PART B – FULL APPLICATION FORM

TO BE SUBMITTED **only** BY THE APPLICANTS WHO RECEIVE AN INVITATION TO SUBMIT A FULL PROPOSAL

I. GENERAL INFORMATION

Reference of the Call for Proposals	**EuropeAid/128320/C/ACT/Multi**
Title of the Call for Proposals	**Thematic programme for Environment and sustainable management of natural resources, including energy**
Lot N°	ENRTP Priority 2 / Lot 8: Fisheries
Name of the applicant:	Benguela Current Commission (BCC)
Title of the action:	Development of ecological sustainable fisheries practices in the Benguela Current Large Marine Ecosystem **(ECOFISH)**
Location of the action: *- specify country(ies), region(s) that will benefit from the action*	Angola, Namibia, South Africa Benguela Current Large Marine Ecosystem (BCLME)
Number of the proposal[1]:	DCI/ENV/2009/8/66

II. THE ACTION

1. DESCRIPTION

1.1. Objectives

Assessors will refer to information already provided under Part A (Concept note), therefore **do not** include any information here as it will not be taken into account.

1.2. Relevance of the action

Assessors will refer to information already provided under Part A (Concept note), therefore **do not** include any information here as it will not be taken into account.

[1] Proposal number as allocated by the European Commission and notified to the applicant at the time of the pre-selection of the Concept Notes.

1.3. Description of the action and its effectiveness

An Ecosystem Approach to Fisheries Management (EAF) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about abiotic, biotic and human components of ecosystems and their interactions, and applying an integrated approach to fisheries within ecologically meaningful boundaries. This new approach to fisheries management, on which the BCC embarked with the aim of implementation by 2012, is developed under conditions of global change – both climate, economic and political changes - which limit the applicability of past experiences to management decisions.

EcoFish will develop a new framework for EAF in the Benguela Current Large Marine Ecosystem (BCLME) based on improved knowledge of basic processes in the ecosystem, improved assessment of the status of the stocks in the ecosystem, and involvement of the relevant stakeholders in the management process. Specifically EcoFish will:

1) Adapt planning tools to the BCLME including implementation of an Ecosystem Approach to Fisheries management (EAF) (objective 1 in the concept note)

This indicator-based tool may be used as a generic tool in African Large Marine Ecosystems, and contribute to sustainable use of marine resources and thereby improved food security and livelihoods of people in Africa.

A central requirement for an indicator-based tool is generally accepted methods for determining the current state of the ecosystem. Part of the EcoFish tool will therefore be

2) Validation or modification of current assessment practices based on spatially explicit analyses (objective 2 in the concept note);

A central part of EAF is a notion of the ecosystem that reaches beyond the fauna of the ecosystem to the people who utilize the resources or services of the ecosystem (stakeholders). EcoFish will formally:

3) Incorporate the knowledge of stakeholders' in data collection and analysis (objective 3 in concept note);

Finally and foremost the objective is to increase the capacity of the region to run a regional EAF of the BCLME:

4) Strengthening of regional capacity to apply the developed assessment tools on a regular basis (objective 4 from the concept note).

EcoFish is conducted in the Benguela Current Large Marine Ecosystem, encompassing fish stocks from Angola, Namibia and South Africa. The EcoFish consortium involves all central scientists and fisheries managers in the three countries, and therefore has state-of-the-art knowledge of the ecosystem in the project. Specifically the project is coordinated by the regional Benguela Current Commision, BCC. Additionally the project involves the National Institute of Aquatic Resource from the Technical University of Denmark (DTU-Aqua) which contributes with advanced statistical and ecosystem analysis techniques. The consortium therefore has the required knowledge and expertise to successfully reach the objectives.

EcoFish will focus on the three fish stocks which are most important for securing the livelihoods of fishermen and the associated industry in the BCC, namely *hake, horse mackerel, and sardinella.*

CASES

EcoFish will focus on two fisheries as cases for an EAF: the trawl fishery for hake (South Africa and Namibia) and the pelagic fishery for horse mackerel and sardinella (Angola and Namibia).

Trawl fishery for hake:

The predominantly trawl fishery for hake contributes about half the landed value of all of South Africa's commercial fisheries, and is approaching the largest contributor to Namibia's gross domestic product (GDP). Two hake species are taken by these fisheries: shallow-water hake *Merluccius capensis* and deep-water hake *Merluccius paradoxus*. The present management framework separates the resources into three areas: Namibia and the South African West and South Coasts. Some 30 years ago, particularly as a result of rapidly increasing foreign fishing effort over the preceding decade, all of these hake stocks had been severely depleted.

Pelagic fishery for horse mackerel and sardinella:

The midwater trawl fishery for Cape horse mackerel (*Trachurus capensis*) and Cunene horse mackerel (*T. trecae*) off Namibia is the largest fishery by volume off Namibia. It is managed on the basis of CPUE data from the commercial fleet and indices of abundance from regular acoustic surveys. Although these species also occur off Angola, midwater trawling for horse mackerel is prohibited there at present. There is however a purse seine fishery for both species in Angola, which is assessed and managed through abundance indices from acoustic surveys. CPUE data from the purse seine fleet are considered to be too unreliable for use in assessment or management because of, *inter alia*, reporting problems.

Off Angola there is a valuable purse seine fishery for sardinella (*Sardinella aurita* and *S. madarensis)* which is assessed and managed through acoustic indices obtained during the acoustic surveys for horse mackerel. The commercial catch data are not used for stock assessment for the same reasons as in the horse mackerel fishery off Angola.

METHODOLOGY

In multi-species, multi-gear fisheries such as the Benguela hake fisheries, and in conditions of severe resource constraints, an EAF may be implemented through indicators (Degnbol & Jarre 2004). Several classes of indicators exist, and the DPSIR classification (OECD 1993, Smeet & Weterings 1999) used in the EU, is a useful framework for management in the BCC as well. Knowledge-based systems are models that have been used successfully to combine the evaluation of indicators of widely different natures into combined evaluation of pressures and state in marine social-ecological systems, including the Benguela (Jarre et al. 2006, Paterson et al. 2007, Jarre et al. 2008; Paterson et al. 2010). This approach uses fuzzy logic to combine indicator-based evaluations of the achievement of specific EAF objectives, which were defined during the Ecological Risk Assessment process in the region (Nel et al. 2007). It provides a time series of evaluations at the integrated scope of a social-ecological system, and therewith provides a structured and easily communicated basis for the balancing of conflicting objectives.

In addition to research-based knowledge (RBK) generated through scientific research, experience-based knowledge (EBK) of non-scientific stakeholders is extremely valuable in defining indicators for management, and towards overcoming several existing temporal and spatial scale mismatches between management and the marine social-ecological system. Building on existing contacts through Ecological Risk Assessments for the Benguela hake fisheries (Nel et al. 2007, Paterson and Petersen 2010), we will widen the collaborative

network of stakeholders, and work with stakeholders through a series of interviews and focus group discussions, as well as joint modelling exercises. Similarly, for Angola, results of ecological risks assessments carried out under the auspices of BCLME will be used as a basis for introducing the project to stakeholders in the purse-seine fishery for sardinella and horse mackerel, jointly establishing a set of agreed indicators and time series behind them, as well as to summarise the information made available through the projects in a prototype knowledge-based (expert) system for assessment of the efficacy of the implementation of an EAF in these fisheries.

Reliable and accepted stock assessments provide indicators for the current state of the ecosystem needed in an indicator based framework for EAF. In the Benguela, as well as for EU stocks, stock assessments are moving towards rigorous statistical models (ICES, 2009). Three methodologies for stock assessment will be pursued and compared:

1. The current assessment of the South African hake resource is based on statistical catch-at-age (SCAA) methodology and distinguishes the two species as well as disaggregating by gender (Rademeyer et al, 2008). The model is fit to data on catches, commercial CPUE, survey indices of abundance, length distribution data from both the commercial fisheries and surveys, and ageing data. The implementation is complex because not all sources of data are species- and gender-disaggregated. Selectivities-at-length are fixed over certain periods of time, and estimated in the fitting process. The Namibian hake assessment currently uses an earlier version of this approach which does not disaggregate by species or gender.

