch and discards, and social and economic issues. A considerably larger number of issues was identified for this fishery than for the other fisheries in Angola in part reflecting the fact that this fishery targets a relatively small number of species and that there is greater knowledge about some of them than for most of the major species caught in the other fisheries. A number of potential management actions or responses was identified to address each group and the estimated benefit:cost ratio for each possible response is shown in Figure 5.1.4.

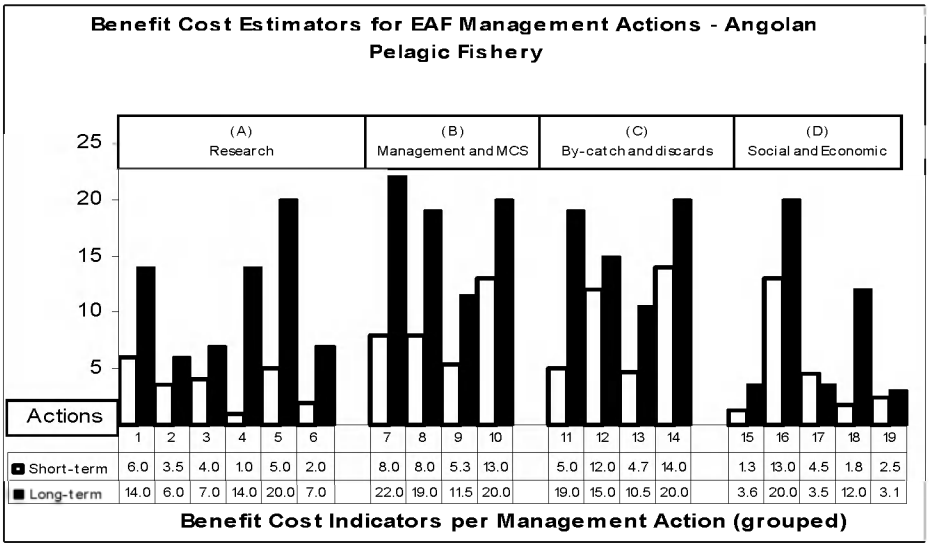


Figure 5.1.4. Benefit:cost ratios for possible management actions to address each of the groups of issues (A to D) identified for the Angolan pelagic finfish fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
35: Inadequate catch statistics – *Scomber japonicus*	30
34: No biomass estimates available *S. japonicus*	25
52: Inadequate catch statistics – *Decapterus rhoncus* is reported as horse mackerel	24
30: Catch statistics – *Sardinops sagax*	24
81: Climatic changes affect availability to the fishery	20
80: Climatic changes affect recruitment	20
79: The oil exploration area seems to function as a barrier to the distribution of *Sardinella*	20
27: Stock identification of *Trachurus capensis* is not known	20
5: Catch statistics of sardinellas are not separated by species	18
7: Lack of knowledge about the biology of the *Sardinella aurita* resource	18
11: Catch statistics of sardinellas are not separated by species	18
13: Lack of knowledge about the biology of the *Sardinella maderensis* resource	18
24: Lack of knowledge about behaviour (especially migrations) of *Trachurus capensis*	15
33: Stock identification of *Sardinops sagax* is not known	15
31: Lack of knowledge about behaviour (especially migrations) of *Sardinops sagax*	15
21: Stock identification of *Trachurus trecae* is not known	15
38: Lack of knowledge about the biology of the *Scomber japonicus* resource	12
55: *Brachideuterus auritus* difficult to identify in acoustic surveying (uncertainty in abundance estimation)	9
18: Lack of knowledge about behaviour (especially migrations) of *Trachurus trecae*	8
46: Lack of knowledge about changes in stock abundance of *Trichiurus lepturus*	4
48: Inadequate catch statistics – *Trichiurus lepturus*	4
50: Lack of knowledge about changes in stock abundance of *Decapterus rhoncus*	4
51: Lack of knowledge about the biology of the *Decapterus rhoncus* resource	4
47: Lack of knowledge about the biology of the *Trichiurus lepturus* resource	4
42: Lack of knowledge about changes in stock abundance of *Selene dorsalis*	4

54: Lack of knowledge about the biology of the *Brachideuterus auritus* resource	4
43: Lack of knowledge about the biology of the *Selene dorsalis* resource	4
44: Inadequate catch statistics – *Selene dorsalis*	4
53: Biomass estimated from the Demersal Surveys	0
New-1: Lack of knowledge on feeding interactions and predation mortality	na

(ii) Proposed management responses

Action 1. Improve database system
Action 2. Biological sampling programme and onboard scientific observer programme
Action 3. Joint and experimental surveys
Action 4. Indicators of ecosystem health
Action 5. Statistical data collection
Action 6. Regular social and economic surveys

Thirty issues were included in the group "research". These included species-specific issues related to *Scomber japonicus, Decapterus rhoncus, Sardinops sagax, Trachurus capensis, Sardinella aurita, S. maderensis, T. trecae, Trichiurus lepturus, Selene dorsalis* and *Brachideuterus auritus*. The issues fall into a number of distinct groups. For many of these species, the catch statistics and the knowledge of their biology and behaviour were considered to be inadequate for effective management. In some cases, there are also unanswered questions about the stock structure and identification of the species. A specific issue for all of them is the difficulty of identifying individual species in the acoustic surveys, leading to uncertainties in the biomass estimates which are a very important input to management of this fishery. Variability in recruitment and availability of these species to the fishery is affected by climate variability and creates difficulties for effective management. The impact of the oil industry on the fishery is also a cause for concern.

Potential management responses to address these concerns were identified. They focused heavily on routine monitoring and improving the database system to handle the data generated. Effective collection and monitoring of fisheries data was considered to have the highest likely benefit:cost ratio (20), followed by improving the data base system, and development and monitoring of reliable indicators of ecosystem health (ratio of 14 for both).

Group B: Management and MCS

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
1: Fishing near the coast	24
71: Monitoring, control and surveillance of management measures inefficient	24
32: *Sardinops sagax* resource is shared with Namibia	24
82: Seasonal migration, especially of shared resources	20
77: Keep open access for artisanal fishery, but start planning for access restrictions	20
76: Open access for artisanal fishery	20
73: Lack of management plans for all species	20
72: Lack of a database system allowing crossing of information about licences, effort and landings	20
20: *Trachurus trecae* resource is shared with Namibia and countries north of Angola	16
8: *Sardinella aurita* resource is shared with countries north of Angola	16
26: *Trachurus capensis* resource is shared with Namibia	16

14: *Sardinella maderensis* resource is shared with countries north of Angola	16
37: *Scomber japonicus* resource is shared with Namibia and countries north of Angola	8

(ii) Proposed management responses

Action 7. An appropriate management plan for the small pelagic fishery, adopted by all main stakeholders
Action 8. Joint management of shared stocks with neighbouring countries
Action 9. Improvement of the MCS system, including the VMS system
Action 10. Licence limitation extended to semi-industrial fishery

The group "management and MCS" included 13 issues. Seven of those issues addressed, completely or in part, the fact that management was not taking into account the shared nature of key species, while a key, underlying issue was the absence of a management plan for the fishery. The open access nature of the artisanal fishery, which also catches these species, was also an important concern. Four possible management responses were identified to address all the issues. As with other fisheries, the development and implementation of a management plan were seen as important with high short and long-term benefit:cost ratios. Extending access restrictions, in the form of licence limitation, to the semi-industrial fishery was estimated to have the highest short-term benefit:cost ratio (13) and also, at 20, a high ratio in the long term. The next most advantageous management response, in terms of benefit:cost ratio, would be the implementation of joint management of shared stocks with neighbouring countries, followed by strengthening of the existing MCS system.

Group C: Bycatch and discards

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
2: Inadequate fishing gear (beach seines)	24
39: Capture of large amounts of horse mackerel by the demersal trawl	24
61: Round herring is discarded	0
45: *Selene dorsalis* is a non-target species, but is nevertheless retained when captured	0
49: *Trichiurus lepturus* is a non-target species, but is nevertheless retained when captured	0
56: Seals consumed when captured as bycatch	0
57: Dolphins consumed when captured as bycatch	0
59: Sharks retained when captured	0
60: Myctophidae are discarded	0

(ii) Proposed management responses

Action 11. Close shallow areas and bays, where smaller fish and vulnerable species concentrate, to purse seine fishery
Action 12. Prohibition of dumping and discards
Action 13. Improve MCS system, including VMS on smaller vessels
Action 14. Support for local fisher's cooperatives, incorporating MCS capability

Only two of the issues identified under this heading were ranked as being of concern, the consequences of use of fine-meshed beach seines (banda-banda) on small pelagics and the bycatch of horse mackerel, which is an important species for the pelagic fishery, in the

demersal fishery. The management response with the highest estimated benefit:cost ratios in the short and long term was to work with fisheries cooperatives, including as a means of improving MCS. The next highest ratio was considered to apply to closures of shallow areas and bays to the pelagic fishery to reduce bycatch of small fish and endangered species.

Group D: Social and economic

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
86: Infrastructures (roads, bridges) are damaged and need rehabilitation	25
63; 64: The working conditions of women in the salt and dry industry are not adequate	20
66: In the coastal provinces of Benguela and Namibe, the fishing industry involves the major part of the workforce	20
67: Many families depend on the artisanal and semi-industrial fishery	20
83: Low life expectancy of fishers due to excess consumption of alcohol and tobacco	16
84: The new generations do not wish to participate in the activity	16
85: The majority of fishers cannot read or write	16

(ii) Proposed management responses

Action 15. Continue rehabilitation and building of support infrastructures
Action 16. Training of fishers, fish processors and managers
Action 17. Support to rehabilitation and modernization of fish processing facilities
Action 18. Expansion and reinforcement of fish quality inspections
Action 19. Increase support to producers' organizations

The issues listed under the heading "social and economic issues" point to some substantial problems in the fishery. High levels of dependency on the fishery for livelihoods, poor working conditions and social problems amongst fishers were highlighted as causes of concern, exacerbated by poor infrastructure. Training of fishers, fish processors and managers was considered to be the management response likely to generate the highest benefit:cost ratios in the short and long term (13 and 20, respectively). The training should address the implementation of more responsible fishing practices which would reduce negative impacts on the ecosystem and on how to improve the quality of the catch and reduce wastage. This would be complemented by improving the effectiveness of fish quality inspections and provision of improved fish processing facilities. Support to producer organizations and improving the infrastructure for fisheries were also identified as potentially beneficial management responses.

5.2 Namibia

5.2.1 Hake fisheries

The broad objectives for the fishery

- Ensure sustainable exploitation of the hake stocks including stock rebuilding, optimizing yield and maintaining size structure.
- Minimize bycatches including incidental mortality of non-commercial species.
- Maintain biodiversity and ecosystem functioning.
- Mitigate habitat and substrate damage.
- Ensure optimum economic return.
- Optimize social returns, employment, food security, empowerment and social upliftment.
- Maintain adequate research and management capacity.
- Namibianization.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop on this fishery were split into the following groups: (A) substrate and ecological effects, (B) retained bycatch, (C) incidental bycatch, and (D) management, monitoring, control, surveillance (MCS) and governance. The comparative results of the benefit:costs assessment for all groups are shown graphically in Figure 5.2.1.

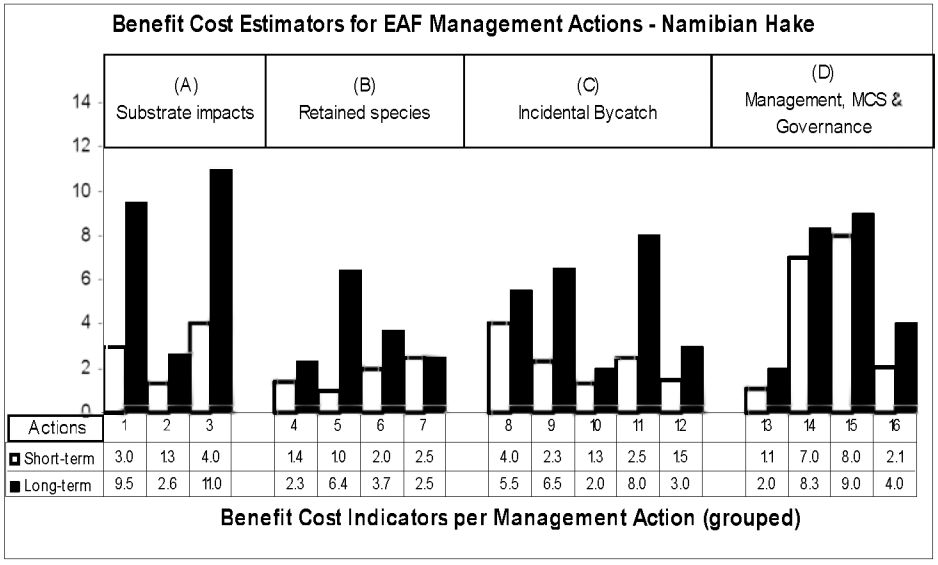


Figure 5.2.1. Benefit:cost ratios for possible management action for Namibian hake fisheries. See text for description of the actions and issues included in each group

Group A: Substrate and ecological effects

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
67: Trophic impact induced by other fisheries (e.g. overfishing of other stocks – prey and predators)	20
34: Removal of biomass (hake and other caught species) may alter the trophic structure and functioning of the ecosystem	15
22: The fishery impacts the populations and structure of the benthic fish community (predominantly rat tails)	15
11: Combined management of the two species may lead to undesirable impacts on one or both species	12
33: Trawling causes physical damage to benthic habitat	8
35: Damage to sensitive benthic biota	8
12: Fishing activity reduces or changes geographical distribution of the species	2
24: The fishery impacts the populations of jellyfish	1

(ii) Proposed management responses

As most of the issues had a common theme, management actions focused on research to address the main issues *viz:*

Action 1. Assess hake species separately
Action 2. Initiate research and introduce management measures on the effect of trawling and other gear types on substrate, habitat and benthic community
Action 3. Initiate trophic and diet-related studies and introduce an associated management action

The anticipated benefits of these actions were most likely to accrue in the long-term and are dependent on not only developing an understanding of the problem,but also on testing the impact of management measures put in place. Action (3) had the greatest perceived long-term benefit. Historically, the two main hake species caught commercially in the region have been assessed as a single stock. This has presented many problems relating to the management of the two species (*M. paradoxus* and *M. capensis*) including general ecosystem effects. Impact on the substrate by trawling is a global problem and addressing this concern was recognized as a major step forward in understanding the effect of trawling on the ecosystem.

Group B: Retained bycatch

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
14: The hake fishery may be negatively impacting the sustainable use of monkfish	24
23:The fishery impacts the population of crustaceans	15
13: No management or bycatch plan is in place to ensure the sustainability of the following bycatch species: angelfish, kingklip, dentex, jacopever, sole, alfonsino, squid (especially kingklip and sole)	15
15: The hake fishery may be negatively impacting the sustainable use of horse mackerel and orange roughy	5
7: Bycatch in the horse mackerel midwater trawl fishery might be contributing disproportionately to low abundance	4

Single species issues with possible linkages to EAF management measures	
27: Lack of an approved management plan (for midwater trawl fishery but also for horse mackerel as a whole) with reconciled objectives	18
37: No direct representation from this industry on the Advisory Council	18
34: Research resources perceived to not be adequate by the industry	12
39: Lack of transparency in decision making and no clear record of decisions	12
29: Information sharing with Angola needs to be improved for Cape horse mackerel	10

(ii) Proposed management responses

It is noticeable that the main risks were believed to be associated with the impact on other fisheries and that the principle management response focused on penalties and closed fishery management areas viz:

Action 4. Introduce appropriate levies and penalties for demersal species
Action 5. Establish closed areas
Action 6. Research on bycatch in the hake fishery
Action 7. Research on impact of hake bycatches in horse mackerel fishery

Bycatch of other marine species in directed fisheries remains problematic. The hake-directed trawl fisheries were no exception to this and the management actions were intended to penalize fishers for unacceptable levels of bycatch as well as increasing research. The action with the highest long-term benefit:cost ratio was Action 5 on enclosed or protected areas.

Group C: Incidental bycatch

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
16: Bycatch of seabirds may be negatively impacting the viability of 13 species of albatross and petrel plus Cape gannet *Morus capensis*	24
27: Change in behaviour and population dynamics (foraging and distribution driven by supplementation of diet) of seabirds – offal management; ingestion of pollution	18
32: Seabirds become oiled from small chronic spills and deliberate disposal of oil and fuel at sea from fishing vessels	12
18: Bycatch of sharks may be negatively impacting the viability of 3 endemic (Benguela) species (puffadder shy shark *Haploblepharus edwardsii*, St Joseph's *Callorhincus capensis* and white-spotted *M. palumbes* sharks)	12
19: Bycatch of skates may be negatively impacting the viability of 3 endemic (Benguela) species (slime skate *Raja pullopunctata*, munchkin skate *R. caudaspinosa* and yellowspot skate *R. wallacei*)	12
25: The fishery impacts the population of other sharks and skates (not currently classified as threatened or specifically protected)	12
29: Shooting of bull seals impacts population dynamics, e.g. sex bias or age structure	10
28: Maceration/release of offal leads to "soaking" of Cape gannets	8
30: Seabirds become entangled or ingest plastics and persistent materials dumped from fishing vessels	6
36: Cetaceans and seals and other species become entangled in lost and trawl longline gear	6
37: Seabirds become entangled in lost trawl and longline gear	5

26: Change in behaviour and population dynamics (foraging and distribution driven by supplementation of diet) of seals – offal management; ingestion of pollution	5
21: The fishery impacts the population of seals	4
17: Bycatch of sharks may be negatively impacting the viability of species of threatened shark e.g. blue and mako sharks (note: a targeted fishery for mako sharks exists)	2
20: Fishery catches dolphin species that are protected under Namibian legislation	2
31: Seals become entangled or ingest plastics and persistent materials dumped from fishing vessels	0

(ii) Proposed management responses

Management responses focused on both research to try and understand the impacts of incidental mortality and also potential mitigation methods *viz:*

Action 8. Assess the extent of chondrichthyan mortality in the hake trawl and longline fisheries
Action 9. Assess and mitigate seabird impacts
Action 10. Assess the extent of seal shooting and introduce appropriate management measures
Action 11. Enforce pollution laws
Action 12. No dumping of fish offal

Incidental mortality in fisheries is a universal problem, with increasing realization of impacts on sharks, seabirds, marine mammals and turtles. In this regard the management actions were aimed at firstly identifying the problem areas and also at mitigation methods to reduce incidental mortality. Enforcement of existing legislation (Action 11) was estimated to have the highest long-term benefit:cost ratio.

Group D: Management and MCS

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
53: Problems with attracting and retaining qualified and experienced staff	24
54: Inadequate research budget leading to insufficient services and facilities	24
61: The lack of wider representative participation in council and working groups, e.g. public interests, conservation groups, NGOs	16
48: VMS is still not in place	12
49: Penalties for transgressions are not adequate	12
47: A need for improved transparency in the management of resources	12
51: Lack of observer coverage on smaller vessels (while observers do not have an enforcement function, their presence increases compliance)	8
63: The absence of an industry code of conduct may disadvantage Namibia's fisheries in the light of global pressure and trends for responsible fisheries	6
62: Improved communication to the general public	6
55: Poor cooperation/interaction between stakeholders (observer agency, industry, directorates, Department of Marine Affairs, NGOs)	6

(ii) Proposed management responses

Management responses (Figure 5.2.1) focused on capacity (relating to insufficient trained staff) and communication between stake holders, and practical governance applications *viz:*

Action 13. Establish a task force to investigate alternative capacity building and incentives (including research budget)
Action 14. Review regulations and revise penalty structure
Action 15. Improve communication between stakeholders and liaison between members of the working group
Action 16. Optimize observer coverage and data quality

In the BCLME region, capacity and experience in not only research, but also other disciplines such a management, monitoring and control is a serious concern. Development of capacity in Namibia as well as the region was critical if ecosystem-based management regimes were to be introduced. Further, MCS underpinned good management and for this reason management actions were focused on both governance and quality data collection. Actions 14 and 15 were considered to have the highest benefit:cost ratios in both the short and long term.

5.2.2 Small pelagics fishery

The broad objectives for the fishery

- Rebuild the pilchard stock (age structure, distribution…).
- Understand the biological parameters of pilchard (especially M).
- Ensure long-term sustainable utilization.
- Improve understanding of the ecology of small pelagics.
- Develop a management plan including clear measures and rules (reference points etc.).
- Management of other harvested small pelagic species (e.g. anchovy).
- Limit pilchard bycatch in other fisheries.
- Stabilize TAC's, with a view to strengthen the markets and employment (markets, financial and job stability).
- Develop transboundary management with Angola.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop on this fishery were split into the following four groups shown graphically in Figure 5.2.2. (A) research, (B) management, (C) social and economic issues, and (D) communication.

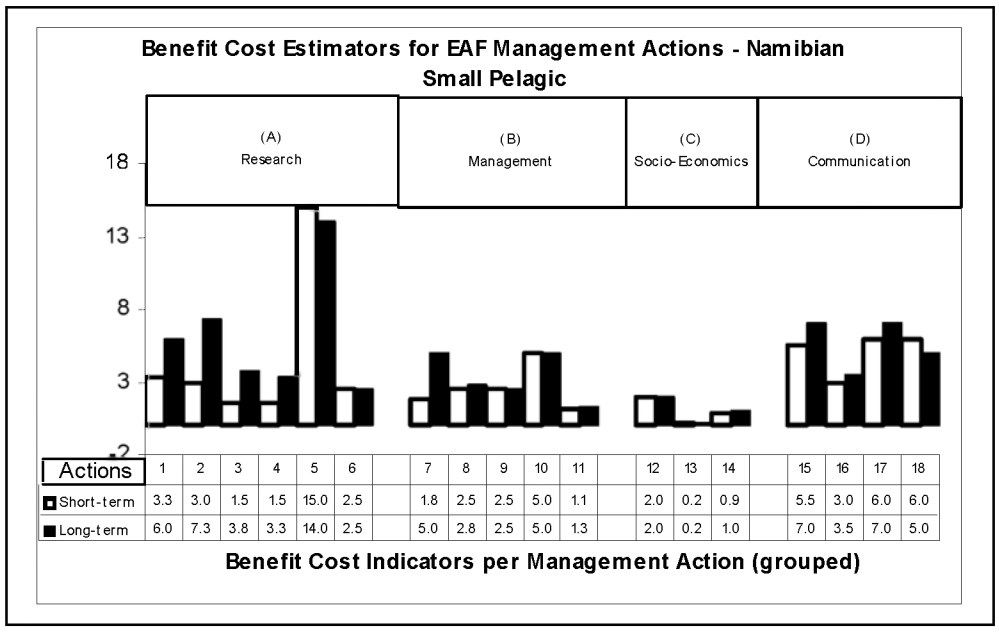


Figure 5.2.2. Benefit:cost ratios for management actions for the Namibian purse seine fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
26: Decreased food availability for predators (gannets, penguins – species unable to make switch to gobies)	24
28: Overfishing may have led to long term change in the trophic structure (possibly an alternate stable state)	20
5: Pilchard: variability in recruitment is not well understood	18
7: Pilchard: unusually high and unknown natural mortality	18
11: Anchovy: variability in recruitment is not well understood	18
14: Horse mackerel: variability in recruitment is not well understood	18
16: Gobies: little known about this species (life history, ecology, etc.)	18
24: Removal of grazers leads to accumulation of plankton biomass possibly leading to sulpur eruptions and low oxygen events	16
25: Removal of small pelagics may have led to the increase in gobies, jellyfish, etc.; abundance and distribution (and other possible trophic impacts)	16
13: Horse mackerel: Fishing of juveniles has unknown effect on recruitment	12
15: Round herring: little known about this species (life history, ecology, distribution, etc.)	12
27: Decreased food availability for predators able to make switch to alternate prey (seals, sharks, hake, snoek, etc.)	12

(ii) Proposed management responses

Benefit:cost ratios of different management actions (Figure 5.2.2) focused on research with the collation of historical data having the greatest perceived long-term benefit *viz:*

Action 1. Intensify/expand research on consumption rates of all predators on small pelagic species and determine population trends of the predators (birds, mammals and fish)
Action 2. Increase research on early life stages of all small pelagic species, identify relationships between fish (including recruitment) and the environment
Action 3. Initiate directed research to estimate abundance, spatial and temporal distribution and impacts on pelagic resources such as trophic effects of jellyfish, gobies and other meso-pelagic species
Action 4. Initiate research on trophic structure of the ecosystem including abundance and consumption levels
Action 5. Collate historical data (especially with respect to information on ecosystem trophic structure)
Action 6. Initiate research on other small pelagic species

Historically, the Benguela region off Namibia supported one of the most productive small pelagic fisheries in the world. Stocks collapsed in the 1960s and have since never recovered. It is in this context that the potential of EAF management was viewed, with management actions aimed at better understanding ecosystem relationships.

Group B: Management

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
4: Pilchard: Size and age structure has changed (fish are much smaller and no more fish older than 3 years)	18
2: Pilchard: Distribution of shoals has become more patchy (effect of decreasing abundance)	15
8: Anchovy abundance is low	12
Single species issues with possible linkages to EAF management measures	
43: Socio-economic demands conflict with sustainability	24
42: Lack of an approved management plan that includes reconciled objectives	20
3: Pilchard abundance is critically low	18
45: Lack of economic information for decision making	18
46: Research budget has got smaller with catches (drawn from levies) – leads to less research vessel availability	18
51: Narrow representation on the Advisory Council and working groups (no labour, civil society, fisheries specific, etc.)	18
53: Lack of external review and appraisal of management procedures	18

(ii) Proposed management responses

The BCA ratios of the various management responses are shown in Figure 5.2.2 with very little difference between short and long-term periods. The responses to management issues were generally seen by the workshop participants to have lower benefits than for research (Group A).

