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*Enhancing the use of Science in International
Waters projects to improve project results*

SYNOPSIS REPORT

LARGE MARINE ECOSYSTEMS AND THE OPEN OCEAN

A global Synopsis of **Large Marine Ecosystems** and the
Open Ocean science and transboundary management



GEF IW:Science Project

Synopsis Report of the Large Marine Ecosystems and the Open Ocean Working Group



IW: Science, or *Enhancing the Use of Science in International Waters Projects to Improve Project Results* is a medium-sized project of the Global Environment Facility (GEF) International Waters (IW) focal area, implemented by the United Nations Environment Program (UNEP) and executed by the United Nations University Institute for Water, Environment and Health (UNU-INWEH). GEF ID Number: 3343.



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Synopsis Report of the Large Marine Ecosystems and the Open Ocean Working Group

March 2012

This report is written as part of the IW:Science series of reports comprising a Synopsis and Analysis for each of five classes of global transboundary water system: River Basin, Lake, Groundwater, Land-based Pollution Sources, and Large Marine Ecosystems and Open Oceans. The findings and content of the Synopsis and Analysis Reports are then integrated into two IW:Science Synthesis Reports to provide a global water view with regard to *Emerging Science Issues and Research Needs for Targeted Intervention in the IW Focal Area*, and *Application of Science for Adaptive Management & Development and use of Indicators to support IW Projects*. All reports can be found on the IW:Science, UNU-INWEH, IW:LEARN and GEF websites.

This report was prepared under the responsibility of the IW:Science Core Partner and Lead Institution of the Large Marine Ecosystem and Open Ocean Working Group:



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Cover photo: Fishing boats in harbor in the Celtic-Biscay shelf Large Marine Ecosystem, Oban, Scotland / A. Dansie

List of Acronyms and Abbreviations

ACRONYM	MEANING
BENEFIT	Benguela Environment Fisheries Interaction and Training Programme
BEP	Benguela Ecology Programme
BONUS	Baltic Organizations Network for Funding Science
BCLME	Benguela Current Large Marine Ecosystem
BSRP	Baltic Sea Regional Project
CTI	Coral Triangle Initiative
CRTR	Coral Reef Targeted Research
EBA	Ecosystem-based Approaches
ENVIFISH	Environmental Conditions & Fluctuations in Recruitment and Distribution of Small Pelagic Fish Stocks
GEF	Global Environment Facility
GIWA	Global International Waters Assessment
HCLME	Humboldt Current Large Marine Ecosystem
HELCOM	Helsinki Commission (Baltic marine protection)
IW	International Waters
ICES	International Council for the Exploration of the Sea
LME	Large Marine Ecosystem

ACRONYM	MEANING
NSAP	National Strategic Action Program
OFM	Oceanic Fisheries Management
PICTs	Pacific Island Countries and Territories
PIF	Project Identification Form
PPG	Project Preparation Grant
RWGs	Regional Working Groups
SAP	Strategic Action Plan
SCS	South China Sea
SIDS	Small Island Developing States
SSME	Sulu-Sulawesi Marine Ecoregion
SPC	Secretariat of the Pacific Community
SPREP	Strategic Action Programme of the Pacific Small Island Developing States
TDA	Transboundary Diagnostic Analysis
TWG	Technical Working Group
VIBES	Viability of Exploited Pelagic Fish Resources in the Benguela Ecosystems in relation to the Environment and Spatial Aspects
WCPFC	Western and Central Pacific Fishery Commission
YSLME	Yellow Sea Large Marine Ecosystem

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CHAPTER ONE

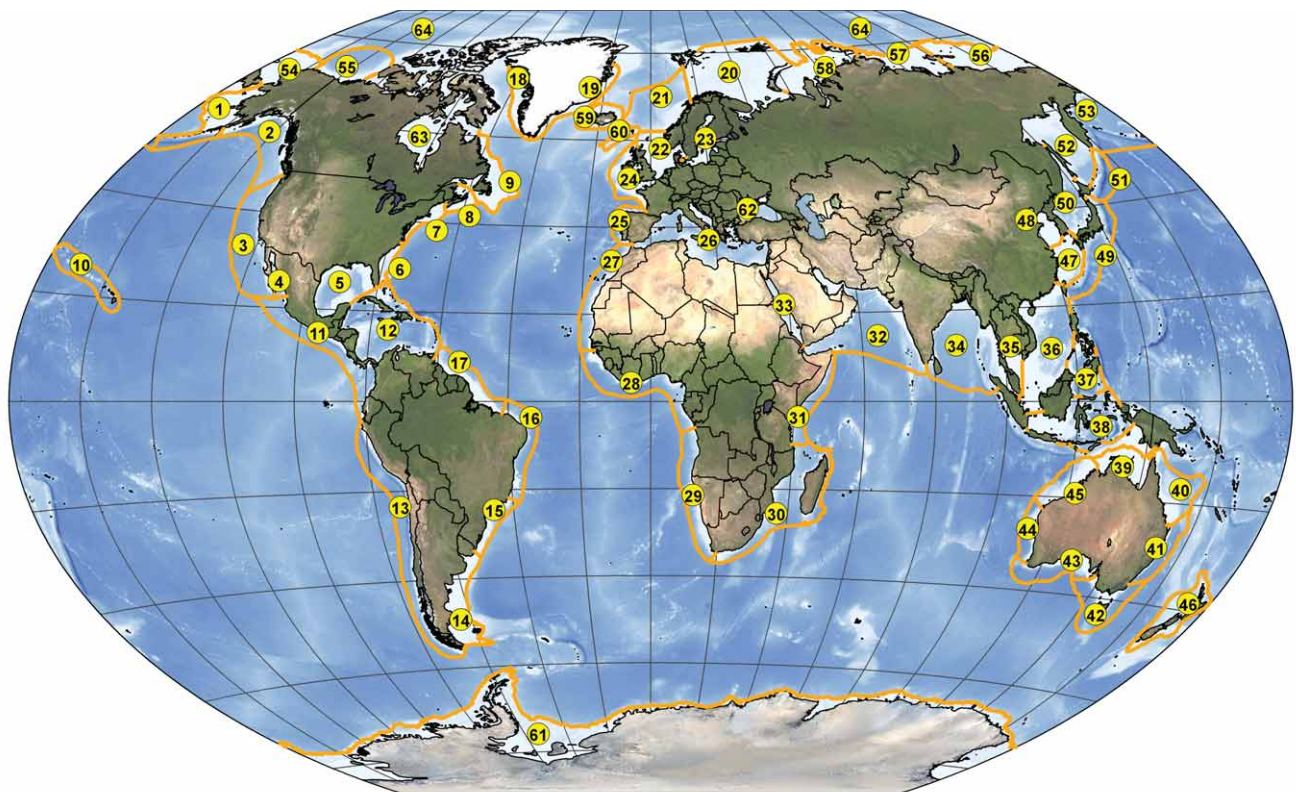
Introduction

Enhancing the Use of Science in International Waters Projects to Improve Project Results is an IW:Science project to collate, analyse, and synthesize the science incorporated into GEF IW projects over the past 20 years. The objective is to achieve a portfolio-wide integration of knowledge, with subsequent formulation of science-based recommendations on critical emerging science areas, application of science for adaptive management, and development and use of indicators for results-based project management. Results should strengthen our understanding of transboundary water challenges, enhance exchange of knowledge and best practices for sustainable water resource management, and play a vital role in the strategic planning of the IW portfolio for GEF5. Five Working Groups were created, each consisting of 15 specialists. The LME working group has responsibility for all Large Marine Ecosystem (LME) and Open Ocean International Waters projects funded by GEF since 1990.