2. SAM (State-space Assessment Model) is a general state-space model for stock assessment based on standard age-based description of population dynamics and a maximum-likelihood estimation of parameter. SAM will be applied to hake and it will be examined if it is possible to get sufficient data to run it for horse mackerel and sardinella. SAM has a number of unique features that makes it interesting to compare it with the current practice. SAM is a full time series approach; the annual stock sizes and fishing mortalities are considered latent time series instead of model parameters. This keeps the number of model parameters low, but at the same time gives a very flexible structure in model that for instance allows the fishing selectivity to adapt throughout the data period. SAM is currently used for a number of European stocks and is being developed for additional stocks. It has a web-based module for running the model and presenting the output.

3. Geostatistical modeling from size of individual fish to spatial distributions of populations (GeoPop) is an advanced and innovative tool that can explain e.g. apparent changes in catchability because it includes space, time and size-correlations (Kristensen et al, 2006). In other words – length frequencies are changed when corrected due to estimated correlations. The model incorporates at the individual level general growth, mortality and recruitment function and can estimate stock biomass with proper confidence limits.

Improvement of stock assessments through use of the spatial information from this project will benefit regional assessment of hake, and thereby management of the South African and Namibian hake fisheries, to the advantage of fishermen and society in these countries at large.

Assessments of the horse mackerel stocks off Namibia and Angola were reviewed at a regional BCLME workshop in Cape Town in 2004, where it was concluded that consideration needs to be given to biases in CPUE data (both commercial and survey) because of changes in fleet strategies, depth limitations on commercial fisheries, catchability of survey trawls and inter-annual variation in the spatial distribution of the populations. There has been no such review since, or reason to believe that any of these problems have now been solved or mitigated. To date there have been no such reviews of the sardinella fisheries or of the attempts to manage them. It is clear however, that in the purse seine fisheries for horse mackerel and sardinella, assessing the quality of the available catch data, and considering methods for improving data quality must be the first step. In the midwater trawl fishery for horse mackerel off Namibia, where the data quality is somewhat better, the first steps would be to update and follow up on the recommendations of the BCLME Workshop in 2004.

To support the stock assessment a number of specific actions aimed at improving the quality of the fundamental data going into the stock assessment will also be undertaken:
Genetic assessment of the hake stocks. Better understanding of hake stock structure is vital for determining the extent to which the hake stocks in the region are transboundary. This is a question of primary importance for the application of the spatially-explicit stock assessment methods being developed in EcoFish.

Improving understanding of variability in hake catchability. Variations in the environmental conditions between years may affect the consistency of time series of survey indices. These so-called year effects can be caused by differences in capture efficiency (catchability) or the availability of the target species to the survey gear (Godø, 1994; Poulard and Trenkel, 2007; Johnsen and Iilende, 2007). Therefore, factors such as light, wind, currents, temperature, dissolved oxygen and time of day affect abundance indices derived from both trawl surveys and commercial CPUE data (Maree, 1999; Rivoirard and Wieland, 2001; Jørgensen et al., 2007). This activity is aimed at investigating these effects from an analysis of existing survey CPUE data for hake, supplemented by the collection of new data aimed at (i) linking catch rates directly to environmental conditions close to the sea bed during trawls, and (ii) gaining a better understanding of the behavioural processes involved. This activity is crucial for improving the reliability of hake stock assessment, and it is directly linked to the validation or modification of current assessment practices. The activity involves the development of novel survey gear and collection of new data.

Growth determination. A fundamental requirement for a realistic assessment of any fish stock is accurate and representative age data for the stock. These data are critical if realistic estimates of vital rates (growth, mortality and recruitment) are to be incorporated into the assessment. At present, age data for hake, horse mackerel and sardinella are obtained from visual analysis (interpretation) of features in otoliths that are presumed to reflect periodic (annual) cycles in otolith growth. Analyses of this nature are subjective, and the resulting age estimates generally incorporate a substantial (and often unknown) level of error that can have a profound impact on the results of the stock assessment. Recent work on European hake, for example, has shown that the level of error inherent in current age estimation methods can be substantial, resulting in a dramatic impact on the results of the stock assessment and hence the understanding of stock dynamics and subsequent recommendations on sustainable utilization of the resource. To reduce the level of error inherent in fish age estimates obtained from otoliths, comprehensive validation studies will be conducted. These studies will test the presumed annual formation of the features being used to estimate age (putative annual growth zones), as well as the ability of individual researchers to correctly interpret these features as such. In view of the spatial and temporal variability in the environmental factors that influence otolith growth in the BCLME, these aspects should be accounted for in the

validation study. Such validation has started for Namibian shallow water hake (*M. capensis*) (Wilhelm in prep), but to date, other validation studies on hake, horse mackerel and sardinella in the BCLME have either been limited, or not conducted at all. It is imperative that the accuracy of the age estimation methods is tested, and the level of error quantified. EcoFish is organised in four workpackages designed to reflect the different layers of knowledge used in the system (Figure 1).

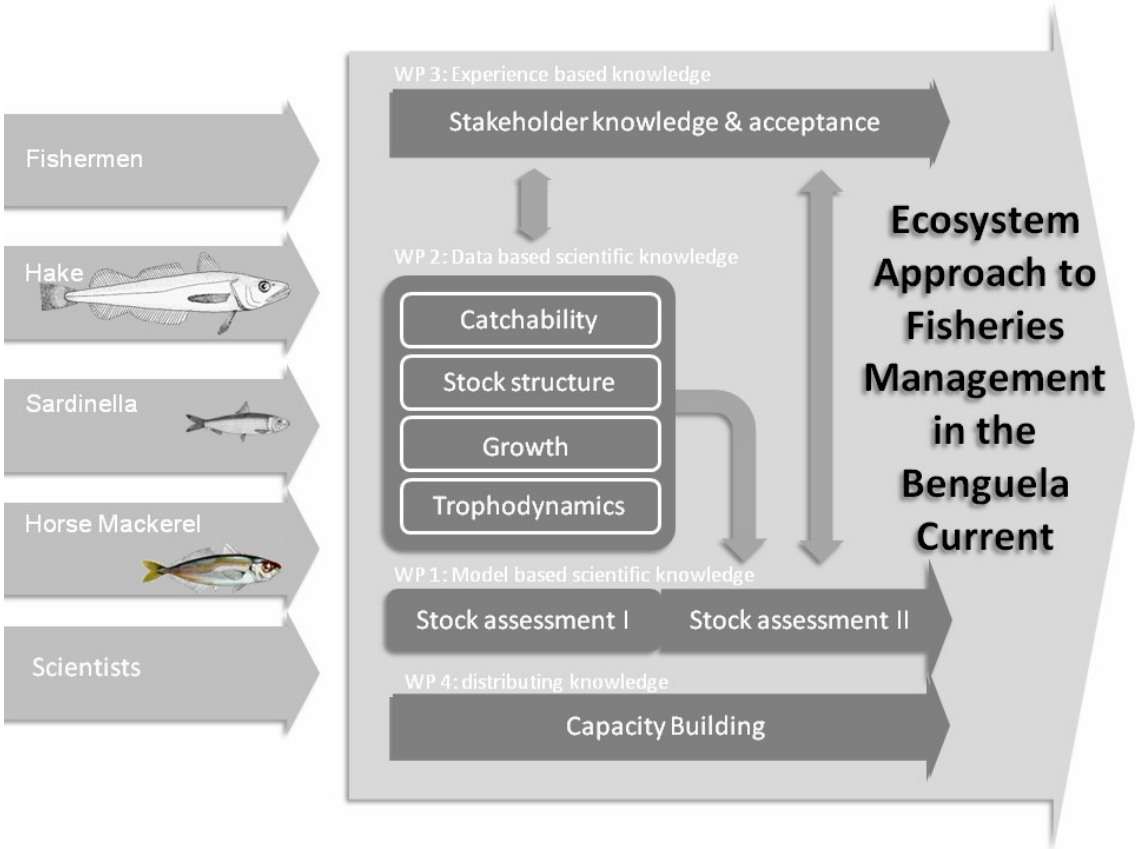

Figure 1. Graphical representation of the work package structure in EcoFish. Knowledge based on experience (WP3), data (WP2) and models (WP1) is combined into a decision support toolbox for EAF in the Benguela current. WP4 is responsible for building and distribution knowledge within the Benguela region.