Action 7. Rebuild stock by closing the fishery (until a reference point is reached)
Action 8. Reduce predation on pilchard

Action 9. Apply a constant minimum catch (pilchard TAC)
Action 10. Set a minimum horse mackerel TAC for purse seiners
Action 11. Apply a closed season and area

Management actions therefore targeted the size structure of the pilchard where the intention is to allow for adequate build up of spawner biomass. This included reducing bycatch of pilchard in other fisheries as well as spatial and temporal measures. Actions 7 and 10, both of which specified direct action to control fishing mortality, were considered to have the highest benefit:cost ratios.

Group C: Social and economic issues

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
35: Changes in TAC affects income and loss of livelihood for workers' dependents	24
34: Variability in resource availability makes planning difficult, low security, low investor confidence	18
37: Collapse of fishery could result in large scale knock-on effects on dependent service providers and retailers (engineering companies, transport, shipping repairs, provisions, fuel, etc.) in Walvis Bay and Swakopmund	10
50: Lack of specific labour regulations for seagoing staff	12
Single species issues with possible linkages to EAF management measures	
40: Historically this fishery was a large contributor to National GDP (large potential for future)	18
55: Loss of markets due to variability in TAC	18
32: Recent decrease in numbers of jobs available - including recent closures of canneries (but fishery still has high potential for future)	12
36: Medical insurance and other employer benefits are no longer available/affordable for the majority of sea-going personnel	12
41: Historically this fishery was the largest employer (large potential for future especially for Namibians)	24
33: Threat of TAC <20 000 tonnes could close the fishery permanently	20
38: Knock on effects on the rural areas from which migrant labour is drawn	10
54: Lack of newly trained skilled labour	10

(ii) Proposed management responses

Of all the Groups for the small pelagic fishery, the CBA for socio-economic management responses was perceived to have the least benefit. Although socio-economic concerns were important in Namibia, particularly for employment, actions that related directly to ecosystem impacts were allocated a higher priority by Workshop participants. This reflected the critically low biomass and vulnerability of the stock. Only once stocks were restored to sustainable levels and a balance achieved in the ecosystem, would social and economic benefits accrue. Management actions suggested were:

Action 12. Minimum TAC (pilchard), rights consolidation and or effort reduction
Action 13. Apply alternative resource options and value adding
Action 14. Apply a minimum horse mackerel TAC

Group D: Communication between stakeholders

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
49: Lack of communication between Ministries (Transport, Fisheries, Labour, Finance)	15
47: Lack of sufficient cooperation within the Ministry (between different Directorates)	12
52: Poor communication with the general public (including transparency in decision making)	12
56: Civil Society and NGOs are poorly organized and represented in fisheries matters, mainly due to a lack of information and communication by management	12

(ii) Proposed management responses

The CBA in this group gave the most consistently high perceived benefits for all suggested management actions with similar benefits in both the short and long-term. These included :

Action 15. More consultative working groups (including Ministry Directorates and industry) with appropriate delegation of authority
Action 16. Creation of public awareness of fisheries
Action 17. Advisory council members to have a wider representation (different stakeholders)
Action 18. Transparency in decision-making (including TAC) at management level

Actions that improved consultation and communication leading to a better understanding of ecosystem effects were seen as a priority. Historically in Namibia, communication between fishers, research and management had been inadequate and the suggested management actions aimed at resolving this concern. The estimated benefit:cost ratios of the set of Actions 15–18 were second only to those proposed under Group A: Research.

5.2.3 Namibian midwater fishery

The broad objectives for the fishery

- Minimize impacts of fishery (trophic relationships with other species, changes in size structure, distribution, biomass).
- Maximize economic sustainability.
- Optimize social and economic benefits.
- Increase understanding of horse mackerel biology and dynamics.
- Ensure sustainable utilization and conservation of the resource.
- Maintain appropriate levels of MCS.
- Manage the resource according to an accepted plan.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop were applied to the CBA workshop with similar groupings applied *viz.* Research, Management, Social and economic, and Compliance (shown graphically in Figure 5.2.3). The highest benefit:cost ratios were found to be achievable in the Research grouping, followed by Management. All issues in the

Social and economic group were deemed target oriented issues and no BCA assessment was therefore performed.

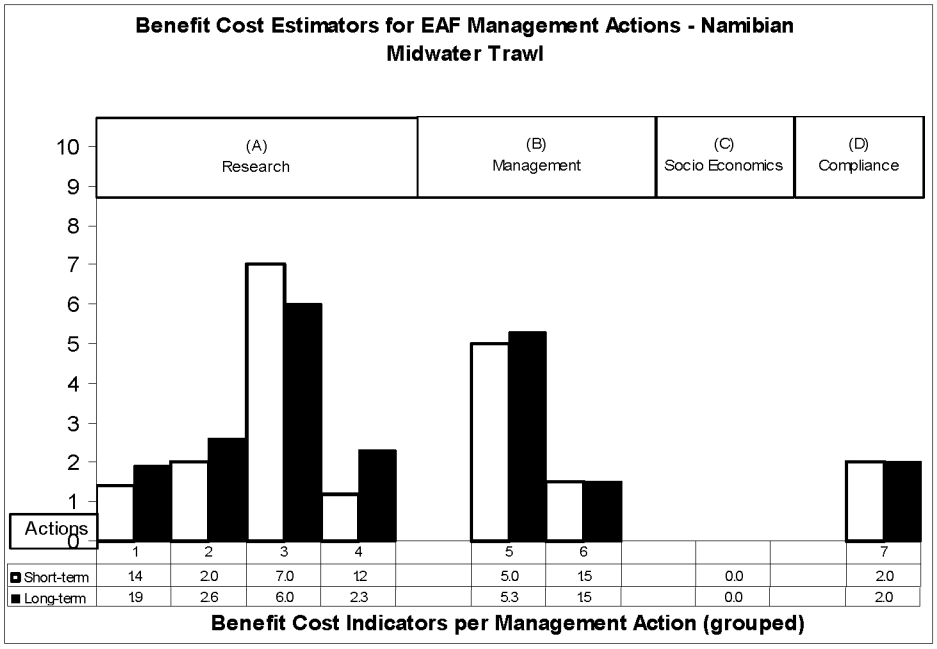


Figure 5.2.3. Benefit:cost ratios for management actions for the Namibian midwater fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
5: Cape horse mackerel: size has decreased significantly and fish are maturing earlier	18
10: Dentex, angelfish, snoek, jacopever, squid, dories, mackerel, ribbonfish: very little known on the biology and potential impacts	18
17: Little known about the trophic role of horse mackerel (e.g. trophic relationship with hake and pelagics) and how fishing impacts this relationship (e.g. changes in size, distribution and biomass)	15
18: Horse mackerel has become a major forage fish for top predators (seals, seabirds - gannets, penguins, large pelagic and demersal fish) and little is known about how fishing impacts this relationship (e.g. changes in size, distribution and biomass)	15
19: Bycatch mortality may have ecosystem impacts in itself	15
20: Impact of relaxing the 200-m restriction on the ecosystem and horse mackerel stock	15
7: Juvenile hake: may be contributing to low abundances (this is not accounted for in hake models)	8
Single species issues with possible linkages to EAF management measures	
4: Cape horse mackerel: estimates of current biomass are highly variable (confidence in certain parameters for model is limited and uncertainty around survey results)	18
3: Cape horse mackerel: Bulk of catches are taken from a small area (where the species is concentrated) in comparison with the wider distribution of the species as a whole	12

(ii) Proposed management responses

The Namibian horse mackerel resource remains one of the strongest resources in the region. However, the species is exploited by numerous fisheries, and also as a bycatch in other target fishery sectors (including hake and small pelagic). Because of the diversity of the exploitation methods as well as the industrial nature of the main fishery (using large midwater trawlers), the management actions proposed aimed at improving knowledge on bycatch as well as spatial and temporal area closures. The workshop participants clearly identified the importance of the 200-m depth restriction on the fishery and the main management action was aimed at evaluating this particular issue.

Action 1. Improve data collection on bycatch
Action 2. Increase data collection on trophic and behavioural dynamics (study diets, consumption rates, biomass)
Action 3. Investigate the impact of relaxing the 200 m depth restriction (north of 18'30° S) through directed experiments
Action 4. Collation and analyses of historical data on horse mackerel dynamics

Group B: Management

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
35: Budget not adequate for broader ecological research	18
40: Lack of regular external review and appraisal of management and research	18
36: Issues general to government departments: availability and retention of skilled personnel; poor training and career development plans; research budgets are limiting (equipment, ship time, etc.)	12
43: Need for responsible NGOs and civil society to be well organized and better represented in fisheries matters	12
Single species issues with possible linkages to EAF management measures	
27: Lack of an approved management plan (for midwater trawl fishery but also for horse mackerel as a whole) with reconciled objectives	18
37: No direct representation from this industry on the Advisory Council	18
34: Research resources perceived not to be adequate by the industry	12
39:Lack of transparency in decision making and no clear record of decisions	12
29: Information sharing with Angola needs to be improved for Cape horse mackerel	10

(ii) Proposed management responses

The CBA identified budget constraints and capacity as the two biggest inhibitors of fisheries management in Namibia. As with other Namibian fisheries, an adequate budget for broad ecological research was needed as well as for skills development.

Action 5. Increase research budget and acquire alternative sources of funding (e.g. international and regional collaboration and exchange programmes)
Action 6. Establish an external research review (e.g. every three years)

Action 5 was considered to lead to the second highest benefit:cost ratio of all Actions in this fishery.

Group C: Social and economic

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
No EAF issues for management action considered necessary in this category	
Single species issues with possible linkages to EAF management measures	
42: Lack of skilled Namibian labour	18
30: Impact of not relaxing 200-m contour on the industry	12
38: Misconceptions on the impact of this fisheries and its benefits to Namibia	12
23: Not a large number of Namibians employed in this industry and these are mainly unskilled	10
26: Contributes to food security in Namibia and Africa	8

(ii) Proposed management responses

As there were no EAF issues identified in this Group, no management actions were proposed.

Group D: Compliance

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
21: Compliance with waste and litter regulations (largest fishing vessels in our fleets)	10
Single species issues with possible linkages to EAF management measures	
33: Fines imposed by inspectors are not an effective deterrent	18
32: Overcatching by certain right-holders	12

(ii) Proposed management responses

As the midwater trawl fishery comprises relatively few large vessels it is easily controlled. However because of the industrial nature of the fishery and the large volumes of horse mackerel processed, disposal of waste and other materials is problematic. The suggested action was therefore to increase MCS effort in the fishery.

Action 7. Increase effort for more focused monitoring, control and surveillance

5.3 South Africa

In all three fisheries actions which develop holistic research, study trophic interactions and develop multi-species/ecosystem models were considered by workshop participants to be within the top five in terms of long-term benefit for the fishery. Actions addressing the distribution and stock structure of hake and West Coast rock lobster were also in the top five. Actions to improve resource management working groups were in the top five for the small pelagic and West Coast rock lobster fishery. ***Clearly, the three common features which will provide the greatest long-term benefit for these three fisheries are: ecosystem data, target species stock structure and resource management.***

5.3.1 *South African hake*

The broad objectives for the fishery

- Maximize long-term economic sustainability of the fishery (e.g. improve catch rates and size structure).
- Manage hake stocks to ecologically sustainable levels (trophic interactions).
- Rebuild hake stocks to minimize risk to the resource (recruitment, etc.).
- Minimize loss of biodiversity due to seabed damage.
- Minimize incidental mortality of seabirds, sharks, marine mammals, etc.
- Minimize discard and loss of target species and manage bycatch.
- Develop appropriate management measures for multiple and shared stocks.
- Optimize social and economic benefits across sectors.
- Maintain adequate research and management capacity.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop on this fishery was split into the following groups shown in Figure 5.3.1: research and modelling, responsible fishing, bycatch, social and economic, database, management, research capacity and policy.

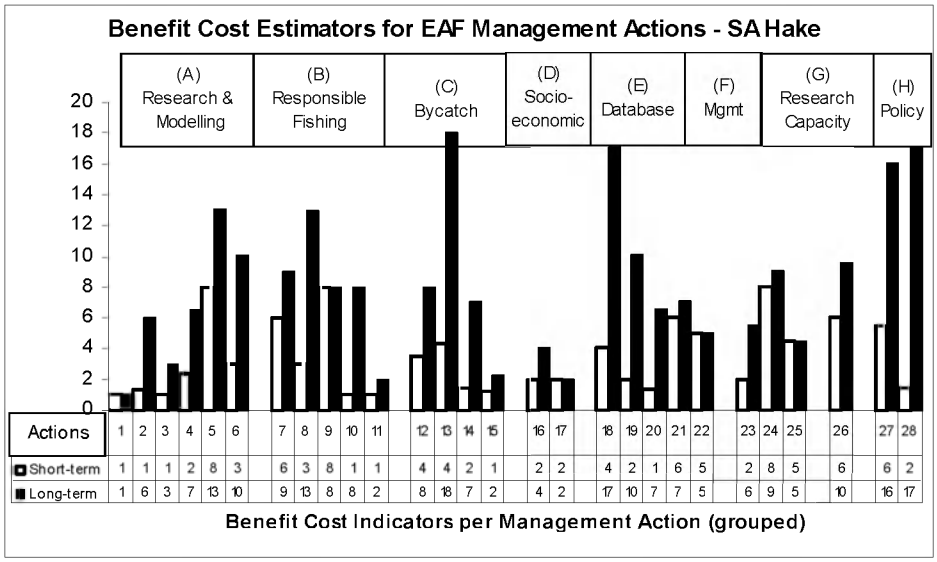


Figure 5.3.1. Benefit:cost ratios for possible management action for South African hake fishery. See text for description of the actions and issues included in each group

Group A: EAF research and modelling dynamics

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
3: Both hake species: uncertainty about the estimation of natural mortality (predation and cannibalism)	18
38: Direct effects of trawling gear on benthic habitat and communities	18
78: Currently biodiversity audits for marine species are not being done	12
34: Removal of predators may have an effect on the abundance of smaller pelagic species and mesopelagics	12
33: Trophic implications for small pelagic and mesopelagic species of removing large hake	12
81: Lack of state of the environment reports	12
35: Change in size structure of hake leads to a switch in prey preference	9
37: Hake are a component of the diet of marine mammals and other top predators (seals, swordfish – possible, snoek)	6
42: Disturbance of sediments may change water chemistry (oxygen, etc.)	0

(ii) Proposed management responses

Action 1. Establish communication with agency conducting biodiversity audits
Action 2. Year of the stomach (for trophic interactions – other data may be collected simultaneously)
Action 3. Program to assess seabed impact and introduce management measures
Action 4. Develop data collection protocol for observer program (general)
Action 5. Fund and undertake the development and refinement of multi-species/ecosystem models
Action 6. Fund and undertake the development and refinement of ecosystem indicators

The South African hake fishery targets two species of hake, *Merluccius capensis* (shallow) and *M. paradoxus* (deep water), whose distributions overlap. The fishery uses both trawl and longline to target these species. The dynamics of this stock are modelled using an age-based model which needs many parameters. In addition, little work has been completed on assessing the ecosystem effects of the fishery. As the issues relate to specific scientific data necessary for resource management, there are almost as many actions as issues in Group A. Actions 5 and 6 are anticipated to provide the most long term benefit relative to cost. Although Action 2 is anticipated to be costly, it will provide data to address several issues.

Group B: Responsible fishing

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
21, 20: Impacts of hake trawling and longlining on threatened species of seabirds	18, 12
39: Effects of offal discards on distribution patterns and behaviour of seabirds	12
25, 30: Bycatch of fish and chondrichthyans in the hake trawl and longline	12, 12
40: Beneficial effect of offal discards for seals	6
19: Seal (protected species) mortality in trawling operations	6

22: Seabirds sometimes caught for human consumption using handlines.	5
32: Potential oiling/soaking of gannets from factory vessels. This has been recorded as an issue off Namibia (observed incidence of birds covered with fish oil at colonies). It has not been recorded off South Africa. However, lack of observations does not mean that there is no problem – it could be that oiled birds do not manage to get back to the colonies	2
36: Ghost fishing by discarded fragments of nets and longlines	2
31: Shooting of seals interacting with gear	0

(ii) Proposed management responses

Action 7. Assess level of interactions using appropriately trained personnel (birds, mammals and sharks)
Action 8. Test and introduce mitigation measures through consultative process
Action 9. Enforcement of new mitigation measures (all species)
Action 10. Assess how species distribution, diet, foraging behaviour and abundance are impacted by offal discards (all species)
Action 11. Education and awareness programme for mitigation measures for all ecosystem impacts

Responsible fishing issues centred on seabirds and seals as these are protected species and have the highest direct interaction with the gear. All actions suggested are anticipated to provide high long-term benefit relative to cost. Actions 7, 9, 10 and 11 would all require a few specially-trained and well-placed observers.

Group C: Bycatch of commercial species

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
27, 28, 26: Bycatch of linefish (e.g. silver and dusky kob) protected in MLRA, on soft ground available to the inshore trawling and operating in nursery grounds of linefish; bycatch of linefish on hard ground; bycatch of wreckfish in waters deeper than 200 m	18, 2, 9
15: Contribution of hake trawl fishery to overexploitation of monkfish (*Lophius vomerinus*) and kingklip (*Genypterus capensis*) stocks	16
24, 18: Impact of hake trawling and longlining on commercial species caught as bycatch (skates, rays, gurnards, sharks, jacopever, Cape dory, angelfish, bellman, chokka squid, etc.) and on other non-utilized benthic species caught as bycatch	12, 12
16: The snoek resource is being impacted by the hake trawl fishery	8
17: Lack of understanding and quantification of the impact on linefish (kob, white stumpnose, etc.)	6
23: Mortality of *Galeorhinus* and *Mustelus* in the longline fishery (these species are commercially harvested)	6
29: Bycatch of other benthic species that have been recorded in the trawl catch	6
41: General pollution associated with fishing vessels and harbour activity is considered across all fisheries	0

(ii) Proposed management responses

Action 12. Where feasible, assess status of, and develop management plans, for "targeted" bycatch species
Action 13. Manage fishing effort
Action 14. Manage and monitor bycatches (includes coordinating with linefish management)
Action 15. Investigate zoning of sector specific fishing areas

The long-term benefit:cost of actions 12–15 are significant when compared to the short term. Success requires 10–20 percent observer coverage of fleet, and commercial catch records must include bycatch declarations, continued collection of catch, catch-at-length, ageing material and biomass survey abundance indices and regular updates of stock assessment models.

Group D: Social and economic considerations

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
44: There is a lack of baseline social and economic information.	30
48: A downturn in the fishery will have a negative impact on businesses who provide gear, boat repairs, etc., in highly dependent communities in Saldanha Bay, St Francis, St Helena, Mossel Bay, Hout Bay and Kalk Bay	15
45: Overdependence on demersal fishery in certain coastal communities	15
51: The impact of a downturn in this fishery on the regional economy (Western and Eastern Cape)	12
53: A downturn in the fishery will have a significant effect on employment in the Western and Eastern Cape	12
49: A downturn in the fishery will have a negative impact on businesses who provide gear, boat repairs, etc., in Cape Town and Port Elizabeth	10
43: Social and economic/welfare effect of trade-offs between longline and trawl fisheries.	9
54: A large quantity of white stock fish is being imported into South Africa	6
14: Increase in parasites, which could affect fecundity and marketing of *M. capensis*	6
46: Safety at sea is a problem	6
47: There is a lack of business skills and entrepreneurship in optimal use and processing.	6
50: The impact of a downturn in this fishery on the national economy	4
52: The impact of a downturn in this fishery on public wellness in terms of food supply	4

(ii) Proposed management responses

Action 16. Analyse data collected as part of the Long Term Rights Allocation Management Process (LTRAMP) process and monitor new data when submitted
Action 17. Conduct and maintain baseline social and economic studies

These actions were estimated to have relatively low but still positive benefit:cost ratios in both the short and long term. There is an urgent need for extensive social and economic data for each of the sectors and its associated communities. A lack of social scientists and

economists who have experience and an understanding of the sector, and a lack of data to aid decision-making result in management decisions which tend to err on the side of human concerns to the likely detriment of the ecosystem as a whole. Both actions are likely to be costly but the benefit was still considered greater than the cost. The LTRAMP awarded long-term (8–10 year) rights in all fisheries. Previously rights were allocated on an annual basis.

Group E: Hake management

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
12: Implications for the hake resource of removing large shallow-water *M. capensis*. Larger females targeted in longline and trawl fishery are likely to produce more eggs than smaller females, and the eggs are probably more viable	24
2: Hake fishing mortality is underestimated owing to discarding, reduced survival after escapement, and loss of large hake from longlines	18
7: Uncertainty about the proportions of each hake species in total catch limits options for species-specific management measures	18
9: *M. paradoxus* resource currently estimated to be below BMSY	18
13: Fishing mortality on small *M. capensis* in inshore trawl fishery on the south-east coast (especially in Agulhas sole-directed trawls)	18
66: Inadequate age information	18
3, 5, 6: Basic knowledge of the life-history strategy is lacking and thus makes hake fishery management difficult (there is uncertainty about the estimation of natural mortality [predation and cannibalism], recruitment variability).	18, 18, 15
65: Technological and effort creep are not incorporated in the analysis of CPUE data and assessments	15
11: Uncertainty and disagreement as to the status of the stock	12
1, 4: Changes in spatial distribution, uncertainty about longshore, offshore and vertical migration by hake in the water column. Decline in catch rate in recent years may be linked to changes in distribution or availability; catch rates on the West Coast declined more than those on the south-east coast, indicating that there may have been a southward shift in the resource (similar to that reported for small pelagics)	8, 8

(ii) Proposed management responses

Action 18. Time-area closures and MPAs to protect specific size classes
Action 19. Management of selectivity and effort
Action 20. Design and implement recruit survey with adequate spatial and temporal coverage
Action 21. Augment CPUE database with retrospective technological improvement data (including skipper effects)
Action 22. Observer program to monitor discarding

Actions 18 and 19 had the greatest long-term benefit:cost as it is anticipated that the data and capacity necessary to achieve these actions are available and the outcome would be hugely beneficial. The remaining actions are anticipated to be more costly as they require data collection and time at sea. This would include using an observer program to determine the proportion of hake catch comprised of *M. capensis* and *M. paradoxus* for the whole fishery and per fleet; quantify hake discards; length distribution of catch per vessel and spatial distribution of catch per vessel. Other data and information needs include size distribution in

the population (research surveys); catch-at-age in the fishery and research surveys; and predation mortality exerted by hake predators.

Group F: Compliance and management

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
68: Lack of management capacity (no-one appointed to manage demersal fishery at present) and institutional knowledge	24
60: There is no Resource Management Working Group (RMWG)	18
61: There are no formal or informal lines of communication with industry bodies and other stakeholders	18
86: NGOs not involved in management and scientific working groups	18
56: Lack of effectiveness of present input and output controls	18
59: Inspector coverage is inadequate and possibly geographically biased and per sector	12
85: The requirements of the MSC are possibly beyond the abilities of management's resources (for those conditions that require MCM to play a role)	12
57: Conflict between sector users	12
70: Inadequate communication with other government departments - specifically with Mineral and Energy Affairs or Petroleum Agency	12
84: The fact that the longline and handline industry are not MSC certified hampers the certification of the trawl fishery	12
71: Inadequate coordination with National Ports Authority with regard to facilities and services for fishing vessels	10
58: Compliance is inadequately enforced – occasional examples are made but the coverage is low	9
79: No institutional reviews of research and management	6
83: Industry is not particularly interested in some broader management issues, focusing on direct issues	6
77: There is no formal peer-review of management plans	6
82: Criteria for representation on SWGs should be reviewed. Difficulties in weighting representation	6

(ii) Proposed management responses

Action 23. Develop capacity for resource management (training and appointments)
Action 24. Establish effective communication between stakeholders (e.g. through RMWG)
Action 25. Enhance compliance by improving and increasing capacity of fishery control officers

Marine and Coastal Management (MCM), which is a branch of the Department of Environmental Affairs and Tourism, is responsible for managing South Africa's living marine resources. Within MCM there are Scientific Working Groups (SWG) which are forums to discuss the science (including Operational Management Procedures – OMPs) used in the management of each fishery. Resource Management Working Groups (RMWG) are the forums for discussing management as a whole, particularly effort control, compliance and monitoring as well as other administrative issues. The South African hake trawl fishery was the first African fishery certified by the Marine Stewardship Council (MSC) in 2004. All three actions in this fishery are concerned with capacity.

Group G: Research capacity

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
67: Inadequate research capacity and institutional knowledge	24
62: Catch data are not available for real time response	18
63: Observer data have not been properly analysed or reconciled with catch records	18
69: Inadequate coordination of research (nationally, regionally and internationally)	18
64: Problems with the validity of scientific observer data in portraying the real picture	12
79: No institutional reviews of research and management	6
74: Insufficient flexibility in the current OMP to deal with exceptional circumstances	5

(ii) Proposed management responses

Action 26. Develop and maintain capacity for research (training and appointments)

Within the context of the institutional structure described for Group F above, the capacity to follow up on data requirements, validation and analysis is crucial.

