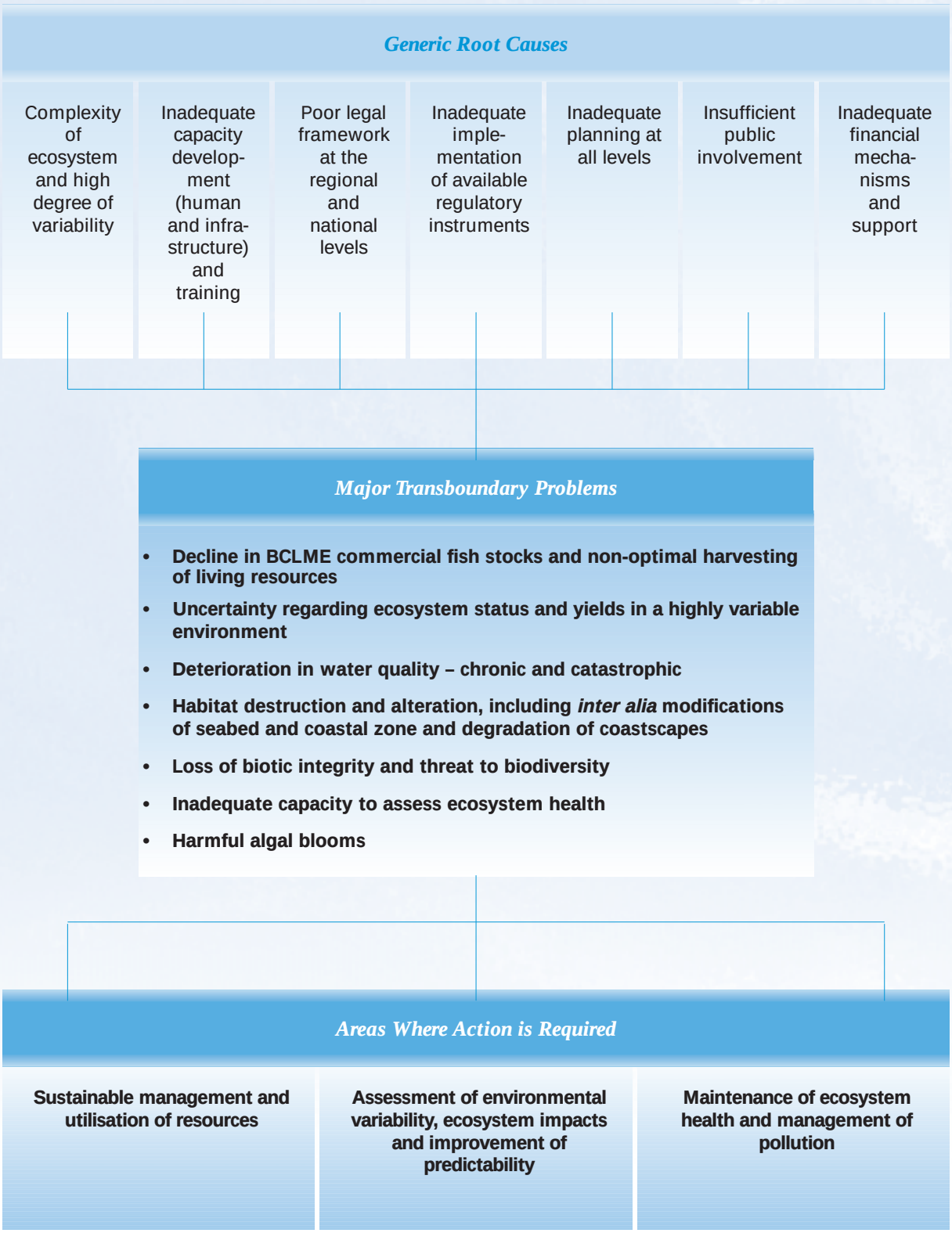

FIGURE 2 Major transboundary problems, generic root causes and areas requiring action

Level Two: Action Areas

An Overview of Specific Transboundary Problems, Causes, Impacts, Actions Required and Anticipated Outputs

In Level One: Synthesis, three broad action areas were identified in order to address the perceived major BCLME problems and the main root causes of these problems. The action areas correspond to the three main issues in the BCLME, namely utilisation of resources, environmental variability, and ecosystem health and pollution. For each action area a set of more specific actions was specified in the Synthesis Matrix. These specific actions were formulated collectively through consensus among stakeholders at the Second Regional BCLME Workshop to identify the specific problems associated with each main issue. These have been prioritised and the outputs or solutions emanating from the specific actions have been listed and costed. The essential information has been summarised in the set of analysis tables which follow. These tabular summaries are necessarily brief – often in point form – and where additional clarification has been deemed necessary, this has been provided following each table in the form of explanatory notes.