WP1: Stock assessment
WP-leader: F. Köster (DTU-Aqua)

Objectives:

1. Improve abilities to discriminate between two species of hake and the possible sub-stocks of each species.
2. Improve the reliability of stock assessments through checking robustness under use of alternative models for selectivity and how this varies with time.
3. Move towards trans-boundary assessment models for hake that could provide a basis for regional management advice.
4. Improve understanding of hake spatial dynamics.
5. Establish improved statistical stock-assessment methodologies for horse mackerel and sardinella that take due account of the data available for input.

Description of work

The work follows two phases. The first phase is extending existing hake stock assessments to take better account of current data and knowledge, as well as setting up alternatives to these models to determine how robust their outputs are. The second stage involves use of the new information gathered from WP2 to improve and elaborate the stock assessments further. For horse mackerel and sardinella phase one is focused on compilation of available data, and phase two on setting up a basic assessment that improves current practice. Both phases are initiated by a workshop to clarify data issues for cross-boundary analyses.

Task 1.1. A basic single-stock SAM, including web interface, will be set up for one of the hake species within South African borders. The results will be compared to an equivalent run of the current SCAA assessment approach to aid checking the implementation.

Task 1.2 The existing SCAA assessment model for South African hake will be modified to move from the current selectivity-based approach for reflecting spatial structure to a spatial-box model with movement. This is a prerequisite to possible trans-boundary extension of the assessment.

Task 1.3 Compilation of existing data available for the stock assessment of horse mackerel and sardinella.

Task 1.4 *SCAA*: The spatial box model developed will be extended to include Namibia, and also to take account of data on possible stock-structure within species The approach used will follow that set out in the May 2006 BCLME international workshop.

Task 1.5. Models developed will be extended to take explicit account of hake cannibalism and inter-species predation (updating and extending the approach of Punt and Butterworth, 1995).

Task 1.6 *SAM***:** The basic model will be extended to take into account two species as well as the South African West coast, south coast and possibly also the Namibian regions. These extensions may also take account of improved growth and catchability estimates, and stock structure information provided by genetic studies.

Task 1.7. *GeoPop:* The geographically explicit model GeoPop will be run on existing survey data to explore the potential utility of this approach as a basis to determine the effects of environmental variation on hake catchability.

Each phase is initiated by a workshop, organized by WP4, capacity building: A preparatory meeting by scientists from SA and Namibia (which could include Angola if only to observe and assist plan for a later similar event between Angola and Namibia for horse mackerel and Sardinella) will review all available hake survey and commercial catch and biological data to assess their current state and suitability for use in assessments. This should ideally take place before the end of 2010.

The phase II workshop is a review in a regional meeting of stock assessment models and methods currently in use, and existing plans to extend these to a regional level. The outcomes include recommendations on structures for developing regional models for providing regional scientific management advice. External assessment experts should be included in, and possibly chair this meeting.

Deliverables

D 1.1. Report on data compilation for hake (Month 12, D. Butterworth, UCT)

D 1.2 Web-based interface for basic SAM (Month 20, A. Nielsen, DTU Aqua)

D 1.3 Report on comparison of the basic SCAA and SAM (Month 18, D. Butterworth, UCT)

D 1.4 Report of data compilation for sardinella and horse mackerel (Month 30, D'Almeida, Namibia)

D 1.6 Web-based interface for the regional and two-species SAM (Month 48, A. Nielsen, DTU Aqua)

D 1.7 Report giving the details of the SCAA box model developed and listing its results for key hake dynamics and management-related quantities (Month 48, D. Butterworth, UCT)

D 1.8 Report on the spatial geostatistical modelling (Month 48, J. Beyer, DTU-Aqua)

D 1.9 Report on assessment of sardinella and horse mackerel (Month 48, D'Almeida, Namibia)

WP2: Input to stock assessment models
WP-leader: L. Hutchings (MCM, South Africa)

Objectives:

This work package is aimed at improving inputs to the stock assessment models to be developed in WP 1, which are ultimately to be applied in management of the hake, horse mackerel and sardinella stocks in the region. The objectives of the four tasks are:

1) To determine the stock structure including possible transboundary nature of the hake stock(s) through genetic analyses
2) To correct extant time series of survey CPUE data on hake stocks taking into account environmentally driven differences in catchability.
3) To improve the growth rate estimates of hake, horse mackerel and sardinella.
4) To determine the trophic position of hake, horse mackerel, and other pelagic and demersal fish.

Description of work:

Task 2.1 *Genetic assessment of hake stock structure (responsible: M. Lipinski (MCM) with Prof. C. Matthee, Stellenbosch University).* New mitochondrial DNA genetic techniques, already tested on hake in previous studies under BENEFIT and the BCLME Programme, offer the best prospect of resolving genetic structure in the population. Samples of *Merluccius paradoxus* and *M. capensis* for genetic analysis will be collected from their geographic range (Cape south coast to southern Angola) during routine demersal trawl surveys, and analysed at the University of Stellenbosch who have provided similar services in similar, preliminary studies under the BENEFIT and BCLME programmes. The samples collected will be added to a store of 6000 samples already awaiting analysis. It is planned to analyze in excess of 3000 fish per annum. Mitochondrial DNA control region sequences and microsatellite data will be investigated to determine the spatial distribution of genetic heterozygosity in both adults and juveniles.
Outputs: Differentiation of dispersal patterns of males and females and improved knowledge of genetic stock structure in hake, to provide a basis for assessment models to take appropriate account of this structure.

Task 2.2 *Improving understanding of variability in hake catchability and quantifying its effects on scientific and commercial CPUE data (responsible: K. Wieland, DTU Aqua)* This task investigates the impact of environmental effects on the availability of hake to the survey gear from an analysis of existing survey data, supplemented by the collection of new data aimed at (i) linking catch rates directly to environmental conditions close to the sea bed during trawls, and (ii) gaining a better understanding of the behavioural processes involved. In the retrospective study, spatially-explicit size-dependent analyses of routine biomass surveys, experimental research cruises to investigate the environmental impact on catch rates of *Merluccius paradoxus* and *M. capensis* in South Africa and Namibia, and if possible, for Angolan waters considering *M. polli* as well. In addition, attempts will be made to correct time series of survey and commercial catch rates for effects of diurnal migration in cases where a relationship is found between time of fishing and depth. Survey and commercial catch rates of hake and associated environmental data are available for the entire region from the regional participants MCM, NatMIRC and INIP. New data will be collected using a self-contained instrument package built into a locally-made underwater housing capable of being mounted on the headline of a trawl net and used from commercial trawlers as well as from research vessels. The usage of the instrument package on the net will be shared between South Africa, Namibia and Angola. DTU Aqua will provide supplementary expertise on the analysis methods and will participate in the data analysis through extended stays of a member of staff in the region when necessary.

Task 2.3 *Improvement and validation of techniques for determining growth rates of hake, horse mackerel and sardinella (responsible: D. Durholtz (MCM)).* This task will validate age estimates obtained from otoliths of hake, horse mackerel and sardinella. In the case of horse mackerel and sardinella, marginal increment analysis presents the most promising approach in the short-term. This requires analyses of otolith samples collected at frequent intervals (ideally monthly) over as broad an area as possible (to account for potential spatial effects). The analysis involves examination of the peripheral region of the otolith (ideally with accurate measurements of the radius of the outer-most, most recent growth zone) in order to monitor the progress of otolith growth over time and test the presumed annual cycle in growth zone formation (as well as clarify the interpretation of these growth zones). Once the results of the validation studies have been obtained, the current age estimation methods can then be implemented with confidence, or modified if necessary. Regional workshops will be convened to ensure that the correct age estimation method for the species is implemented throughout the BCLME. Such workshops include a training and capacity building component.

Task 2.4 *Trophic position of hake, horse mackerel and sardinella in the northern Benguela ecosystem (responsible: N. Moroff (NatMIRC))*. This task will determine the trophic position of hake, horse mackerel, sardinella and other important pelagic and demersal species. This will be achieved through 1) Collection and preparation of samples during national surveys and from commercial sampling, and dispatch to the Centre for Marine Environmental Studies (CMES), Japan, for analysis. 2) Stable isotope analysis (SIA) on existing and new samples from five major species groups in the northern Benguela (Small pelagic fish, horse mackerel and important demersal species, gobies, jellyfish and mesopelagic fish, zooplankton and top predators). 3) Refinement and further development of ecosystem simulation models based on the trophic information. The new data will be collected and prepared for analysis by scientists at NatMIRC and INIP, who will interpret the results through ecosystem models, with the assistance at a regional workshop of co-workers in the southern Benguela where this technique is already being

applied. **Outputs:** The main result will be a better understanding of the functioning of the food web for use in ecological models and developing ecological indicators, and in the incorporation of ecosystem considerations into management advice.