Group H: Policy

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
8, 10: Management implications of *M. paradoxus* and possibly also *M. capensis* shared between Namibia and South Africa	18, 9
80: Lack of accessibility to records of decisions (minutes, etc.)	12
55: Larger number of rights-holders result in increased management complexity	10
72: Allocation of possibly subviable quotas has complicated management	8
73: Cost involved in attaining transformation – both within the industry and for MCM itself	6
75: The MLRA needs to be revised; CAF, consultation	4
76: There is no current clear sector management policy	3

(ii) Proposed management responses

Action 27. Develop joint research program to investigate distribution and stock-structure of both species across both coasts and borders

Action 28. Assess need for joint management if stocks are shared (covered by current BENEFIT programme)

Very high long-term benefit:cost ratios were considered likely for these two actions. The Marine Living Resources Act (MLRA) was ratified in 1998 and provides the legal framework to sustainably utilize South Africa's living marine resources. In the Act provision was made for a Consultative Advisory Forum (CAF) to the Minister of the Department of Environmental Affairs and Tourism with whom the final decisions rest. The Benguela Environment and Fisheries Interaction and Training (BENEFIT) programme is a needs-driven cooperative research programme focussed on fish resources, interactions with the environment and the training of scientific and technical personnel to undertake research and

management within the exclusive economic zone (EEZ) of South Africa, Namibia and Angola.

Conclusions

This fishery had the most RASF issues raised with most of the high and moderate issues relating to governance and retained species. This trend is echoed in the number of management actions and their wording. Issue Groups A, B and C reflect the biological concerns of the fishery and for several management actions the short-term cost is anticipated to be high while the long-term benefits are enormous. In general the most debilitating feature was the lack of experienced and qualified capacity to manage the fishery and research the species affected. Management actions with the highest long-term benefits were manage fishing effort (13), time-area closures and MPAs (Marine Protected Areas) to protect specific size classes (18), develop a joint research programme to investigate distribution and stock-structure of both hake species across both coasts and borders (27) and to assess the need for joint management if the stocks are shared (28 – which is covered by current BENEFIT project). Looking across all Groups, the vast majority of the actions (both long and short term) were estimated to have aggregated benefits that exceeded the aggregated cost. Thus this process has transparently elicited 88 stakeholder issues and developed 28 responsive management actions which are anticipated to provide great benefit relative to cost.

5.3.2 South African small pelagics

The broad objectives for the fishery

- Maximize long-term economic sustainability of the fishery.
- Maintain target resources at ecologically sustainable levels (trophic interactions, spatial distribution of stocks).
- Minimize direct ecological impacts of fishery (incidental interactions).
- Maintain adequate research and management capacity.
- Optimize socio-economic benefits.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop on this fishery were split into the following groups shown graphically in Figure 5.3.2: research, socio-economics, resource management and compliance.

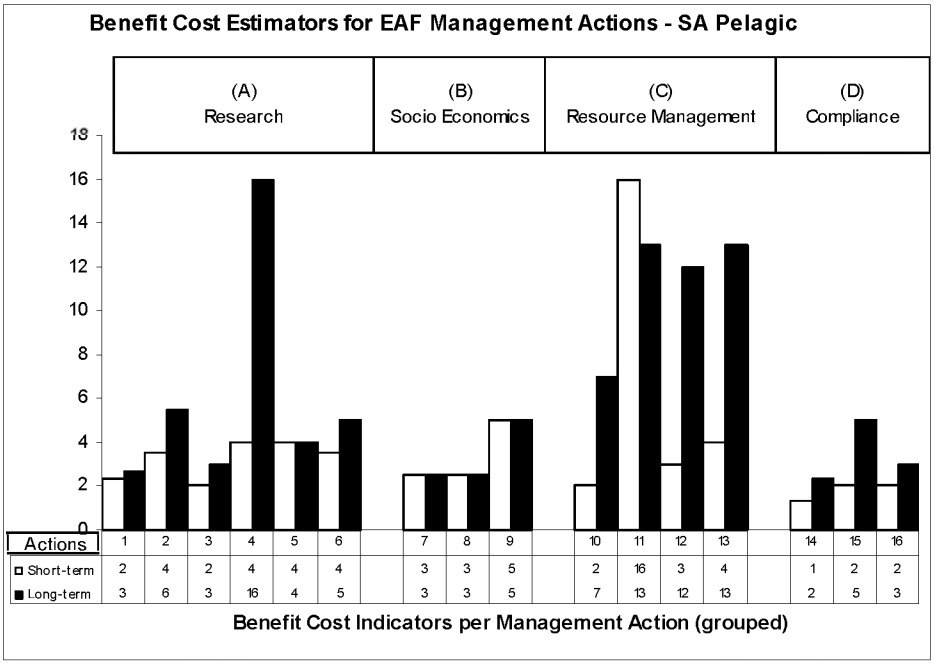


Figure 5.3.2. Benefit:cost ratios for management actions for the South African small pelagic fishery. See text for description of the actions and issues included in each group

Group A: Research

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
45, 1: Uncertainty around decade-scale fluctuations in abundance of small pelagics, and evidence of a recent decline in productivity of sardine stocks	24, 12
33: Impacts of removal of forage fish on species bound to breeding sites on land (seabirds)	24
4: Implications for pelagic fisheries and their management of spatial shifts in sardine distribution (eastward distributional shift of sardine and low occurrence of sardine on the West Coast)	18
22: Insufficient information for management of horse mackerel: insufficient knowledge of life history; inadequate survey data and poor stock assessment	18
70: Lack of resources (and inappropriate allocation within MCM) for resource management and research (staffing issues). Industry is concerned at the lack of skilled and experienced scientists in MCM	15
14: Implications for anchovy fisheries of distributional shifts in anchovy spawning patterns (from the western Agulhas Bank to the central and eastern Agulhas Bank)	12
32: Implications of removal of forage fish for top predators other than seabirds (e.g. Bryde's whale, linefish including hake, seals)	12
10: Coping with mass mortality of sardine due to disease (although there have been no recorded occurrences in South Africa)	12
31: Ecosystem impacts of removing increased amounts of round herring if this fishery is expanded	10
34: Impacts of zooplankton and phytoplankton abundance on pelagic fish and fisheries (the recruitment problem)	8
3: Concentration of fishing effort may have changed the distribution of pelagic fish through disturbance and by altering the genetic composition of the stocks	6

20: Lack of information for management of mesopelagic fish resource; lanternfish and lightfish stock sizes and spatial distributions are poorly known (and mesopelagic stocks are not managed)	5
23: Implications for fisheries management of fluctuations in chub mackerel *Scomber japonicus* abundance possibly linked to sardine abundance/productivity	5
67: Need to quantify processing capabilities for assessing effort and capacity	4
75: Interaction between scientists and new rights holders (esp. smaller rights holders) and industrial bodies is perceived to be suboptimal	2

(ii) Proposed management responses

Action 1. Maintain and expand current monitoring programmes (time, space, surveys, and field stations)
Action 2. Initiate new research projects to test hypotheses about population abundance and distribution fluctuations (genetics)
Action 3. Further investigate and manage the potential impact of food availability to land-based breeding colonies (new models, pilot closed areas, etc.)
Action 4. Develop framework for holistic research
Action 5. Formulate and initiate horse mackerel (*Trachurus trachurus capensis*) research project (recruitment, life-cycle, etc.)
Action 6. Hire, develop and retain capacity for research

Most of the Actions relate to research beyond the target species of the fishery (i.e. anchovy and sardine) as the acoustic surveys in use are considered more than adequate, although age data are necessary. Crucially, though Action 1 must continue if the satisfactory role of acoustic surveys is to continue and the Action is inextricably linked to Action 6 in this regard. Both of these actions are costly but still provide an overall benefit in both the short and long-term. Action 4, if successful, should provide the greatest long-term benefit of all the actions in this fishery.

Group B: Social and economic issues

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
54: Higher salaries and lifestyles resulting from higher catches will not be maintained in the future when catches decline including factory workers in St Helena Bay, Gans Baai, Laaiplek and Lamberts Bay	24
55: More than 50% of the whole community in St Helena Bay, Laaiplek and Lamberts Bay are dependent on the pelagic fishing industry - as such are highly vulnerable to stock status	24
78: Costs associated with complying with HACCP	18
52: Under current estimates there is surplus capacity in the fishery	12
58: Tourism surrounding seabirds which are dependent on small pelagic fish e.g. Lamberts Bay, Simon's Town	12
46: Small rights holders are running at a loss or ceasing operation under current price and exchange rate conditions, in spite of high TACs	10
16: Redeye: industry may expand to catching redeye as the resource has been identified as an underutilized	8
60: A collapse of fishery would counteract national strategy of decentralization for employment opportunities	8

9: Suboptimal economic use of sardine resource by using sardine for fishmeal instead of allowing sardine to grow into larger, more valuable fish for canning	6
48: Value-adding is suboptimal	6
49: A number of West Coast fishermen now find themselves based on the east coast as the fish have moved eastward (only sardine)	6
50: Safety at sea is a concern as it is a highly industrial fishery	6
56: Factory workers in Hout Bay, Mossel Bay and Port Elizabeth are dependent on healthy stocks	6
51: During periods of high availability, factories tend to process their own catches ahead of those of smaller independent operators. This could disadvantage small quota holders	5
59: The effect of a collapse of the pelagic fishery on the national economy	4
61: The sector is the biggest employer in the fishing industry (10 000 people)	4
57: Tourism around Kwa-Zulu Natal sardine-run (lifestyle and seasonal economic benefits for lower income groups) dependent on sardines.	3
44: Concerns about the high proportion of landed sardine catch that is reduced to fish meal REFER No. 9	0

(ii) Proposed management responses

Action 7. Analyse social and economic data collected as part of LTRAMP process and monitor new data when submitted
Action 8. Conduct and maintain baseline social and economic studies
Action 9. Liaise with other Government Departments and inform them of how resource dynamics may impact social and economic benefits

The small pelagic fishery (like the hake fishery) is limited by a total allowable catch (TAC) which is set on an annual basis. Right-holders have rights to catch a percentage of the catch within each year. Actions 7 and 8 are anticipated to be costly but will provide the social and economic information necessary to make informed management decisions which do not jeopardize the fishers or the fishery. Action 9 speaks to the same purpose but should be far less costly.

Group C: Resource management

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
72: The RMWGs are not functional but are considered as sectoral replacements for the CAF	18
73: There is no statutory requirement or structure for participatory decision making (including co-management)	18
70: Lack of resources (and inappropriate allocation within MCM) for resource management and research (staffing issues). Industry is concerned at the lack of skilled and experienced scientists in MCM	15
79: Poor communication between MCM and NGOs and civil society	12
80: Poor representation of stakeholders on RMWG and SWG	12
69: Difficulties in accessing Vessel Monitoring System (VMS) data (within MCM)	8
62: There are large delays in administration of permits	6
74: There is a lack of follow-up reporting on management decisions taken	6
76: Lack of communication with industry and formal documents identifying observers	2

77: Self policing of bycatch and closed areas - problem companies and skippers	2
71: Potential conflict due to interference by large purse seiners with line fishery when they come close inshore	0

(ii) Proposed management responses

Action 10. Develop capacity for resource management (training and appointments)
Action 11. Establish effective RMWG with broader stakeholder participation (improve communication) with a view to making it a statutory body
Action 12. Implement appropriate formal co-management structures
Action 13. Improve access to information for wider public – disseminate and open dialogue (all resources, e.g. website and roadshows)

Within MCM there are Scientific Working Groups (SWG) which are forum's to discuss the science used in the management of each fishery. Resource Management Working Groups (RMWGs) are the forum for discussing management as a whole, particularly effort control, compliance and monitoring as well as other administrative issues. The Marine Living Resources Act (MLRA) was ratified in 1998 and provides the legal framework to sustainably utilize South Africa's living marine resources. In the Act provision was made for a Consultative Advisory Forum (CAF) to the Minister of the Department of Environmental Affairs and Tourism with whom the final decisions rest. Action 11 which proposes that RMWGs should also be made statutory bodies, is the only case where the short-term ratio surpasses the long term. This is attributed to the immediate resolution of several issues should the action be successful.

Group D: Compliance

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
24: Illegal, directed catches of linefish in the pelagic fishery (yellowtail, white steenbras, kob)	12
65: There is evidence of illegal dumping (compliance issue)	12
66: Quantity of landings has prompted the compliance directorate to investigate controlling the fishing effort because of problems of monitoring the landings (but this is contrary to the needs of the data requirements for assessment of the resource)	10
64: Need increased observer coverage of vessels at sea and scale monitors or inspectors at landing points	6

(ii) Proposed management responses

Action 14. Expand/refine current observer program to determine levels of dumping and causes
Action 15. Determine and implement mitigating measures to prevent dumping and illegal targeting (incentives, self-regulation, etc.)
Action 16. Improve compliance at sea and response to reported incidents of dumping and illegal targeting

These actions are essentially all directed at limiting dumping of fish at sea which will facilitate better estimates of natural mortality. It is anticipated that this will have a greater

long-term benefit as regulations will be better enforced, stock assessment will be more accurate and thus management better informed and ultimately the stock more sustainably managed.

Conclusions

The small pelagic fishery had almost half the number of RASF issues of those raised in the hake fishery. Once again retained species and governance were dominant but none of these issues were extreme. External impacts had several extreme issues which reflect stakeholder awareness of the impact of the environment on the fishery. Thus the management action to develop a framework for holistic research (Action 4) has the highest long-term benefit in the Issue Group Research. Nevertheless the management actions with the highest long-term benefits were dominant in the Resource Management Issue Group. An immediate and large short-term benefit could be achieved if an effective RMWG with broader stakeholder participation (improve communication), with a view to making it a statutory body (Action 11) could be established. The other two actions are to implement appropriate formal co-management structures (Action 12) and improve access to information for the wider public – disseminate and open dialogue (all resources, e.g. website and road shows) (Action 13).

5.3.3 South African West Coast rock lobster

The broad objectives for the fishery

- Sustain the rebuilding of the stock.
- Ensure economic viability of different fishing sectors.
- Effectively manage TAC and effort allocation across areas.
- Mitigate substrate impact in sensitive areas.
- Manage and mitigate impact of geographic shift in biomass.
- Manage discarding effects.
- Manage ecosystem effects of regime shifts.
- Maintain 20:80 inshore:offshore ratio and 10 percent recreational – exclusion of subsistence sector.
- Address conflict with mining industry.
- Improve management capacity and communication.

Benefit:cost ratios for possible management responses

The set of EAF issues identified during the RASF workshop on this fishery were split into the following groups shown graphically in Figure 5.3.3: research, socio-economics, monitor biological trends and institutional structures.

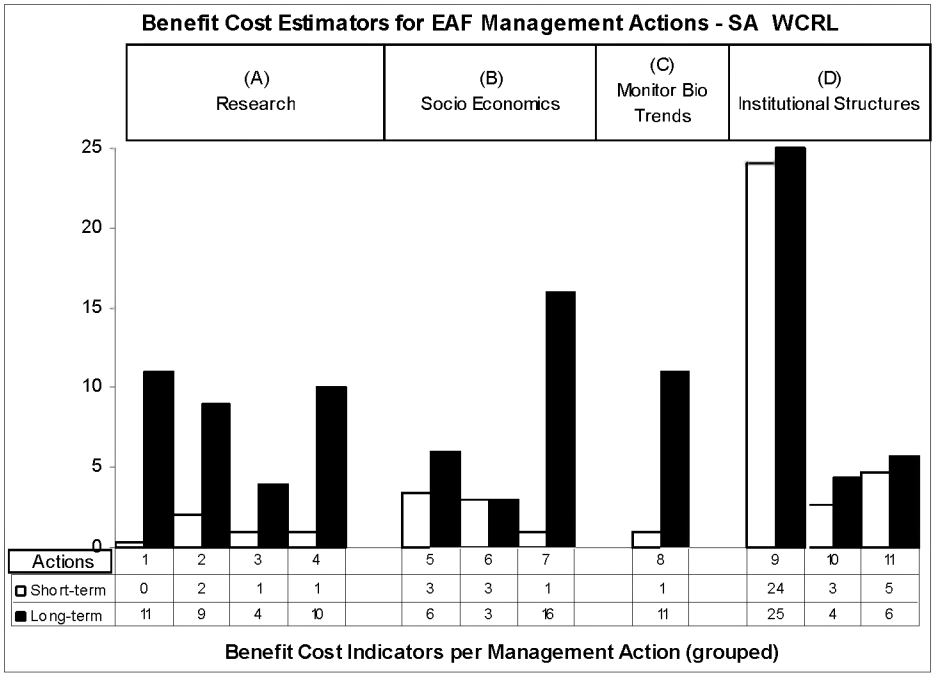


Figure 5.3.3. Benefit:cost ratios for management actions for the South African West Coast rock lobster fishery. See text for description of the actions and issues included in each group

The West Coast rock lobster (WCRL) fishery had an equivalent number of issues as the small pelagic fishery. Once again, as with the other two fisheries, governance and external impacts were dominant. The management action which had the highest long-term benefit was to conduct integrated studies to assess the magnitude of conflicts with the mining industry (Action 7). Management Action 9 to urgently develop co-management via a WCRL Resource Management Working Group echoes the sentiments of the other two fisheries. Action 8 to monitor WCRL distribution, abundance and population structure and manage accordingly should also provide high long-term benefits.

Group A: Initiate research to improve understanding of changes in the ecosystem on the fishery

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
11: Trophic influences (interactions with sea urchins and abalone) of large-scale movements of West Coast rock lobster	24
56: No link with biodiversity audits	15
61, 62: Increased frequency of harmful algal blooms and/or low-oxygen events leading to rock lobster strandings (walkouts)	15, 15
14: Detrimental effects of the rock lobster fishery on other biota and the environment	12
15, 13: Discarding of plastics, or netting during repairs, ingested by seabirds or causing seabird entanglement	12, 4
3: Abundance of lobster currently below desired level	10
7: WC rock lobster: variability in moult timing creates problems for monitoring and management	6

(ii) Proposed management responses

Action 1. Support research on trophic interactions
Action 2. CD RA&I to establish communication with biodiversity auditors
Action 3. Initiate research to establish whether fishing gear damages benthos
Action 4. Maintain an OMP that allows for stock rebuilding

The Chief Directorate of Research, Antarctica and Islands (CD RA&I) is responsible for marine research in MCM. Actions 1 and 4 were considered to have the highest benefit:cost ratios. In order to successfully complete these actions much data will need to be collected (catch statistics, survey based data, growth data and spawner-biomass estimates for rock lobster and abalone, experimental and correlative comparisons of fished and unfished areas, observer coverage of discarding, and real-time monitoring of temperature, oxygen and chlorophyll at Elands Bay, etc.).

Group B: Maintain social and economic well-being through management measures

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
42: Poaching or illegal catch	24
44: Insufficient enforcement (inadequate numbers, salaries, cooperation between agencies)	24
19: A lack of coordinated marketing results in lower prices (fragmentation of industry)	24
43: Insufficient observer coverage on deck boats (with specific compliance duties)	15
22: Concerns about incidence of work-related injuries – safety at sea	15
25: Exclusion of fishers is leading to poaching, that reduces TACs, lowers prices	15
27: Lack of capacity in business skills is hindering effective transformation (nearshore fishery)	15
16: Stakeholder conflicts between offshore commercial, nearshore commercial and recreational fishing sectors within the West Coast rock lobster fishery	12
17: Conflicts caused by different prices paid to fishermen for over-the-scale vs direct deals	12
29: Substantial number of people that would be negatively impacted by closure of recreational fishery: dive operators, tourism industry, boat industry, service stations, restaurants, cafes	12
23: Problems related to maintaining employment in processing plants in remote areas	10
57: Impacts of mining (hydrogen sulphide eruptions, sediment turnover, suspension of particles) on lobster resource and fishery	6
45: "Sanctioned" poaching is allowed in diamond areas	6
28: Negative impacts on lobster fishery would create substantial hardship for large number of people between Saldanha Bay and Port Nolloth.	6
31: Collapse of rock lobster industry would remove important lifestyle component for the Western Cape	6
58: Inadequate access for compliance officers to mining areas	4
21: Lack of economic benefits of collecting walk-out lobsters	3
30: Negative impacts on lobster industry would have significant impacts on socio-economy of Western and Northern Cape	2

(ii) Proposed management responses

Action 5: Improve compliance and increase policing and penalties
Action 6: Promote processing permits for multiple species
Action 7: Integrate studies to assess magnitude of conflicts with mining industry

Although Action 5 addresses several issues, the cost of policing in order to enforce compliance by the legitimate fishery and prevent poaching results in a relatively low benefit:cost ratio. However, it is clear that Action 7 will provide the second greatest long-term benefit should conflict with the offshore and coastal diamond mining industry be resolved.

Group C: Monitor biological trends in the fishery in order to maximize sustainable yield

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
2: Southward shift in the spatial distribution of West Coast rock lobster	18
1: Slow growth rate of lobster caused by environmental factors; somatic growth rate of lobster below historic average, this influences the recruitment of large lobsters to the fishery and therefore has TAC implications	18
5: Management implications of absence of large female lobster in population (role of fishing in skewing lobster sex ratio towards males)	15
8: Physical damage to lobster through fishing activities	5
4: WC rock lobster:sex ratio skewed towards males	4

(ii) Proposed management responses

Action 8: Monitor WCRL distribution, abundance and population structure and manage accordingly

If there is adequate knowledge of stock dynamics it will be possible to develop appropriate management responses when the reasons for the southward shift are understood. This will provide considerable long-term benefits.

Group D: Ensure MCM institutional structures are in place and communication is effective

(i) EAF issues in order of priority and associated risk values

Issues	Risk values
35: Lack of cooperation between scientific decisions and management implementation (5th/7th Floor hiatus)	30
36: Lack of participation by managers/administrators (7th Floor) on SWGs	30
37: Lack of discussion, feedback, transparency, accountability, for departures by resource managers from scientific advice	30
46: Understaffing at MCM caused by radical failure to fill posts	24
33: Effective abolition of the CAF is hindering consultation	24
32: Resource Management Working Groups are not functioning effectively	24
52: Communication difficulties between industry to managers/administrators on ad hoc issues during year	24
53: Inadequate implementation of co-management, failure to use Resource Management Working Groups	24
38: Inadequate representation of social and economic staff at MCM	18

47: Lack of capacity amongst previously disadvantaged sector to fill science/technical/management posts	18
59: Absence of representative structures for communities hinders effective communication and participation	15
48: No working relationship with Department of Trade and Industry, Labour and Mineral and Energy Affairs	12
54: Inappropriate means of communication results in target audience not being reached	10
55: Peer-review not obligatory part of management plans and OMPs	10
34: Lack of devolution of authority to appropriate local level	10
39: Inability to interact with recreational sector (no representative body). Included in No. 32	10
60: Absence of watchdog NGOs and CBOs at community level is contributing to poaching, disappearance funds, etc.	8
6, 40: Management implications of shared lobster stock between South Africa and Namibia	6, 5

(ii) Proposed management responses

Action 9: Urgently develop co-management via WCRL Resource Management Working Group
Action 10: Establish effective and independent advisory forum (i.e. replace CAF)
Action 11: Build research and management capacity (human resources)

Action 9 was estimated to provide the greatest short and long-term benefit for the fishery, once again encompassing several issues (13 in total). Achieving success for Action 9 requires: attendance of management at joint meetings; interactive decision making; records of joint decisions; regular and numerous meetings of the RMWG; minutes and records of decisions of the RMWG and representation of all stakeholders on the RMWG.

5.4 Conclusions

The project was given the task of evaluating the feasibility of implementing EAF and therefore the BCAs undertaken addressed, in general, only those issues that were considered the "add-ons" necessary to move from the current single-species oriented approaches to EAF. In interpreting the results of these analyses, it is important also to take into account the many other issues, many of high and very high priority, that were identified as single-species issues and were therefore not considered in the BCAs. Action will be required on all of these too and management actions being considered to address them should also be subjected to benefit:cost analyses to identify those most likely to achieve the agreed objectives for the fishery as a whole.

While the results obtained from the analyses presented here are preliminary, the BCA process was found to be a very informative and important step in implementation of EAF. It provided a framework for, and required, the workshop participants (and ultimately will require for implementation, full stakeholder representation) to identify and agree on the broad objectives for each fishery and then to evaluate the performance of any management action being considered against each of those objectives. This structured and, if properly applied, rigorous process provides decision-makers with detailed but comprehensible information that should enable them to arrive at optimal decisions and, as such, is far preferable to the more

fragmented and reactive approach to addressing problems that typifies many fisheries management decisions around the world at present.

In this feasibility study, the management actions were only identified at a broad scale (e.g. apply a closed season and area, or improve communication between stakeholders). The costs and benefits of such actions could vary substantially depending on the exact specifications of the final management action, such as the timing and duration of the closed season or the size and position of a closed area or set of closed areas. It will be necessary to formulate the proposed management responses to a greater level of detail and precision before detailed costs and benefits, that would be reliably informative for decision-makers, can be estimated.

It must also be noted that, for the results of the benefit:costs analyses to be useful in decision-making in practice, it will be essential to consider the relative importance, or weights, of the different broad objectives. Agreement on the relative weightings of different objectives is a political matter and, to be acceptable and politically effective, would require agreement and support from all stakeholders. Achieving such consensus was beyond the scope of this project and, for the purposes of these feasibility studies, it was therefore assumed that all broad objectives have the same policy weighting. In practice, equal priority across all objectives is highly unlikely but any attempt to arrive at weightings within the project would have been contentious and the answers not necessarily representative of the range of stakeholders or the final policy choices. As the BCLME countries and the BCC move towards wider implementation of EAF, the actual weightings for each objective will have to be determined by a participatory political process.