What is not immediately apparent from the Level Two tables, developed by consensus at the Second Workshop, is that there are a number of generic actions which cut across the specific actions within each of the three broad action areas, and indeed even between the broad action areas. For the sake of completeness the essence of this alternative but complementary approach is as follows:

Action Area A:
Sustainable management and utilisation of resources

Generic Actions:

- Capacity strengthening and training
- Joint surveys and assessments of shared resources and intercalibration
- Policy harmonisation and integrated management
- Co-financing with private sector/industry
- Development of new industries (e.g. mariculture, tourism)

Action Area B:
Assessment of environmental variability, ecosystem impacts and improvement of predictability

Generic Actions:

- Capacity strengthening and training re transboundary concerns
- Regional networking and international linking
- Development of regional early warning system, assessment and prediction capability (including re-assessments) and joint response policies
- Cross-cutting demonstration projects

Action Area C:
Improvement of ecosystem health and management of pollution

Generic Actions:

- Capacity strengthening and training
- Policy harmonisation, and development
- Development of regional framework for assessment
- Establishment of effective surveillance and enforcement agencies
- Development of stakeholder participation structures

What emerges quite clearly from the above approach is that generic actions, such as capacity strengthening and training, the development of regional collaboration or networking in respect of surveys and assessments, and policy development and harmonisation, are over-arching actions. These are obvious priorities for GEF support.

Analysis Tables and Explanatory Notes

NOTE: The numbering of these Tables corresponds with the Action Areas identified in the Level One Synthesis Matrix

TABLES A: SUSTAINABLE MANAGEMENT AND UTILISATION OF RESOURCES

TABLE A1: FACILITATION OF OPTIMAL HARVESTING OF LIVING RESOURCES

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
A1. Non-optimal harvesting of living resources: **Non-optimal harvesting includes over-harvesting, such as over-fishing, as well as wastage through dumping of bycatch and the catching and dumping of under-size fish. It also includes not taking advantage of resources with the potential to offer sustainable development opportunities (e.g. seaweed, some invertebrates). This often results from a lack of technology or knowledge of the opportunities available.**	• Fishing over-capacity • Inadequate tools • Non-sustainable utilisation of resources • Lack of collaborative assessment and monitoring • Inadequate information • Inadequate management • Inadequate control • Lack of collaborative management of shared resources • International policy on seal harvesting	• High by-catch and undersize catch • Fisheries impacting productivity cycle • Ecosystem change • Resource depletion • Human population movements (local and regional) • Large variation in landings • Variation in food supply for birds, seals etc. • Conflict (e.g. artisanal vs. commercial vs. recreational; conflict with mining) • Exploding seal population • Competition for exploited resources	• Irreversible ecosystem change • Biodiversity change • Habitat destruction • Collapse of commercially important stocks

A1 EXPLANATORY NOTES
PROBLEM: NON-OPTIMAL HARVESTING OF LIVING RESOURCES

Causes

- Fishing over-capacity – Too many fishers, too many boats, excess processing capacity.
- Inadequate tools for assessment – Currently available tools for assessment do not always produce effective results, data for assessment are not equally available and are not in a uniform format. Assessment tools that are available are not applied equally within the region, and fishing methods are not sufficiently selective.
- Non-sustainable utilisation of resources due to over-fishing, high bycatch, catches of small fish and non-targeted species. This is a tradition in world-wide fisheries management.
- Lack of collaborative assessment and monitoring – there is no effective mechanism within the region to ensure that collaborative assessment takes place.
- Inadequate information – The biology of all harvested and potentially harvested species is not always well known. In the latter, some groups with economic potential, such as seaweeds and some invertebrates, are very poorly known within the region.
- Inadequate management – Management due to insufficient information, vulnerable to pressure from industry, over-riding socio-economic and political pressures. Lack of informed advice sometimes results in ill-advised management decisions.
- Inadequate control – Even when assessments and quotas are used to manage fisheries, the control and enforcement mechanisms are often lacking.
- Lack of collaborative management of shared resources.
- International policy on seal harvesting – Conservation pressure on national governments prevents utilisation of seals, and contributed to the increase in seal populations, with implications for other components of the ecosystem.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Variable and uncertain job market • Loss of national revenue • Lack of food security: artisanal /industrial • Erosion of sustainable livelihoods • Missed opportunities (under-utilisation and wastage) • Loss of competitive edge on global markets	• Most harvested resources are shared between countries, or cross national borders, over-fishing in one country can cause depletion in a neighbouring country • Common problems • Shared solutions	• Provision of information: to facilitate regional assessments of shared resources and ecosystem impacts • Joint surveys and assessments • Gathering and calibration of baseline information • Analysis of socio-economic consquences for the whole ecosystem • Assessment of potential of new resources • Establish a regional forum for stock assessment, ecosystem assessment and annual advice	1 1 1 1 2 1	$ 500 000 $ 2 000 000 $ 400 000 $ 400 000 $ 1 000 000 $ 800 000	• Optimal sustainable resource utilisation • Improved forecasting • Establishment of a regional forum • Prevention of irresistable ecosystem change