Deliverables:

D 2.1 Compiled validated data sets of survey and commercial CPUE and associated environmental information for various hake stocks and areas (Month 6, responsible: R. Leslie (MCM), P. Kainge (NatMirc) and Q. Fidel (INIP))

D 2.2 International peer-reviewed publication(s) describing the results of the genetic analysis of hake (Month 30, responsible: M. Lipinski and C. Matthee (MCM))

D 2.3. Consistent time series of corrected CPUE data of hake as input for stock assessments in WP1. (Month 36, responsible: K. Wieland (DTU-Aqua) and R. Leslie (MCM))

D 2.4. International peer reviewed publications on methodological aspects and results of the hake catchability analysis in task 2.2. (Month 42, responsible K. Wieland (DTU-Aqua) and P. Kainge (NatMirc))

D 2.5. Time series of improved growth estimates of hake, horse mackerel and sardinella to be used in WP 1 (Month 36, responsible: D. Durholtz (South Africa))

D 2.6 Database of the results of stable isotope analyses to be held regionally and regularly updated. Report on database. (Month 30, responsible: N. Moroff (NatMirc))

D 2.7 Publications in the primary literature on the results of stable isotope analysis and ecosystem modelling (Month 42, responsible: N.Moroff (NatMirc))

D 2.8 International peer-reviewed publication(s) on the environmental and behavioural processes affecting hake catchability in bottom trawl survey catches (Month 54, responsible: L. Hutchings (MCM) and K. Wieland (DTU-Aqua))

WP3: Incorporation of stakeholders' knowledge in data collection and analysis
WP-leader: Barbera Patterson, UCT

Objectives:

1. Development of social and economic indicators
2. Development of expert systems to integrate a multitude of indicators into a coherent assessment
3. Development of methodology to include stakeholders' experience-based knowledge into such assessments, as well as into management
4. Capacity building and training in application and development of EAF tools.

Outcomes will comprise

- Improved understanding of fishers and other non-scientific stakeholders for an EAF
- A set of agreed indicators for evaluation of pressures and state in the three dimensions of an EAF (ecological, human and ability to achieve)
- Time series of data behind these indicators
- Knowledge-based system models for joint evalation of these indicators
- Improved collaboration between scientists and other stakeholders in the management of the Benguela fisheries in focus

Description of work

WP3 will build on earlier experience with the South African small pelagics fisheries, and will be implemented on the two case studies in EcoFish: The Namibian hake fisheries (Case study 1), and the Angolan purse-seine fisheries for sardinella and horse mackerel

(Case Study 2). Both case studies will work very closely with the key stakeholders in each fishery through series of interviews and focus group discussions, workshops for each stakeholder group, as well as workshops including all stakeholders.

Senior staff of the MA-RE Institute, UCT and the Danish Technical University, Institute of Aquatic Resources, will provide methodological backup to both case studies with regard to indicator definition and expert system modelling.

Case study 1
Hake off Namibia are targeted using bottom trawling and long-lining. Major landing ports are Walvis Bay and Luederitz. The project will establish contacts with stakeholders (fishing companies, skippers, scientists and managers from MFMR, coastal community institutions and representatives) towards incorporating indicators pertaining to the human dimension of an EAF. The research on the case study is carried out in collaboration between the MA-RE Institute, University of Cape Town (Dr Barbara Paterson) and scientists of MFMR, Swakopmund and Luederitz, Namibia, specifically Dr Carola Kirchner, Mr. Johannes Iitembu, Mr Rudi Cloete.

Case study 2
The Angolan purse-seine fishery for sardinella and horse mackerel operates in the central and southern region of the country, out of five ports (Benguela, Lobito, Namibe, Tombua, Kuanza Sul). The fishery comprises about a dozen companies organised in three associations. Contacts will be established to these industry stakeholders as well as relevant community representatives, towards co-operation on defining management objectives for the human dimensions of an EAF for this fishery. The research on the case study is carried out in collaboration between INIP (Luanda and general leadership: Dr. Nkosi Luyeye, Benguela: Ms Joaquina Duarte, Namibe: Ms Quilanda Fidel) and the MA-RE Institute, University of Cape Town (Dr Barbara Paterson).

Senior staff of the MA-RE Institute, UCT and the Danish Technical University, Institute of Aquatic Resources, will provide methodological backup to both case studies with regard to indicator definition and expert system modelling.

Task 3.1. Socio-economic indicators
Because the development of ecological indicators is relatively advanced in the Benguela region, Task 1 will focus on shedding light on the human dimensions of an EAF based on our experience with the South African small pelagics fishery. Data series behind indicators will be compiled from available data, as well as new series generated through expert interviews, focus group meetings, and stakeholder workshops.

Task 3.2. Expert systems
Task 2 will build on the collaborators experiences in establishing a fuzzy-logic expert system for the South African small pelagics fishery, and focus on one major Namibian and Angolan fishery as introduced above, in order to broaden our experience with building such tools in all BCC member countries in the region, and for different fisheries. Specific, coherent evaluations of the efficacy of EAF implementation will be generated, in support of the management process in these two fisheries.

Task 3.3. Effects Methodology to include EBK into decision support tools
The work on Tasks 3.1 and 3.2 will yield generic experience with, and methodology for, incorporating non-ecological objectives, as well stakeholders' experience-based knowledge, more generally into management advice as prepared by BCC.

Task 3.4 Capacity building and training
Will be carried out continuously during the project with regard to coherent evaluations of the efficacy of implementation of an EAF in important Benguela fisheries, with scientists experienced in the methodology training colleagues working on implementing an EAF, as well as and non-scientific stakeholders. This task will be closely intertwined with Work Package 4 of ECOFISH.

Deliverables: (responsible person indicated in brackets)
Case 1, Namibian hake fisheries:
D3.1. Specification of objective hierarchies, Namibian hake fisheries (Month 18, B. Paterson, UCT)
D3.2. Inventory of socio-economic indicators, Namibian hake fisheries (Month 24, B. Paterson, UCT)
D3.3. Indicators for employment and user value, Namibian hake fisheries (Month 36, B.Paterson, UCT)
D3.4. Evidence-based management recommendations, Namibian hake fisheries (Month 36, B. Paterson, UCT)
D3.5. 1st prototype expert system, Namibian hake fisheries (Month 36, B. Paterson, UCT)
Case 2 Angolan purse-seine fisheries for sardinella and horse-mackerel
D3.6. Introductory workshops conducted at five locations, reported (Month 6, Luyeye, INIP)
D3.7. Inventory of socio-economic indicators, Angolan purse-seine fisheries (Month 24, Luyeye, INIP)
D3.8. Objective hierarchies, Angolan purse-seine fisheries (Month 48, Luyeye/Paterson)
D3.9. Indicators for employment and user value, Angolan purse-seine fishery (5 locations) (Month 48, Luyeye/Paterson)
D3.10. Evidence-based management recommendations, Angolan purse-seine fishery (Month 60, Luyeye, INIP)
D3.11. 1st prototype expert system, Namibian hake fisheries (Month 60 Luyeye/Paterson)
Overarching
D 3.12 Methodology for incorporation of stakeholders' experience-based knowledge into decision support for the BCC (Month 60, B. Paterson, UCT).

WP4: Capacity building in stock assessment and EAF implementation
WP-leader: K. Stephanus, BCC

Objectives:
This work package is aimed directly at strengthening regional capacity in
a) stock assessment and
b) the implementation of EAF in fisheries management,
through formal courses targeting scientists and managers within the region, through stock-assessment workshops, and through yearly project meetings. Each of the courses will be presented twice, on alternative years, starting with the stock assessment course.

Description of work
A large part of the capacity building in EcoFish takes place through the education of PhD students and the workshops, both specific to individual WPs or tasks and the general project meetings. In addition four specific activities are planned:
Task 4.1: Stock Assessment course
The aim is to educate scientists from Angola, Namibia and South Africa in the stock assessment methods that are in use, or in the processes of being developed, to manage stocks sustainably in the region. The course will target stock assessment scientists at an intermediate and advanced level, and is aimed specifically at the further education of a group of some 15 trainees from the fisheries institutes in Angola, Namibia and South

Africa who will be receiving training in basic stock assessment methods at a BCC-funded course at the University of Cape Town in April 2010. It will be presented by regional lecturers as far as possible and will include the education of trainers to build capacity for future training. Lecturers from DTU Aqua would be used where shortcomings are experienced at a regional level, for example the use of spatial statistical techniques such as GeoPop in stock assessment. The course would be of between two and three weeks duration, and would cover some or all of the following components, taken from the current BCC Training and Capacity Building Work Plan.