This chapter summarizes the full results obtained from the BCAs done for each of the seven fisheries considered. As such, only the aggregated benefit:cost ratios are presented here, although some of the details are addressed in the brief discussions under the results for each group of issues. The ratios themselves are highly informative but the process of aggregation, even with agreed weighting, inevitably conceals the details of the benefits and costs against each of the broad objectives. It will be important for decision makers to examine not only the ratio as a whole but also the estimated impacts of each management action against each of the broad objectives if their decisions are to be properly informed and the risk of unexpected and undesirable outcomes minimized. It also should be noted that in many cases there are common themes across fisheries, such as for example, ecosystem-based research needs and capacity and skills development. In these cases, consolidation of management actions will have the greatest potential benefits.

Notwithstanding the preliminary nature of the results and the need to consider relative weightings of the broad objectives for each fishery, it is significant that, overwhelmingly, the management actions considered in the BCAs as contributions to the implementation of EAF were estimated to produce net benefits in both the short and long terms. A common result in the BCAs was that costs in the short term were frequently estimated to be high and benefits relatively low, as it would take time for the affected stocks and ecosystem to recover. Further, the greatest costs, or negative impacts, were usually experienced in relation to social and economic objectives. This creates a substantial problem for decision- and policy-makers and strategies will have to be developed to mitigate undesirable or untenable social and economic costs. At the same time, the potential catastrophic long-term costs: social, economic and ecological, of allowing ongoing unsustainable use of the BCLME must always be borne in mind.

The overall net benefits estimated for the management actions, under the assumptions made, can clearly be seen in the histograms presented for the different fisheries. This is also clearly demonstrated in the example, from the BCA of the South African hake fishery, of a scatter plot of benefit:cost ratios for each management action grouping (Figure 5.4). The figure shows the short-term (black) and long-term (grey) average benefit and cost ratios for each management action considered for the South African hake fishery. The graphs demonstrate that all the actions are above the line where benefit equals cost and none are below in either the long and short term.

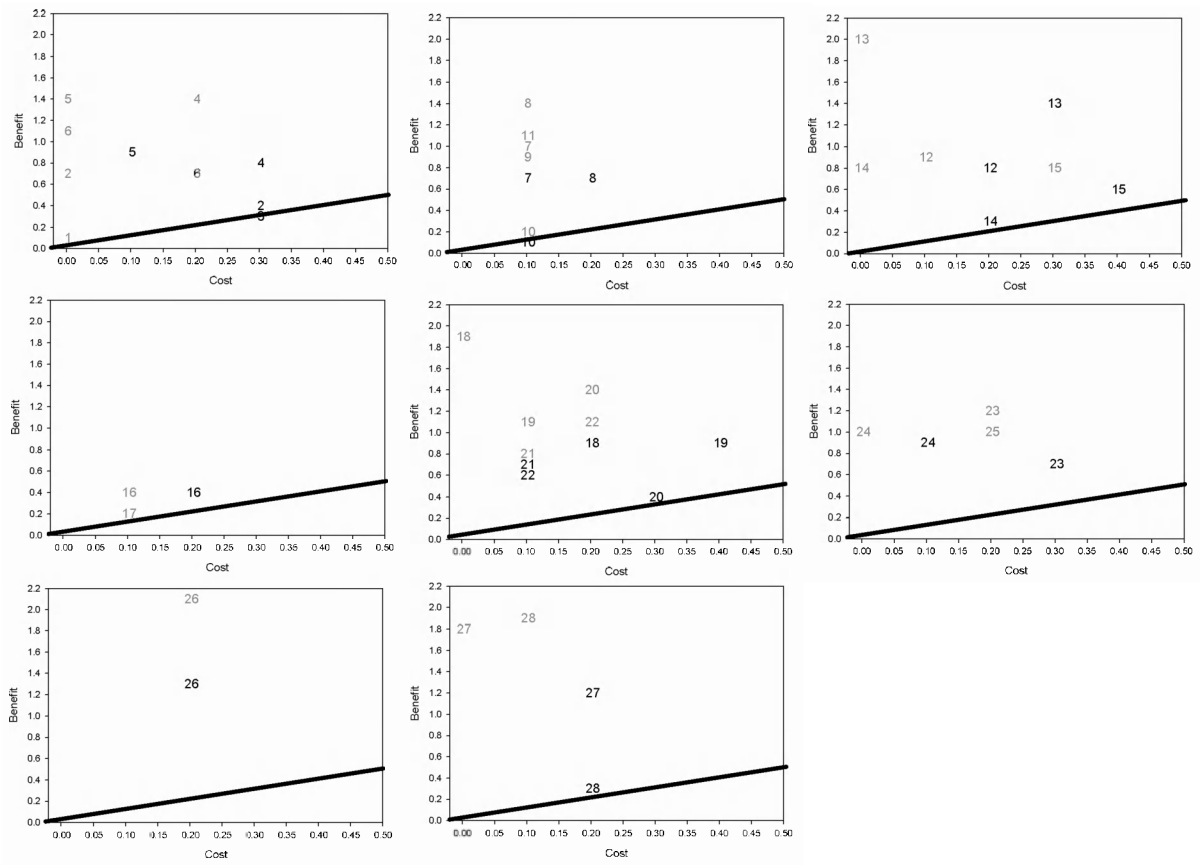


Figure 5.4. Scatter plots showing the short-term (black) and long-term (grey) average benefit and cost values for each management action for each issue grouping for the South African hake fishery. Where the average cost or benefit is "null" the corresponding value was plotted against zero. The black line represents where benefit is equal to cost

6. RESULTS FROM APPLICATION OF SIMULATION MODELS TO INVESTIGATE FEASIBILITY OF EAF

6.1 South Africa

This section summarized a report, presented at the Third Regional Workshop, on a series of Ecopath with Ecosim (EwE) simulations undertaken to evaluate and demonstrate the potential for using ecosystem simulation models to assist in assessing the feasibility of implementation of EAF (Shannon and Jarre, 2007). A model of the southern Benguela for 2000–2004 (L. Shannon MCM, pers. comm.) was used for simulation purposes, biomasses were fixed at these values so that any changes in model results could be attributed to the altered fishing strategies being explored and not to biomass adjustments being made for groups for which biomass was not a model input. EwE default setup parameter settings were accepted and a 20-year period was examined. Altered fishing strategies were modelled for year 2 and carried through the full simulation period. A simple form of wasp-waist flow control was adopted for the anchovy, sardine, round herring and other small pelagic fish model groups for interactions involving anchovy, sardine, round herring and other small pelagics. For all other groups, mixed control was assumed. Two issues identified during the risk assessments of the pelagic and hake fisheries were selected as examples for development of EwE simulations to explore possible ecosystem effects. There were: the bycatch issue in the South African demersal fishery; and the effect of slippage (dumping) of anchovy and sardine.

In relation to the simulations on the bycatch issue, the authors noted that, even though the simulations had been unable to capture the interactions and complexities of the demersal fish assemblage in sufficient detail, they had nevertheless highlighted the benefits of reducing fishing mortality on bycatch species, in particular kingklip and monkfish. The simulations had demonstrated that reduced bycatch led to the biomass and overall catches of the fished benthic-feeding demersal fish increasing substantially, with an even larger increase in the catch value, given the high value of the two species compared to others such as hake. The authors recommended that a detailed demersal fish EwE model should be developed to model the trophic interactions of the demersal fish assemblage (which was not the aim of the existing model adapted here), to facilitate more detailed and robust simulations regarding bycatch issues in the demersal trawl fishery.

In concluding the investigations into discarding of pelagic fish, the authors noted that the available EwE model was not set up to simulate intra-annual changes or spatial issues and therefore that some important EAF issues could not be addressed in this particular exercise but could in principle be done using the EwE software. An EwE model in which zooplankton is further disaggregated was recommended to account for the new dietary studies being undertaken on small pelagic fish and their probable resource partitioning. Modelled discarding was estimated to impact sardine more strongly than anchovy, as was to be expected from the higher fishing mortality of sardine compared to anchovy (0.07 vs. 0.06 $year^{-1}$), and also reflecting the differences in prey niche overlaps between anchovy and sardine, which can cause cascading trophic effects. EwE simulations had been found to be sensitive to settings of flow control, and the model exercise conducted here was no exception to the rule. A revised model was in the process of being fitted to new and updated time series data (L. Shannon, MCM, pers. comm.) and should provide an improved basis for testing management strategies such as those described here. The model results showed stronger impacts of slippage in situations with reduced biomass and higher fishing mortality, both with respect to the target species and to the ecosystem as a whole.

6.2 Angola

A report on the progress that had been made in developing and testing an EwE model of the north-central area of Angola was made to the Third Regional Workshop (Vaz Velho, 2007).

Development of the EwE model of the north-central area of Angola was started in 2005 and further progress had been made at a project workshop in Cape Town in August/September 2006, with additional work done on the model subsequently. The model represented an area of 50 000 km^2. It included 28 functional groups of which five were top predators, nine were finfish species or species groups and the remainder were crustaceans, cephalopods, benthos (micro and meio), zooplankton (large and small), phytoplankton and detritus. Three fisheries had been included in the model, representing the industrial, semi-industrial and artisanal fisheries. It was reported that the model developers had struggled to achieve the necessary mass balance but had finally succeeded for all but two groups, shrimps and phytoplankton. Possible problems with the shrimp group was that biomass and production may have been underestimated or catch overestimated. The input parameters for shrimps and phytoplankton needed to be re-checked.

It was also reported that the model would continue to be improved and tested within a new project funded by BENEFIT (Vaz Velho, pers. comm.).

6.3 Namibia

A report was presented to the Third Regional Workshop on the preliminary results of a simple model of Cape hake (*Merluccius capensis*) recruitment taking into account intercohort predation (cannibalism) within the first two juvenile cohorts (Roux, 2007). Simulation results showed that this very simplistic model can reproduce the complex apparent dynamics of the interactions between juvenile Cape hake cohorts in Namibia observed in the last 13 years and that cannibalism on the 0+ group by the 1+ group could be the dominant driving factor of Cape hake recruitment dynamics in the northern Benguela at present. Diet information comparisons between the northern and southern Benguela for these young hakes suggested that the low level of biomass of small pelagic fish and environmental anomalies (e.g. Benguela Niño events) in the northern Benguela at present could be the main causes for the high variability in Cape hake recruitment. A recovery of the small pelagic stocks (sardine and anchovy) could result in higher and more stable recruitment levels. This demonstrated a possible strong interaction between the management of small pelagic fish and the dynamics of an important demersal species through alteration of the trophic pathways.

6.4 Comments from the Third Regional Workshop

In the discussions, it was pointed out that the models presented are being developed to potentially assist in providing scientific advice for management actions. One participant suggested that, in relation to ecosystem models, the primary limitations did not lie in the models themselves but in our underlying knowledge of the ecosystem and the processes taking place. Ecosystem models attempt to integrate in a structured way what is and is not known about ecosystem structure and functioning and so contribute to understanding of the interactions in the food web and with humans, to complement the more focused approach provided in most stock assessment models of the interaction between humans (e.g. a fishery) and one or two species. Models can be confusing for many people and the more complex the model, the more difficult it is for non-modellers to understand. People are frequently reluctant

to believe results from a model that they perceive to be a "black box" and it is important to ensure that any model used is well-understood by all and is as transparent as possible. An essential step for dealing with uncertainties in any model is to test the sensitivity of the model, and robustness of results, to plausible ranges of possible values or states. There would be benefit, as with any model, in comparing results from different models as a means of validating their outputs.

It was noted that the latest version of EwE can take cannibalism into account because it allows for detailed age structure within species groups. It was also pointed out that, by changing the vulnerability parameters, it is possible to simulate the range of standard feeding responses (Holling types I to IV) but that this also implicitly determines the nature of the stock recruit relationship. It is therefore important to ensure that the implications of the set of vulnerability settings in an EwE model are well understood.

In response to a question, it was pointed out that EwE is considered to be a useful tool for the project and for providing strategic advice on ecosystem responses to human intervention but is not considered to be the only such tool and that different models have different strengths and weaknesses.

The project had drawn on ongoing work with EwE to provide useful input to some scientific questions. The benefits of using ecosystem models, including EwE, include identification of data gaps, facilitating comparisons and synthesizing available information on ecosystems. Within the BCLME activities, progress is being made towards putting together time series of data, fitting the models to observed time series and using them for forward projections. South Africa has been successful in this regard with biological data. However, a problem throughout the region was the poor availability of economic and social data.

7. INDICATORS FOR EAF

7.1 Introduction

The terms of reference for the project required that it "Identify ecosystem indicators likely to provide useful insights or advice for fisheries management in the BCLME". This task has been addressed in two ways. The Performance Reports produced at the RASF workshops and the aggregated Performance Reports produced at the BCA workshops include a section on indicators and reference points. At both workshops, participants attempted to identify suitable indicators that would enable progress towards achieving the operational objective associated with the particular issue or group of issues to be identified. These indicators are considered to provide useful information but must be considered preliminary with the same limitations and need for critical evaluation as the other results discussed above. The Performance Reports, which include suggested indicators, can be found in the 2005 Annual Report (Report No. 2 UNTS/RAF/011/GEF) and the national BCA reports (in press) In addition, a review "Ecosystem Approach to Fisheries (EAF) Indicators for the BCLME" was undertaken for the project by Bianchi and Shannon (2007). This review and a second paper "Principles and guidelines for the use of indicators in contributing to the formulation of management recommendations for commercial fisheries subject to quantitative assessment or OMP-based regulation" by Butterworth and Plaganyi (2007) were presented to the Third Regional Workshop.

7.2 Conclusions and recommendations of the Third Regional Workshop

Taken together, the two papers proposed six principles to be considered when selecting indicators for fisheries management under an EAF. One principle relates to the need for a strict relationship of the selected indicator to specific management objectives. It was noted, however, that consideration should be given to developing a set of indicators to monitor the marine environment independently of specific fisheries management objectives, to allow for environmental reporting. Such a scheme should also result in consistent time series and these, in turn, could form the basis for developing various new indicators as needed, but also for exploratory data analyses.

A good correlation with the property for which management objectives have been set (e.g. biological, ecological, social and economic) and a consistent response to changing levels of fishing are also necessary features of the selected indicators. If these relationships are not clearly demonstrated, the indicators will be less useful and in some cases could be misleading. In particular, for indicators used to determine fisheries management measures it is important to show that the selected indicators respond primarily to changes in the management measure and, conversely, have low responsiveness to other causes of change.

Indicators should be observable, both in technical and economic terms, within the economic and human resources available, and should be relevant to the social and institutional context.

Different indicators may be appropriate to specific time and space scales and these were therefore considered as two very important criteria.

Stakeholder participation in all steps of the decision making process is one of the pillars of EAF. This requires that indicators are acceptable, and therefore understood, by all stakeholders, both within the fishery system and by the public.

It was noted that once the indicators have been filtered through the above criteria, there is still the important challenge of setting meaningful reference points. These could be chosen through modelling and, in the case of poor data/models, reference points could also be set empirically or even heuristically. Where it is not possible to set reference points, reference directions may be useful. An additional difficulty is related to integrating a wide variety of indicators to facilitate management action. The need for developing meta decision rules that summarize the direction of action for the various issues and indicators was stressed, as well as the lack, so far, of well established procedures for this.

In terms of indicators for ecosystem effects of fishing, the Third Regional Workshop agreed that (Report No. 4 UNTS/RAF/011/GEF) indicators could be split into four categories:

(i) target species affected by the fishery;
(ii) non-target and dependent species affected by the fishery (e.g. vulnerable species);
(iii) effects on ecosystem as a whole (diversity, trophic levels); and
(iv) environmental effects on fisheries.

Specific comments that emerged from the discussion were as follows:

- Assumptions for indicators must be clearly defined in relation to the biology of the species in question, community, property or the ecosystem as a whole.
- It is preferable to use a suite of indicators to guide management action. These indicators must not present duplicate information or data which is already contained within existing stock assessment models or there is a risk of using the same data twice and interpreting it differently to the way in which it is incorporated in the model. It is preferable to use indicators which can be assessed rigorously for categories (i) and (ii). Indicators for categories (iii) and (iv), for which sufficiently rigorous assessment will frequently be impractical or impossible, will need to be evaluated by more general understanding, for example by considering trends and combinations of trends.
- Indicators in categories (iii) and (iv) can be used to inform management on possible trends that could be relevant to management of the fishery (including wider implications within the context of EAF) and, where considered necessary, will be placed in a "red-light", warning box. They could be used for strategic decision-making or as considered relevant (see Figure 7.1).
- Developing indicators which are understandable to all stakeholders will increase their usefulness as a management tool. Basic ecosystem state and environmental indicators should be incorporated into the background provided for management recommendations and documents.
- Consideration should also be given to distributing information on the state of indicators to the public on a regular basis to keep them informed on the status and trends of fisheries and the ecosystem.
- Society sets objectives but experts are needed to design the systems for fulfilling those objectives. An important component of designing such systems is, where possible, to hold workshops or other consultative processes with relevant stakeholders to define the decision rules to be used in the management actions.

The need for objective and transparent decision-making was stressed as important. This should apply not only when rigorous assessments are available, but also when only more general information is available but is still considered to be sufficiently important to require consideration. Furthermore, in those cases where rigorous assessments are not available but

negative trends have been shown and accepted as being meaningful, reasons for not taking any management action should be justified, i.e. it should be demonstrated that the risk of not taking any corrective action to avoid negative outcomes can be considered to be low.

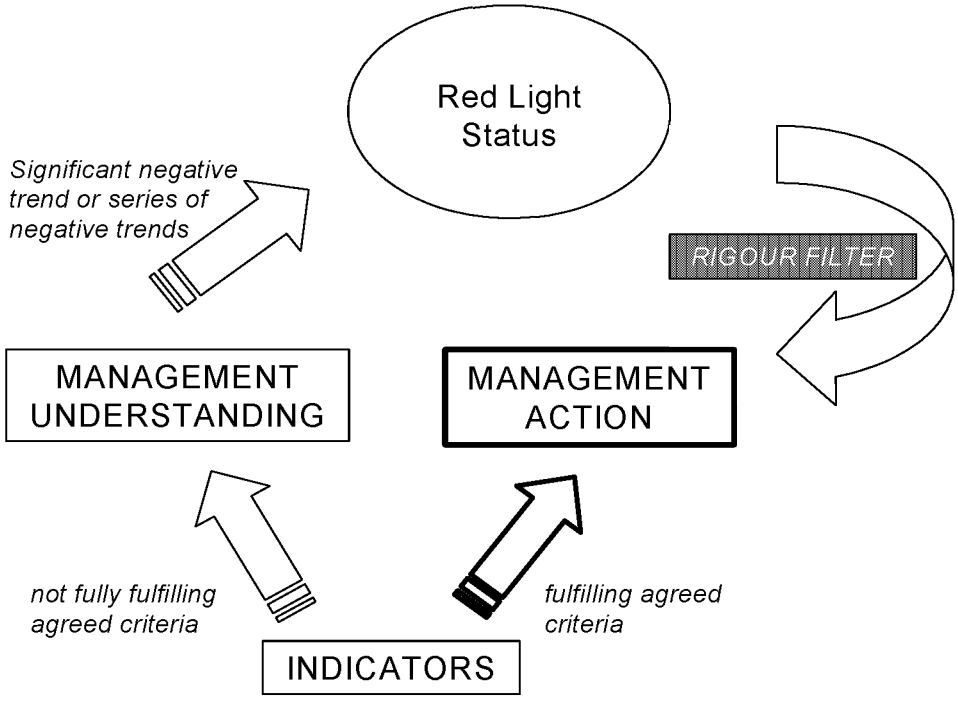


Figure 7.1. Indicator flow chart

8. COMPARATIVE APPLICATION OF INDICATORS TO CHARACTERIZE ECOSYSTEM STATES, CHANGES AND FUNCTIONING IN THE BENGUELA REGION

8.1 Overview of existing knowledge on ecosystem states, changes and functioning in the BCLME

A paper was prepared on this topic for discussion at the Third Regional Workshop (Shannon and van der Lingen, 2007), The authors reported that, despite their possibly expected similarities, the northern and southern Benguela have shown very different ecosystem dynamics in recent decades. Differences between the two parts of the Benguela may be related to the fact that the southern Benguela upwelling region is bounded by the shallow Agulhas Bank, with an associated diverse demersal fish assemblage. Both systems are affected by dramatically different environmental perturbations. For example, the northern Benguela is regularly affected by low oxygen events, and by large-scale warm water events such as Benguela Niños.

The ecosystem structure and trophic functioning of the northern Benguela in recent years seems to have differed from the way in which the system functioned in the 1970s. Between the late 1960s and the late 1970s, anchovy and sardine stocks were replaced by a suite of zooplanktivorous fish including horse mackerel, mesopelagic fish and pelagic goby. Most fish stocks in the northern Benguela underwent large declines towards the end of the 1990s at the time of major environmental anomalies, while jellyfish *Chrysaora hysoscella* and *Aequorea aequorea* have attained large abundances during the same period, possibly changing the energy flow through the northern Benguela food web. Overall, the northern Benguela appears to have undergone a regime shift since the 1980s with the effects of an unfavourable environment having been exacerbated by heavy exploitation. This has resulted in extreme modifications to the pelagic ecosystem there (Cury and Shannon, 2004).

Resources in the southern Benguela also varied substantially between 1980 and 2004, but seemingly without a shift to a completely new ecosystem state. Despite the differences in fish stock sizes and catches (particularly of small pelagics) between 1980 and the mid-1990s, the trophic models used by Shannon *et al.* (2003) did not reveal a change in the overall trophic functioning of the southern Benguela between 1980 and 1997. It has been argued that the southern Benguela experienced a pelagic species replacement rather than a clear regime shift to a different ecosystem state because ecosystem functioning remained relatively constant over that period.

The paper outlines the trophic models of the southern Benguela that are available for the periods 1980–1989 and 1990–1997, as well as a comparable model of the period 2000–2004. In the case of the northern Benguela, several models have been constructed (Shannon and van der Lingen, 2007). In order to facilitate meaningful comparisons between systems, models of both systems have been standardized according to established methods (Moloney *et al.*, 2005). In the same way, standardized, updated models were constructed for the northern Benguela for the 1960s, 1980s and 1995–1999 and used to illustrate the main ecosystem changes that have occurred off Namibia. Details of those changes were presented to the workshop. In addition, models of the southern Benguela have been fitted to time series data and used to quantify ecosystem changes (Shannon, Field and Moloney, 2004). These studies supported earlier findings which indicated that environmental factors have been more

important drivers of South African ecosystem dynamics than fishing over the latter part of the twentieth century (Shannon, Christensen and Walters, 2004).

8.2 Discussion and conclusions of the Third Regional Workshop

There was considerable discussion at the Workshop on the significance of ecosystem states for fisheries management. There were differences of opinion on what constituted a change in state and the definition of an ecosystem state and reference was made to published work on this issue (e.g. Bakun, 2004; Cury and Shannon, 2004; de Young *et al.*, 2004; Jarre *et al.*, 2006; Mantua, 2004). Nevertheless, it was recognized by all participants that the state of the northern Benguela ecosystem had changed within the last decade or so and that this needed to be recognized in the assessment and management of the affected resources. It was also pointed out that had it been recognized earlier that the ecosystem was in a changed, less productive phase, it would have been possible for management to respond to this sooner with likely beneficial consequences for the stocks.

In other cases, there were three possibilities: (i) ecosystems did not change significantly and important rates and parameters could be considered to be constant; (ii) there are discrete and distinct states in ecosystems and that management regimes need to be established for each state; or (iii) ecosystems are substantially dynamic and parameter values can change significantly, requiring constant review and, where appropriate, changes in assessment assumptions (e.g. changes in the value of M and recruitment variability) and management regimes. There was no consensus on which of the three was more likely but the majority viewed that option (i) was unlikely.

It was noted that results from the EwE simulations of the southern Benguela indicated that the predation rate on sardine (total amount of sardine consumed/sardine biomass) was estimated to have increased by about 25 percent since 1990. Since predation mortality comprises most of M, this likely indicates a similar rise in M, a possibility which should be investigated further.

9. OPTIONS FOR IMPROVED TECHNIQUES AND APPROACHES TO STRENGTHEN THE DECISION-MAKING PROCESS

9.1 Introduction

Two studies were commissioned by the project to consider techniques and approaches that could be used to strengthen the decision-making process in the implementation of EAF. The first of these was a review on "Multicriteria Support for Decision-Making in the Ecosystems Approach to Fisheries Management" by Stewart and Joubert (2007). The second study "Using a fuzzy-logic approach to multicriteria decision-making for an ecosystem approach to fisheries management" was implemented in cooperation with the Department of Zoology, University of Cape Town (Patterson, 2007). The summaries presented here are taken from the main body of that Workshop report.

9.2 Multicriteria support for decision-making in the ecosystems approach to fisheries management

A core feature of adopting a broad ecosystems approach to fisheries management is that decision making needs to give consideration to widely divergent effects on different sectors of the ecosystem, and to potentially conflicting values and goals of different stakeholders. The search for solutions satisfying all those perspectives, values and goals to the greatest extent creates the need for effective decision support to those involved in fisheries management. The principles underlying multiple criteria decision making (MCDM) have been developed over the past 30 years within the broad arena of operational research and management science. This has led the existence of a number of different, sometimes divergent, schools of thought which are still not fully integrated. The review by Stewart and Joubert (2007) provided a broad overview of the different schools and approaches, as they could each be of value for certain aspects of decision making in fisheries management.

The authors pointed out that the fundamental paradigm of the multicriteria decision analysis (MCDA) is that, in order to ensure that all stakeholder interests and concerns are fully taken into account in planning and decision making, the process must include:

- explicit identification of the relevant criteria according to established principles;
- evaluation of alternative courses of action or policies in terms of each criterion individually;
- synthesis of the individual preference orderings by an aggregation across criteria which recognizes both the importance of each criterion relative to the others, and the extent to which improved performance on one criterion may or may not compensate for losses on others.