One of the world's 64 Large Marine Ecosystems, the Indonesian Sea supports a highly biodiverse tropical ecosystem / A. Dansie

Figure 1 Large Marine Ecosystems of the World



- | | | | | |
|-------------------------------------|--------------------------|----------------------------|----------------------------|-----------------------|
| 1. East Bering Sea | 14. Patagonian Shelf | 27. Canary Current | 40. Northeast Australia | 53. West Bering Sea |
| 2. Gulf of Alaska | 15. South Brazil Shelf | 28. Guinea Current | 41. East-Central Australia | 54. Chukchi Sea |
| 3. California Current | 16. East Brazil Shelf | 29. Benguela Current | 42. Southeast Australia | 55. Beaufort Sea |
| 4. Gulf of California | 17. North Brazil Shelf | 30. Agulhas Current | 43. Southwest Australia | 56. East Siberian Sea |
| 5. Gulf of Mexico | 18. West Greenland Shelf | 31. Somali Coastal Current | 44. West-Central Australia | 57. Laptev Sea |
| 6. Southeast U.S. Continental Shelf | 19. East Greenland Shelf | 32. Arabian Sea | 45. Northwest Australia | 58. Kara Sea |
| 7. Northeast U.S. Continental Shelf | 20. Barents Sea | 33. Red Sea | 46. New Zealand Shelf | 59. Iceland Shelf |
| 8. Scotian Shelf | 21. Norwegian Sea | 34. Bay of Bengal | 47. East China Sea | 60. Faroe Plateau |
| 9. Newfoundland-Labrador Shelf | 22. North Sea | 35. Gulf of Thailand | 48. Yellow Sea | 61. Antarctic |
| 10. Insular Pacific-Hawaiian | 23. Baltic Sea | 36. South China Sea | 49. Kuroshio Current | 62. Black Sea |
| 11. Pacific Central-American | 24. Celtic-Biscay Shelf | 37. Sulu-Celebes Sea | 50. Sea of Japan/East Sea | 63. Hudson Bay |
| 12. Caribbean Sea | 25. Iberian Coastal | 38. Indonesian Sea | 51. Oyashio Current | 64. Arctic Ocean |
| 13. Humboldt Current | 26. Mediterranean | 39. North Australia | 52. Sea of Okhotsk | |

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CHAPTER TWO

Methodology

LME working group members and their respective fields of expertise are presented in Table 1. The working group consists of four scientists from Europe, one from Africa, five from Asia, two from South America and three from North America (Figure 1). Their expertise includes most large marine ecosystems covered by the IW LME projects.

At the inaugural meeting of the IW:Science project in Macao (January 2010), the working groups were given a common set of core questions to answer in detail, and most (except the LME group) completed a specific form to answer these questions. The LME group decided to spend some time addressing the questions for one ecosystem type – the Baltic Sea – to find some generic answers that might pertain to all systems, and produce an example of how the questions should be answered. Much of the information gained has stemmed from individual insights of working group members, rather than from the documentation itself. In most cases, working group members with direct knowledge of a project were asked to review the science. We found that even the most diligent review of GEF documents could provide only limited insight in the absence of other sources of information.

The LME Working Group was allocated 52 projects (Figure 2), ranging from those fully completed, with most of the documentation available (such as the Benguela LME project, GEF ID 789) to those that have only recently started (the Canary Current LME, GEF ID 1909), with very few documents available (Appendix 1). Of these 52 projects, only 41 were investigated in this review (Figure 3), due to lack of information, or the realization that the project was not one that centered on the use of science, or, quite simply, lack of time.



A. Dansie

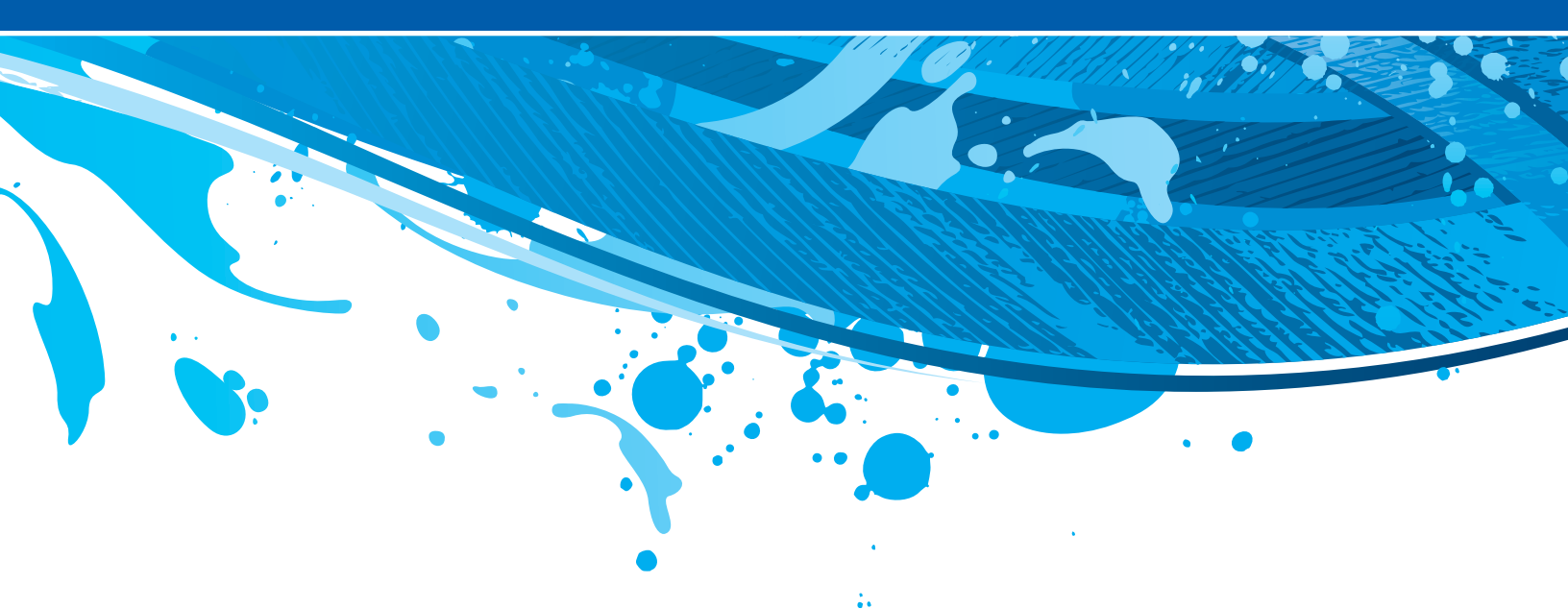


Table 1 LME working group members and expertise.

PERSON	AFFILIATION	REPRESENTING	EXPERTISE
Laurence Mee	Director, SAMS, Scottish Marine Institute, Oban, PA371QA, UK	Europe	Black Sea, BCLME, HCLME, GIWA
Annadel Cabanban	Senior Fisheries Expert Sulu-Celebes (Sulawesi) Seas Sustainable Fisheries Management Project, Unit 1801, 18th Floor, One Magnificent Mile CITRA Building, San Miguel Avenue, Pasig City 1605, Metro Manila, Philippines	Asia	South China Sea, Indonesian Seas, Sulu-Sulawesi Seas, Coral Triangle Initiative, Bay of Bengal, GIWA
Sheila Heymans	Lecturer, SAMS, Scottish Marine Institute, Oban, PA371QA, UK	Africa	BCLME
Ahmed Kideys	Executive Director, Black Sea Commission, Dolmabahce Sarayı, İl. Harekat Kosku Besiktas, Istanbul	Europe	Black Sea, GIWA, Caspian
Ricardo Delfino	Fundación Patagonia Natural, Marcos Zar 760 - 9120 Puerto Madryn, Chubut, Argentina	South America	Patagonia
Simon Nicol	Principal Fisheries Scientist, Oceanic Fisheries Programme Secretariat of the Pacific Community, BP D5 - 98848 Noumea Cedex, New Caledonia, Australia	Asia	West Pacific, East Asia, OFM, Pacific SIDS OFM, SPREP (Project 530)