- Overview of different stock assessment modelling approaches
- Data needs (i.e. biomass data, fecundity, catch data, ageing, growth data, etc.)
- Validation of model outputs
- Limitations of models due to underlying data quality problems
- Computer programming
- Development of mathematical models
- Running and updating of models
- Testing for robustness and sensitivity of models

Task 4.2 Implementation of EAF

The aim here is to improve basic understanding in the region of EAF principles, and the ability to implement management practices according to EAF principles into regional fisheries management, using case studies. The course would target both regional scientists and fisheries resource managers. Lecturers for this course would be sourced both locally and internationally and as in stock assessment course, would include the building of trainer capacity. The course would be of between one and two weeks duration, and would cover the following topics, again taken from the current BCC Training and Capacity Building Work Plan.

- Introduction to EAF
- Target Reference Oriented Management (TROM) reviews
- Ecological risk assessment
- Cost benefit analysis
- Implementation Plans
- Implementation reviews

The target group would be large to incorporate people from both the regional scientific and management structures

Task 4.3 Stock assessment meetings

These meetings will be held between involved assessment scientist of the hake, horse mackerel and sardinella stocks. The workshops will include externally invited stock assessment expertise to aid in the evaluation of the quality of the stock assessments.

Task 4.4 Yearly project meetings

Meetings will be held yearly between all participants in the project. Where possible the workshops in the WPs and the meetings in the steering committee will be held in conjunction with the yearly meetings. During the yearly meetings progress in the WPs will be presented, and outstanding issues will be discussed and resolved.

Deliverables: (responsible person indicated in brackets)

D 4.1 Courses in stock assessment (Month 6 and 36, responsible: K. Stephanus, BCC)
D 4.2. Courses in EAF (Month 18 and 48, responsible: K. Stephanus, BCC)
D 4.3 Report of first hake stock-assessment workshop (Month 3, D. Butterworth, UCT)
D 4.4 Report of first horse mackerel/sardinella workshop (Month 12, F. Vaz Velho, INIP)
D 4.4 Report of second hake stock-assessment workshop (Month 36, D. Butterworth, UCT)
D 4.5 Report of the second horse mackerel/sardinella workshop (Month 48, G. D'Almeida, NatMirc)
D. 4.6 Reports on the yearly meetings (each year, responsible: H. Hamukuaya, BCC)

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1.4. Methodology

Approach in relation to state-of-the-art

The combination of front-edge science, tested state-of-the-art methodology and involvement of all knowledge bases available in the region is expected to result in major progress in fish stock assessment and fisheries management in the region. The proposed stock assessment, spatially-explicit data analysis and modeling methods in WP1 are front edge science in fisheries research, but experience in application by partners exists from European areas. Genetic techniques to be used in WP 2.1, the age –determination methods in WP 2.3 and the stable isotope techniques and modeling techniques to be used in the trophodynamic study in WP 2.4 are all state-of-the-art methodology, which can be handled by regional participants. The approach to be used in WP 2.2 to investigate directly the effect of the environment on the availability and catchability of hake, however, is novel, promising new insights hitherto elusive. The development of expert systems in WP3 to integrate a multitude of indicators into a coherent assessment including stakeholders' experience-based knowledge is front edge development. It is based on considerable regional experience as well as results from ongoing European framework projects and is expected to deliver new insight, which will be useful in the management of fisheries also in other sea areas, e.g. European waters.

Work package structure and flow of information

The project activities are organized in 4 work packages (WPs) (see figure in 1.3), with focus on integration and development of experienced based, data based and model based knowledge, as basis for development of the 'Ecosystem Approach to Fisheries management' in the BCLME.

WP1 concentrates on stock assessments extending existing hake stock assessment methodology to take better account of current data and knowledge, as well as setting up alternatives to these models to determine how robust their outputs are. The second stage involves use of new information on stock separation, population dynamic rates and catchability gathered from WP2 to improve and elaborate the stock assessments further. Scientific lead: Senior staff of the MARAM Institute, UCT and the Danish Technical University, Institute of Aquatic Resources (DTU Aqua).

WP2 is aimed at improving inputs to the stock assessment models to be developed in WP 1, which are ultimately to be applied in management of the hake, horse mackerel and sardinella stocks in the region. Methods applied include:

1) genetic analyses to determine the stock structure including possible transboundary nature of the hake stock(s); scientific lead: MCM and Stellenbosch University,
2) correction of existing time series of survey based hake CPUE data taking into account environmentally driven differences in catchability; scientific lead: DTU Aqua,
3) enhanced otolith analyses to improve the growth rate estimates of hake, horse mackerel and sardinella; scientific lead: MCM,
4) stable isotope techniques in combination with traditional diet composition analyses to determine the trophic position of hake, horse mackerel, and other pelagic and demersal fish; scientific lead: NatMIRC.

WP3 develops and deploys expert systems to integrate a multitude of indicators into a coherent assessment approach including environmental indicators and stakeholders' experience-based knowledge. WP3 will build on earlier experience with the South African small pelagics fisheries, and will be implemented on the two case studies: The Namibian hake

fisheries and the Angolan purse-seine fisheries for sardinella and horse mackerel. Both case studies will work very closely with the key stakeholders in each fishery through series of interviews and focus group discussions, workshops for each stakeholder group, as well as workshops including all stakeholders. Senior staff of the MA-RE Institute, UCT and DTU Aqua will provide methodological backup to both case studies with regard to indicator definition and expert system modelling.

All three scientific WPs include field research, lab work, collaborative analysis of existing data and modeling and will be accompanied by a program of capacity building under WP4, see below. The scientific lead is taken by high profiling scientists from the region, with the Danish Technical University, Institute of Aquatic Resources having only a scientific lead responsibility in areas where the regional expertise is limited, e.g. the catchability study under WP2, or in areas where an extraordinary effort needs to be conducted, e.g. in WP1 and WP3.

WP4 will strengthen the regional capacity in stock assessment and the implementation of EAF in fisheries management, through formal courses targeting scientists and managers within the region, through stock-assessment workshops, and through yearly project meetings. Each of the courses will be presented twice, on alternative years, starting with the stock assessment course. Under each scientific WP there will be additionally capacity building activities, such as exchange of scientist between participants and participation of related PhD students in European PhD schools. BCC will coordinate activities under WP4.
The interlinkage, coordination and communication between the WPs will mostly take place through the yearly project meetings and at the annual BCC Science Forum. The Steering Committee will meet at least once a year, at the annual BCC Science Forum, also to facilitate integration and exchange with other BCC research activities and associated projects such as the NansClim and GENUS Projects.

Larger equipment

New data will be collected using a self-contained instrument package built into a locally-made underwater housing capable of being mounted on the headline of a trawl net and used from commercial trawlers as well as from research vessels. The package will be deployed widely during trawl surveys on the continental shelf in both the southern and the northern Benguela, to monitor environmental conditions close to the bottom at the time of trawling. It will also be employed opportunistically on commercial trawlers in the southern Benguela to observe directly responses of hake to changing environmental conditions. The cost of this equipment is estimated to € 75.000.

Project management and role of participants
BCC coordinates the project in collaboration with the WP leaders and the Project Steering Committee, which includes representatives from BCC (including representatives from all three countries) and DTU Aqua, see Table 1 for organisation of project – roles and responsibility specifically with respect to project-and WP coordinator, administration and dissemination. Besides the project applicant BCC and the partner DTU Aqua, the following institutes will participate in the proposed project as subcontractor or associates:

1) Institute National Investigacao Pescas (INIP), Luanda contributes to all WPs
2) National Marine Information and Research Centre, Swakopmund (NatMIRC) contributes to all WPs
3) Marine and Coastal Management, Cape Town (MCM) leads WP2 and contributes to WP4
4) University Cape Town (UCT) leads WP3 and contributes to all other WPs
5) University Stellenbosch contributes to WP2

6)Center for Marine Environmental Studies, Japan (CEMS) contributes to WP 2.