Impacts

- Resource depletion – This is an obvious effect of over-harvesting, a depletion of the resource below optimal levels.
- High bycatch and undersize fish catch – This reduces the productivity of fisheries, and may lead to ecosystem change (uncertainty) and decreased yields.
- Fisheries impacting productivity cycle – The depletion of, for example, a grazer such as pilchard from the system could cause the diversion of production into eutrophication with subsequent sulfur eruptions that might kill off zooplankton grazers and further shift the system out of balance. Changes in the system could reduce yields in other ways too, e.g. changes that favour large gelatinous plankton. Recruitment fisheries result in productivity and yields that are less than what they could be under better management.
- Ecosystem change – Over-harvesting of ecologically important species may change the nature of the ecosystem, such as diverting productivity into decompositional pathways that may lead to increases in frequency/intensity of anoxic events. (S.Afr. J.Mar.Sci.12)
- Human population migration (local and regional) – Declines in opportunities in resource harvesting at the coast leads to increased migration into cities, and the expansion of urban poverty, exacerbated by large slumps in catches. (BCLME Thematic Report 6)
- Large variation in landings – Results should be precautionary approach leading to reduced levels of over-harvesting. Regularity of employment, reliability of markets etc., all suffer when variation is great.
- Variation of food supply for birds, seals etc. Humans and other organisms compete for food. Over-harvesting of resources by humans may lead to a decrease in food supply available to seabirds, seals, and other marine organisms that may themselves be important as tourism resources. (S.Afr. J.Mar.Sci.12)
- Conflict (e.g. artisanal vs. commercial vs. recreational) – Artisanal, recreational and commercial fishers often compete for the same resources. Conflicts among these sectors may increase when resources become depleted.

- Exploding seal population.
- Competition for exploited resources – Harvesting of pelagic resources has had a huge impact on food availability for other top predators.

Risks/uncertainties

- Irreversible ecosystem change – The degree to which changes that take place in the ecosystem (as a result of over-harvesting) are reversible is not known.
- Biodiversity change – Changes in biodiversity (genetic, species, ecosystem) may occur as a result of the over-harvesting of resources, but the lack of good baseline data makes this difficult to assess. Hence we do not know the degree to which over-fishing affects biodiversity.
- Habitat destruction – The degree to which over-harvesting affects habitat through impacts on dominant species, or directly through impacts of the harvesting technology (e.g. bottom trawls) is unknown. Baseline data are lacking.
- Actions in one country can cause collapse of a shared commercially important stock (e.g. collapse of Benguela hake stock in 1970s as a result of gross over-fishing by foreign fleets).

Socio-economic consequences

- Financial and job numbers – Over-harvesting of resources reduces the number of jobs and the financial gain accruing to coastal communities. Jobs lost in one country may result in an increase in job opportunities in another country due to changes in employment opportunities.
- Loss of national revenue – If resources are over-harvested, or if opportunities for developing new resources on a sustainable basis are missed, then the contribution of those resources to the national revenue base is reduced.
- Lack of food security (artisanal/industrial) – Artisanal fishers depend on fisheries resources directly for protein; over-harvesting by the industrial sector may erode the food security of coastal artisanal fishers and their families. Loss of jobs in the industrial sector may also increase poverty, and decrease food security.
- Erosion of sustainable livelihoods – Livelihoods of coastal people may often depend on activities that are based on assets (e.g. fish resources) that are harvested by other sectors. Over-harvesting of those assets, either by coastal dwellers themselves or by industrial harvesting, may erode the livelihoods of coastal people, and bring about increased urban migration and increases in urban poverty and the spreading of poverty-related diseases.
- Missed opportunities (under-utilisation and wastage) – There may be many opportunities for the novel utilisation of marine resources. Examples include drugs from both inshore and deep-water invertebrates, as well as drugs and other low-volume, high-value products from seaweeds. A co-ordinated regional assessment of such resources and co-ordinated development could bring regional benefits in this area.
- Competitive edge on global markets – Lost markets are difficult to regain, and could have global impacts (retain dominating role in hake market, regain role in fishmeal market). Increases or reductions in yields in one area may impact upon another area (country), resulting in market competition among the BCLME countries. To retain a competitive edge in rapidly changing markets, stability of the throughput and quality enhancement that comes with that stability are essential.

Transboundary consequences

- Most of the region's important harvested resources are shared between countries (i.e. straddle national boundaries), or move across national boundaries at times. (See Oceanogr. Mar. Biol. Ann. Rev. Vol 25, pp 353 - 505, and also BLCME Thematic Report 1.) Over-harvesting of a species in one country can therefore lead to depletion of that species in another, and in changes to the ecosystem as a whole. (For example, the collapse of the Namibian sardine in the 1970s followed the collapse of the sardine in South African waters.)
- Inappropriate management of regional resources endangers sustainability of resources and consistency of catches, and leads to sub-optimal use, resulting in lower food production, loss of jobs and national revenue, and increased reliance on foreign aid.