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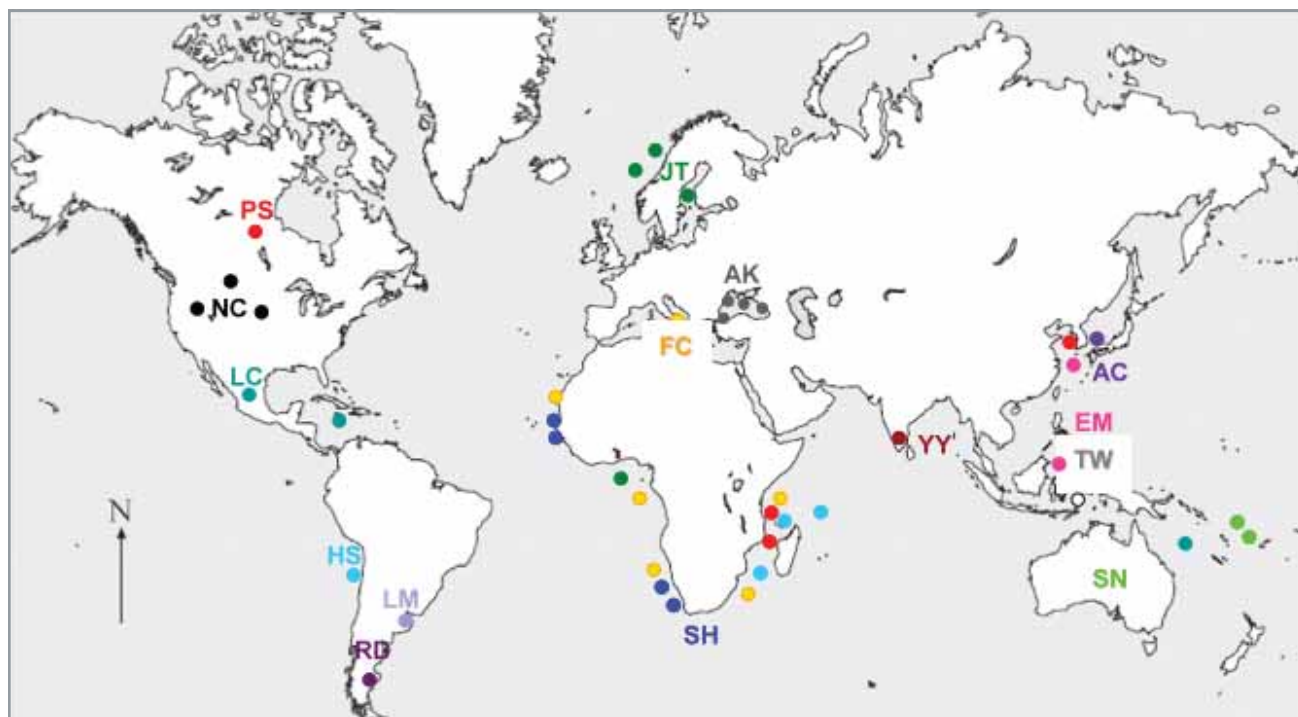
PERSON	AFFILIATION	REPRESENTING	EXPERTISE
Peter Sale	Assistant Director, United Nations University - Institute for Water, Environment and Health (UNU-INWEH) and University of Windsor, 1047 Brandy Crest Road, RR#1, Port Carling, Ontario, Canada, P0B 1J0	North America	Coral Reef Targeted Research (CRTR)
Jan Thulin	Senior Advisor, ICES, Ulseröd, Brattåsmon 250, 45391, Lysekil, Sweden	Europe	BSRP, Baltic
Tonny Wagey	Regional Coordinator, Arafura & Timor Seas Expert Forum (ATSEF), Jl. Pasir Putih I, Ancol Timur, Jakarta, Indonesia	Asia	Arafura Sea, Coral Triangle Initiative
Leon Cuahthemoc	Chief Technical Advisor, International Marine & Climate Change Issues (CTA) (Environmental Management Center), Andador Luis Martinez No 18, Col. Romero de Terreros, Mexico D.F. CP 04310	South America	Institutional and legal framework, Gulf of Mexico
Evangeline Miclat	Marine Program Coordinator, Conservation International, 6 Maalalahanin St., Teachers' Village West Diliman, Quezon City, Philippines		
Asia	Sulu-Sulawesi Seas, South China Sea, GIWA		
Hector Soldi	Admiral, Instituto Del Mar Del Peru, Av. Laguna Grande 1291 - La Molina, Peru	South America	Humboldt LME
Ned Cyr	Director, Office of Science and Technology, NOAA Fisheries, 1315 East-West Hwy, Silver Spring, MD 20910, USA	North America	Ecosystem approaches for sustainable fisheries, Yellow sea, Guinea Current
Frank Chopin	Senior Fishery Industry Officer, FAO, Rome, Italy	Europe	CTI by-catch, Global by-catch projects
Yugraj Yadava	Director, Bay of Bengal Program, FAO, Chennai, India	Asia	Bay of Bengal, GIWA

Large Marine Ecosystems and the Open Ocean

Figure 2 Co-chairs (in blue) and working group members (in red) of the LME working group.



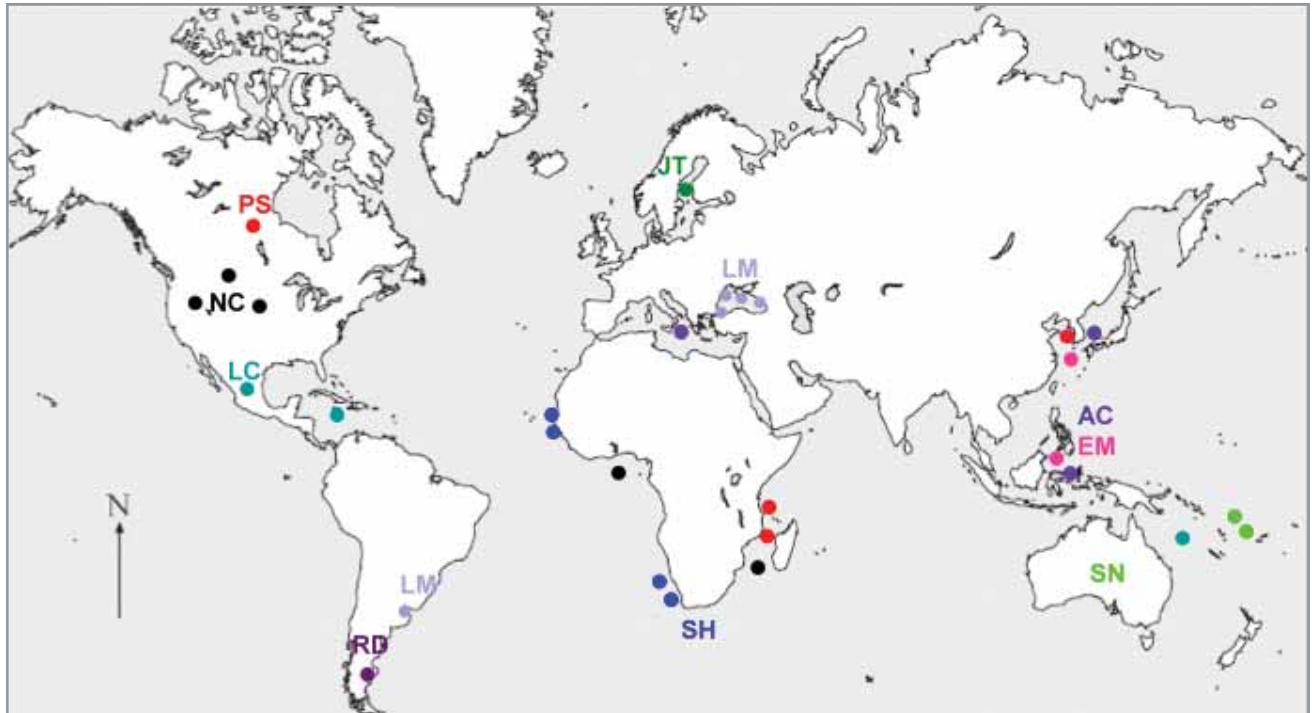
Figure 3 Projects and people selected to undertake the analyses



(PS – Peter Sale, NC – Ned Cyr, LC – Leon Cuauhtemoc, HS – Hector Soldi, LM – Laurence Mee, RD – Ricardo Delfino, JT – Jan Thulin, AK – Ahmed Kideys, FC – Frank Chopin, SH – Sheila Heymans, YY – Yugraj Yadava, AC – Annadel Cabanban, EM – Evangeline Miclat, TW – Tonny Wagey, SN – Simon Nicol).

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Figure 4 Projects and reviews undertaken and included in this synopsis report (with the names of people who undertook the analysis).