Table 1 Organisation of project – roles and responsibility

Function/ role	**Responsible person/team**	**Responsibility and activities**	**Justification (qualifications)**
Project-Coordinator	BCC Chief Technical Advisor	Overall responsibility for project management and for the supervision of the technical and administrative aspects of the project.	BCC has a wealth of experiences in coordination and management of regional research projects. Currently there are about twenty projects on-going addressing areas in resources management, environment, data and information and capacity building and are executed by national research institutes and private contractors in Angola, Namibia and South Africa.
Project Steering Committee	Project coordinator BCC Ecosystem Coordinator DTU Aqua representative Key BCC stakeholders	- Steer the project to its final conclusion - Scientific strategic planning and monitoring of progress against workplan and budget. - Be aware of relevant activities in other projects. - Resolve any technical administrative or contractual issues, which have not been resolved by other means within the project. - Be the overall quality manager of the project	Steering Committee will include key BCC stakeholders including Institute National Investigacao Pescas in Luanda, National Marine Information and Research Centre, Swakopmund, Marine and Coastal Management, Cape Town, MARE-UCT, MARAM-UCT. The recommendations and advice will feed into BCC Ecosystem Advisory Committee and eventually into BCC Management Board.
Project-Administration & Finance	BCC Secretary/UNDP	- Arrange and implement project- and steering group meetings - Co-ordinate information exchange within the project - Financial management - Report to the European Commission - Other administrative matters	BCC has extensive experience in project management including coordination and administration, while UNDP Namibia supports financial administration and contractual modalities.
Dissemination group	Principal investigators of work packages, DTU Aqua and BCC Secretariat	- Project implementation - Facilitate publication of scientific results - Participate in conferences and meetings - Facilitate effective and efficient communication with stakeholders - Advice on implementation of project results	Dissemination group has extensive experience in participating in conferences and meetings, organising workshops and seminars, and collaboration with other platforms. BCC hosts annual science forums in the region, which has proved to be a highly effective platform for communicating with wider stakeholders.
WP 1	DTU Aqua	See. 1.3. for descriptions of the	The teams comprise scientific

WP 2	MCM	activities	excellence, local knowledge and management skills.
WP 3	MA-RE, UCT		
WP 4	BCC		

Follow-up, monitoring and evaluation

The Steering Committee will be responsible for the monitoring of project progress on the basis of annual progress reports submitted by the WP leaders. Budgets will be revised annually and funds allocated according to needs, progress and performance. Evaluation of the quality of the work will occur at various stages through review by international experts, particularly at the workshops within WP 1.

Input will be obtained at critical "Stage/Gates" or decision points in the project from the BCC Ecosystem Advisory Committee to ensure that the key objectives of the WPs and the overall project remain on target. This internal review combined with external advice is deemed critical to ensure that the project remains proactively managed throughout its lifetime.

An adequate contingency planning to mange project risks, both external and internally will be in place and continually updated as the work progresses. In case the work is not of sufficient quality or not achieved on time, resulting in potential slippage of other project work components the Steering Committee will have the power to implement necessary corrective actions according to the adopted contingency plans to keep the overall project to schedules. For further information on risk analyses and contingency plans see section 1.6.

Dissemination and visibility of the action

The results of the work will be disseminated through publications in the peer-reviewed scientific literature, workshop and meeting reports (all of which will be posted on the BCC website) and through presentations at regional and international symposia and other scientific meetings. Overviews will be provided in the BCC Annual Report, and presented at the Annual BCC Science Forum, where further dissemination will take place through formal presentations of specific results and informal interaction with colleagues.

Popular articles on various aspects of the project will be published in the press and posted on the BCC website from time to time. The EC funding of the Project will be advertised in all popular articles and will be emphasized in presentations to the BCC Forum and similar meetings. The EC support will be acknowledged in any publications emanating from the project.

Dissemination will follow the guidelines for EU External Actions as outlined by the Communication and Visibility Manual with focus on the project implementation, monitoring and evaluation stage of the project cycle, but aiding help to the commission services in all other project stages as well. For further information on the dissemination see section 1.6.

1.5. Duration and indicative action plan for implementing the action

The overall duration of the action will be 60 months and details for the different activities are listed below.

WP 1: Stock assessment

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Inception workshop													DTU Aqua, MCM, NatMIRC, INIP
Setting up of a basic single stock SAM of South African hake species													DTU Aqua, MCM, NatMIRC, INIP
Motification of existing SCAA assessment model for South African hake													DTU Aqua, MCM, NatMIRC, INIP
Compilation of existing data for stock assessment of horse mackerel and sardinella													DTU Aqua, MCM, NatMIRC, INIP

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Extension of spatial box model to include Namibian hake									as above
Assessment of hake canibalism and inter-species predation									as above
Extension of basic model to account for two hake species in South Africa and in Namibia									as above
Application of GeoPop to explore potential utilityto determine the effect of environmental variaation on hake catchability									as above

WP 2, Task 1: Genetic assessment of hake stock structure

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Sample collection (both species of hake)													MCM
Sample analysis													Univ. Stellenbosch
Data analysis													Univ. Stellenbosch

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Sample collection (both species of hake)									
Sample analysis									MCM, Univ. Stellenbosch
Data analysis									Univ. Stellenbosch

WP 2, Task 2: Improving understanding of variability in hake catchability and quantifying its effects on scientific and commercial CPUE data.

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Data preparation (Survey and commercial catch rates and environmental variables)													MCM, NatMIRC, INIP
Analyses of existing data													DTU Aqua, MCM, NatMIRC, INIP
Assemblage and test of self-contained instrument package													MCM, NatMIRC, INIP
Deployment of the self-contained instrument package and recording of accoustic data from research and commercial vessels													MCM, NatMIRC, INIP
Analysis of new data													MCM, NatMIRC, INIP, DTU Aqua
Dissemination of results to stakeholders and publication in peer-reviewed journals													DTU Aqua, MCM, NatMIRC, INIP

1st workshop

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Data preparation (Survey and commercial catch rates and environmental variables)									
Analyses of existing data									as above
Assemblage and test of self-contained instrument package									
Deployment of the self-contained instrument package and recording of accoustic data from research and commercial vessels									as above
Analysis of new data									as above
Dissemination of results to stakeholders and publication in peer-reviewed journals									as above

2nd workshop

WP2, Task 3: Improvement and validation of techniques for determining growth rates of hake, horse mackerel and sardinella

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Sample collection (hake) - radiochemical dating													INIP, MFMR, MCM
Sample delivery (radiochemical dating)													MCM
Sample analysis (radiochemical dating)													Contractor
Sample collection (all species) - marginal increment analysis													INIP, MFMR, MCM
Identification of students (marginal increment analyses)													INIP, MFMR, MCM
Marginal increment analysis (all species)													Students
Cod end construction (hake mark-recapture experiment)													MCM
Hake mark-recapture experiment													MCM
Standardization workshop													INIP, MFMR, MCM

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Sample collection (hake) - radiochemical dating									INIP, MFMR, MCM
Sample delivery (radiochemical dating)									MCM
Sample analysis (radiochemical dating)									Contractor
Sample collection (all species) - marginal increment analysis									INIP, MFMR, MCM
Marginal increment analysis (all species)									Students
Hake mark-recapture experiments									INIP, MFMR, MCM
Standardization workshop									INIP, MFMR, MCM

WP2, Task 4: Trophic position of hake, horse mackerel, and sardinella in the northern Benguela ecosystem

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Project initiation and assignment of coordinator													INIP, MFMR, MCM, CEMS
Optimize sampling design (sampling time, sampling frequency, and sampling method)													INIP, MFMR, MCM
Sample collection (new samples, and preparation of existing samples)													INIP, MFMR, MCM
Sample processing (stable isotope analysis)													CEMS or regional institutes
Decision on publication (paper objectives, titles, and co-authorship) and collection of additional samples when needed													INIP, MFMR, MCM, CEMS

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Preliminary data analysis									INIP, MFMR, MCM, CEMS
Write up of papers (submit for publication)									INIP, MFMR, MCM, CEMS
Adaptation of ecosystem models									INIP, MFMR, MCM, CEMS, DTU
Model validation and calibration									INIP, MFMR, MCM, CEMS, DTU
Write of papers based on modelling work (submit for publication) and project report									INIP, MFMR, MCM, CEMS, DTU