Their paper discusses the process and provides examples of criteria and value tree structuring within an overview of MCDA approaches. The objective of MCDA is to aggregate the preferences in terms of each criterion into an overall preference order or, alternatively, to classify the preferences into classes such as "excellent", "very good", etc. Several different approaches have been developed for this and are described in the paper. These include: value measurement or scoring; outranking methods in which, for each pair of alternatives, an assessment is made of the strength of evidence for and against the assertion that "a is at least as good as b"; goal programming and reference point approaches in which alternatives are assessed according to how well they satisfy identified goals or aspiration levels of

achievement; and rule-based methods which can be considered to be a generalization of the other three, in which decision rules are constructed in order to classify alternatives into reference classes on the basis of the attribute values. Direct (constructive) and inverse (holistic) methods for constructing preference models are described followed by some general comments on subjective assessments of quantitative parameters by groups. Finally the topics of uncertainty and risk and time value and discounting are introduced.

9.3 An application of fuzzy logic to facilitate decision-making

In the paper "Using a fuzzy-logic approach to multicriteria decision-making for an ecosystem approach to fisheries management" (Patterson, 2007), a transparent decision-support system (DSS) prototype was developed to assist in balancing the many conflicting goals and objectives that need to be weighed in order to implement EAF. The system was developed using commercially-available NetWeaver and Geo-NetWeaver software. The DSS tracks the fulfilment of EAF goals based on information collated in the risk assessment for sustainable fisheries (RASF) workshop report for the South African small pelagics fishery. The system is designed as a tool for monitoring and evaluating the success of EAF implementation. The South African small pelagics fishery targeting sardine was chosen as the first test case because there is good knowledge of this (recovering) fishery. Sardines are favoured by predators and are utilized for both canning and fishmeal, thus providing a good example case for EAF.

The structure of the prototype follows the hierarchical tree approach recommended in the FAO guidelines for responsible fisheries (FAO, 2003). After eliminating any areas of overlap, the final list of issues contained 12 from RASF category *Ecological well-being*, five from category *Human well-being* and eight from category *Ability to Achieve*. This prototype was enhanced during a consultative process with key experts. Input parameters are based both on quantitative and data expert opinion. An 11 point scale was chosen, by which experts are asked to rate the trueness of a given proposition, e.g. "no unaccounted dumping of small sardine is taking place in the sardine directed fishery".

Sensitivity tests are being undertaken to evaluate the system in terms of robustness to input changes, the impacts of individual parameters, the influence of system structure and the appropriateness of the input scales for parameters based on expert opinion. Preliminary results suggest that the system is robust to input changes. A negative truth value impacts stronger than a positive truth value and sensitivity is lower when the truth values of remaining parameters are low. Sensitivity is highest when truth values of remaining parameters are high and the value of the parameter under investigation is low. In other words the system is conservative.

The DSS synthesizes a large amount of information, which is important for EAF where many different aspects and factors have to be considered. The system aims at improving understanding rather than achieving precision by focusing on the direction of the effect of variables. The strength of the approach lies in the ability to include variables which are difficult to measure. It provides a means of rendering value judgments explicit and transparent. The process of developing the prototype DSS has already been perceived as helpful by the scientists and managers involved. The process of prioritizing and structuring the main factors has helped to bring into focus the gaps in the way the social dimension for the small pelagic fishery is addressed at present. It seems that knowledge of the linkages

between the status of the natural resource base, the management of the fishery and the implications for the people whose livelihoods depend on the utilization of the resource are not well represented in the decision-making process. Further efforts are needed and perhaps different approaches have to be found to elicit expertise on social and economic and institutional issues.

9.4 Conclusions of the Third Regional Workshop

The general discussion of the Third Regional Workshop included some important proposals and recommendations that should be considered by the three BCLME countries and the BCC. They were summarized in the report (Report No. 4 UNTS/RAF/011/GEF) as follows.

In the general discussion following both presentations, it was suggested by one participant that, while it was desirable for all stakeholders to be involved in the formal process of multicriteria-decision making, in practice decision-makers were reluctant to use this approach and that the task generally fell on the scientists. This problem was acknowledged but others thought it essential to persevere in trying to get decision-makers to use formal techniques to facilitate improved decisions.

There was considerable discussion about the importance of transparency and the role that formal MCDM techniques can play in facilitating transparency. As an example, a participant from the fishing industry referred to the problems that are being faced in the rock lobster industry in South Africa as a result of some quota applications being sub-economic and suggested that this was a result of government having given insufficient attention to economic stability in the criteria it had used in rights allocations. In his view there are four major legs that need to be considered in fisheries, including EAF. Those are: political, social, economic and environmental, and it is essential to maintain the correct balance between those four. T. Stewart suggested that this case provided a good example of the need to ensure that the criteria used in MCDM are the most appropriate ones.

B. Patterson pointed out that weightings can be used with fuzzy-logic decision-making methods and that different levels in the hierarchy can be weighted independently. Therefore, for example, it would be possible for scientists to determine the weightings for scientific criteria and decision-makers to determine the weighting for policy criteria in a single tree. In this regard, T. Stewart informed the group that while the contribution of the weightings to the output was clear in value-based techniques, they were less so when used with fuzzy-logic.

The importance of using sensitivity analyses was stressed. B. Patterson drew attention to the bias towards biological and ecological issues in the South African hierarchical tree developed for the small pelagic fishery and the resulting skewness of the system, and its outputs in this direction. This demonstrated the importance of ensuring representative participation in the development of such systems. The importance of the psychological issue of how questions are framed was discussed as the framing can significantly alter the likely response. It is important to be aware of the problems and careful consideration should be given to how to frame questions and the criteria.

Many workshop participants agreed on the importance of using such methods in fisheries management. It was suggested that in the BCLME countries, the process to provide scientific advice was formalized and rigorous but that management decisions were often made in a

haphazard and unstructured way. Formal methods also provide an audit trail of the decision-making process. Formal decision-making encourages transparency, fairness and participation and should be put in place and encouraged. Returning to the theme of the need to improve co-management, which cropped up many times during the workshop, the importance of joint responsibility and joint decision-making by stakeholders was emphasized. Some suggested that a top-down, command and control system of management is still widespread globally and is still the predominant style in the BCLME countries and that this needed to be changed.

10. POTENTIAL INCENTIVES FOR FACILITATING EAF

10.1 Introduction

As with some of the other specialist sections included in the project Terms of References, the subject of incentives for facilitating EAF was dealt with by the project by commissioning a review by suitable experts and then considering that review within the context of EAF in the Benguela Ecosystem at the Third Regional Workshop. The review "Creating Incentives for the Ecosystem Approach to Fisheries Management: A Portfolio of Approaches for Consideration in the Benguela Current Large Marine Ecosystem" (de Young and Charles, 2007) was presented to the Third Regional Workshop, Cape Town, South Africa.

The following summary of the review is quoted from the main part of the report of the Third Regional Workshop.

> "Incentives" were defined as "any factor that affects individual choice of action". The need for appropriate incentives was related to the existence of externalities, grouped into five main categories (stock, crowding, technological, ecological and techno-ecological externalities). These, if not managed, would have negative impacts on the ability to achieve the overall goals of contributing to economic development and of maintaining a wide range of services provided by fishery ecosystems.
>
> Incentives were classified into legal, institutional, economic/market-based and social incentives. As an example, setting property rights systems was considered as an important legal incentive relevant to EAF. Creating mechanisms for greater coordination and communication among different resource users in the planning and implementation process was an example of an institutional incentive. Economic incentives were classified as economic disincentives (sticks) and economic incentives (carrots) considering that economic incentive mechanisms could be used either to penalize undesirable behaviour or promote desired behaviour, respectively.
>
> Most of the incentives presented are already part of conventional management strategies but new ones are emerging as particularly relevant to EAF, such as the non fisheries "polluter pays" or incentives for getting support for globally distributed benefits and localized costs.
>
> Having recognized the importance of incentives for realising EAF goals, the role of government institutions was acknowledged as fundamental, also under an EAF.

10.2 Conclusions of the Third Regional Workshop

The review (de Young and Charles, 2007) was discussed at the Workshop and a number of recommendations relevant to incentives was agreed upon, as follows:

1. Improved communication between stakeholders, policy makers and management. The question was raised as to who are legitimate stakeholders and the need to clearly identify these was recognized.
2. The importance of making available scientific information as a basis for negotiation with stakeholders was emphasized as an incentive.

3. Co-management, understood as joint decision-making, could be seen as an important incentive for sustainable use.
4. The importance of using and strengthening cooperatives to assist with management of artisanal fisheries was stressed. Greater coordination of small- and medium-companies (e.g. through cooperatives) was seen as a way to facilitate participation in the management process.
5. It was suggested that a reward system should be established to promote good behaviour in fishing companies and it was noted that WWF are planning such an approach.
6. Ecolabelling could be an important incentive. It was suggested by one participant that eco-labelling, including the MSC, may not be making an important difference in marketing and pricing but it was also recognized that the scheme could grow in significance.
7. Social and economic incentives are very relevant in a developing country context. Alternative livelihoods are a possibility in the case the resource cannot sustain the level of fishing.
8. Incentives should be considered for all the stakeholders (including sectors other than fisheries)
9. Allocation of long-term user rights was seen as a strongly motivating, if not essential, element for sustainable use.
10. Prospects of higher catches would be important for motivating the industry to buy-in to the EAF approach. However, it was recognized that other stakeholders also need to be considered and that under an EAF, benefits may be distributed to a wider group of stakeholders.
11. More effort should be put into education and awareness raising of the importance of sustainable use of marine ecosystems, which is the primary goal of EAF.

The Workshop also "recognized that while incentives are applied in many instances in the region they have not been considered as a discrete management tool as presented in this session. It is recommended that they are further investigated in the context of EAF in the BCLME."

11. INSTITUTIONAL ARRANGEMENTS FOR SUCCESSFUL IMPLEMENTATION OF EAF

11.1 Angola

Overall, it was necessary to establish an effective resource management structure that included improved communication with stakeholders. Within the management structure, a need for an improved procedure for allocation of access rights, especially in the artisanal sector and for operational management plans for all sectors and resources had also been recognized. In relation to research and management, there were several areas where improvement was required, including improvements in data quality and information flow, training and career paths for researchers and management and the establishment of an on-board observer programme. Several problems in the existing MCS capacity were also identified while improved support to fisher communities and organizations was also highlighted as an important requirement. It was also reported that multisectoral coordination needed to be strengthened, both within the context of EAF and recognizing the wider interactions inherent in integrated coastal area management. The full list of requirements is presented in Table 11.1.

Table 11.1. Institutional requirements for EAF: Angola
The institutional needs presented below were raised during the RASF and cost-benefit workshops conducted in Angola.

Overall

- Establish an effective resource management structure
- Including improved communication with stakeholders
- Research and management capacity
- Monitoring, control and surveillance
- Social and economic
- Education and awareness
- Multisectoral coordination

Governance

Management structure

- Increased stakeholder participation in decision-making for management measures
- Improve procedure for allocation of access rights especially in the artisanal fisheries sector
- Operational management procedure for quota/effort allocation
- Establish action management plan for all resources

Research and management

- Streamline and improve information flow
- Data quality assurance
- On-board Observer Programme
- National Fisheries Sampling Programme
- Logbooks for all industrial/semi-industrial vessels
- Training of researchers and managers
- Career paths for researchers and managers

Monitoring, control and surveillance

- Motivation of fisheries inspectors
- VMS system expanded
- Improve compliance on reporting of accidental catch
- Involve local communities and cooperatives in monitoring and surveillance of fishing activities and use of coastal ecosystem

Multisectoral coordination

- Integrated coastal area management
- Compensation/penalty system for pollution events
- Establishment of multisectoral Working Group
    - Environment/fisheries/oil/ports/transport/tourism
- Regional Working Groups
    - Congo/Gabon
    - Namibia

Human well-being/social and economic

- Education and awareness programme
- Build body of extensionists for running education and awareness programmes with artisanal fisher communities
- Reinforce and expand fishers' producer organizations
- Industrial/semi-industrial vessel owners
- Artisanal fisher's cooperatives
- Improve capacity of fisheries schools

11.2 Namibia

In Namibia, the TAC recommendations are presented to the Marine Resources Advisory Council which advises the Minister, who presents the recommendations to Cabinet for approval. Once approved, the TAC is then divided into quotas and allocated to individual companies. The institutional needs for Namibia, which are listed in Table 11.2, were raised by stakeholders during the risk assessment and benefit-cost workshops held in that country. They include a number of different issues related to management, compliance, the existing legal framework and other components of the management process and structure. The risk value, estimated in the RASF workshops, is shown in brackets after each item.

Table 11.2. Institutional requirements for EAF: Namibia

Ability to achieve governance

Management
- Lack of approved management plans including reconciled objectives based on an integrated approach with reference points (24)
- Working groups need clear terms of reference (12)
- A need for improved transparency in the management of resources (12)

Compliance
- At the time of the Third Regional Workshop, VMS was still not in place (12)
- Penalties for transgressions are not adequate (12)
- Need for real time reporting and overcatching of quota (12)
- Lack of observer coverage on smaller vessels (while observers do not have an enforcement function, their presence increases compliance) (8)

Information
- Inadequate and incomplete data recording, capture and storage (24)

Resources
- Problems with attracting and retaining qualified and experienced staff (24)
- Inadequate research budget leading to insufficient services and facilities (24)

Inter-agency cooperation
- Poor cooperation/interaction between stakeholders (Observer agency, Industry, directorates, Department of Marine Affairs, NGOs) (6)

Legal framework
- Regular updating of legislation (e.g. NPOA – sharks adopted, but has not filtered down into legislation) (24)
- Establishment of transboundary management regime for shared stock(s) (8)
- Problems with the current allocation system result in a failure to meet the policy standard of strengthening the Namibianization of the fishing sector (16)

Consultation
- The lack of wider representative participation in council and working groups e.g. public interests, conservation groups, NGOs (16)
- Improved communication to the general public (6)

Industry
- The absence of an industry code of conduct may disadvantage Namibia's fisheries in the light of global pressure and trends for responsible fisheries (6)

Access rights
- Need for capacity and development in joint venture agreements in order to achieve desired outcomes (economic empowerment) (16)
- Need for implementation of transparency in quota transferability (16)

11.3 South Africa

The institutional needs that were identified for successful implementation of an ecosystem approach to fisheries in South Africa are listed in Table 11.3. These are issues that had been raised by stakeholders during the risk assessment and benefit-cost workshops held as part of the project. They encompass three main areas that require urgent attention:

- capacity, not only in numbers but also in skills, for management, research and compliance;
- sufficient finances to achieve research objectives and provide advice to management and monitor catches;
- data management, noting that the research section is lacking a data manager and that data management is a complex task requiring coordination with the monitoring and compliance unit in order to ensure all necessary data are collected and stored usefully.

Table 11.3. Institutional requirements for EAF: South Africa

Establish an effective resource management structure and improve communication with stakeholders

- Establish effectively functioning and representative Resource Management Working Groups (RMWGs), with broader stakeholder participation (improve communication), with a view to making it a statutory body:
  - This would establish effective communication between stakeholders (e.g. through RMWG). Implement appropriate formal co-management structures.
  - Development of co-management via the West Coast rock lobster Resource Management Working Group was a matter of urgency.
  - The effective integration of scientific recommendations and management decisions within MCM was seen as an important step in facilitating EAF in South Africa. A means of achieving this is to establish effectively functioning and representative Resource Management Working Groups for each fishery.
  - This will require an efficient and effective administrative structure as well as good communication between MCM, industry and communities. Co-management dealt with here relates only to resource management, and needs to be dealt with at Ministerial level (across fisheries).
- Develop capacity for Resource Management (by means of training and new appointments).
- Increase awareness and educate the stakeholders as to the importance of various EAF issues, such as the very important bycatch issues in the hake longline and hake trawl fisheries.
- Improve access to information for the greater public by disseminating information and encouraging open dialogue (this should be done for all resources e.g. by means of the DEAT website and roadshows, by Marine Day 2006 activities, etc.).
- A record of management decisions needs to be kept and maintained. It was felt at the workshops held that consultations were often inadequate. Stakeholders were concerned about departures from scientific recommendations without reasons or feedback.
- Maintenance of the rights holders databases is seen as a priority for EAF.

- Establish an effective and independent advisory forum (i.e. to replace CAF). It was felt that this is currently being done in an informal way but really should be dealt with at the MCM level and should pertain to all management procedures.
- Promote awareness programmes at school level.

Build research and management capacity (HR)

- Put into place a staff retention strategy that takes account of career paths and market-related salaries. Policies that sufficiently support HR requirements for a research environment are needed.
- Participation of staff in internationally engaging research programmes should be encouraged (e.g. mini Centres of Excellence to build capacity). Opportunities should be sought and a structure put into place for international experts to spend time at MCM, and for MCM staff to spend time at partner organizations overseas as visiting scientists.
- Staff should be encouraged/rewarded for producing internationally peer-reviewed scientific outputs (number of scientific publications). Staff turnover (annual vacancy rate) is a major concern.
- Recruit previously disadvantaged individuals (PDIs) for tertiary studies in marine science.
- Social and economic expertise needs to be enhanced at MCM (recognized as a major gap and highlighted as a very important requirement for EAF).
- An efficient and functioning infrastructure to support research is needed (e.g. vessels, offices, labs, computers, etc.).
- Problems that need to be overcome to facilitate an adequate research base for the success of EAF include a lack of transparency in employment procedures, understaffing, lack of capacity amongst the previously disadvantaged sector to fill science/technical/ management posts. Stakeholders felt it important to maintain sufficient capacity and experience at MCM to manage fisheries, within transformation targets, and recognized that experience and institutional memory have their place and are required. This issue should be dealt with at a departmental level.

Develop a clear research and development strategy

- A strategic research and development plan is required for all major South African resources for the ecosystem approach to fisheries, it should focus on multidisciplinary research outputs, and should include operational plans for real time catch data, analyses of observer data, adequate fish ageing information, biodiversity audits, state of the environment reports, scientific working groups, TAC/TAE-driven and other research, etc.).
- Develop a clear strategy to utilize the potential within ecotourism and the implication of commercial activities. This is particularly relevant to the small pelagic fishery, where ecotourism based on penguins, gannets and the sardine run is recognized and may be seen to compete with the small pelagic fishery.
- Consider an outside review panel (perhaps independent advisory forum to the minister) to review and appraise performance of the department; Industry to review MCM performance and service delivery (after LTRAMP); Independent Human Resources Department (from Pretoria); outsourcing of work that is not a core competency of MCM (e.g. administration).
- Promote processing permits for multiple species?

Compliance needs for EAF

- Increased resources for compliance are required.
- Improve compliance at sea and response to reported incidents of dumping and illegal targeting. In particular, compliance in the longline fishery needs to be improved. It was suggested that if permit conditions resulting in major infringements, the vessel could be issued a Section 28 (see 4th bullet in this list for explanation), and that an appropriate action for the trawl fishery needs to be considered once mitigation measures are decided on.
- Enhance compliance by improving and increasing capacity of fishery control officers.
- Increased policing is essential: the South African Marine Living Resources Act of 1998 makes provision to withdraw a fishing right from any entity (commercial or recreational) if found guilty of illegal activities (section 28); this management measure needs to be strictly implemented e.g. in the case of poaching or illegal dumping.
- Re-establishment of Green Courts?

Social and economic needs for EAF

- As already mentioned above, increased skills and capacity in social and economic studies are crucial for EAF.
- An effective Fisheries Development Corporation is needed.
- Industrial Bodies (with the emphasis on Small and Medium Enterprises, SMEs) should be recognized and strengthened.
- The development of SME medical aid schemes should be encouraged, also provident funds and insurance.
- The role of TETAs (Transport Education and Training Authority) needs to be examined.

Possible EAF incentives

- Develop a size-based levy disincentive to use economic pressures to drive catches to the desired size structure.
- Need to develop/improve collection of land-based monitoring and put a system of penalties/incentives to manage this.

11.4 Discussion and conclusions of the Third Regional Workshop

All BCLME countries indicated that lack of capacity in their institutions was a critical factor affecting service delivery. This related particularly to research and management staffing, but not exclusively. Capacity in other departments, such as policy, economics and social sciences related to marine fisheries was problematic. This was seen as a major inhibitor for future capacity to deal with EAF in these countries. Furthermore, the lack of opportunity for advancement and career paths was a major concern.

In South Africa, and to a lesser extent, Namibia, the process of transformation and poor salaries were also cited as issues that exacerbated the institutional capacity problems.

In plenary, the following issues were identified:

1. Diminishing capacity in South Africa and Namibia combined with loss of institutional memory and knowledge is resulting in lack of confidence by stakeholders in scientific and management outputs. Further, pressure and/or interference in the process of making scientific recommendations compromises scientific objectivity.

2. All countries suggested that there was a strong need to develop an effective resource management structure for EAF that included the main stakeholders with particular reference to the fishing industry. This should include co-management in which stakeholders were directly involved in the decision-making process.

3. In Angola, there is a particular need to improve communication with the oil industry as this had direct ecosystem effects and often oil-related activities were given precedence over fisheries. Similarly, in Namibia, this concern applied to the ongoing development of marine diamond mining.

4. The need for increased capacity to sustain long-term ecosystem monitoring, the deployment of scientific observers and improved data management was emphasized.

5. In Angola, improvement of surveillance and compliance as well as addressing access rights relating specifically to artisanal fisheries was critical if the implementation of EAF was to be effective.

6. While most workshop participants agreed that lack of adequate capacity was detrimental to fisheries management, it was agreed that EAF needed broad acceptance and lack of capacity should not preclude the implementation of EAF measures. The implementation of EAF was important enough to justify having dedicated focused institutional arrangements with strong leader(s) to help drive the process.

7. The workshop participants were in general agreement that single species approaches (SSA) are an essential component of the fisheries management approach, but that EAF required that SSA strategies be broadened to be more inclusive of ecosystem effects. Basic EAF measures can be implemented immediately, such as specific permit conditions.

8. EAF required a "mind-shift" amongst researchers, managers and industry (at all levels) to broaden their perspectives. Once this was achieved, the introduction and acceptance of EAF would be easier.

9. With respect to the implementation of EAF in the region, all three countries will need to fulfil their responsibilities with respect to EAF. In addition each country should liaise with the BCC and other Regional Fishery Management Organizations (RFMOs) as needed.

12. RESEARCH NEEDS

12.1 Angola

The list of research needs for Angola that had been identified during the various workshops held within the project is provided in Table 12.1. The list was split into categories covering common research needs and those specifically addressing research required in relation to each of pelagic fish, demersal fish, deep-sea crustaceans, the artisanal fishery, ecosystem research and social and economic research.

Table 12.1. The research needs for implementation of EAF in Angola, as identified during the RASF workshops

Common research needs

- Develop a refined data collection protocol for the observer programme.
- Develop a refined data collection protocol for the National Biological Sampling Programme.
- Include bycatch declarations in commercial catch records and further investigate mitigation measures.
- Obtain improved species-specific catch estimates.
- Undertake studies on species subject to Illegal, Unreported and Unregulated Fishing (IUU).

Pelagic research needs

- Continue routine acoustic surveys of biomass.
- Implement CUFES survey of eggs and larvae.
- Deepen research on methodology of acoustic abundance estimation, namely on avoidance, target strength, daily vertical migrations.
- Continue research on yearly cycles of biological parameters, using the National Biological Sampling Programme.
- Monitor distributions of catch and effort by means of logbooks and geographic information systems (GIS).
- Monitor size and age distribution of catches in the most important fishing gear types
- Plan and undertake genetic studies on stock variability and characteristics (separate sub-stocks?).
- Recover the historical data on catches, effort and biological characteristics of small pelagic fish.
- Undertake studies on life-cycles and migration patterns.
- Undertake studies on the movements of shared stocks, and the fluctuations in abundance in the different countries.
- Undertake behavioural studies of the response of fish schools to fishing activities.
- Expand/refine current observer programme to determine levels of dumping and causes.
- Determine and implement mitigating measures to prevent dumping and illegal targeting (incentives, self-regulation, etc.).
- Continue investigating environmental effects on distribution and migrations of small pelagic fish, including the changes in species composition of sardinellas and horse mackerels.

Demersal fish research needs

- Undertake studies on the selectivity of fishing gear.
- Expand studies on the feeding habits of the main commercial species.
- Undertake studies of bycatch and discards in the bottom trawl finfish and cephalopods fisheries.
- Continue surveys of stock size and distribution.
- Undertake studies on distribution, life-cycle and migrations.
- Continue studies on composition and biodiversity of demersal assemblages.
- Undertake studies on the seabed impacts of bottom trawl gear.
- Establish an agreement with Namibia to obtain the estimated amount of *Dentex macrophtalmus* caught as bycatch in Namibia.

Deep-sea crustaceans fishery research needs

- Undertake studies of bycatch and discards in the bottom trawl deep-sea crustacean fisheries. Quantify and investigate mitigation measures.
- Undertake studies on the distribution, life-cycle and migrations.
- Continue studies on composition and biodiversity of demersal assemblages.
- Undertake studies on the seabed impacts of bottom trawl gear.
- Continue surveys of stock size and distribution.
- Expand National Biological Sampling Programme to cover the transhipment of deep-sea crustaceans.

Artisanal fishery

- Undertake studies on the selective properties of the gear used by artisanal fisheries in Angola.
- Undertake studies on the risk of ghost fishing from the gear used by artisanal fishers in Angola.
- Continue the survey series on inshore resources.