The 41 projects are the Baltic Sea (Project 922), Benguela LME (Project 789), Black Sea Ecosystem Recovery Project (Projects 341, 397, 1580, 2263, and its associated Projects 1014, 1159, 1202, 1351, 1355, 1542, 1661, 2141, 2143, 2970, 3148), Gulf of Guinea LME (Project 393), Tropical Shrimp Trawling Impact reduction technologies (Project 884), Rio de La Plata (Project 613) Senegalese small scale fisheries (Project 3314), Bay of Bengal LME (Project 1252), Canary Current LME (Project 1909), Caribbean LME (Project 1032), Somali Current LME (Project 3313), East coast of Africa (Project 2456), Yellow Sea LME (Project 790), Patagonian Marine Ecosystem (Project 459), GIWA Sulu-Sulawesi (Project 584), Pacific Islands (Projects 530, 2131, 3523), Sulu-Celebes LME (Project 3524), Coral Reef Targeted Research project (Project 1531), Viet Nam coral reef system (Project 3187), South China Sea and Gulf of Thailand (Project 885). Knowledge transfer projects covered in this report include DList coral triangle (Projects 4164, 3340), DList project in the Benguela (Project 2571), EBS to fisheries Conservation and Large Marine Ecosystems (Project 2474), and the Global Dialogue project (Project 2722).

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Figure 5 Large Marine Ecosystems of Africa and the Mediterranean



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CHAPTER THREE

Problems encountered

At the meeting in Macao, it was suggested that the PIF, TDAs and so forth would contain the relevant information to review the science, but in reality this was not the case. In some projects, existing scientific information was synthesized as the basis for the formulation of projects and interventions (e.g., South China Sea and Gulf of Thailand Project; Sulu-Celebes Sea Sustainable Fisheries Management Project). In some cases science was not evident in the GEF documents because science-based research was not part of what GEF wanted to fund, so any element of research, even though necessary to fulfil the project objectives, was not reflected in the documents.

Our working group felt that if GEF wants to acknowledge the importance of science, they should create a deliberate process to document and track the use of science as part of each project. This could take the form of a section within the TDA/SAP that explicitly identifies existing science knowledge and science gaps. Terminal evaluations should be required to determine the extent to which science (research, monitoring and assessment) was used properly in projects. The GEF should include science relevant to management in their documentation, rather than exclude all science.

GEF should acknowledge the need for a science-based approach and appropriately detailed treatment of background science. A detailed discussion of how the science will be implemented and advanced through execution of the project would serve to direct project managers in its use. In particular, it would help if the names of scientists actively participating in the design and execution of a project were clearly evident on project documents. That would permit an assessment of the science background and results, by way of a screening of published technical literature.

The GEF documentation available for review was written for monitoring and evaluation purposes, from

a management perspective, and was not intended for scientific assessment. For instance, in two of the GloBallast projects (Projects 610 and 2261), project documents did not include citations to support science nor a bibliography based on primary literature. In addition, there was a perception that at the policy level, science was being hidden because there was a sense that its presence would increase the risk of the project not being funded by GEF.

Yet another issue affecting the review was the fact that some of these projects have only just started, so not enough information was available to fill in the online synopsis forms or add to this synopsis report. To summarize, these are the reasons for not including all the allocated LME projects:

1. Lack of information in the database;
2. Not enough scientific information in the available documentation;
3. Lack of knowledge of specific projects within the working group ;
4. Projects were not science based; and,
5. Lack of time to conduct a review by working group members.

The 11 projects not included explicitly in our synopsis are as follows: Southwest Indian Ocean Fisheries Project (Project 1082 – just started and only preliminary information are available); Agulhas and Somali Current LME (Project 1462 – just started); Humboldt Current LME (Project 1443 – just started); Land based activities in the Western Indian Ocean (Project 1247); LME of Sub-Saharan Africa (Projects Trance 1-3, 2093, 2574, 3271, 3559 – no information available); and GloBallast (Projects 610, 2261 – judged to be efforts to build administrative structures and policies rather than to investigate risks and consequences of invasive species via ballast water discharge – they both seem to be science-based but not science-generating).

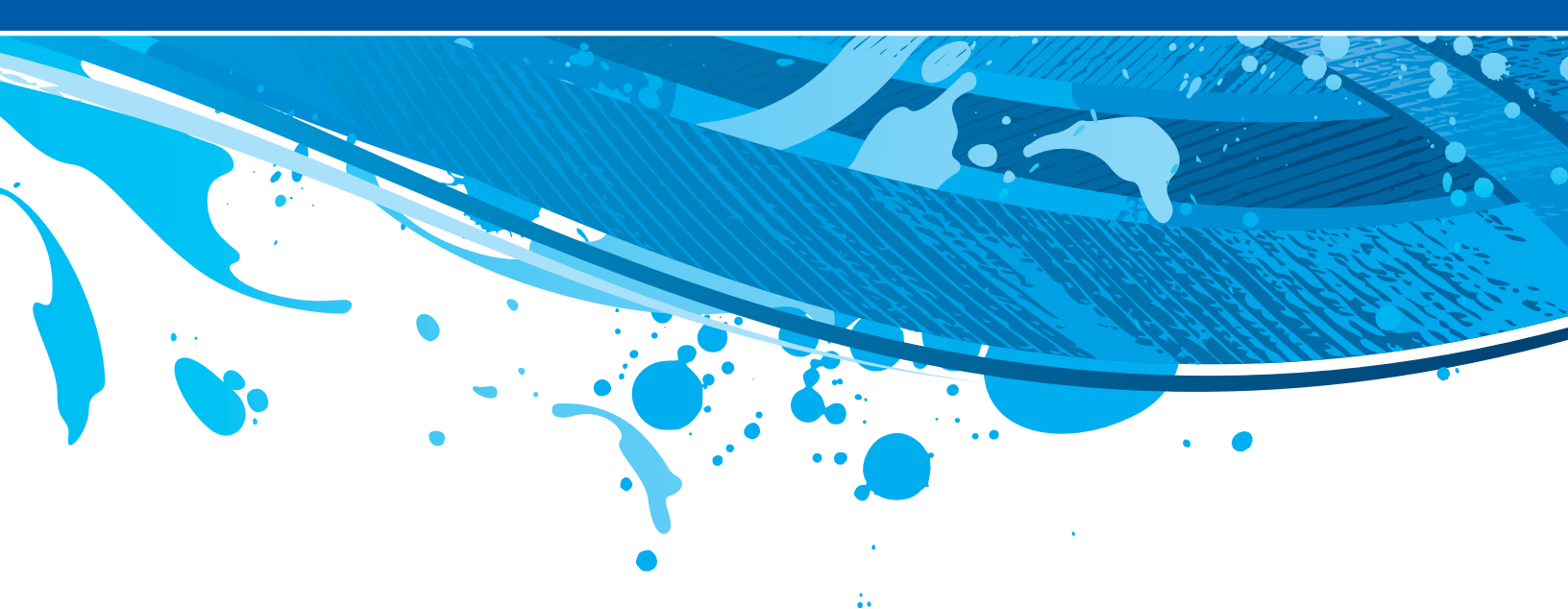
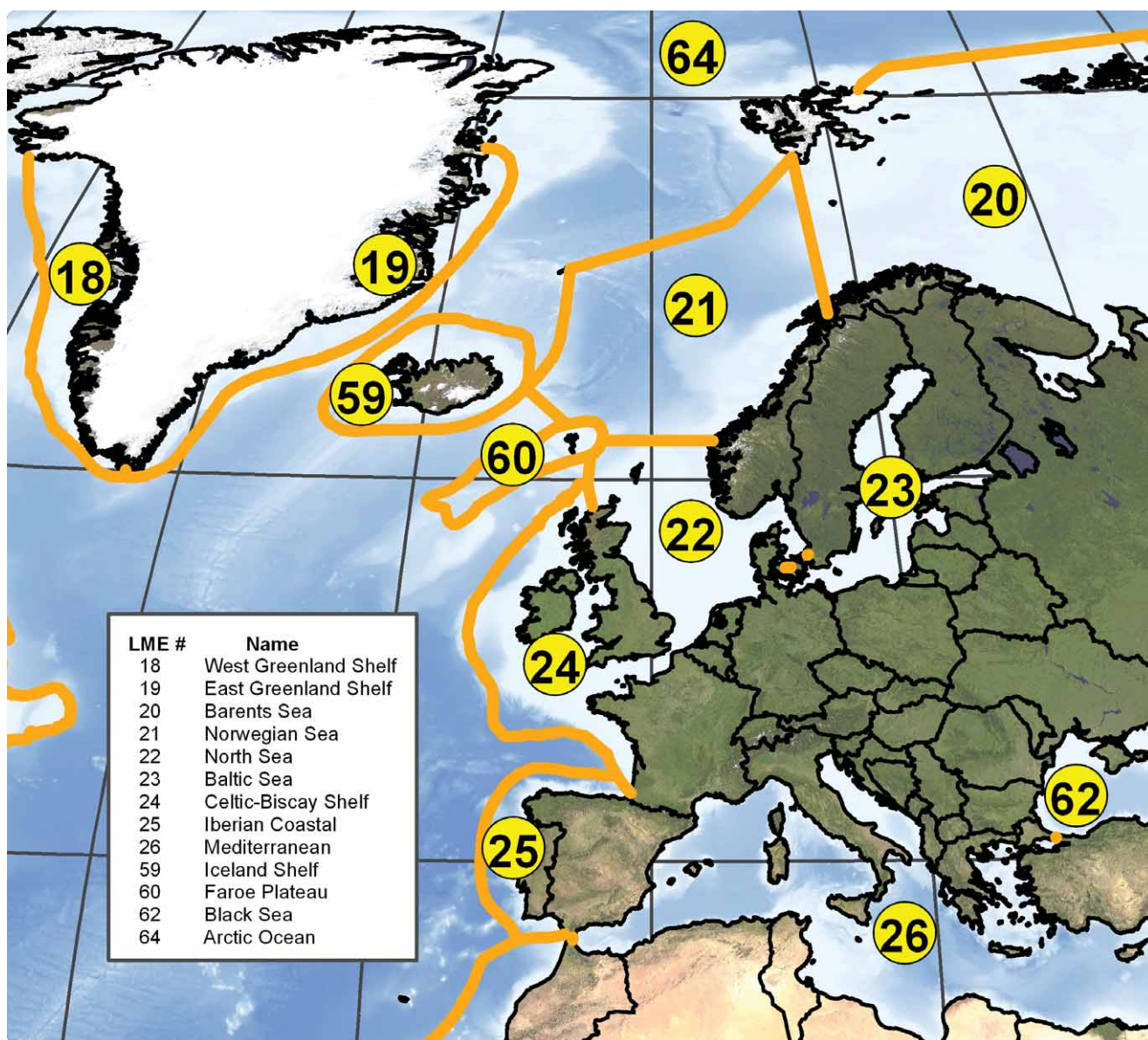