WP 3: Incorporation of stakeholders knowledge in data collection and analysis

		Responsible	Collaborators	Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Task 1 (socio-economic Indicators)																						
1.1.	Inventory of socio-eonomic indicators, Namibian hake fisheries	B. Paterson	Rudi Cloete, Johannes Iitembu																				
	Indicators for employment and user value, Namibian hake fisheries	B. Paterson	Rudi Cloete, Johannes Iitembu																				
	Evidence-based management recommendations, Namibian hake fisheries	B. Paterson	Rudi Cloete, Johannes Iitembu																				
	Establish contact to stakeholders, Introduction of project through worskhops: one per location (=total of 5)	Nkosi Luyeye	J. Eduardo, + social scientist, Quilanda Fidel, Barbara Paterson																				
1.2.	Inventory of socio-economic indicators, Angolan purse seine fisheries (sardinella, horse mackerel)	Nkosi Luyeye	J. Eduardo, + social scientist, Quilanda Fidel																				
1.4.	Indicators for employment and user value, Angolan small pelagics fisheries (sardinella, horse mackerel)	Nkosi Luyeye	J. Eduardo, + social scientist, Quilanda Fidel, B.Paterson																				
1.6.	Evidence-based management recommendations, Angolan small pelagic fisheries (sardinella, horse mackerel)	Nkosi Luyeye	J. Eduardo, + social scientist, Quilanda Fidel																				
	Task 2 (Expert systems)																						
2.1.	Objective hierarchies, Namibian hake fisheries	B. Paterson	Rudi Cloete, Johannes Iitembu																				
2.2.	1st prototype expert system, Namibian hake fisheries	B. Paterson	Rudi Cloete, Johannes Iitembu, A. Jarre																				
2.5.	Objective hierarchies, Angolan small pelagics fisheries (sardinella, horse mackerel)	Nkosi Luyeye	J. Eduardo, Q. Fidel, B. Paterson																				
2.6.	1st prototype expert system, Angolan small pelagics fisheries (sardinella, horse mackerel)	Nkosi Luyeye	J. Eduardo, Q. Fidel, B. Paterson, A. Jarre																				
	Task 3 (Methodology to include EBK into decision support tools)																						
	Methodology to include EBK into decision support tools	B. Paterson	A. Jarre, Q. Fidel, J. Eduardo, J. Iitembu, R. Cloete																				

WP 4: Capacity building in stock assessment and EAF implementation

Year 1													
Activity	**Semester 1**						**Semester 2**						**Implementing body**
	Mnth 1	**Mnth 2**	**Mnth 3**	**Mnth 4**	**Mnth 5**	**Mnth 6**	**Mnth 7**	**Mnth 8**	**Mnth 9**	**Mnth 10**	**Mnth 11**	**Mnth 12**	
Stock assessment course													BCC & DTU (ECOFISH partners)

For the following years:									
Activity	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Implementing body**
	Sem. 3	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	
Stock assessment course									BCC & DTU (ECOFISH partners)
EAF implimentation course									BCC & DTU (ECOFISH partners)

1.6. Sustainability

The project will deliver new results on all target areas identified by the call, specifically a better understanding of the ecosystem approach to fisheries in the Benguela Current System and it will demonstrate added value of this concept in the fisheries management. It will enhance the regional capacity for applying the ecosystem approach to fisheries, thus not only operating as a template for other marine ecosystems, but seek to increase the regional capacity in a facilitatory manner. Spatially explicit tools will allow design and monitoring of MPAs to address the regeneration of fish stocks and alleviation of poverty.

The approach includes policy makers, industry and other stakeholders and thus will enhance cooperation mechanisms and information/experience exchange being promoted across the region. Besides the clear relevance of the proposed project, efficiency is ensured by combining the expertise, infrastructure, resources and data of an international organisation, fisheries research institutes, universities and stakeholders, thus achieving the results at reasonable costs, in high quality and in time according to the workplan. Thus, the project will be effective, because it involves all major regional and local players in fisheries management, ensuring acceptance and a strong chance of implementation of the results.

A. Expected impacts: Positive impacts of the project are expected on:

1. **fisheries science,** through an improved understanding of key elements of the population dynamics of key fish species in the Benguela Current System (stock structure, catchability, growth and trophodynamis), their role in the ecosystem and thus a better understanding of the ecosystem dynamics, being a prerequisite of the ecosystem approach to fisheries. It will improve the cooperation between marine environmental and fisheries science and contribute substantially to capacity building in the region. The latter will be achieved at scientist, post-graduate and graduate level through dedicated workshops and exchange programs organised jointly by involved institutions as well as contributions to teaching at the involved universities.
2. **scientific advice,** through an improvement of the analytical fish stock assessment methodology, improved stock separation and population dynamics rates and by being spatially explicit. Understanding of the spatial dynamics of fish stocks is a prerequisite for any spatially explicit management measure like the establishment of MPAs. The implementation of enhanced expert systems in the advisory process will allow consideration of environmental drivers not explicitly incorporated into the stock assessment and ensure the utilisation of stakeholder knowledge in the advisory process, thus improving not only the quality of the advice, but also stakeholder acceptance in the region.
3. **fisheries management,** through further development of the ecosystem approach to fisheries, taking as well into consideration the maximum sustainable yield concept and its implementation by 2015, as committed to by the region. This will allow the development of strategic long-term fishing plans and rebuilding in an ecosystem context in cooperation with stakeholders, or strengthen existing plans where those exist, a prerequisite for development of integrated policy objectives for the management of the Benguela Current System and its sustainable exploitation with minimised impact on ecosystems.
4. **the fisheries sectors,** through development of a more holistic view on fisheries management based on cooperation and dialogue between scientists, advisors, managers, industry and other stakeholders. The aim would be to focus on strategic long-term planning and development of the sector, considering environmental drivers and

environmental concerns, avoiding micro-management and prescriptive management regulations, and instead opening up to a more results-based adaptive management.

B. Dissemination plan: Dissemination will follow the guidelines for EU External Actions as outlined by the Communication and Visibility Manual with focus on the project implementation, monitoring and evaluation stage of the project cycle, but aiding help to the commission services in all other project stages as well:

The project will place a high priority on the timely delivery of appropriate policy advice as pertinent new science becomes available, ensuring transparency of management objectives, underlying science, advisory tools and data. This will happen on all levels, from targeted information to policy makers, information dissemination at high level meetings and engaging the public through the media where appropriate via press releases and organisation of specific information events.

Apart from close contact with and dissemination to policy organisations, the project will consult with stakeholders such as industry and industry associations, not only to agree on how to implement project results, but also to obtain their support in facilitating effective and efficient communication with a wider stakeholder base.

Project participants will target selected professional and academic publications (including the highly-rated African Journal of Marine Science) to publish scientific results of the project as well as popular publications to disseminate the results in a user-friendly manner. Partners are expected to leverage their local and international positions and influence in order to publicize the outcomes of this project as widely as possible. This could include participation in other regional fisheries management organizations.

Active dissemination will be conducted by participating in conferences and meetings, by organising workshops and seminars, and through collaboration with other platforms, e.g. other regional projects and fora, such as the BCC Annual Forum and SAMS (Southern African Marine Science Society, held every three years). where project results will be represented and actively promoted.

Finally, to contribute towards the education of the next generation, there will be dedicated courses in 'Ecosystem approach to fisheries' and 'Fish stock assessment methodology' for graduate and post-graduate students in collaboration with the involved universities. Participation of related PhD students in European PhD schools will be facilitated.

C. Risk analysis and assumptions: The achievement of project objectives is always subject to influences beyond the control of the project management and project participants. The assumptions and risks in the proposed project are, however, small on the cooperation side, as participants include all relevant fisheries and marine research institutes in the areas under the leadership of the regional international scientific organisation. The region has a history of successful co-operation, as evidenced by results of the regional BENEFIT and BCLME programmes since 1997. By applying a sectoral involvement approach, ensuring communication with stakeholders and policy makers during the course of the project, risks with respect to acceptance and implementation of results are minimised.

A strong group of participants has coalesced in the project consortium in order to form the critical mass needed to reach the project objectives and to ensure maximum value of the results. It is therefore evident that the consortium has the scientific and technical history and capability to carry out the proposed work and also to create the impact to disseminate and exploit the results.