- Potential irreversible changes in nature of ecosystem due to depletion of widely distributed ecologically important species. (S.Afr. J.Mar. Sci.12)
- Movement of vessels and humans across borders in response to depletion of resources. Increased local and regional conflicts. (Refer to ICSEAF reports)
- Depletion and/or large-scale distributional shifts in predator species in response to reduced prey abundance (S. Afr. J. Mar. Sci 12). For example, there is evidence that the Namibian seal population was severely depleted and some animals migrated into Angola and South African waters following the 1995 Benguela Niño.

Activities/solutions

- Co-financing with industry – Co-financing from the fishing industry and other donors is a priority for effective management.
- Provision of information to facilitate regional assessments of shared resources. This will be augmented by BENEFIT outputs (co-financed). A structure should be established to conduct regional stock assessments, ecosystem assessments, evaluate resource-environmental linkages, and facilitate post-harvest technology.
- Joint surveys and assessments carried out co-operatively will help produce enhanced management and optimal utilisation. These joint surveys will be offered as a five-year demonstration of the benefits to the individual nations of joint transboundary assessments.
- Gathering and calibration of baseline information – This should be done on resources, potential resources before harvest, as well as ecosystems.
- Co-operative analysis of socio-economic consequences – Analyses of the socio-economic consequences of non-optimal and improved use of resources should be done with a view to appropriate intervention within the framework of improving sustainable livelihoods.
- Co-operative training – Co-operative training will be essential to generate regional capacity needed to address the transboundary issues, and to promote sustainable integrated management. Co-operative training targeted at communities will be necessary. Training – in management, enforcement, and the creation of new opportunities.
- Co-operative assessment of potential new resources. Many biological resources and potential new resources in both offshore and inshore areas are common to the BCLME, and assessments should be conducted co-operatively. Only those activities which address transboundary problems requiring incremental funding are listed.

Priority

- Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

- Optimal resource utilisation – This is the most obvious output from the suggested solutions; there will be a reduction in the exploitation level of resources that are deemed to be over-harvested so that stocks can be rebuilt to optimum levels, and an increase in the benefit to coastal communities from the exploitation of novel or currently unexploited resources.
- Improved forecasting – Joint assessment will enable/improve predictions of sustainable resource-harvest levels.
- Establish regional structure – This regional structure will be responsible for producing annual stock assessment reports, annual ecosystem reports, and provide advice or suggestions of resource harvesting levels, and other matters related to resource use, particularly fisheries.
- Training packages on management, enforcement, and opportunity creation – all at the regional level to advance the concept of sustainable integrated management of the BLCME.

TABLE A2: ASSESSMENT OF MINING AND DRILLING IMPACTS AND POLICY HARMONISATION

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
A2. Mining and Drilling Impacts: **Exploration for oil and gas and minerals such as diamonds is expanding throughout the Benguela. This involves drilling, dredging and seismic exploration. There is substantial oil extraction in northern Angola (Cabinda) while the development of oil/gas fields (with pipelines) are planned further south (e.g. Namibia). Capped wellheads hamper fishing while drill cuttings and hydrocarbon spills impact on the environment. Extensive diamond mining is being conducted using dredging equipment along the coasts of and continental shelves of Namibia and South Africa. Ecosystem effects of these activities are not fully known.**	• Pipelines • Drilling and dredging • Seismic exploration	• Habitat destruction • Seabed modification • Coastal soil, beach, intertidal and subtidal profile destruction • Conflicts (fish, diamonds, gas) • Behaviour of resources • Mortality of larvae	• Cumulative impacts • Effects on benthos • Change of biodiversity • Cost/ benefit

A2 EXPLANATORY NOTES
PROBLEM: MINING AND DRILLING IMPACTS

Causes

- Pipelines
- Drilling and dredging
- Seismic exploration

Impacts

- Habitat destruction – Habitat destruction from drilling may be localised, but dredging for diamonds disrupts large areas of seabed, disturbs the sediments and changes the particle size distribution. The impact of this on benthos and other resources, particularly fisheries resources, needs to be assessed and mitigated if necessary.
- Seabed modification – Seabed modification, related to habitat destruction, may impact on the exploitation of other resources; for example, pipelines and wellheads and their potential impact on availability of bottom areas to trawl fishing.
- Coastal soil, beach, intertidal and subtidal profile destruction. Coastal mining moves the coastal soils, alters the beach profile and destroys coastal vegetation, and intertidal and subtidal habitats.
- Conflicts (fish, diamonds, oil and gas). Conflicts may arise between different sectors. Appropriate strategies are needed to decrease the potential for conflict, and to resolve conflicts that arise (e.g. lobster/ diamond, fishing/oil).
- Behaviour (e.g. scaring of mammals and fish during seismic surveys) and mortality (e.g. mortality of larvae) of resources – Fish migrating away from, and fish larvae being killed by, activities.