Figure 6 Large Marine Ecosystems of Northern Europe



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CHAPTER FOUR

Results

Results are presented under the following headings: 1) significant natural and social science findings, 2) unique research, monitoring and assessment issues, 3) role of science within projects, 4) design and use of (local) science networks and scientific advisory bodies, 5) scientific best practices, 6) intended target users, and 7) science-management implications.

4.1 Significant natural and social science findings

Very few of the projects were designed with significant scientific output in mind. The Coral Reef Targeted Research Project (Project 1531) was one of the few that made development of new science a core activity. Most projects focused on the use of pre-existing science to resolve clearly identified management issues. In some cases, new insights emerged. For instance, in the Senegalese small-scale fisheries project (Project 3314), an improved understanding of the interaction between social-ecological systems at different scales was gained. At the project scale, overfishing due to the uncontrolled expansion of the number of fishers, boats and gear, as well as land-based fish processing and preservation facilities are important, and have led to fishing down the food web. Knowledge of this relationship has helped design local-scale action to reverse the decline. At the larger scale, however, the system is vulnerable to legal and illegal fishing by the EU. Social impacts at the larger scale can be seen in illegal immigration of Senegalese fishers to Spain and Europe.

In the Caribbean LME (Project 1032), intensive exploitation of coastal resources by large numbers of small-scale fishers leads to increased dependence and fishing pressure on offshore resources, which are already fully- or overexploited. Inadequate institutional, legal and policy frameworks or mechanisms for managing

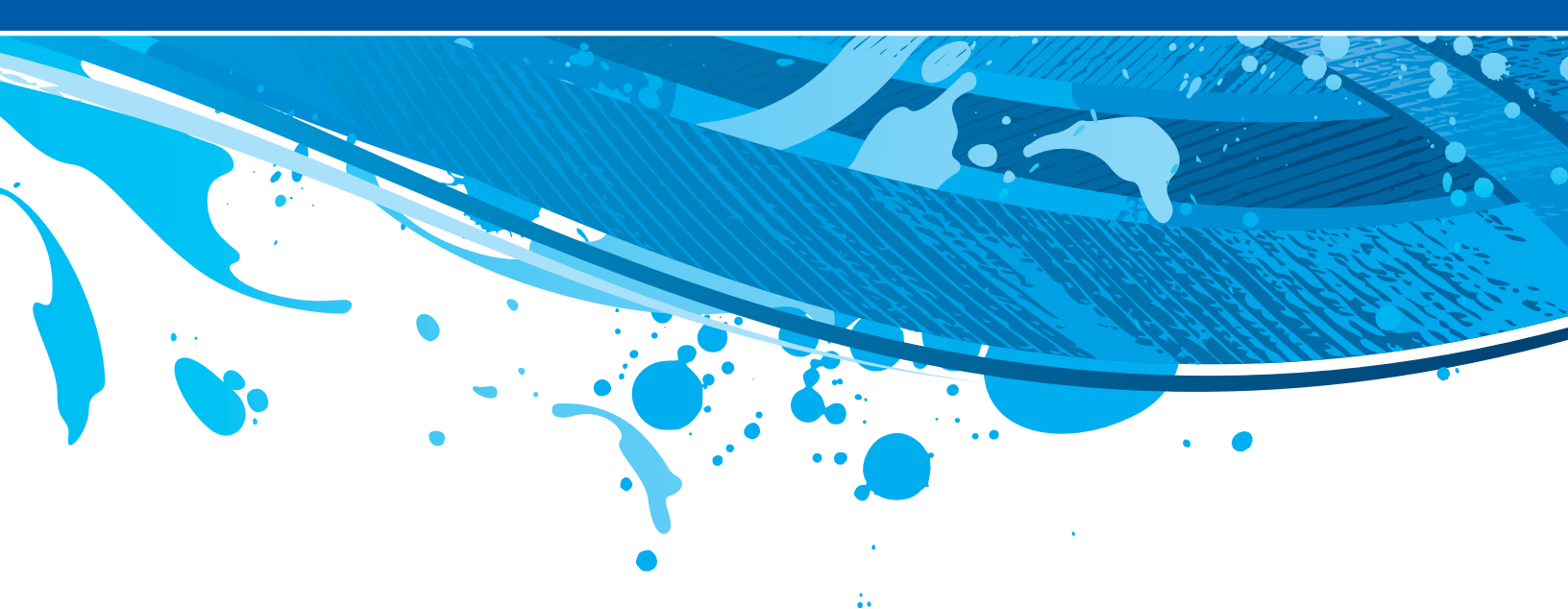
shared living marine resources across the region are seen at various geopolitical scales. There is a shortage of capacity at the national level and information is lacking, particularly in relation to the transboundary distribution, dispersal and migration of these organisms.

In the Somali Current LME (Project 3313), poverty and unsustainable use of natural resources caused resource degradation in the coastal zone, as well as overexploitation of the near shore and offshore fisheries. In this system, impacts of improper land use on the coastal environment are important.

In the Yellow Sea LME (Project 790), science issues include how to sustain ecosystem carrying capacity to continue providing ecosystem services. There is a need to determine changes in ecosystem configuration resulting from environmental deterioration that can cause changes in carrying capacity. Predicting the impact of climate change on the system is a challenge, but is important, in view of expected disturbances in the hydrological cycle; sea-level rise; ocean acidification; spread of diseases; rising surface temperature that may result in water stratification and consequent vertical migration of animals; and changes in the food availability for and breeding season of migratory birds.

In the Bay of Bengal (Project 1252), increasing coastal populations and demand for protein have led to unsustainable fishing of small pelagic fish stocks. Environmental variability in the form of the Indian Ocean monsoon was found to have a significant effect on fish stock productivity.

In the Patagonian Marine Ecosystem (Project 459), overfishing for species such as hake has caused a decrease in reproductive biomass to values below reference limits. The discarding of non-commercial species, the bycatch of invertebrates and fish, and the



incidental catch of mammals and birds were also found to be important.