Ecosystem research needs

- Monitoring of species assemblages and biodiversity in the coastal area.
- Monitoring of accidental catches of threatened, protected and vulnerable species.
- Monitoring of pollution events in the coastal area.
- Assess status and monitoring of mangrove ecosystems.
- Undertake research on role of mangroves as nursery areas for commercial species
- Monitoring of marine litter.
- Undertake ecosystem studies to understand the catch level and availability of juveniles of commercial and non-commercial species to the artisanal fishery.
- Undertake studies to establish whether fishing gear causes significant damage to benthic biota.
- Undertake studies to assess the type and intensity of the relation between seabirds and fishing, especially with offal.
- Undertake studies to assess the type and intensity of the relation between seals and fishing activity.
- Undertake studies on appropriate indicators of ecosystem health and status.
- Undertake research on benthic communities.
- Undertake research on distribution and movements of whales.

Social and economic research needs

- Undertake a comprehensive social and economic study of the Artisanal fishery.
- Undertake a comprehensive market study of the artisanal fishery.
- Undertake studies on techniques to add value to fish from the artisanal fishery.
- Investigate the use of economic/marketing incentives to reduce potentially wasteful or suboptimal usage of small pelagic resources, including the use of horse mackerel for fish meal and oil.

12.2 Namibia

The research needs for Namibia identified in the national workshops held under the project are listed in Table 12.2 and are split into the following categories: general ecosystem, demersal sector, midwater sector, pelagic sector, crustaceans, top predators and general. The list includes the needs for research identified for the purpose of providing recommendations for fisheries management at the ecosystem level, in addition to the stock specific research and monitoring currently undertaken for stock assessment purposes. The needs were being prioritized at the time of the Workshop by the newly formed Integrative Marine Ecology Working Group (IMEWG). It was stressed that that the present scientific research capability of the Ministry of Fisheries and Marine Resources (MFMR) was considered to be insufficient to undertake most of the needs identified and that future development and implementation of a science-based EAF in Namibia would therefore be dependent in the medium-term on regional and international scientific collaboration that should include a strong capacity building and training component.

In subsequent discussions on the presentation on Namibian research needs, it was noted that most of the needs included in Table 12.2 were national or institutional issues, although some dealt with transboundary issues. However, it was recognized that the seemingly national issues were, in fact, often the same across all three countries, thus they were, in a way, regional.

The workshop was informed that while the existing assumptions of the effects of bottom trawl on the habitat were currently based on information from outside the region, a pilot study from NORSA-BENEFIT on effects of bottom trawling (including taking box-cores) was being planned for the BCLME. With reference to the spatial shifts that have been observed in South Africa, J.-P. Roux elaborated on the northward shift/shrinkage of distribution in Namibia of top predators following the decrease of small pelagic species, notably sardine.

It was suggested that the output of research cruises could be increased by combining different disciplines and/or conducting joint transboundary surveys. In this regard, F. Botes of the BCLME Secretariat reported on a meeting planned between Namibia and Angola early in 2008 to improve regional collaboration.

The Workshop noted that the list of Namibia's research needs included in Table 12.2 appeared to have filtered out the social and economic issues identified at the RASF workshops. It was suggested that these social and economic issues will need to be addressed, but were not within the scope of the Directorate of Resource Management in Namibia. On this matter, the need for assistance in setting up fisheries management plans from the Directorate of Policy, Planning and Economics of the MFMR was highlighted. It was acknowledged that cooperation and communication were needed across different sectors, including the need to

involve social scientists professionally in the ministries (similar to the Economic Directorate of the MFMR in Namibia). The importance of including social and economics in fisheries research and continuing to invite social and economic scientists to workshops was stressed. F. Botes responded that five social and economic projects were being conducted within the BCLME and that some had already produced reports.

The Workshop agreed that the wealth of BCLME project outputs and recommendations needed to be consolidated. The EAF project had been a good way of doing this, as most information could be fed into it. This insight also strengthens the need for a next phase of the BCLME EAF project. In addition, a formal process to discuss and consolidate all key findings of the projects by the end of 2007 was a part of the mandate for the BCC.

Table 12.2. The research needs for implementation of EAF in Namibia, as identified during the RASF workshops

General ecosystem
• What is the present trophic role of jellyfish and their impact on the ecosystem?
• Establish the trophic role of pelagic goby and assess the degree of interactions (competition?) with commercial small pelagic stocks (anchovy-sardine).
• Conduct stable isotope studies on goby, jellyfish and mesopelagic fish species (in addition to the species considered below).
• Conduct biomass acoustic surveys of jellyfish, goby and other forage fish species.
• Retrospective analysis of past changes in ecosystem functioning and structure with particular emphasis on pelagic-benthic energy flows (trophic models) and perceived regime shifts and possible changes of ecosystem state since the 1960s.
• Use a variety of modelling approaches to investigate the relative (plausible) contributions of fishing and environmental forcing to the perceived changes in ecosystem states.
• Improve and update food web models to provide ecosystem indicators and recommendations on strategies for fisheries management.
• What (trophic) processes are involved in the observed responses of top predators to variability in environmental forcing (upwelling)?
Demersal sector
• Diet studies of the demersal species assemblages with particular emphasis on the differences between the two species of hakes and ontogenic changes. Detailed intensive sampling should be coordinated with the planned "year of the stomach" in South Africa, and "lower level" routine diet monitoring should be implemented to quantify interannual variability (both during research surveys and commercial fishing operations through observer sampling).
• Stable isotope characterization of tropic levels of demersal species for "ground-truthing" diet studies and trophic models.
• Quantification of bycatch levels of other commercial species by gear and area with particular emphasis on commercial stocks (crustaceans, monk fish, kingklip etc.) and demersal chondrichthyans (sharks and skates).
• Develop management plans for commercial bycatch species of the demersal fishery.
• Compile gear selectivity information and conduct additional gear selectivity experiments.

- Quantification of the impact of demersal fishing on seabirds including incidental direct mortality (by gear and area), offal provision and utilization, and impact of oiling (particularly on gannets) due to offal and macerate release.
- Assess impact of gear on demersal habitat.
- Assess the role of the main hake predators in terms of their contribution to natural mortality per species and size class.
- Model the impact of changes in the biomass and size composition of the two hake species on the trophic functioning of the ecosystem.
- Study the processes contributing to recruitment levels and variability (environmental forcing and predation/cannibalism).
- Assess the extent of the interactions between seals and long-line fishing for hakes, conduct (gear) experiments and recommend mitigation measures.
- Assess the impact of offal/discards on scavengers (particularly seabirds and seals).
- Improve estimates of commercial catches by size and by species and implement split-species hake assessments.
- Assess need and feasibility of joint management strategies for shared stocks (in particular for *Merluccius paradoxus* with South Africa).

Midwater sector

- Quantification of bycatch levels of species other than horse mackerel by area and depth with particular emphasis on vulnerable species (cetaceans, seabirds, chondrichthyans) and commercial stocks (snoek, sardine, hakes, dentex etc.).
- Develop management plans for commercial bycatch species of the midwater fishery.
- Assess the diet compositions and trophic levels of "midwater species" using stomach analysis and stable isotopes during surveys and commercial operations per size classes, depth and area.
- Determine the ecosystem impact of changes in horse mackerel size composition.
- Determine the trophic impact of changes in biomass and distribution of the horse mackerel stock.
- The horse mackerel stock being shared with Angola: a routine joint research survey programme covering the entire range of the species needs to be implemented and a joint transboundary management strategy needs to be investigated.

Pelagic sector

- The sardine stock being shared with Angola: the routine joint research survey programme needs to continue joint transboundary management strategy needs to be implemented.
- Assess the ecosystem (trophic) impacts of the reduced abundance and restricted distribution of sardine and anchovy on the dynamics of their prey (e.g. zooplankton) and on their predators.
- Has the "keystone" trophic position of small pelagics in the ecosystem been filled by other species and have the changes due to low small pelagic biomass triggered negative feed-back loops, e.g. through competition (horse mackerel, goby, jellyfish), predation (goby, jellyfish) or habitat modification (low oxygen, sulphur eruptions) leading to an alternate stable ecosystem state?
- Investigate and quantify the trophic effects (predation) potentially limiting the productivity of small pelagic stocks at present, e.g. effect of jellyfish on recruitment, effect of fish and top predators (birds and seals) on natural mortality.

- Assess the main contributors to natural mortality and investigate the trophic controls at play (top-down, wasp-waist, bottom-up) to test the different hypotheses regarding the present dynamics of the small pelagic stocks (predator pit).
- Assess the interactions between different fisheries of this sector through bycatch studies (e.g. bycatch of sardine during juvenile horse mackerel purse seine fishery operations).
- Using predator functional responses assess what target minimum biomass of small pelagic fish should be chosen to restore the ecosystem functions for sustainable management at the ecosystem level.

Crustaceans

- Assess the impact of mining on rock-lobster habitat, and biological parameters (growth, recruitment, feeding etc.).
- Assess the potential of MPAs in the management of rock-lobster and recommend implementation.
- Assess the effects of environmental forcing (oxygen, upwelling, wind and swell) on lobster dynamics and on the fishery.
- Implement regular transboundary surveys and assessments and propose a transboundary management strategy for deep-sea red crab shared between Namibia and Angola.

Top predators
(Includes seabirds, cetaceans and seals)

- Implement a standardized seabird monitoring programme and analyse historical data on population trends, distribution, breeding success and diets.
- Analyse the functional response of seabirds to their prey fluctuations and determine their trophic needs. Develop spatially disaggregated bioenergetic models.
- Implement MPAs to minimize disturbance and interactions between seabirds and fisheries.
- Continue and improve the monitoring of seal diet and couple this with telemetry studies to take into account spatial changes in foraging effort and overlap with fisheries effort.
- Continue to develop and test the usefulness of top-predator based indicators of changes in the system (e.g. recruitment indices for predator species).
- Assess the contribution of predation by top predators to the natural mortality of their prey species and investigate the trophic controls (top-down vs. bottom-up) and the predator's functional responses.
- Implement joint regional surveys and management strategies for shared predator populations.

General

- The quality, reliability and scope of the data collected by fisheries observers need to be upgraded in all sectors. The observer data need to be curated and analysed. The sampling strategy by observers needs to be improved to get a better coverage of the different sectors of the industry as well as a better geographical coverage.

12.3 South Africa

The list of research needs identified for South Africa during the RASF Workshops is provided in Table 12.3. Five key areas of research which encompassed all three fisheries had been identified.

1. Social and economic: some data were collected during the long-term rights allocation process but these will need to be updated in the future.
2. Surveys and life history data: surveys must be continued and expanded if possible as they are necessary for determining biological parameters (reproduction and growth), size structure and sex ratio of the population. In particular there is a need to work on the early life stages of species and determine recruitment. Surveys must include collection of environmental data which is collected throughout the year.
3. Environmental data: there is a need for dedicated year-long data collection at strategic points along the coast in order to draw better conclusions about the effect of the environment.
4. Observer programme and monitoring: the current programme must be continued and specialized where necessary to provide as much detail as possible about catch composition, discards, dumping and implementation of bycatch mitigation measures. Monitoring of catches at field stations needs to be improved and there is a need to resolve differences between landing totals from inspectors, observers and logbook returns.
5. Experiments: investigations are needed on the impact of fishing on the seabed, predator influences, usefulness of time-area closures and MPAs.

The number of species that data are required for is prolific: hake, sardine, anchovy, horse mackerel, redeye, seals, seabirds, snoek, linefish, sharks, skates, monk, kingklip, kob, rock lobster, urchins, abalone, octopus and mesopelagics. However, there are data available for several of these species which have not been analysed, and hypotheses could be tested using these data.

Table 12.3. The research needs for implementation of EAF in South Africa, as identified during the RASF workshops

Pelagic research needs

Anchovy, sardine and redeye

- Continue routine acoustic surveys of anchovy spawner biomass and continuous underway fish egg sampling (CUFES) surveys of anchovy eggs.
- Undertake frequent and regular sampling along a line extending offshore in the region east of Cape Infanta (collection of fish eggs, temperature and currents).
- Continue routine monitoring of fish abundance and biological parameters, phyto- and zooplankton abundance, upwelling indices, etc.
- Evaluate relative abundance of pelagic fish, zooplankton and phytoplankton to determine the scope for growth and successful recruitment of pelagic fish populations in relation to plankton productivity.
- Continue to monitor catch distributions by means of GIS.
- Plan and undertake genetic studies on stock variability and characteristics (check whether separate sardine stocks exist on south vs west coasts).
- Undertake behavioural studies of response of fish schools to fishing activities.

- Undertake further studies to understand decadal-scale fluctuations in abundance of small pelagics, and the reasons for and implications of shifts in anchovy spawner distribution (which may impact recruitment success).
- Expand/refine current observer programme to determine levels of dumping and causes.
- Determine and implement mitigating measures to prevent dumping and illegal targeting (incentives, self-regulation, etc.).

Horse mackerel, mesopelagic fish, chub mackerel

- Develop acoustic surveys of juvenile horse mackerel and demersal surveys of adult horse mackerel to obtain relative indices of abundance.
- Conduct life-history studies on horse mackerel.
- Collate existing data on mesopelagic fish off South Africa and their spatial and temporal distribution.
- Develop mesopelagic fish stock assessments and surveys.
- Investigate whether chub mackerel abundance (currently low) is related to sardine abundance.

Seabirds-pelagic fish

- Need to maintain seabird monitoring programmes.
- Urgent need to initiate programmes to investigate/model the links between seabirds and fishing and other human activities to ensure sufficient forage fish remains in the system for seabird predators, but also for seals, snoek, tuna and hake (the latter three supporting important commercial fisheries). Research approaches may include minimum realistic models and spatialized models of pelagic fish around seabird colonies (need to determine viable population sizes of predators).
- Quantify functional responses of seabirds to small pelagic prey and identify thresholds below which there are serious negative implications for seabirds.
- Expand satellite tracking projects to assess foraging ranges of seabirds.

Social and economic

- Investigate the use of economic/marketing incentives to reduce potentially wasteful or suboptimal usage of sardine resource.
- Undertake cost-benefit analyses to assess the potential for eco-tourism based on small pelagic fish (e.g. seabird colonies, marine mammals, sardine run, sport and recreational line fishing) versus commercial fishing on small pelagics.
- Undertake cost-benefit analyses (including ecological costs and benefits) on whether it is feasible, viable and/or beneficial to reduce fishing on small pelagics in favour of fisheries on predatory fish such as snoek and hake.

<u>Hake research needs</u>

EAF research and model dynamics

- Plan and implement a "Year of the stomach" to collect dietary information related to hake, including the whole demersal assemblage and also pelagic linkages (focus on trophic interactions, although other data may be collected simultaneously).
- Establish communication with agency conducting biodiversity audits.
- Assess seabed impact and introduce management measures.
- Further refine and develop new models of hake in terms of multispecies/ecosystem interactions.

- Research environmental effects on ocean productivity and fish stocks, ultimately affecting the South African hake resources.
- Undertake satellite remote-sensing studies to assess the effects of climate change on hake
- Continue surveys of stock size and distribution.
- Ensure balance in trophic levels (use models): consider possible benefits of ensuring sufficient small pelagics and mesopelagics for hake predation.
- Simulate effects on hake stocks of climate change using model scenarios – relate hake abundance, distribution and availability to the fishery to environmental factors.
- Model estimates of M higher than expected for hakes and fewer large fish in recent catches than expected – leads to high estimates of age-dependent M. The problem is interlinked with the issues around the lack of recruitment variability, age estimation, and sea-based catch-at-length data; cannot be dealt with on its own, until the other factors are better understood.
- Explore the different impacts of fishing large *M. capensis* and large *M. paradoxus* on interspecies predation, which may alter the stock size and distribution.
- Monitor abundances and effects of top predators feeding on hake.
- Examine hake recruitment fluctuations and their causes.
- Design and implement recruit survey with adequate spatial and temporal coverage.
- Improve estimates of hake recruitment – undertake exploratory recruit survey.
- Develop a refined data collection protocol for the observer programme (this is also relevant to other fisheries).
- Explore and develop early warning indicators of hake collapse/reduced availability.

Responsible fishing

- Continue current observer programme to monitor catch of small *M. capensis* in the inshore trawl fishery and discarding.
- Analyse data collected by observers.
- Strengthen current data collection efforts on shark bycatch by observers (improve species identification skills; species-level identification is a difficult task but is vital for assessing the impact of the fisheries. In addition, determine whether chondrichthyans are retained or discarded (alive?), and their sex and size should be recorded).
- Explore effectiveness and positioning of offshore trawling MPAs to protect a representative portion of South Africa's offshore benthic habitats.
- Investigate mitigation measures to reduce seal-trawl fishery interactions.
- Continue to explore, refine and implement mitigation measures including carrying of observers, line weighting, tori lines, offal discharge control, all dead birds must be landed and times of line setting, in the longline fishery.
- Explore and implement mitigation measures in the demersal trawl fishery to reduce bycatch of fish, birds, etc.
- Assess how species distribution, diet, foraging behaviour and abundance are impacted by offal discards (all species) and complete offal management guidelines being developed for the trawl fishery.
- Consider seabird mortality when determining the proportion of TAC allocated to longline and trawl.
- Investigate whether foraging around trawlers affects seabird survival, breeding success, abundance and community structure.

- Examine trade-off effects of favouring opportunistic seabirds for distribution and abundance of threatened specialist seabirds, versus the provision of a high-quality, predictable food source in the form of offal (assess potential mortality of seabirds while scavenging at fishing vessels versus potential mortality through removal of this food source).
- Undertake an updated analysis of effects of discarded offal on seal population dynamics.
- Undertake an updated study of seal diet and feeding behaviour (to assess the benefit of offal).
- Quantify the extent of lost fishing gear in the hake fishery and estimate the potential impacts of ghost fishing by lost/discarded fishing gear.

Bycatch of commercial species

- Improve assessments for monk fish and kingklip stocks (these commercially valuable species are caught as bycatch in the hake trawl fishery).
- Estimate the impact of the hake fishery on the retained bycatch species.
- Estimate the impact of the hake trawl fishery on non-retained bycatch species.
- Continue to collect catch, catch-at-length, ageing material and biomass survey abundance indices; continue to monitor biomass indices from swept-area research surveys; continue to collect fishery-independent and dependent data for resource assessment.
- Expand research surveys to include additional trawl sites to enhance survey based estimates for these species.
- Continue observer programme currently in place to monitor catches but improve coverage of current observer programme.
- Investigate factors affecting chondrichthyan bycatch.
- Include bycatch declarations in commercial catch records and further investigate mitigation measures.
- Improve linefish assessments (poor assessments at present due to uncertainties and lack of data and effort monitoring).
- Continue to monitor snoek catches and CPUE in line-fishery and trawl fishery.
- Use data on spatial overlap between trawl and linefish distribution to site effective time/area closures.
- Improve chondrichthyan identification (observers) – quantify chondrichthyan bycatch by sex, size and whether discarded live/dead.
- Although some mitigation measure to reduce bycatch in the hake fishery are already in place (most bays on the southeast coast closed to trawling; move-on rule for kob catches; bycatch limit for kob), there is still a need for further measures to be investigated and implemented (such as setting a per-trip-linefish-bycatch, time/area closures, and use of escape panels or selector grids), and for area-specific application of mitigation measures to be explored.
- A holistic management approach of commercial species caught as bycatch in the hake fishery is needed.
- Holistic management of the snoek resource is required because snoek is caught in several fisheries (trade-off between maximizing economic return from the resource and maximizing jobs).

Social and economic parameters

- Undertake a comprehensive social and economic study of the South African hake fishery that is internationally accredited.

- Analyse data collected as part of LTRAMP process and monitor new data when submitted.
- Collect data for Black Economic Empowerment (BEE) database (emphasis on SMEs).
- Continue to monitor the incidence of gill parasites during biomass surveys.
- Explore (predict by scenarios) the social and economic consequences of long-term climate change leading to catastrophic decline in fisheries such as the hake fishery.

Hake management (these are largely research needs applicable even without moving towards EAF)

- Quantify hake discards.
- Continue investigating environmental effects on hake distribution; modify survey to take account of changes in hake distributions; extend biomass surveys into deeper waters.
- Investigate the feasibility and applicability of time-area closures and MPAs to protect specific size classes of hake, hake nursery areas and spawning areas.
- Augment CPUE database with retrospective technological improvement data (include skipper effects).
- Improve models and undertake research to increase agreement between models and observations - the apparent contradiction appears to be due to a scarcity of small (young) *M. capensis* observed in the surveys (estimated numbers at age increase up to age 4 years) resulting in low estimates of catchability, i.e. the model suggests that a substantial proportion of the *M. capensis* biomass is avoiding or is not available to the trawl. Improved ageing studies are required to generate revised age-length keys (apparent anomalous catch-at-age may be the result of erroneous ageing) and studies are needed to determine whether *M capensis* are less susceptible than *M paradoxus* to capture by trawl nets. Improved estimates of the proportion of *M. capensis* in the total hake catch per fishing sector are required, as is enhanced reporting of environmental information with catch data. Historic environmental data needs to be captured.
- Improve the hake OMP: (i) incorporate uncertainty about hake species split in catches; (ii) use annual industry-based species splitting algorithms to disaggregate commercial catches to species level; (iii) incorporate uncertainty about *M. capensis* stock status into OMP (more conservative TACs); (iv) incorporate environmental factors into stock assessment models and OMP; (v) continue to run robustness and sensitivity tests within the OMP and run robustness tests for hake species split in OMP, recruitment variability, M, test for uncertainty about biological model parameters into the OMP.
- Estimate the extent of seasonal and cyclic changes in distribution as well as long-term shifts.
- Use survey and catch-at-sea (cf. landed) measurements to develop size distributions of catch by area (i.e. spatial) and season; match these series with landings reported by vessels fishing in that area.
- Better analyse and utilize existing data and update with recent records; estimate natural mortality (M), recruitment variability, age structure of populations and sea-based catch-at-length data; use research survey data and models.
- Design studies to measure life-history traits and to refine estimates of biological parameters.
- Identify causes of apparent lack of recruitment variability (error in ageing?); undertake tagging studies using tetracycline markers to validate age rings.

- Obtain improved species-specific hake catch estimates; improve observers' identification skills through training to facilitate estimation of species composition of hake catches by observers; analyse existing observer data; consider potential change in behaviour of fishers in presence of observers.
- Continue (and improve method of) recording length distribution of landed catch per vessel to detect possible high-grading.
- Use database of expected size distribution of catches by area and season to identify vessels suspected of high-grading; deploy inspectors on vessels suspected of high-grading; consider aerial patrols to collect evidence of excessive discarding.
- Develop length/sex keys for trawl catch to decompose catch-length data into catch per species per sex.

West Coast rock lobster research needs

Ecosystem research

- Undertake ecosystem studies to understand the processes involved in interactions among lobsters and benthic organisms, particularly urchins, abalone and octopus in order to retain the potential for fisheries of impacted species such as abalone, and to provide information for management of the rock lobster-abalone assemblage as a unit.
- Explore spatially disaggregated West Coast rock lobster assessments and revise the OMP for stock rebuilding accordingly.
- Undertake studies to establish whether fishing gear causes significant damage to benthic biota.
- Continue to monitor early warning signs of low oxygen events that may lead to rock lobster walk-outs.
- Identify hotspots. Research on main channels of distribution. Refer to Southern African Development Community (SADC) MCS workshop.

Monitoring of biological trends to maximize sustainable yield of West Coast rock lobster

- Continue the annual hoop-net surveys.
- Continue current mark-recapture programme to assess rock lobster growth.
- Improve and refine lobster growth rate determination.
- Investigate the effects of limb loss on growth of lobster: undertake a time-at-large experiment to assess the effects of limb loss, assessing juvenile growth, condition factors to predict growth.
- Continue collecting independent data sets (inshore and offshore) Fishery Independent Monitoring Surveys (FIMS).
- Continue to undertake monthly random sampling for size and sex ratios.
- Continue to undertake commercial catch sampling and collect onboard observer data.
- Assess the number of injured lobsters in wild populations (use onboard observers and also assess during research surveys).
- Continue to explore the possibility of developing a spatially disaggregated OMP to set individual zonal TACs (currently, a TAC for West Coast rock lobster is set globally using the current OMP, then subdivided into zones on the basis of estimated relative abundances).
- Explore ways in which information on environmental fluctuations and climate change can be incorporated into assessment models to manage the resource more effectively.
- Modify the existing OMP, which is robust to different growth rates, to be more sensitive to growth rates once sufficient understanding is reached.
- Explore seasonal area-specific closures to protect berried females.

- Explore the benefits and feasibility of a male-only fishery.
- Dedicate additional research effort to understand/define factors and mechanisms responsible for the geographical shift in the distribution of West Coast rock lobster; closely examine environmental factors and examine and monitor condition factors.
- Investigate causes and effects of low growth rate and address growth-rate changes with respect to historical growth rates, especially considering long-term environmental trends and temporal food availability and lobster condition (compare similar areas with different food supplies).
- Document and understand change in size structure of females.
- Examine the division of lobsters' resources between growth and reproduction.
- Monitor size-at-maturity trends.
- Use historic data to design a plausible dynamic population model.

Maintenance of social and economic well-being through management measures

- Increase observer coverage and training.
- Assess impacts of mining on benthos in lobster areas (physical damage to benthic habitat; hydrogen sulphide eruptions, suspended particles).
- Monitor future recruitment through FIMS.
- Assess feasibility of growing out lobster larvae.

Related to section on regional research needs:

Policy

- Develop joint research programme to investigate distribution and stock-structure of both species across both coasts and borders.
- Assess need for joint management if stocks are shared (covered by current BENEFIT project).