Risks/uncertainties

- Cumulative impacts – The cumulative impacts of lots of smaller impacts from mining, as well as the cumulative effects over time, are unknown, but may be significant within the context of the ecosystem.
- Effects on benthos – The effects of mining on benthic communities are uncertain.
- Change of biodiversity – It is not known whether mining impacts lead to a reduction in biodiversity in the mined areas
- Cost/benefit – Costs and benefits to the environment from mining and drilling in this perspective are unknown.

Socio-economic consequences

- *Negative:* Exclusion zones around mining operations, wellheads on Agulhas Bank

  Positive: Reserves – A negative effect of mining is the closure of large areas of coastline, restricting access to living resources by coastal dwellers or potential dwellers. A positive effect is that exclusion zones could act as biotic reserves.
- Reduced artisanal fisheries – This is a negative effect of the exclusion, as well as the impact of mining-related coastal activities.
- Coastal tourism – The closure of large areas of coast reduces the potential for tourism development in affected areas.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Financial and employment benefits • -ve: exclusion +ve: reserves • Reduced artisanal fisheries • Coastal tourism • Onshore development • Effects on coastal communities, post-mining	• Three countries share common problems • Cumulative impacts are unknown but may be substantial • Shared solutions	• Policy harmonisation • Enhanced consultation – sectoral and regional • Cumulative impact assessment for BCLME	1 2 1	$ 100 000 ($ 100 000) $ 500 000 ($ 500 000) industry	• Environmental management plan • Integrated management • Solution to capacity problem

- Onshore development – Onshore development increases opportunities for jobs, but also modifies habitats through construction and pollution. In addition, coastal migration, urbanisation and poverty may be an impact where open towns are adjacent to mining areas.
- Effects on coastal communities post mining – Mines eventually close, leaving former mine workers without obvious sources of sustainable employment.

Transboundary consequences

- Mining activities occur in all three countries (see BCLME Thematic Reports 3 and 5). Most of the impacts are localised but uncertainty exists regarding cumulative impacts of oil/gas and diamond mining which added to impacts of fishing and pollution could be significant, especially regarding benthos. As such, an assessment of the cumulative impacts of mining/drilling is a prerequisite for sustainable integrated management of the BCLME.
- The mining industry in RSA, Namibia and Angola undertake EIAs for all projects. The oil/gas and diamond industry in RSA and Namibia are working together to consolidate baseline information. This results in an appreciable level of co-financing.
- All three countries share common problems. For example, conflicts between resource users and lack of post-mining opportunities.
- Regulation of mining activities needs to be standardised within the region.

Activities/solutions

- Policy harmonisation – Co-operative harmonisation of mining policies, particularly related to shared resources and cumulative impacts and their mitigation, will be needed.
- Cumulative impact assessment for BCLME (industry co-funding) – An overall impact assessment of the mining industry is needed.
- Enhanced consultation (sectoral and regional) is needed to reduce impacts of mining and ensure benefits accrue and conflicts are reduced.
- Co-operative training will be needed for the effective management of mining impacts, as well as developing activities following cessation of mining.

Priority

- Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

- Environmental management plan – An overall environmental management plan for the whole BCLME will be produced, including management plans for mitigating mining and other impacts.
- Integrated management – this will be the output of the above plan.
- Solution to capacity problem – This will be the result of training to improve assessment and management capacity with respect to the transboundary issues.
- Regional training packages on managing mining impacts, community development following mine closure.

TABLE A3: RESPONSIBLE DEVELOPMENT OF MARICULTURE

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
A3. Mariculture is under-developed but this is rapidly changing: **Mariculture has the potential throughout the Benguela region to provide labour-intensive employment, protein and foreign currency from export of high-value products. The respnsible development of a mariculture industry is hampered by lack of information and capacity, and lack of harmonised/regional policy.** **Ecosystem effects of mariculture developments are uncertain; for example introduction of exotic species and transboundary consequences thereof.**	• Inadequate policy • Differential regional policy – policies differ in the three countries • Space • Lack of information	• Threat to biodiversity • Diseases • Conflict over space/ markets • Eutrophication	• Environmental variability • Market uncertainty • Feasibility

A3 EXPLANATORY NOTES
PROBLEM: MARICULTURE REQUIRES RESPONSIBLE DEVELOPMENT

Causes

- Introduction of exotics – Mariculture may use exotic species, which can create threats to biodiversity and ecosystem function.
- Inadequate policy – While some countries have policies in place, others do not. Policy may not be enacted even where it exists, although at least Namibia apparently has a good policy that is about to be enacted.
- Differential regional policy – Policies differ among the three BCLME countries. It will be necessary to harmonise policies to minimise transboundary effects of mariculture.
- Space – The coastline of the region experiences mostly a high-energy wave climate. This means that sheltered water space needed for mariculture is limited, and other sectors also make use of sheltered water, including ports, fisheries and tourism. This results in conflict with other sectors.
- Lack of information – One of the reasons mariculture is poorly developed in the region is lack of information and lack of capacity. This is particularly true when it comes to the use of mariculture to develop and broaden the livelihoods of coastal communities.