In the Black Sea Ecosystem Recovery Project (Project 2263), significant new research was undertaken on the recovery of the Black Sea “dead zone” following a long period of eutrophication, coupled with the arrival of an alien species. This is one of the only examples of system recovery in the world, and the research will have major impacts on other systems and the way in which they are managed.

The Sulu-Celebes LME sustainable fisheries management project (Project 3524) had not started at the time of writing, but basic fishery-related science challenges to highlight here are an understanding of the biology and ecology of small pelagic fish, determination of population levels of economically desired species, exploitation rates and viability of fishery resources, severity of IUU fishing, status of transboundary stocks, and pragmatic approaches to regional management. There are also uncertainties about the negative impacts of climate change, which, in itself, is a major emerging threat to vulnerable coastal and marine ecosystems in this LME.

In the Ecosystem-Based Approaches to Fisheries Conservation and LMEs project (Project 474), two separate sources of ecosystem impact were addressed: nutrient over-enrichment and overfishing. These were addressed through science-based approaches, though not in an integrated manner. Nutrient over-enrichment was addressed through development of models to estimate the quantity of nitrogen entering coastal watersheds from riverine and atmospheric sources. Overfishing was addressed through training LME project practitioners in the use of the Ecopath with the Ecosim model, which is intended to allow estimations of ecosystem carrying capacity and reduce potential for overfishing.



Atlantic Bluefin Tuna / Marine Photobank, NOAA

In the Pacific Islands projects (Projects 530, 2131), the trophic dynamics of the warm-pool ecosystem of the western Pacific Ocean were described, identifying the keys role played by skipjack tuna, juvenile reef fish, and apex predator diversity in maintaining the resilience of this ecosystem to the impacts of fishing. The role of seamounts in aggregating pelagic biodiversity and tuna was also quantified.

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By definition, the project on Environmental Impact from Tropical Shrimp Trawling through by-catch reduction technologies (Project 884) is a scientific investigation. It has a worthy objective but was an ambitious undertaking for a short-term project. It used scientific knowledge to demonstrate that inappropriate gear can reduce the numbers of non-target species, especially juveniles of commercially important species. The project, thus, has promoted use of gears supported by results from scientific investigation on selectivity of fishing gears.

However, most projects do not explicitly address the problem of interdisciplinary challenges to be solved by local or regional institutions. Social and natural scientists (consultants) do not necessarily interact to address these problems. Legal/enforcement challenges can be oversimplified by managers.

4.2 Unique research, monitoring and assessment issues

GEF does not fund research projects but it funds research for management. Transboundary Diagnostic Analyses of large marine ecosystems are based on secondary data and information from pre-existing national and regional research programs. In some projects, gaps in knowledge are identified at the TDA phase, and scientific research on indicators of environmental status and socio-economic benefits are recommended for the formulation of the Strategic Action Program. Almost all projects have had to engage with the issue of monitoring, and this has included addressing the need for developing new indicators where appropriate, the lack of follow-up projects for monitoring, or the lack of policy response for monitoring and adaptive management. The main problem, however, has been ensuring that these new monitoring and indicator systems are taken up by the local and national governments and sustained beyond the end of the project cycle.

In very few cases, specific research questions were investigated in the projects. A particular case is the Black Sea Recovery Programme (Projects 1580, 2263) that funded research to understand the state of the system and its recovery from eutrophication. In the Gulf of Guinea LME Project (Project 393), ecosystem research is one of the activities to address agricultural, industrial,

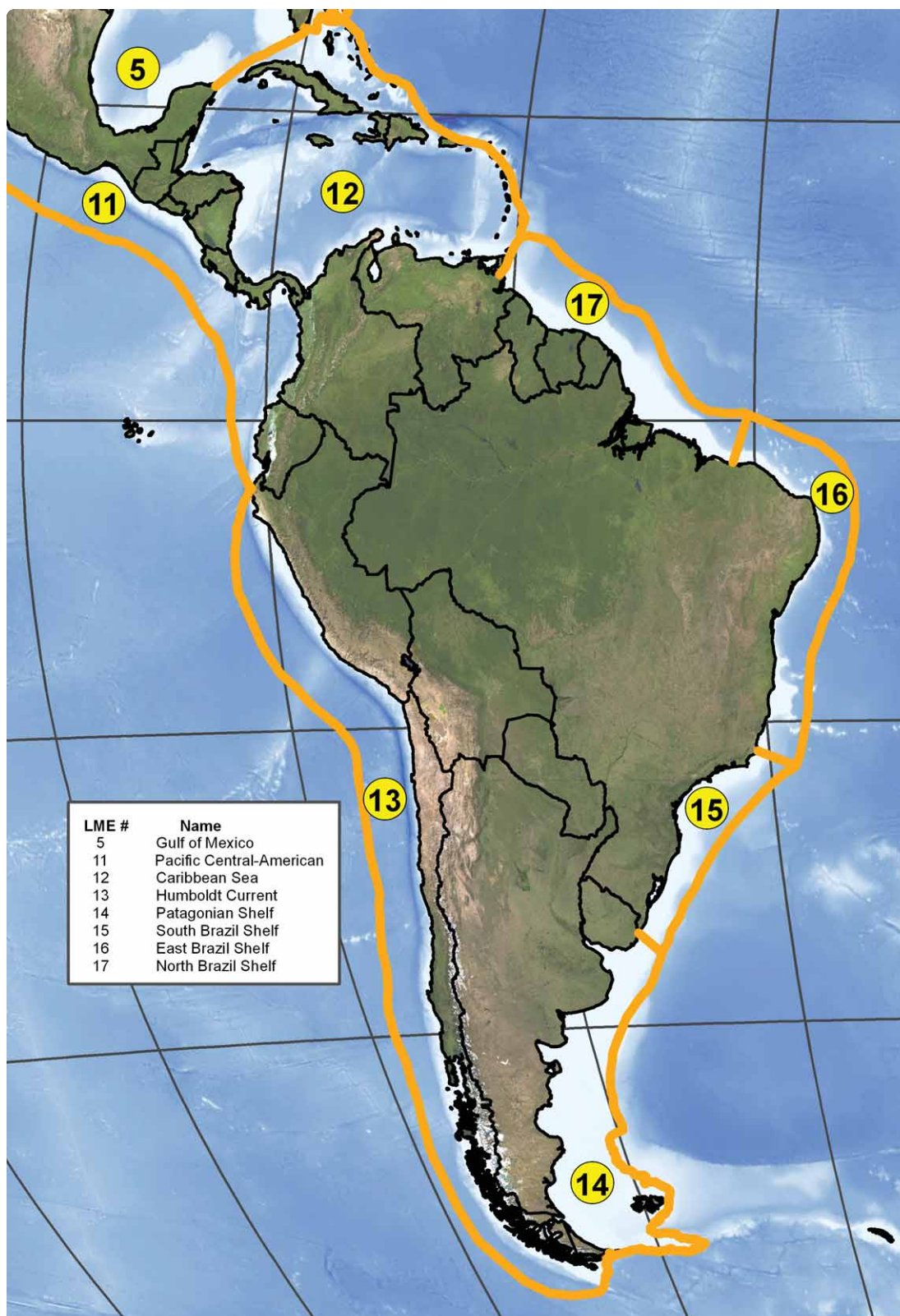
and urban pollution. In other cases, the project was developed in synergy with research projects. A good example is the Benguela current system (Project 789), developed in synergy with Benguela Environment Fisheries Interaction and Training Programme (BENEFIT), a multi-country research programme on fisheries and supporting ecosystems. Another good example is the Baltic Sea LME (Project 922) where the project was instrumental in development and implementation of the Science Plan for the EU-funded Baltic Organizations Network for Funding Science (BONUS) project, which is designed in accordance with the LME concept. This science project is fully operational with a budget of over € 23 million engaging more than 200 Baltic scientists.

In the Patagonian Marine Ecosystem (Project 459) and the Rio de la Plata and its maritime front project (Project 613), new research was undertaken on the use of a Geographic Information System for data assimilation and presentation. This led to new findings about the system state that were directly useful to managers.