12.4 Conclusions on research needs from the Third Regional Workshop

It was agreed that the list of research priorities for each of the three countries should be examined for opportunities for cooperation at the bilateral and regional levels as this could reduce costs and lead to greater efficiency and quality in the studies.

There was a lot of discussion about the possible need for a regional strategy for specialized survey vessels and there was a concern that, with each country planning on purchasing new survey vessels, there would be costly surplus of capacity. It was also suggested that, for some survey purposes, commercial fishing vessels could be suitable, also pointing to the need to be cautious in the construction of new vessels. In contrast, it was noted that the R/V DR. FRIDTJOF NANSEN was heavily utilized and was already fully committed for 2008 so that the region needed to develop greater local capacity for surveys. These discussions reinforced the need for the development and implementation of a regional strategy.

It was agreed that there is an urgent need for greater cooperation with social scientists and economists in fisheries research and management. This had been recognized as a problem for many years but the problem has persisted. People from the social and economic sciences had been invited to participate in this project but, in general, this had not been successful. Their failure to become involved probably stems from some fundamental differences in methods and approaches and it was reported that social scientists often found it difficult to know when

and how to contribute to workshops and processes that were run by natural scientists. The tendency in fisheries research to think in terms of socio-economics was an example of a failure to understand the scope of the topic because, when this is done, economic considerations inevitably dominate but the human condition and perspective cannot be reduced to economics alone. Such communication failures can only be solved by dialogue. It was agreed that fisheries scientists and managers, in consultation with human scientists, need to consider the nature of the potential contribution of human scientists and the roles that they can play. Some examples include the need to translate biological information into economic terms, for example through economic and bio-economic analyses and models but there are many other roles as well.

Some participants reported that it was very difficult to obtain comprehensive and accurate economic data due, in part, to fears over confidentiality and potential misuse by competitors. However, there had also been examples of very good cooperation although it was pointed out that these tended to occur in times of crisis in the industry.

Other points raised included:

- The importance of long-term monitoring to establish and maintain long-time series of relevant data.
- There was a lack of capacity in all countries to control quality and make full use of the data that were collected, including fisheries independent, observer and fisheries data, and that this was hindering progress on some key research and management questions.
- One approach to improving the use of available data was to make use of the opportunities presented by graduate students to use the data to address key questions.
- Pilot scale studies are useful to test and demonstrate the value of new management measures.
- Some countries had identified a "year of the stomach" to improve knowledge of trophic interactions but it was suggested that it would be necessary to follow up and to continue to monitor diet composition on an on-going basis as this would provide information on possible changes in M.

13. CONCLUSIONS AND RECOMMENDATIONS

13.1 Introduction

This project was set up in consultation with FAO, and commissioned by the Steering Committee of the Benguela Current Large Marine Ecosystem Programme. It was a very broad and ambitious attempt to assess the feasibility of implementing an ecosystem approach to fisheries within the LME at both national and regional levels. It examined the major fisheries in the three countries in order to identify the problems, or issues under the existing management regimes and to identify potential management measures and approaches to address those problems. It also examined some of the fundamental institutional and operational requirements for EAF, including the role and characteristics of indicators for EAF management, possible approaches to assist decision-making in the multi-stakeholder and therefore multi-criteria context of EAF, incentives to encourage stakeholders to implement EAF, institutional arrangements to address the broader perspectives and mandate of EAF and research to inform and advise on its effective implementation.

With this broad mandate, it would have been impossible for the project to come up with firm and rigorously considered concrete options for implementation of EAF and an assessment of their feasibility. Such a task would probably be impossible in only three years even with the full time attention and all the capacity of the three national fisheries agencies. The project therefore was never intended to provide final recommendations but, instead, has attempted to provide preliminary indications of where the major concerns lie, possible generic management approaches to address them, and preliminary indications of the benefits and costs of both alternative and complementary measures. It has also reviewed some of the practical tools and requirements for decision-making and implementation of EAF and commented on key aspects of their application and relevance in the BCLME. As far as the authors and the BCLME partners are aware, this is the only example of such a wide-ranging and holistic assessment of the feasibility, and implications, of implementing EAF at a regional scale.

The results and conclusions should not be seen or used as being either final or definitive. However, the authors of this report are confident that they provide a highly informative and solid starting point from which the three participating countries, nationally and through the BCC, can initiate the most urgent actions required for EAF and move forward in planning and implementation of EAF as a whole, in accordance with the commitments made in the Plan of Implementation of the World Summit on Sustainable Development in Johannesburg in 2002.

13.2 The issues and priorities

13.2.1 National

A total of 10 fisheries was included in the seven RASF workshops held within the project and the number of issues identified for each ranged from 20 in the Angolan artisanal fishery to 96 in the South African hake fishery, with a median number of approximately 70 issues per fishery (Chapter 3). Not all of these issues were considered to be of high or extreme priority, but the number that were does give cause for concern and demonstrate the urgent need for the countries to move forward rapidly in implementation of EAF. The percentage of issues that were considered to be high or extreme ranged from 23 percent in the South African small pelagics fishery to 66 percent in the Angolan small pelagics fishery. These figures would, in

part, reflect the perspectives and composition of the group of participants and their interpretations of risk. They should not therefore be used for comparison between fisheries but do reflect a large number of problems that are not being adequately addressed by existing management approaches in each. It should be noted that the issues with moderate risk values should also be examined carefully and considered for possible action where necessary.

The types of issues identified varied considerably from fishery to fishery, particularly in relation to ecosystem well-being. In all cases, many of the issues reflected problems in the existing single-species approaches to management, including insufficient knowledge of abundance and life-history characteristics, uncertainties about stock structure and distribution, and problems associated with high natural variability in target species. Arguably the most important ecological issues that could be considered as EAF "add-ons" were related to bycatches, including of species of importance to other fisheries, species of conservation concern and other species perhaps of less direct importance to humans but significant components of the ecosystem. The lack of good knowledge of and concerns about the impact of bottom fishing gear on benthic habitat was also an important theme across the three countries. There were also concerns about damage to habitats considered to be important to species survival and ecosystem functioning. There was a number of high priority issues related to human well-being and governance, which showed considerable similarities across all fisheries.

A useful summary of the major issues in the Namibian and South African fisheries examined in the project is provided in Nel *et al.* (2007). In that analysis, the authors identified 22 operational objectives that addressed the major issues identified in the RASF workshops for those two countries. The list is summarized in Table 13.1.

Table 13.1. Broad objectives incorporating the most important issues identified by the RASF workshops in Namibia and South Africa (from Nel *et al.*, 2007).

Category	Operational objective
Ecological well-being	1. Adequate stock assessment models and management procedures maintain target species at ecologically sustainable levels.
	2. Understand and manage bycatch of overexploited fish stocks.
	3. Assess and mitigate fisheries impact on vulnerable species.
	4. Assess and manage impact on marine habitats.
	5. Understand and manage trophic impacts of fishing.
	6. Identification and protection of ecologically important areas (spawning areas, nursery areas, predator foraging areas).
Human well-being	7. Understand and mitigate social and economic impacts of management advice.
	8. Improve long-term stability of fishery and financial security of fishers.
	9. Improve skills and capacity of fishers to deal with variability and change.
	10. Improve international market security.

Governance	11. Government has adequate capacity and skills to implement an EAF.
	12. Effective participatory management and transparent decision-making processes are in place.
	13. Develop common understanding and clear communication between government departments and between fisheries management divisions within fisheries agencies (i.e. research, resource management and compliance).
	14. Data management allows for timeous management responses.
	15. Government has appropriate skills, understanding and motivation to ensure high levels of compliance to fisheries regulations.
	16. Appropriate plans incorporate EAF considerations and guide management of the fishery.
	17. Minimize conflict between fisheries sectors and management that is compounding risks.
	18. Harmonize regional management procedures for transboundary issues.
	19. Cultural and national transformation of fisheries.
	20. Fishing sectors and employees are consolidated around structures that enhance communication, consultation and competitiveness.
External impacts	21. Ensure that fisheries are able to remain economically viable within predicted climate change scenarios.
	22. Integrated management of the exclusive economic zone which incorporates and balances multiple needs i.e. fisheries, mineral and gas exploration, civil society.

In general, the generic operational objectives included in Table 13.1 are applicable to the fisheries of Angola as well. However, there are two characteristics of the fishery sector in Angola that set it apart from the sectors in its two southerly neighbours. Those characteristics are: (i) the high species diversity in the demersal ecosystem in the northern and central parts of the country and (ii) the fact that the very large artisanal fishery, which includes some 130–140 000 fishermen (Cardoso, Sowman and Duarte, 2006), is currently open-access and poses some substantive challenges to management (see Table 3.1d). These two features, as well as the high priority given by Angola to the social contribution of the fishing sector, result in some differences in issues and relative priorities in Angola compared to South Africa and Namibia.

The relatively small number of operational objectives identified by Nel *et al.* (2007) within the category human well-being reflects the results of the RASF workshops but the number does not reflect the priority given to human well-being by the workshop participants. In general, many of the human well-being issues were allocated high to very high risk values and priority. The prevailing concern in all three countries is that there is a high degree of dependence on fishing and fishery resources by coastal communities that, coupled with concerns about the sustainability of current fishing mortality in some fisheries, is leading to high vulnerability of fishers and fishing-dependent communities. This is exacerbated by a range of external threats, including the existence of social problems within the fishing

communities such as a common lack of skills and capacity to secure and take advantage of their access to the fishery, the threat imposed by HIV/AIDS and others. While management in all three countries has been reasonably successful in controlling exploitation of target resources, it has been giving insufficient attention to facilitating optimal human well-being within the fisheries.

The details and priority of the operational objectives listed in Table 13.1, and the issue or issues underlying each, would vary from fishery to fishery but the list as a whole provides a useful checklist of likely areas of concern in all. It should be noted that the issues identified, in all the RASF workshops, will reflect to a certain extent the composition of the group that compiled the list. The workshops tended to be dominated by staff of the management agencies in each country and the issues and their priorities probably reflect this. If there had been stronger stakeholder representation, while the overall pattern would probably have been similar, some of the details could be different. Management agencies should also put plans in place for incremental attention to the issues of moderate priority.

Recommendation: the BCC and the responsible authorities in each country should examine the lists of issues and priorities, as well as the draft Performance Reports, from all the RASF workshops, re-evaluate them as necessary with full stakeholder participation and use the best available scientific information, and act with urgency on the higher priority issues. While each of these varies from fishery to fishery, the following may justify particular attention:

- bycatch issues across commercially and ecologically important species as well as species of conservation concern;
- ensuring adequate protection of critical habitat from damage by fishing or other human activities;
- addressing the vulnerability of coastal communities arising from their high level of dependence on fishing and fish products;
- improving governance in particular through efforts to improve capacity for research and management and by improving consultation with stakeholders and co-management.

13.2.2 Regional

As would be expected in the Benguela Current large marine ecosystem, there are several stocks and species that are shared between two or all three of the coastal States which require coordinated and cooperative approaches in management of activities affecting them. These species and stocks include some of commercial importance such as the hakes, sardine, horse mackerel and deep-sea crab, as well as species of conservation concern such as a number of seabirds, turtles, deep-sea sharks and others (Table 4.1).

The recent establishment of the Benguela Current Commission is a necessary development towards assuring the regional cooperation necessary for sustainable use, whether consumptive or non-consumptive, of these common resources and the ecosystem that supports them. Within the context of EAF, the incorporation of an Ecosystem Advisory Committee is an important and constructive feature of the BCC. As reported in Chapter 4, it will be essential for the Advisory Committee to take cognisance of the high priority regional issues identified at the RASF workshops, re-evaluate them as necessary and to take appropriate action to remedy them. Some of the major regional issues identified at the RASF and BCA workshops included the:

- need for Namibia and South Africa to cooperate in research and management of the deep-water hake *M. paradoxus*;
- need for Angola and Namibia to cooperate in research and management of the sardine *S. sagax* stock shared between those countries;
- need for the BCC to identify any other priority species to be addressed at a regional level and the action or actions required (Table 4.1 provides some information to assist in this);
- BCC should also give consideration to addressing regional environmental issues such as monitoring and mitigating the impacts of red tides, low oxygen events and other large scale environmental events and anomalies;
- BCC may also have a role to play in monitoring pollution from, amongst others, land-based activities, oil and gas exploration and extraction and offshore mining, and addressing their impacts on fisheries.

Recommendation: The BCC and its associated Ecosystem Advisory Committee should move ahead rapidly in fulfilling their mandates and take due note of the relevant issues identified in this project, in particular those summarized in Chapters 3 and 4 of this report.

13.3 Options for EAF management action

In almost every case, it will be possible to address a particular issue or group of issues with a range of different management measures, each of which will have different advantages and disadvantages. For example, hypothetically, a problem of excess bycatch in a demersal trawl fishery could be remedied through implementation of closed areas, gear regulations, effort control on the fleet taking the bycatch or, possibly, closed seasons. In deciding which one of these would be most effective, it is necessary to consider the advantages and disadvantages of each for the different objectives being pursued in the fishery. This was the purpose of the BCA workshops. It was not possible to do complete detailed BCAs across all groups of issues in each fishery and this component of the project should be viewed more as a trial application of the methodology than a detailed analysis.

A key component of the process was to agree on the broad objectives for each fishery, where the broad objectives should encompass the operational objectives and values of the full set of stakeholders. The broad objectives for all the fisheries agreed on in the BCA workshops are provided in Chapter 5 and give an informative overview of the goals that should, in the view of the workshop participants, be pursued in each case. An example of the results of assessing benefits and costs of a possible management action is shown in Table A3 of Appendix.

If realistic and acceptable benefit-cost analyses are to be undertaken, it will be necessary, first, for decision-makers to review those objectives, in consultation with the stakeholders, to ensure that they are the best expression of the genuine broad objectives in each case. It will then be necessary to rank the objectives in order of priority and to assign weightings to each of them, according to their relative importance for the fishery. This is likely to be a contentious process but is essential if management is to be directed at achieving society's goals for the ecosystem as a whole. The weighting process should be transparent and participatory and equally, the results should be transparent to all.

As done in the BCA workshops, the groups of issues described in Chapter 5 and the full BCA reports, will need to be revised and refined in order to arrive at groupings that can be

effectively and realistically addressed by common management approaches and a management strategy (i.e. set of management measures) that is as simple as possible while still addressing all the priority issues within the EAF framework. This should be done through a mixture of science and consideration of values and needs of the stakeholders. The overall suite of management measures needs to be considered in its entirety to ensure that, in striving to address one operational objective, or subset of objectives, the management strategy is not unintentionally impacting another. This is the purpose of the cost-benefit analysis and, in order to demonstrate how to achieve it, the following steps were followed in the project:

- setting the broad objectives;
- identifying and aggregating the EAF issues into groups that could be addressed by the same management measures;
- identifying alternative and complementary measures to address each group of issues;
- assessing the costs and benefits (standardized measures of the advantages and disadvantages) across the set of broad objectives.

The final step, which was not done in the project, would be to identify and implement the set of management measures that has the optimal aggregated costs and benefits, taking into account the agreed weightings of the broad objectives. Each outcome of the work done in the project towards this goal of implementation will need to be reviewed, and the analyses almost certainly repeated in a more detailed and rigorous process that brings together the best scientific and management knowledge and expertise and the knowledge and needs of the stakeholders. In this way, through an iterative process of negotiation informed by scientific information on feasibility and implications, it should be possible to arrive at optimal management strategies to achieve the agreed broad objectives.

Recommendation: Even in those fisheries in the BCLME region where some EAF operational objectives are being addressed by management, the current management measures and strategies have tended to be developed in disjointed and often reactive ways. As a result, the RASF workshops identified many gaps and conflicts between different objectives in the same fishery and between fisheries. The national fisheries agencies and the BCC should adopt a coordinated and holistic approach in the development of management strategies that recognize and reconcile, as far as possible, the conflicting goals of all stakeholders, including those within and those outside the fishery sector. A formal, transparent and participatory analysis of the costs and benefits of alternative measures, as demonstrated in the project, should underlie the choice of these strategies.

13.4 Potential use of simulation models

Capacity for and application of different types of mathematical ecosystem models is well developed in fisheries science in Namibia and South Africa (see Chapter 6) and there is growing attention to their potential use to advise and inform management, particularly in relation to strategic matters (i.e. broad and longer term) rather than in shorter term tactical management. This project has initiated the development of capacity, and a first ecosystem model, in Angola as well.

Ecosystem models can contribute to the identification of data gaps, facilitating comparisons between, for example, different ecosystems and the same ecosystem at different times. They

may also contribute to understanding the implications and ramifications through the ecosystem of human and natural impacts.

Ecosystem models can contribute to understanding the interactions in the food web and with humans and thereby complement the insights and predictions of more focused stock assessment models. For their responsible application it is important that any models (including stock assessment models) are well-understood and are as transparent as possible. Any information generated by models for management advice must be accompanied by assessments of the uncertainties associated with that information. This requires testing the sensitivity of the model and the robustness of results to plausible alternative values or states.

A problem throughout the region for development and application of ecosystem models is the poor availability of economic and social data.

Recommendation: Ecosystem models, of different types, can make an important contribution to informing management and policy for the implementation of EAF. The BCLME countries, and the BCC, should encourage the development of capacity in ecosystem modelling and the appropriate use of such skills and models in planning and implementing EAF.

13.5 Indicators for EAF

The best indicators to use, whether for single-species management or management with EAF, will depend on the particular characteristics of each case, including the capacity of the management authority. They will also be dependent on the operational objectives for the fishery or ecosystem as a whole. For this reason the project did not attempt to compile a list of recommended indicators, although some potential indicators are put forward in the draft Performance Reports produced during the RASF and BCA workshops (see e.g. BCLME, 2006).

It was concluded that indicators can be split into four categories: target species affected by the fishery; non-target and dependent species affected by the fishery; effects on ecosystem as a whole; and environment effects on fisheries. Any indicators applied in management should adhere to six principles (see Chapter 7):

- there needs to be a strict relationship of the selected indicator and the specific management objectives, including objectives related to monitoring the marine environment where applicable;
- there must be a good correlation between an indicator and the property for which management objectives have been set (i.e. biological, ecological, social or economic);
- there should be a consistent response in the indicator to changing levels of fishing and the indicators should respond primarily to changes in the relevant management measure;
- indicators should be observable, within the technical and economic capacity of the management agency;
- different indicators may be appropriate to specific time and space scales;
- indicators should be acceptable and therefore understood by all stakeholders.

In addition to selecting suitable indicators, meaningful reference points also need to be selected as either targets for which management should strive or limits that management needs to avoid crossing. In general, it is preferable to use a suite of indicators to guide

management action as no single indicator is likely to be completely reliable or to reflect the full set of operational objectives.

Recommendation: Reliable and informative indicators are essential for management to track what is happening in the system of interest and to adjust the management measures, as necessary, to achieve the desired objectives. They also facilitate objective and transparent decision-making. The national management agencies and the BCC should ensure that:

- a suite of suitable indicators, consistent with the principles listed above, and associated reference points are identified for the range of activities under their mandates;
- that the data necessary to track these indicators is systematically collected and analysed;
- that management decisions take into account the status of and trends in the indicators in relation to their reference points.

13.5.1 Comparative application of indicators to characterize ecosystem states

There is uncertainty and controversy about what defines a "state" of an ecosystem and therefore when, and whether, an ecosystem can be defined as changing or having changed state. Nevertheless, it is clear and beyond dispute that the detailed structure (e.g. the relative abundances and distribution of different species) and functioning of ecosystems is dynamic and can change substantially on different time scales, including decadal scales. This has happened and continues to happen in the Benguela ecosystem. One of the most obvious examples of such change has been in the northern Benguela ecosystem within approximately the last decade (see Chapter 8).

Management, and those dependent on the ecosystem including specific fishery resources, need to be able to respond to such changes with a minimum of negative impacts on either human or ecosystem well-being. This requires a measure of flexibility and adaptability in governance and in the affected fisheries or other dependent activities. Adaptive management, which is an integral property of the OMPs currently being applied in most of the major fisheries in Namibia and South Africa, should provide for adequate adaptability in managing human impacts for all but the most extreme rates of change. Governments should work with the fishery sector to ensure that those dependent on fishing for their livelihoods are not highly vulnerable to such change. Strategies to reduce vulnerability include ensuring that fishing capacity is commensurate with the long-term productivity of the resource, ensuring suitable diversification in livelihoods, and the availability of alternative livelihoods for those that cannot be accommodated in a fishery when the "state" of the ecosystem changes.

The ability of both management and those dependent on fishing for their livelihoods to adapt timeously and appropriately to ecosystem changes would be enhanced if validated, accurate, precise and feasible methods of forecasting change in advance could be developed.

Recommendation: All fishery stakeholders including managers, fishery groups, conservation groups and others need to recognize that the Benguela Current ecosystem is inherently variable and that abundances and productivity of constituent populations can change substantially on a range of time scales. Human dependence and management of human impacts on the ecosystem must be able to adjust to these changes. While existing management approaches in a number of the fisheries include some measure of flexibility, the national management agencies and the BCC should strengthen this where necessary, including through consideration of developing improved forecasting capacity. Governments and potentially

affected stakeholders need to work together to minimize the vulnerability of stakeholders to inevitable changes in the ecosystem, including in abundance and productivity of important fishery resources.

13.6 Options for strengthening the decision-making process

Even within a single-species fishery and management paradigm, there are inevitably conflicting objectives that need to be taken into account and reconciled, for example between short-term social or economic needs and the need for long-term sustainability of a productive resource. The nature and extent of these conflicting objectives are drastically expanded within an ecosystem approach to fisheries. As a result, decision making in fisheries management within EAF needs to address widely divergent desires and needs and the likely conflicting values and goals of the different stakeholders. Effective decision making involves seeking solutions, in the form of management responses, that satisfy all those values and goals to the greatest extent possible. Multiple criteria decision making (MCDM) aims to assist decision-makers to identify such solutions and has developed a range of different tools and approaches to facilitate this (Chapter 9).

It is recognized that many decision-makers and stakeholders involved in fisheries in the region are not familiar with such approaches and are likely to be reluctant to use them. However, the project concluded that these tools could make an important contribution to improved decision-making in the region and should be encouraged. The success of the RASF workshops, which made use of an MCDM approach in the form of the hierarchical trees used to identify issues, provides a valuable demonstration of their potential contribution.

One of the more important issues to emerge from this project is that transparency and participatory management and decision-making need to be improved urgently if national and regional policies and objectives for fisheries in the region are to be obtained. It was also recognized by the project that in Angola, Namibia and South Africa, the scientific advice is frequently generated in a formalized and rigorous way but that "management decisions were often made in a haphazard and unstructured way" (Chapter 9). The use of suitable MCDM techniques in formal and transparent decision-making would address this problem.

Recommendation: Decision-making in fisheries management in the BCLME countries is frequently opaque and unstructured. This is likely to lead to sub-optimal decisions and wide-spread dissatisfaction with decisions made in this way, leading to conflict and lower levels of compliance. The national fisheries agencies and the BCC must take steps to ensure that decision-making is transparent, participatory and arrives at optimal solutions. MCDM techniques have a critical role to play in achieving this and should become a formal and routine component of decision-making in fisheries management in the region.

13.7 Potential incentives for facilitating EAF

Incentives can be considered as "any factor that affects individual choice of action" (Chapter 10). They can be either coercive or encouraging, for example economic incentives can include fines for unacceptable practices or rewards, such as market accessibility, for adhering to rules. Incentives can be classified as (de Young and Charles, 2007):

- Legal incentives (e.g. effective legislation creating positive "carrots" as well as "sticks" in the form of significant penalty structures with effective enforcement capability).
- Institutional incentives (e.g. fisheries management systems and participatory governance arrangements that induce support from stakeholders).
- Economic/market-based incentives (e.g., win-win measures that lead to outcomes that are better both for the fisher and for the fishery ecosystem, such as the use of some excluder devices in fishing gear, to increase profits by reducing fishing costs and broadening market access, while also reducing bycatch).
- Social incentives (e.g., community-based institutions and social environments that create peer pressure on individuals to comply with agreed-upon community rules).

Some specific applications and considerations for using incentives to facilitate the implementation of EAF in the region included:

- The positive contribution that could be made through improved communication between stakeholders, policy makers and management.
- The importance of making available scientific information as a basis for negotiation with stakeholders.
- Co-management is an important incentive for sustainable use but will require strengthening cooperatives where they exist and improving coordination within different fishery sectors where necessary.
- Ecolabelling is not always seen by the fishing sector in the region to be making an important difference in marketing and pricing but the scheme could grow in significance.
- Allocation of long-term user rights is a very important incentive for sustainable use.
- Alternative livelihoods will provide essential incentives in cases where fishing capacity needs to be permanently reduced.
- Incentives should be considered for all the stakeholders (including sectors other than fisheries).

Recommendation: It is recognized that while incentives are being used to encourage compliance and responsible fishing in the region, the full range of possible incentives and their potential contribution as a management tool in the implementation of EAF has not been formally and explicitly evaluated. It is therefore recommended that the options for making better use of incentives in fisheries be further investigated in the context of EAF in the BCLME.

13.8 Institutional arrangements for implementation of EAF

The formal institutional structure in the BCLME countries was not perceived to be a substantial problem and there did not appear to be any need to modify the existing governmental institutional arrangements to accommodate implementation of EAF. Instead, the overriding institutional problem for all three countries was insufficient capacity, a problem that was already affecting the ability of the fisheries management agencies to fulfil their responsibilities. This lack of capacity was considered to be particularly serious in relation to research and management but also extended to other services such as policy, economics and social sciences. Lack of capacity was exacerbated by what was seen to be insufficient opportunity for advancement and career paths. One potential approach to addressing these problems could be to change institutional structures to, for example, a more flexible fisheries agency-type structure. This may be more feasible in South Africa than in the

other two partner countries. However, even in that country, such changes would not necessarily address the problem of inadequate financial and human resources because it is always likely to be difficult to recover research, management and MCS costs fully from the various fisheries sectors in developing countries.