Impacts

- Threat to biodiversity – The introduction of exotic species for mariculture purposes may threaten indigenous biodiversity by displacing indigenous species.
- Diseases – Introduction of species for mariculture may spread disease, and cause other unwanted side effects.
- Conflict over space/markets – Conflicts among sectors for limited sheltered water space are common. Transboundary conflicts over markets may occur, and countries without clear policies may be denied certain markets.
- Eutrophication is a consequence of uncontrolled development of feed-based mariculture systems. Such development must occur only within the confines of strictly enforced guidelines.

Risks/uncertainties

- Environmental variability – This creates uncertainty about the suitability of the limited sheltered water space for mariculture.
- Market uncertainty – Means that the development of mariculture carries high risk for potential entrepreneurs.
- Feasibility – The feasibility of mariculture is not known for many potential species.
- Threat to biodiversity, introduction and spread of diseases.

Socio-economic consequences

- Employment and sustainable livelihoods – Mariculture has the potential to allow the broadening of the livelihoods of coastal communities if developed with a sustainable community development policy.
- Revenue – Revenue may accrue not only to entrepreneurs but also to local communities and to the national revenue base. However, the latter will be small due to the limited water space available.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Employment and sustainable livelihoods • Revenue • Potential growth industry	• Biological invasion to adjacent country by alien species • Threat to biodiversity • Common problems, shared solutions	• Undertake socio-economic and feasibility assessment as basis for and harmonisation of national policy, and develop regional policy to mitigate against potential problems and promote responsible development of mariculture in the BCLME	1	$ 300 000	• Report on socio-economic assessment • Feasibility report • Harmonised policy and regional policy • Training package

- Potential growth industry – Mariculture is one of the few industries based on living resources that has growth potential. There is very limited capacity for the expansion of harvesting from the wild. Clear sight must be kept of the limited space availability though.

Transboundary consequences

- Mariculture is under-developed in all three countries and is being activity promoted throughout the region in view of its economic and employment potential. Co-operative transboundary activities that promote the responsible development of mariculture will minimise negative environmental consequences and also help reduce pressure on traditionally (over-) harvested resources.
- Differences in policy among countries in the BCLME could lead to conflicts (e.g. as a result of the spread of disease from one country to another, alien species invasion of the ecosystem from a country point source, market conflicts etc), and differential development of the mariculture industry. Harmonisation of policy will reduce the potential harmful effects of differential development.
- The introduction of exotic species into the region for mariculture, by any one country, has the potential to lead to transboundary biological invasions of the target organism or other species accidentally introduced with it. Such invasions have the potential to be a threat to the biodiversity of the BCLME as a whole.

Activities/solutions

- Socio-economic assessment of potential – A full socio-economic assessment needs to be conducted into the ability of mariculture to contribute to regional economy and the improvement in the living conditions of coastal communities.
- Feasibility assessment – The feasibility of mariculture for particular species in certain areas of the region needs to be assessed, and the best species for development need to be chosen on the basis of this assessment.
- Formulate harmonised policy for the region – Crucial if the negative effects of one country's policy on the economic potential of another are to be precluded.
- Training – Training will be needed, particularly in terms of promoting community-based mariculture, as well as the overall management of mariculture in the region.

Priority

- Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

- Report on socio-economic assessment, including advice for action, particularly targeted at communities.
- Feasibility report, including advice on recommended species and areas for regional initiatives.
- Policy statement looking at overall and community potential.
- Training package aimed at managers, communities and potential entrepreneurs.

TABLE A4: PROTECTION OF VULNERABLE SPECIES AND HABITATS

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
A4. Threats to vulnerable species: **Human impact on the ecosystem by way of fishing, increasing pressure on the coastal zone, pollution etc. has impacted negatively on components of the system, in particular top predators such as coastal birds, e.g. penguins and gannets.** **Vulnerability of habitats: Several habitats, in particular coastal habitats, have been perturbed or lost as a consequence of development and other human impacts, e.g. loss of wetlands, destruction of mangroves, lagoons, etc. These have transboundary consequences and may be significant globally.**	• Salt production • Population migration to coast • Pollution • Reduction of prey through fishing • Historical harvesting • Competition for space and prey (seals, birds, humans)	• Threat to global biodiversity of coastal birds • Ecosystem change • Loss of wetlands • Population reduction • Competition for exploited resources	• None given

A4 EXPLANATORY NOTES
PROBLEM: THREATS TO VULNERABLE SPECIES AND VULNERABILITY OF HABITATS

Causes

- Salt production – Changes to wetlands and lagoons.
- Population migration to coast – Especially mangroves. This is a worldwide trend. Logical consequence is a threat to habitats and resources that are attractive to tourists.
- Pollution – Impacts on threatened populations, especially penguins.
- Reduction of prey through fishing – Humans catch fish that are the food of seals and seabirds, reducing food available for them, and can lead to breeding failures in some years as an example.
- Historical harvesting – Especially penguins and gannets, particularly eggs and guano. This is one of the reasons these populations are in a depressed state.
- Competition for space and prey (seals, birds, humans) – Seals and seabirds compete with one another for food and breeding space. Both are in competition for food and space with human populations.