GEF distinguishes between process, stress reduction indicators, and ecological impact indicators. Changes in the ecological conditions of an LME cannot be known unless governments put new or improved policies, regulations and monitoring systems in place. Very few LMEs have long-term investments by GEF or governments and are ready for evaluation of ecological impacts: the Baltic Sea and South China Sea LMEs are two examples. Many of these indicators are process oriented and relatively easy to measure and monitor. Ecological indicators are much more difficult to develop and monitor. In the GEF LME project cycle, baselines of the environmental and socio-economic indicators should be collected and a monitoring plan prepared in implementing the Strategic Action Program. The expectation of GEF is for riparian governments to take the SAP and translate it to a National Strategic Action Program (NSAP), which includes monitoring of ecological and socio-economic indicators. As regards the Baltic Sea, the Baltic Commission has been formed and monitoring of various indicators is assigned to the laboratories of the member states. However, the Strategic Action Plan (SAP) of the South China Sea and Gulf of Thailand, formulated in 2009, is still in the process of being translated to NSAPs. A monitoring program is needed to assess actual improvement in ecological conditions and to allow adaptive management

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Figure 7 Large Marine Ecosystems of Latin America



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to occur. Here are some examples of new monitoring and assessment programmes created with GEF project support:

- In the Benguela current (Project 789), ecosystem health and socio-economic indicators aimed to identify positive improvements in sustainable fisheries and habitat protection, as well as effective transboundary institutional performance and long-term financial sustainability.
- The Patagonian Marine Ecosystem project (Project 459) included a logframe of anticipated results and indicators to measure. The project's output indicators were modified, but there were no changes in the project's development or global environment objective. Many indicators are still monitored (and budgeted) past the project end date.
- The EBA and LME project (Project 2474) established indicators such as 1) Increased dissemination of lessons learned by establishing a collaborative network of scientists, managers and policy makers to promote sound scientific approaches to fisheries sustainability and management, with an emphasis on the large marine ecosystems of developing countries; 2) ECOPATH/ECOSIM food-web modelling results adopted in at least 10 countries involved in implementation of the GEF/LME's projects for management actions supporting recovery of depleted fish stocks; 3) nutrient forecast models adopted in at least 10 countries involved in implementation of the GEF/LME's projects for management actions to reduce coastal eutrophication.
- In the Pacific Island projects (Project 530, 2131, 3523), process, stress reduction and environmental status indicators are included in the design. Development of stress reduction and environmental status indicators are expected outcomes of the project and should have a life beyond the projects.
- In the Baltic Sea (Project 922), the project developed ecosystem health indicators that were subsequently accepted and applied by HELCOM.
- In the South China Sea and Gulf of Thailand – Demonstration Sites for management of coral reefs, seagrass beds, and mangrove forests were established. The local resource management units were taught to collect indicators of improvement of biodiversity (e.g., demonstration sites in the Philippines).



Abandoned fishing boat, Indonesia

In some cases, the monitoring showed some deficiencies. In the Sulu-Celebes Sustainable Fisheries Management Project (Project 3524) both process and ecological indicators were identified at the PIF stage but empirical baselines were not gathered during the PPG stage, due to lack of funding and time limitations. Instead, baselines for each ecological and socio-economic indicator were obtained from the literature. Baselines will be revisited in the first stage of the first year of implementation and a monitoring plan will be developed with the formulation of the SAP. Similarly, in the Canary Current LME (Project 1909), impact indicators and environmental stress reduction indicators are mentioned but it is not clear how these are implemented. Eight process indicators were defined including: capacity-building outcomes for transboundary management of resources, habitats and water quality; and contributions toward achievement of Millennium Development Goals.

4.3 Role of science within projects

It is important to distinguish between those projects that make use of pre-existing science — either off-the-shelf or expert opinion or through synthesis of available information — and those few projects that included a significant investment in new science. Almost all of the projects examined had some element of science. However, most was off-the-shelf, and it is not yet clear whether or not this was the most current science or was science synthesized some years before the project was developed. Here are some good examples of the categories delineated above:

[1.1] Global International Waters Assessment (GIWA) relied entirely on secondary data and information and expert opinion, and there are major differences between the quality of the assessments conducted (See Appendix 2 for a synopsis of the GIWA Project Final Evaluation and highlights of the process and results). An example of a credible transboundary assessment under GIWA is the Sulu-Celebes (Sulawesi) Seas LME. Contracted staff used information already gathered in Sulu-Sulawesi Marine Ecoregion (SSME) Conservation Planning of the World Wide Fund for Nature, which employed an ecoregional approach. The Sulu-Sulawesi Marine Ecoregion (SSME) engaged marine and social scientists to gather and analyze information and subjected the data to validation through stakeholder workshops, held across countries. This is a case where a GEF project (GIWA) benefited greatly from the non-GEF supported project such as the tri-national SSME initiative of a non-governmental organization. The added value of GIWA is the inclusion of watersheds and climate change in the threat analysis.

[1.2] Transboundary Diagnostic Analysis (TDA) of large marine ecosystems in the GEF project cycle also uses secondary data and information, subsequently analyzed by experts. Transboundary environmental concerns are first identified and ranked according to expert opinion. Perceived transboundary problems are then verified by collection of secondary data and information and validation via meetings with national experts and stakeholders. The South China Sea LME TDA was prepared in the early 1990s by regional experts who gathered secondary information that was analyzed and validated. For the South China Sea (SCS) and Gulf of Thailand Project (Project 885), secondary data and information on habitats (wetlands, mangroves,

and seagrass beds), fisheries, and marine pollution were gathered to establish a current scientific basis for the SAP and for the selection of demonstration sites. In the Sulu-Celebes LME (Project 3524) Project, the TDA component was an update of the earlier assessment conducted under GIWA Project, following the guidelines of GEF (Mee et al., n.d.; <http://www.iwlearn.org>) and engaging local scientists in the SSME. GEF has provided support to a few LME Projects (e.g., Arafura-Timor Sea, Benguela Current LME, Bay of Bengal LME, Yellow Sea LME) that allowed the gathering of primary data on environmental and socio-economic indicators. In the Yellow Sea, additional funds were provided for this purpose because the GIWA Report was unacceptable to the experts of the countries. In the Arafura Sea and Timor Sea LME, secondary data are not available so a component of the ATSEA Project is collection of primary data on oceanographic biophysical characteristics.

[2] The Benguela LME Project is a good example of synthesis of cutting-edge science conducted in parallel with the project. In the Agulhas-Somali LME (Project 1462), the project is participating in establishment of an observation system for climate change in the western Indian Ocean. In the Patagonian Marine Ecosystem (Project 459) about 30 per cent of the GEF grant was applied to a science matching grant program that funds 48 research subprojects producing new science results. In the YSLME (Project 790), specific research topics were investigated in preparation for the SAP: for example, feasibility of polyculture along the coastline as a strategy to reduce overfishing.

[3] In the Black Sea (Projects 1580, 2263), there was a significant investment in research cruises to understand the nature of ecosystem recovery. The results of this work were published in the open literature including the widely-read journal *Scientific American* and the more specialist journal *Oceanography*. This followed the earlier Black Sea Ecosystem Project that published a comprehensive collection of scientific information about biodiversity, aquaculture, pollution and fisheries in a series sold through the United Nations. It was the first time much of this information had been available, as until then it was not freely distributed in the Soviet Union.

[4] In the Viet Nam coral reef project (Project 3187), initial surveys of potential SCS LME sites were conducted by a panel of scientific experts, and the data

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collected were used to classify and assign conservation priority for each site. The site chosen for development into an MPA was ranked second by this science-based survey. The emphasis of the coral reef CRTR project (Project 1531) was on conducting new science rather than applying conventional science. Even within CRTR, however, it was not apparent from the standard project documents (PIF, Project Document) that a substantially large cadre of leading coral reef researchers was directly involved at every stage, from initial project design to implementation. In fact, about 75 scientists, chiefly from academia and with established international reputations in their fields, drove the project, which engaged an equal or greater number of graduate students and post-doctoral scientists, almost entirely from developing countries. All aspects of the project were strongly international and the resulting global science network was a major output of the project. Within the project, there were significant advances in many aspects of science related to reef management and to reef responses to global change. The project captured these advances in peer-reviewed journal articles, including in some of the most highly-cited coral reef science articles, during the years it ran.