Other priorities identified included:

- The need to develop resource management structures in all countries involving the main stakeholders, particularly the fishing industry, and including co-management.
- Improved communication with stakeholders outside the fishery sector but impacting fisheries, for example the oil and offshore mining industries, and the relevant government departments, particularly in Angola and Namibia.
- The need for increased capacity to sustain long-term ecosystem monitoring, the deployment of scientific observers and improved data management.
- Improvement of surveillance and compliance in Angola, as well as addressing access rights relating specifically to artisanal fisheries.
- While single species approaches are an essential component of fisheries management, EAF requires that those strategies must be broadened to be more inclusive of ecosystem effects.
- All three countries will need to fulfil their responsibilities with respect to EAF and to effectively liaise with the BCC and other RFMOs as needed.

Notwithstanding these needs, the project concluded that the current problems with capacity should not preclude progress in implementation of EAF measures.

Recommendations:

(a) At present, the absence of adequate capacity, and declining capacity in Namibia and South Africa, is seriously threatening the ability of all three countries to implement effectively even the current predominantly single-species approaches. The shortage is more critical in the context of the broader requirements of EAF. The BCLME countries need to give urgent attention to retaining existing capacity and strengthening overall capacity in their fisheries management agencies, particularly but not exclusively in research and management.

(b) Co-management as well as improved liaison with other stakeholders impacting the marine ecosystem and the relevant government departments is necessary for effective fisheries management.

(c) Countries will need to address the implementation of EAF seriously, including through the BCC, and this will require additional institutional changes as summarized above.

13.9 Research needs

The three BCLME countries have identified lengthy and far-reaching lists of research needs at national and regional level. They will need to evaluate these lists and set realistic priorities that recognize and devote greatest attention to the higher priority issues identified at the RASF workshops. The countries should also examine opportunities for research cooperation at the bilateral and regional levels in order to reduce costs and achieve greater efficiency. This review should also develop a regional strategy for the purchase and use of research vessels.

There is an urgent need for greater cooperation with social scientists and economists in fisheries research and management. This had been recognized as a problem for many years but it has not yet been resolved. Fisheries scientists and managers together with human scientists need to consider the nature of the potential contribution of human scientists and the roles that they can play. The communication failure is not only one-sided and human scientists also need to take the initiative and become more directly involved at management level in fisheries.

Other major problems included the need to ensure long-term monitoring of important variables so as to establish and maintain long-time series of relevant data. Capacity also needs to be strengthened to control the quality and make full use of the data that were and are being collected, including fisheries independent, observer and fisheries data.

Recommendations:

(a) Research capacity is severely limited in the region. It is therefore essential that, even while building capacity, the countries ensure that higher priority research questions are being addressed. The lists of research needs provided in Chapter 12, evaluated in conjunction with the results of the RASF workshops, provide a useful starting point for countries to review and prioritize their research requirements for implementation of EAF.

(b) Countries need to give serious attention to boosting liaison with and capacity in social and economic research.

(c) Countries, and the BCC, need to ensure that they implement, where not already being done, and maintain long-term monitoring of indicator variables to provide effective feed-back on key ecosystem states and functions.

(d) Existing capacity for quality control, storage and processing of data and information is inadequate and needs to be strengthened as a top priority.

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APPENDIX

METHODS

1. The institutional structure of the project

EAF is as much about people and policy as it is about ecosystems. It is therefore essential that, from the outset, planning for EAF is conducted in a consultative and transparent manner that allows for interaction between stakeholders, managers and those providing scientific and other information. In order to facilitate this, a rather cumbersome but necessary structure was used in the BCLME EAF project (Figure A1). EAF is still perceived by many to be essentially a scientific exercise and the debate is frequently dominated by scientific considerations. To avoid this, the institutional structure of the project was designed to ensure that societal goals and operational requirements of EAF were the guiding force, notwithstanding the essential role of scientific information and advice. The Steering Committee and Regional Workshops were intended to facilitate and maintain the regional perspective of the project and ensure good communication and coordination between the three countries. The National Task Groups (NTGs) in each country ensured participation by and guidance from the range of stakeholder views, including managers, decision-makers, fishing industry members and conservation groups, while the science and modelling groups have provided the crucial scientific advice and input to the process.

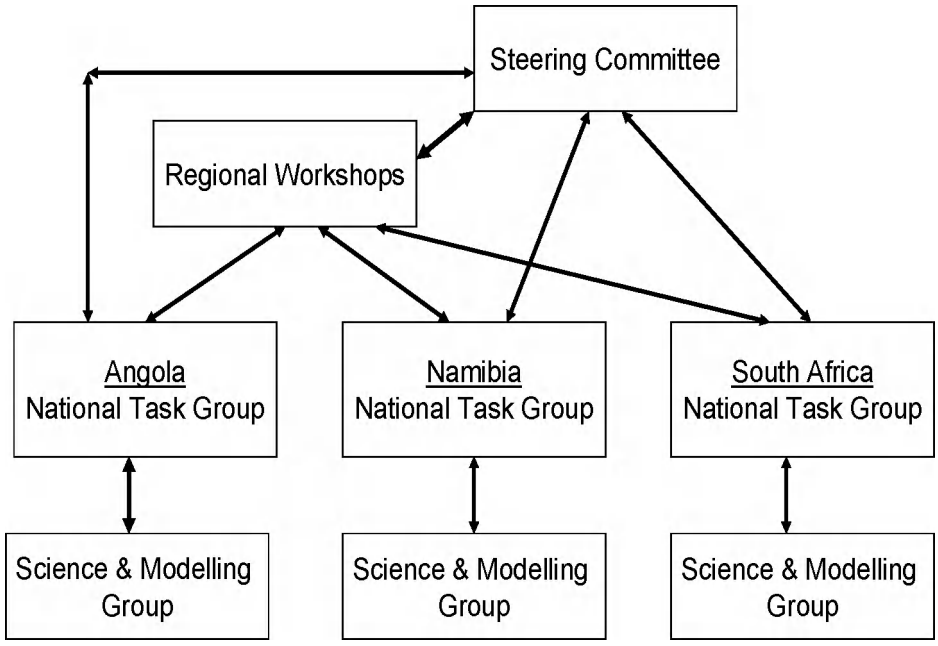

Figure A1. The institutional structure used in the EAF project to ensure coordination at the regional level and interaction between policy-makers, stakeholders and scientific advisers

2. The scope of the project

Within the context of an ecosystem approach, it would have been desirable to include all fisheries in the Benguela ecosystem in the project, which would have allowed all the ecological and technical interactions between the different fisheries to have been taken into account. However, this was not practical with the limited time and resources available and it was therefore decided to focus on selected fisheries in each country. The fisheries that were

addressed in the project include the most important fisheries in each country and, collectively, were considered to cover most of the major impacts of fishing on the ecosystem (Table A1).

Table A1. Fisheries included in the EAF project.

Angola	Namibia	South Africa
• Small pelagics	• Sardine purse seine	• Small pelagics purse seine
• Demersal trawl (finfish and deep-water shrimp)	• Hake trawl and long-line	• Hake
• Small-scale fishery using gillnets and beach seine nets	• Horse mackerel midwater trawl	• West Coast rock lobster

3. The process for evaluating the feasibility of EAF

The approach used in this project to clarify the concept of EAF was to start by examining the strategies currently being used for management in each fishery and any problems or concerns, within the wider context of EAF, that were not being satisfactorily addressed by the existing management strategy. Any factors beyond the mandate or control of the fishery managers that were impacting on the fishery and stocks were also considered. All of these factors were then prioritized and potential management actions to resolve the problems were identified. The overall goal of this process was to identify where the current management systems may have been failing to prevent or adequately control impacts that threaten the sustainability of the fishery itself including key species, impact on other stakeholders, both within the fishery sector and outside it, or that may threaten the long term sustainability and productivity of the ecosystem.

The process included the following steps (Figure A2).

(a) The TROM reviews.
(b) Issue identification: i.e. identification of all issues of concern in the fisheries, within the context of EAF, that were not being satisfactorily addressed under the existing management strategy and system.
(c) Risk assessment: the issues identified under point were prioritized by assessment of their relative risk.
(d) Preparation of performance reports for each issue of moderate or higher priority. The performance reports outlined an appropriate management response to resolve, or mitigate, the issue.
(e) The issues were aggregated into groups in which they could potentially be addressed by a common management measure or set of management measures.
(f) The performance reports within each group of issues were amalgamated and refined to produce a single performance report for each group, including feasible management actions to address each group.
(g) Benefit-cost analyses were undertaken for the issues considered to arise and require action as a result of adoption of EAF. These analyses consisted of:
    - identifying the broad objectives for the fishery against which costs and benefits needed to be evaluated; and

- performing preliminary evaluations, based on expert opinion, of the benefits and costs (i.e. positive and negative impacts) of alternative management responses for each group of issues.

The results from this process provided an assessment of the feasibility of implementing EAF in the fisheries that were considered.

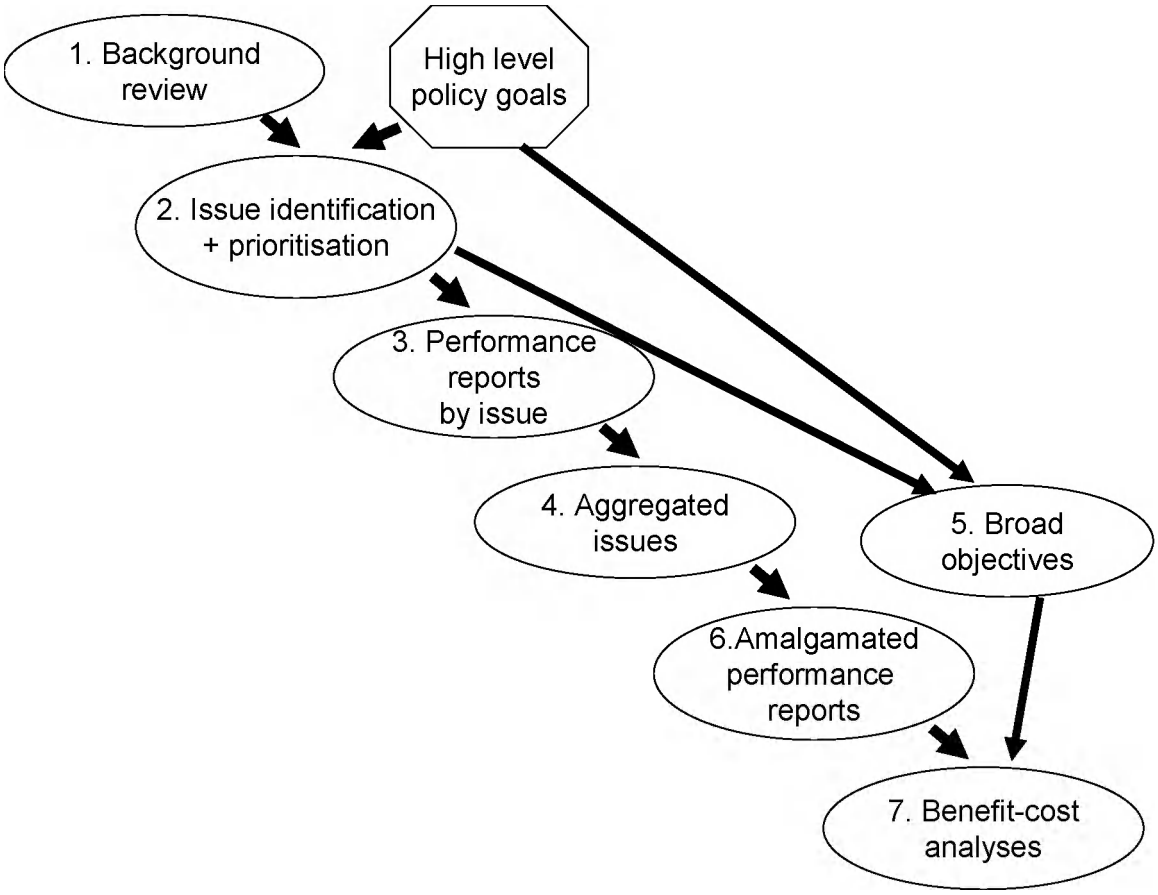

Figure A2. The process followed in evaluation of the feasibility of EAF in the BCLME. The ovals represent outputs from activities undertaken within the project and the hexagon represents an underlying external input (from Cochrane, Augustyn and O'Toole, 2007).

4. Methods Used in Implementing the Process

(i) Identification and prioritization of issues and potential management responses for those issues

The TROM Reviews provided an initial evaluation of the problems being experienced and potentially arising from the existing management strategies. This information provided background for the issue identification and risk assessments that followed. Issue identification and risk assessments were undertaken through the RASF (risk assessment for sustainable fisheries) workshops held for each fishery in each country during the course of 2005. The methods used and results of those workshops were described in detail in the Appendices of the Annual Report: January–December 2005 (Report No. 2 UNTS/RAF/011/GEF). They

followed the methods developed by the "ecologically sustainable development" (ESD) initiative undertaken in a number of Australian Federal fisheries (Fletcher *et al.*, 2002).

The first task undertaken at the RASF workshops consisted of the identification of issues for each fishery. This was done in a participatory manner, guided by the hierarchical trees developed within the ESD framework (Figure A3). The next step was to prioritize the identified issues on the basis of estimated or perceived risk, should the existing management strategy be continued without change. For the purposes of this exercise, risk for any particular issue was estimated as:

Risk = likelihood of the feared outcome * consequences of that outcome

where both likelihood and consequence were reflected by ordinal scores based on the ESD guides.

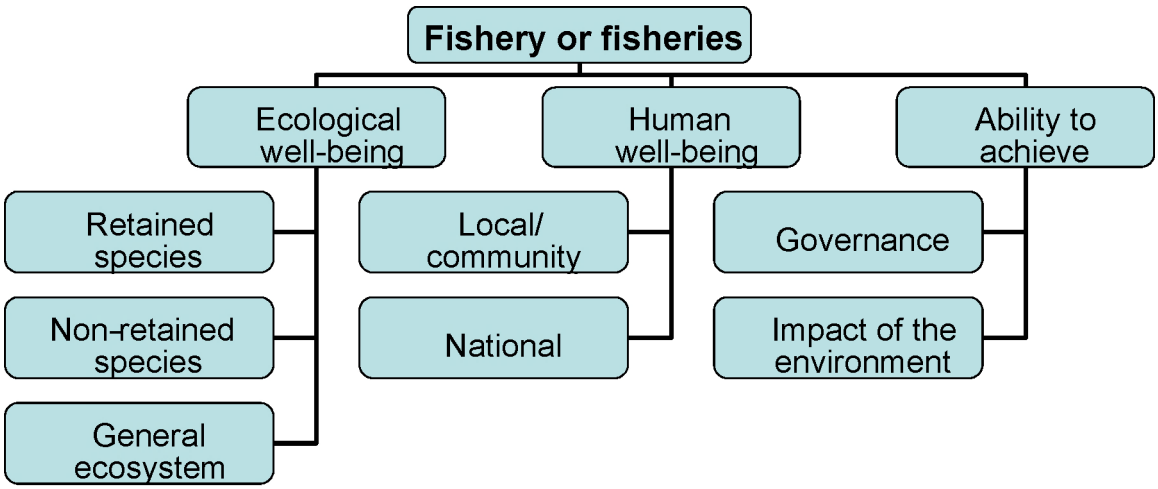

Figure A3. The basic hierarchical tree (after Fletcher *et al.*, 2002) used to guide deliberations on the issues of concern in the fishery or ecosystem under consideration. Additional trees developed by those authors break down the boxes under each of the three second-level headings (ecological well-being, etc.) into more and more detail to assist users to think broadly across all possible issues that could apply in the fishery or ecosystem under consideration.

Thereafter, Performance Reports (following the ESD terminology) were prepared for all the medium or higher risk issues. A Performance Report is intended to describe the best, or recommended, management response to reduce or eliminate the risk associated with the particular issue it addresses. The topics included in the Performance Reports are shown in (Table A2).

Table A2. The structure of a performance report used in the BCLME programme to describe the potential management response to a particular EAF issue or group of issues where a number of issues could be addressed by a common management response (after Fletcher *et al.*, 2002).

Performance report heading

1. Issue or issues being addressed
2. Objectives
   (i) Operational objectives
   (ii) Subsidiary objectives (where appropriate)
3. Indicators and robustness
4. Reference points
5. Data requirements/availability
6. Fisheries management response
   (i) Current
   (ii) Future (i.e. additions and modifications to address the issues of concern)
7. Future research
8. Comments and action
9. External drivers that could negatively influence attempts to address issue

The RASF workshops therefore generated three major results: a list of issues of concern for each fishery, the estimated risk associated with each issue, and preliminary Performance Reports that proposed potential management responses to address the higher priority issues. The workshops were intended to be participatory and to include representatives from the range of managers, science and information advisers and stakeholders, including representatives of fishery sub-sectors and conservation groups. Responses from stakeholders varied with good representation in a number of workshops, but disappointing in some other cases. Ensuring good stakeholder representation will be very important as the process is taken further across the region.

Even after prioritization of the issues, a large number of Performance Reports were required and, with the limited time available, in most cases only preliminary and readily available information was included in these first drafts of the Performance Reports. Notwithstanding this problem and the incomplete representation by stakeholders, the Performance Reports are considered to provide useful insights into the types and magnitude of actions that are likely to be required to address the more urgent EAF issues.

(ii) Separating out the EAF issues

EAF encompasses but goes beyond conventional management. Any issue, even if arising purely from a single or target-species objective, falls within EAF and successful conventional management is an essential part of successful EAF. However, this study was intended to investigate the feasibility of implementing EAF and this project therefore focused on those

issues that would not normally be addressed by effective conventional management. The RASF workshops were intended to explore and prioritize all the issues, thereby helping to illustrate the relationships and relative priorities of all of them. Thereafter, in order to evaluate the feasibility and implications of addressing the EAF issues, they were separated from the others.

EAF issues were defined as:

> "any impact of the fishery on the wider ecosystem or any impact of the environment (human or ecological) on the fishery, apart from the direct interactions between a fishery and the species it targets."

Some EAF issues are already being addressed in all three countries and this emerged in the RASF workshops and should be reflected in the risk assessments (i.e. the risk should be low if the issue is already being well addressed). In such cases, the evaluation of costs and benefits would be for any actions necessary to improve or strengthen the current approaches. If no additional action was required, the issues should either not arise or have been given a low priority in the RASF workshops.

(iii) Benefit cost analyses and aggregated performance reports

Effective implementation of EAF will result in benefits (ecological, economic, social or some combination of those three) but will frequently also invoke additional costs across the same dimensions. If EAF is to be effectively implemented it is essential that in the planning and implementation, the decision-makers and all stakeholders are well aware of the range of benefits and costs that will result from different options.

In order to ensure that they are reliable sources of advice to inform management decisions, it is essential that the benefits and costs should be estimated using the best available information (both scientific information and stakeholder knowledge). This was not practical in this feasibility study because of the capacity and time constraints in the project coupled with the wide range of issues and management actions being considered. It has therefore not been possible to investigate the benefits and costs thoroughly and rigorously. In addition, the project intentionally emphasized participation and consultation, as being key to awareness-building and buy-in. Therefore broad-based workshops were the favoured tool, even though in some cases a small group of experts may have been able to provide at least some answers with greater scientific rigour from relatively quick analyses. Given time and resources, a combination of these two approaches should be used, with any scientific results being reviewed and commented on by stakeholders as a part of the information-generation and decision-making processes.

The benefit-cost analyses (BCAs) were done through a series of benefit cost workshops (BCWs), one for each fishery. As with the RASF workshops, the BCWs were intended to include good stakeholder representation but, again, this varied from case to case. The tasks of each workshop were as follows.

- To aggregate and develop:
  - Broad objectives from the full set of detailed objectives for each fishery. The benefits and costs of each management action were then estimated across the set of broad objectives.

  - Groups of issues according to their broad theme and on the basis of whether they could be addressed by similar management responses.
  - Performance reports for each group of issues that included potential management measures or rules to resolve or mitigate each group.
- To evaluate the expected benefits and costs of those management measures or rules in relation to the broad objectives, using the best information available, within the time and personnel constraints. Benefits and costs were estimated for both the short-term, which was defined as up to three years, and the long term which was defined as five to ten years.

The benefits and costs were based almost entirely on the collective wisdom of the participants in each workshop, which would generally have included stakeholders and scientists with knowledge of the best available practical and scientific information. Each workshop was asked to provide an estimate of benefits and costs, against each broad objective, for each action on a scale of 0 to 4 where:

0 = negligible cost or benefit
1 = small but noticeable impact
2 = moderate impact
3 = major improvement or will have major negative impact
4 = immediate and long-term impact or will be unsustainable from the outset

The assumption was made that the difference in value between each score is constant across the range of scores (i.e. they are linearly related to actual impact). In addition the assumption was made that the sum of zero costs (i.e. the sum of a series of negligible costs) across all broad objectives would generate a total cost for the measure of 1 (i.e. small). This was based on the assumption that no benefit would be achieved without some cost. Those assumptions are necessary for benefit and costs ratios to be used for comparative purposes. An example of a completed benefit cost table for one potential management response in one fishery (the artisanal fishery in Angola) is shown in Table A3.

An important assumption in the results presented in this study is that all broad objectives have the same policy weighting. It was recognized by all participants that in practice this is highly unlikely but any attempt to arrive at weightings within the project would have been contentious and the answers not necessarily representative of the range of stakeholders or the final policy choices. For implementation, the actual weightings for each objective will have to be determined by a participatory political process. The assumption of equal weights was therefore selected as an interim representation only.

It must be emphasized again that, as with the performance reports, the benefit-cost analyses and the results that have been produced from them are preliminary only and that no focused scientific assessments (including the human sciences where appropriate) and validations were undertaken. Such improvements and checks will still need to be done, where feasible, before this advice can be considered sufficiently reliable and accurate for use by decision-makers in setting management regulations.

This project set out to make use of the best information available and in the project planning phase it had been hoped that the national science and modelling groups would be able to supplement existing information through undertaking new analyses to evaluate, for example, risks, the feasibility and impacts of specific changes to management measures, and some of the costs and benefits. As a result of heavy commitments to other responsibilities by all

scientific staff participating in the project, this has, to a large extent, not been possible. As a result, most of the results generated by the project are based on existing scientific knowledge and results available at the workshops. This information unquestionably has at least indicative value and the results and conclusions are considered to be qualitatively valid and accurate, but not necessarily quantitatively so. They will therefore need to be reviewed and, where necessary and feasible, re-evaluated before being used to advise management decision-making.

The results obtained are still considered to be informative, providing guidance on the possible options for and obstacles to implementation of EAF. However, as the three countries move forward in implementation of EAF, it will be necessary to revisit results and conclusions that would benefit from more precise or rigourous analysis. This will include the need for quantitative analyses and information, such as estimated future total allowable catches, or the risk of overfishing on retained and non-retained species. Where improved information required for decision-making can be provided in a timely and cost-effective manner it should be generated and used to improve the information obtained in this feasibility study.

Table A3. Example of a benefit cost table produced to facilitate comparison of alternative potential management responses to address specific groups of issues. The table shows the estimated positive and negative impacts (costs and benefits) of the management measures under consideration for each of the broad objectives identified for that fishery. The example shown here is an assessment of the use of marine protected areas (MPAs) to address problems related to bycatch and other gear issues in management of the artisanal fishery in Angola. For details of the scoring, see the text.

Broad objectives	Comments/rationale on the Effects of the proposed management response	Short term		Long term	
		Cost	Benefit	Cost	Benefit
Maintain biomass of commercially important coastal fish species at optimal levels of productivity.	If properly designed and managed, may help protect critical habitats, promoting stock recovery.	0	1	0	2
Minimize impact of fishery on juvenile or undersized fish.	If properly designed and managed, may help protect critical habitats where juveniles tend to concentrate.	0	1	0	2
Minimize impacts of fishery on threatened, protected or vulnerable species (turtles, cetaceans, seabirds).	If properly designed and managed, may help protect critical habitats for these species, and areas where species of conservation concern concentrate or are particularly vulnerable.	0	1	0	2
Minimize impact of fishery on coastal communities and ecosystems.	If properly designed and managed, may help protect critical habitats and ecosystems, especially mangrove areas.	0	1	0	2
Maintain or increase the supply of good-quality fish to the population.	Indirect positive effect, via stock recovery. May have negative effect, especially in the short-term, if their location and system does not take the needs of coastal provinces into account.	1	1	0	2
Contribute to poverty alleviation through the increase of opportunities of employment in the fisheries extractive sector and in small-scale fish processing in the coastal provinces.	Indirect positive effect, via stock recovery. May have negative effect, especially in the short-term, if their location and system does not take the needs of coastal provinces into account.	2	2	1	2
Increase equity in the distribution of employment and income among the regions of the country and in the coastal provinces	May have an indirect positive effect, via stock recovery. May have negative effect, especially in the short-term, if their location and system does not take the needs of coastal provinces into account.	1	2	1	2
Maximise the contribution of the fishery to the national economy, and especially of the coastal provinces.	May help stock recovery. Will have noticeable economic costs, especially related to enforcement.	2	1	1	2
	Total cost-benefit	6	10	3	16
	Average cost-benefit	0.8	1.3	0.4	2.0
	Benefit to cost ratio	**1.7**		**5.3**	

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