Impacts

- Threat to global biodiversity of coastal birds e.g. African penguins, bank cormorants. Various scientific publications by R.J.M Crawford and co-workers refer – also see BCLME Thematic Reports 1-5 for overviews and references to changes documented in the BCLME.
- Ecosystem change
- Loss of wetlands
- Population reduction – This has happened to several resources.
- Competition for exploited resources – Harvesting of pelagic resources has had a huge impact on food availability for other top predators.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Tourism	• Most vulnerable species occur throughout the region or migrate between countries. National activities have transboundary consequences. • Common problems, shared solutions.	• Assessment of status of vulnerable species and habitats – both those which are shared between countries and those which play a key role in the whole ecosystem.	1	$ 500 000	• Ecosystem status assessment and report

Risks/uncertainties

➤ None were identified.

Socio-economic consequences

➤ Tourism – Marine mammals, seabirds, turtles and vulnerable habitats (e.g. wetlands) contribute extensively to tourism.

Transboundary consequences

➤ Most vulnerable species, including several endemics, occur throughout the region and in some cases internationally. Some vulnerable habitats occur regionally (e.g. wetlands and lagoons), others in one country (e.g. mangroves), but many are of importance to migratory species. Therefore the consequences of any actions, whether national, regional or international, will have direct transboundary consequences and may be of significance globally.

➤ National policies to enable protection of vulnerable species and habitats need standardisation throughout the region.

Activities/solutions

➤ Assessment of status of vulnerable species and habitats – Work has started in some countries, but a holistic regional study is sought.

Priority

➤ Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

➤ Ecosystem report – A report on the status of the eco system, and the impacts of human activities on the relationships among non-consumptive resources, together with management advice.

TABLE A5: ASSESSMENT OF NON-HARVESTED SPECIES AND THEIR ROLE IN THE ECOSYSTEM

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
A5. Role of non-harvested species in the ecosystem is unknown. **Assessments of non-harvested species (except for some seabirds and marine mammals) are not conducted. Some of these species probably have high biomass (e.g. light and lantern fish), have potential for harvesting (and with it job and wealth creation), yet the consequences of harvesting on the food webs and presently harvested species are uncertain. There is a general lack of knowledge on the subject.**	• Lack of information	• All impacts are unknown	• Unable to predict impacts of changes in abundance of unharvested species upon harvested species • Predator/prey relationships • Large unknown biomass • Market potential • Economic viability • Unknown impact of harvest • Ecosystem impact of pollution

A5 EXPLANATORY NOTES
PROBLEM: UNKNOWN ROLE OF NON-HARVESTED SPECIES IN THE ECOSYSTEM

Transboundary consequences

➤ Many unused or under-used taxa in the BCLME have transboundary distributions, and therefore any exploitation or shared knowledge gained in one country would have an effect in all countries. Such ecosystem effects ought to be addressed in a dedicated manner by gaining basic knowledge of what is in the system, its biology, and what role it plays, and how it can be impacted by anthropogenic activity.

Activities/solutions

➤ Joint dedicated surveys and assessment – Such surveys need to be dedicated to the non-harvested species because of the special technology needed.

Priority

➤ Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

➤ Information on non-harvested species and assessment of their role in the ecosystem.

➤ Ecosystem model as a tool for sustainable integrated management of the BCLME.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Food security potential • Jobs • Revenue	• Many non-targeted species have trans-boundary distributions. Some have potential for harvesting, but their role in the ecosystem is uncertain. In the absence of information, action by one country could disturb the ecosystem. • Common problem, shared solutions.	• Dedicated joint surveys and assessments of non-harvested transboundary species to provide baseline for integrated ecosystem manage-ment.	1	$ 1 000 000	• Information on non-harvested species, assess-ment of ecosys-tem role. • Ecosystem model for management.