However scientific technical problems may be encountered in: i) distribution of work tasks, e.g. mis-match in timing of available results, ii) communication breaches between different science disciplines and/or stakeholders and iii) insufficient funding, e.g. due to cut-back in funding from other donors. Risks include securing sufficient research funding from national governments, which may reduce the effectiveness of participation of

government scientists in the action. Thus, at key milestones in the project, a Steering Committee will review progress of the overall project work, and the main tasks with converging timelines. Input will be obtained at these critical "Stage/Gates" or decision points in the project from the BCC Ecosystem Advisory Committee to ensure that the key objectives of the work packages and the overall project remain on target. This internal review combined with external advice is deemed critical to ensure that the project remains proactively managed throughout its lifetime.

D. Contingency plan: Proper **contingency planning** to mange project risks, both external and internally will be in place and continually updated as the work progresses. In case the work is not of sufficient quality or not achieved on time, resulting in potential slippage of other project work components the Steering Committee will have the power to implement necessary corrective actions according to the adopted contingency plans to keep the overall project to schedules.

E. Sustainability after the action: With respect to **sustainability** of the proposed project outcomes, there are no major problems envisaged:

1. **Policy level sustainability:** The Reykjavik Declaration (FAO, 2002) urged governments to make fishing policies using an ecosystem approach. The Ecosystem Approach to Fisheries (EAF) calls for modification of the perception of fisheries management in an ecosystem context. The need for EAF has been clearly identified in a number of major jurisdictions, e.g. the EU Marine Strategy Framework Directive (Directive 2008/56), the Common Fisheries Policy (Council regulation 2371/2002), in Canada (Fisheries and Oceans Canada, 2007) and the US (Burgess et al., 2005). Consequently, the European Strategy for Marine and Maritime Research (COM(2008)534) prioritises the ecosystem approach to resource management and spatial planning as a major cross-thematic research challenges. EAF has been identified as a central principle of the BCC's strategy and implementation plans, and all three member countries have committed themselves to an ecosystem-based approach since a joint EAF implementation feasibility project was carried out under the BCLME.
2. **Environmental sustainability:** With respect to ecological sustainability UNCED (1992) defined the overarching objective as maintenance of the reproductive capacity of the living resources to ensure sustainable exploitation. In contrast WSSD 2002 is more ambitious and agreed on the objective to restore stocks to levels that can produce the Maximum Sustainable Yield (MSY) at the latest by 2015. How to merge the EAF with the MSY is one of the main challenges in fisheries management (EU Green Paper; COM (2006) 360). The proposed project will address this challenge and results will be of importance for the global discussion on sustainable management of marine living resources. Further implementation of the ecosystem approach to fisheries and MPAs as management measure is not only expected to improve the state of the stocks, but also to minimise the effect of fishing on the ecosystems, and as such in line with the socio-cultural development worldwide.
3. **Institutional sustainability**: Given the policy relevance of the work proposed, described above, and the management systems already in place, no problems in sustainability of developed and agreed management procedures to be implemented are envisaged. However, there is a risk in ensuring access to sufficient capacity since there are few mathematically inclined graduates interested in fisheries stock assessment and in retaining skilled people once they are trained. In South Africa's case this is being addressed to an extent through the implementation of an Occupational Specific Dispensation for scientists in government.
4. **Economic and financial sustainability:** Developed fisheries management concepts, fish stock assessment tools and expert systems will be ready to use and without extra

funding to sustain in all three partner countries participating in the project. A certain multiplier effect in neighbouring countries is expected, but needs support for implementation in potential follow-up projects. Both management concepts and management tools are expected to improve the utilisation of marine living resources in the Benguela Current System, both in terms of real biological production and from consumer perspective, which is especially of importance in the export market to Europe. Consequently, project results will have a long-term positive effect on the state of the living resources, fishing and trade opportunities. Some of these results are likely to find implementation through the conditions needed for certification of fisheries such as the South African hake trawl fishery.

5. **Socio-cultural sustainability:** Involving stakeholders in the assessment and advisory process of fisheries management is expected to improve cooperation between science, managers, industry and other stakeholders, reducing conflicts on management objectives and measures to be implemented.
6. **Technical sustainability:** The developed stock assessment methodology and implemented expert systems will be maintained by the participating research institutes, with capacity and training measures planned within the project, which will ensure proper handling and interpretation of the methodology in the fisheries assessment and advisory process.
7. **Factors of ownership (Intellectual Property):** All concepts, software and tools developed under the project will be available in open access.

1.7. LOGICAL FRAMEWORK FOR THE PROJECT

	Intervention logic	Objectively verifiable indicators of achievement	Sources and means of verification	Assumptions
Overall objective(s)	*Promote implementation of the ecosystem approach to fisheries (EAF) in the Benguela Current Large Marine Ecosystem (BCLME) and supporting the conservation of marine resources through the effective management of Marine Protected Areas (MPS's) while contributing to poverty reduction*	*No. of ECOFISH EAF projects completed or running in region* *Recommendations for implementing EAF in management of hake, horse mackerel and sardinella fisheries* *No. of scientists and stakeholders involved in EAF in region* *Structures for interaction between scientists and stakeholders*	*BCC Annual Report* *Annual project progress reports* *Final project reports*	*Buy-in from stakeholders* *Adequate, sustained human resources from regional institutes and international partners*
Specific objective(s)	***1.** State-of-the-art stock assessment methods and MPA planning tools has been adapted for implementation in the BCLME region.* ***2.** Data and other inputs (growth rates, stock identity etc.) to above models have been improved and validated* ***3.** Practice for incorporation of the fishing industry knowledge into data collection and analysis established* ***4.** Regional capacity to apply the developed techniques and tools improved*	*New or adapted regional stock assessment models running and implemented* *New MPA planning tools available for use in region* *Reports on data quality and results of work done on inputs* *Results of tests on model performance (sensitivity, robustness tests etc.)* *New inputs to models (eg variable catchability)* *No. of models incorporating stake-holder knowledge* *No. of indicator time series incorporating stake holder knowledge* *No. of courses presented and no. of people trained* *No. of new staff working on stock assessment and EAF implementation at an appropriate level.*	*DTU Reports* *Workshop reports (BCC Secretariat)* *Publications in primary literature* *International reviews* *Meeting and project reports (BCC Secretariat)* *Course reports* *BCC reports* *Working Group reports and recommendations*	*Availability of suitable experts to develop Models* *Adequate, sustained human resources from regional institutes and international partners* *Adequate, sustained human resources from regional institutes and international partners* *Sufficient, sustained and active participation from stake holders* *Sufficient no. of suitable tainees* *Adequate retention of trained staff in the fields in which they were trained.*

Expected results	***1.*** *Regional co-operation in managing target fisheries sustainably according to EAF principles by 2015* ***2.*** *State-of-the-art tools for planning MPAs suitable for the BCLME* ***3.*** *Involvement of the hake, horse mackerel and sardinella fishing industries in data collection and analysis - including existing and future knowledge* ***4.*** *Increased ability of scientists in the BCLME region to become involved in (1) and (2) at an appropriate level & strengthening of the professional and scientific network in the region*	*Regional management procedures developed and used by joint scientific working groups to make management recommendations* *Report on set-up of MPAs* *No. of consultation meetings and interviews with stakeholders* *No. of stakeholder participants in ECOFISH* *Percentage of trainees applying the new techniques in the region*	*Working Group reports and recommendations* *National reports* *BCC Annual report* *Project reports* *Annual BCC Training and Capacity Building report.* *Annual progress reports or when requested*	*Sufficient, sustained and active participation from stakeholders*

Activities	***Work Package 1*** *Develop regional stock assessment methods through interaction between local and DTU stock assessment scientists.* *Validate through analysis of existing survey, commercial catch and biological data* ***Work Package 2*** *Improve the quality of data input to the stock assessment models, and of other inputs such as growth rates and information on stock identity. Add new inputs on for example trophodynamics and variability in catchability.* ***Work Package 3*** *Integrate science-based and experience-based knowledge of stock status through expert system methods,and use in development of ecosystem models for managing the target species according to EAF principles.* ***Work Package 4*** *Build local capacity in stock assessment and the implementation of EAF through a series of training courses on these topics & involvement of local scientists in project activities*	***Means:*** *Regional meetings and workshops (travel, subsistence etc.)* *Acquisition of computer hardware and software* *Building and acquisition of specialised oceanographic equipment* *Laboratory equipment* *Recruiting and training personnel at various levels* *Engaging of specialist services* *Co-ordinaion and integration of activities*	***Costs*** *Refer to Budget breakdown*	