TABLES B: ASSESSMENT OF ENVIRONMENTAL VARIABILITY, ECOSYSTEM IMPACTS AND IMPROVEMENT OF PREDICTABILITY

TABLE B1: REDUCING UNCERTAINTY AND IMPROVING PREDICTABILITY

Problems	*Causes*	*Impacts*	*Risks/Uncertainties*
B1. ***The BCLME is a complex and highly variable system for which there is evidence of system change and fragmentary but important evidence of increasing instability/variability.*** **Scales of variability include: A. large scale sustained events; B: decadal changes; and C: high frequency short-lived events and/or episodic events.** **Human impacts on the BCLME (e.g. by fishing) is superimposed on the inherent natural variability, and the combined effect of anthropogenic disturbance and this variability has been implicated in ecosystem change and the collapse of harvested resources.** **There is also considerable uncertainty regarding ecosystem status and yields. Lack of information about and understanding of environmental variability and system-wide impacts hampers sustainable management of BCLME resources and results in the non-optimal utilisation of these resources.**	• Complexity of processes • Poor understanding of processes and cause and effect relationships • Poor understanding of global driving forces (linkages) • Lack of data/ information • Inadequate mathematical models • Lack of capacity	• Change to coastal ecosystems from altered wind field/rainfall • Changes in coastline morphology • Damage to coastal infrastructure • Unpredictable variations in zooplankton and fish egg/larval survival • Unpredictable changes in fish growth, mortality and recruitment • Unpredictable changes in species' abundance, composition, distribution and availability • Regime shifts • Cross-boundary movements of fish, seabirds and seals • Change in flux of CO_2, methane and H_2S between atmosphere, ocean and sediments • Difficulties in managing resources sustainably • Operational difficulties with resource utilisation • Assessment of anthropogenic impacts difficult	• Long-term net change or natural cycles? • Time periods sufficiently long to detect changes?

B1 EXPLANATORY NOTES
PROBLEM: HIGHLY VARIABLE SYSTEM, UNCERTAINTY REGARDING ECOSYSTEM STATUS AND YIELDS

Causes

The Benguela upwelling area is a highly variable "convex" system with three open and variable boundaries. It is unique in that it is bounded at both equatorial and poleward ends by warm water (tropical) systems viz the Tropical Atlantic and Agulhas Current. It is sensitive to environmental events (variability and change) in the Atlantic, Indo-Pacific and Southern Ocean. Unlike the Humboldt Current there are few long-term data series to form a baseline against which changes can be predicted or assessed. There is an uneven spread of data between disciplines and between the participating countries. Difficulties in predicting changes in the system is a consequence of:

- Complexity of physical, chemical and biological interactions and processes, and the difficulties in predicting environmental variability.
- Our limited understanding of cause and effect relationships, compounded by the problems of predicting environmental variability and eco-system impacts.

Socio-Economic Consequences	Transboundary Consequences	Activities/Solutions	Priority	Incremental Cost (5y)	Anticipated Outputs
• Uncertain employment (job losses and gains) • Variation in revenue • Over- and under-utilisation of resources. • Lack of food security • Human population migration • High production costs • National/regional conflicts • Reduced capacity to support artisanal fisheries • Changes in government revenue, private income and exports.	*Climate Change:* • Contribution to global climate change (CO_2, methane flux) *Ecosystem:* • Shifts in distribution of biota • Loss of species/ biodiversity • Altered food webs • Disruption of faunal migrations *Fisheries:* • Unsustainable management of shared and straddling stocks • Altered fish spawning patterns and population shifts • Unpredictable fluctuations and availability of fish stocks • Unpredictable and variable distribution of fishery benefits • Regional economic instability and unemployment • Regional conflicts with other users *Coastal infrastructure:* • Costly maintenance of coastal infrastructure	• Develop regional early warning system for environmental change • Targeted feasibility assessment of PIRATA link-up/application to BCLME • Targeted transboundary assessment of large-scale hypoxia/impacts • Assess role of upwelling systems as CO_2 source/sink • Analyse plankton data archives for measurement of decadal change • Develop transboundary state of the environment analysis/reporting system • Develop links with CLIVAR • Adapt/develop predictive models • Establish regional advisory groups • Data gathering community projects • Transboundary environmental variability networking (including Internet) • Establish links with the Gulf of Guinea LME	1 1 1 2 1 1 2 2 2 2 1 1	$ 1 600 000 $ 400 000 $ 250 000 ($ 300 000) $ 100 000 $ 250 000 ($ 50 000) $ 300 000 $ 50 000 $ 100 000 $ 400 000 $ 50 000	• Regional early warning systems for major environmental events/ change • Quantification of utility/application of PIRATA for SADC • Information needed to design monitoring/predictive systems • Quantification of CO_2 flux • Record of decadal ecosystem changes • Regional environmental analysis/ reporting system/ network • Knowledge and expertise on global climate links • Predictions and models • Regional advisory groups • Availability of important/useful data • Regional environmental variability network • Links with Gulf of Guinea LME

- Our limited understanding of driving forces (global linkages). There is evidence from case studies that inter-annual variability in the northern Benguela is associated with changes in zonal (east-west) winds in the equatorial Atlantic, and also that there are some common features in the variability of the north and south Atlantic. There is also fragmentary evidence linking variability in the Pacific El Niño/La Niño (ENSO). Thus, although there are pointers to the importance of remote physical (global climate) forcing of the Benguela, the linkages and mechanisms are not understood.
- Lack of data/information: Long-term data series are few, and except for the extreme southern Benguela, the ecological processes are poorly understood.
- Inadequate mathematical models applicable to the region: Very little mathematical modeling of the Benguela has been done internationally, and there is a general lack, in the region, of the capacity (skills and technology) to adapt available models from elsewhere, to run these or to develop new models. This applies to physical, chemical and biological (ecosystem) modeling. This is a serious drawback to developing predictive capacity.