Bycatch from prawn trawling comprises up to 2 to 10 times the weight of the retained catch / *Marine Photobank 2008, S. McGowan*

In some cases, the science produced or used in the project has not been considered adequate:

The EBA and LME project (Project 2474) was criticized in its project evaluation as providing science-based tools that could not be easily applied by regional LME projects. At least three issues have been identified:

- The project seems to have overestimated interest in using the ecosystem-based assessment and management tools provided;
- Some of the science-based tools that were the focus of the project (Ecopath with Ecosim and size-based particle spectra) were not easily transferred and applied in areas where there was no history of using model outputs in management; and
- Nutrient modelling work only estimated inputs without actually making the quantitative link between nutrient inputs and ecosystem condition.

This reveals there is a problem with poorly formulated project objectives, as well as a technological mismatch between the science-based tools proposed and the capability of the projects to utilize them effectively.

Environmental problems are generally well understood (pollution, species population dynamics, land use changes, overfishing, etc.), but an understanding of the drivers of problems and the solutions to them requires application of social sciences and involvement of policy-makers; changes in laws or legal frameworks; and enforcement measures. Most of the projects seem to underestimate the power of or the need for social science expertise. Most projects do not explicitly declare the need for a long-term perspective to influence social systems; the documents show no information regarding the time needed to influence institutional frameworks. The Coral Reef CRTR project (Project 1531) was predominantly physical/ecological during its first phase, but social scientists participated to a limited extent. Planning for a continuation phase substantially ramped up the role of social scientists and economists, while at the same time increasing the focus on implementing science-based changes in management that addressed specific concerns. In the SCS SFM Project (Project 3524), involvement of socio-economists was planned, as a result of lessons learned in marine resource conservation in the Philippines (see SSME Ecoregion Conservation Plan).

4.4 Design and use of (local) science networks and scientific advisory bodies

There is no obligation to create a scientific advisory body for any of the GEF projects but many of them found it a convenient mechanism for gathering and synthesizing information. Projects that made extensive use of science either tapped into pre-existing scientific networks (BEP, BENEFIT, ENVIFISH and VIBES in the Benguela) or, in some cases, created their own:

- The Pacific Islands projects (Projects 530, 2131, 3523) have the significant advantage of being embedded in the work programs of participating countries, and the Forum Fisheries Agency and the Secretariat of the Pacific Community (SPC). These two organizations provide technical support for fisheries to PICTs in the region, and SPC has also been the science provider for the WCPFC over the time-period of the projects. Integration has meant that engagement of local and wider science communities has occurred from the onset of project planning.
- In the coral reef targeted research project (Project 1531), the six “working groups” that led research on the six general topics were all deliberately international and included academic representatives from developing and developed countries. In addition, there were “centres of excellence” in the four regions of focus and each of these conducted local research and interfaced with some or all of the working groups. The project included about 75 active, chiefly academic scientists and built an effective network among them and a similarly sized cadre of graduate students (most from developing countries).
- The Baltic Sea LME project (Project 922) had the advantage of being executed by the management body HELCOM and the scientific advisory body ICES; under the latter, the project was able to establish a number of science working groups.
- The Yellow Sea LME Project (Project 790) engaged highly qualified scientists and experts in Regional Working Groups, the Project Management Office, and the Regional Scientific and Technical Panel for the Yellow Sea Project. It also engaged experts in the ad-hoc RWG dedicated to writing up the SAP and

consulting on the TDA. Beyond the technical reports of the Regional Working Groups (RWGs), the author of the TDA held additional discussions on scientific, legal and administrative matters, within and outside the TWG, Scientific and Technical Panel, and the Project Steering Committee.

4.5 Scientific best practices

At the level of detail of this analysis, it is difficult to ascertain and generalize on scientific best practice because the science should fit the purpose and the purpose will vary with each situation. However, early engagement of local active scientists and scientists from a number of relevant disciplines is key to successful implementation.

The South China Sea project (Project 885) established a Scientific Steering Committee and RWGs for fisheries, wetlands, seagrass beds, and coral reefs. The RWGs are composed of scientists/researchers from each participating country and one or two regional scientific advisors. The RWGs synthesized the available information on their respective habitats and, using a set of criteria, selected the regional demonstration sites for management interventions.

In the Sulu-Celebes Sustainable Fisheries Management Project (Project 3524), both process and ecological indicators were identified at the PIF stage but no empirical baselines were gathered at the project preparation stage, due to insufficient funds. However, there were baselines identified for every aspect of the Ecosystem Approach to Fisheries Management, e.g., knowledge of the biology and ecology of small pelagic fish populations, estimate of the size of the stocks, current management interventions, and availability of the policy or framework for integrated coastal management. In the implementation of the SCS SFM Project, gathering of baseline data for all indicators (environmental, fisheries, socio-economics, and governance) will be undertaken along the Ecosystem Approach to Fisheries management.

In the South China Sea and Gulf of Thailand project (Project 885), information on natural and socio-economic conditions was collected during the TDA process. In the SAP, socio-economic and ecological systems were coupled. Management interventions for



Tourism and fishing boats in the Banda Sea / A. Dansie

each of the marine ecosystems, and to address marine pollution and fisheries issues, were costed and their benefits provided. Moreover, the SAP was formulated based on the TDA and the synthesis of up-dated information and was approved by the Project Steering Committee, represented by environmental ministers of the respective countries. The SAP is now up for ratification by governments of these countries. Secondly, the demonstration sites for management of ecosystems and environmental concerns (fisheries issues and pollution) are being implemented in a co-management arrangement between the communities and the managers.

In the Yellow Sea (Project 790), the coupling of social and ecological systems was kept in mind throughout the process, from data gathering and analysis to preparation of the TDA and SAP. The YSLME highlights the relationship between the ecosystem carrying capacity and delivery of ecosystem services to benefit human communities and climate systems. The SAP, which espouses the ecosystem approach, takes into consideration the institutional capacities and legal frameworks needed for its implementation.

Overall, we have seen very few examples of projects that considered coupled-social-ecological systems, and the science observed has often been synonymous with “natural science”. For instance, in the Baltic Sea (Project 922) a coordination centre for societal impacts was established, but the difficulty of coupling social and ecological systems was underestimated and a consultant had to be brought in to evaluate the situation. In the Pacific Islands (Projects 530, 2131, 3523) and the Patagonian Marine Ecosystem (Projects 459) projects, no clear indications of the coupled-social-ecological systems were evident in the documentation. However, in the Pacific

Islands, the focus upon strengthening participation in the WCPFC, the major policy instrument for managing transboundary fish stocks in the region, is clearly an example of the coupling of science (through capacity building) with governance processes.

In the Coral Reef Targeted Research project (Project 1531), the focus during Phase 1 was explicitly on natural sciences, although it included a component on modeling and decision support, which recognized that management guidance had to be provided in the societal context of each specific location, and that sociological factors would have to be important drivers in the kinds of system models developed. In Phase 2, now being planned, there is a deliberate effort to include socio-economic considerations as a core component of the project. These include efforts to develop better ways of valuing ecosystem services provided by reefs, and multi-disciplinary ecological/social science demonstration projects built around reef and reef resource management issues.

The coupled social-ecological system was a major focus of the Global Dialogue (Project 2722), which sought to create policy dialogues where policy-makers and managers from across a wide spectrum of marine issues could exchange views and best practices. This was accomplished through a series of “Global Forum” meetings that convened groups of scientists, managers, policy makers and in some cases ministers, around topics such as high-seas areas beyond national jurisdiction, linking freshwater and marine management in coastal zones, and climate change adaptation in marine management.

Finally, there are very few examples of targeted research conducted within a GEF project (e.g., the

Coral Reef Targeted Research Project, 1531). There is an assumption that research results are an input to the project. However, a failure to engage in targeted research on unanswered questions may lead to inadequate management responses. Again, the early establishment of a project science advisory board is an important factor in success and the quality of the outputs, as seen in the South China Sea and Yellow Sea projects.

4.6 Intended target users

Intended target users of the science should be defined within the project documents. In the Environmental Impact from Tropical Shrimp Trawling through by-catch reduction technologies (Project 884) project for example, the target user for technological advancement is the fishing sector, including fisheries management agencies and the fishing industry. The TDA SAP process is a vehicle for ensuring that science is used to provide effective management advice. In all cases, the intended users are the policy makers who can influence future system state.

4.7 Science/management implications

Almost all the reviewed projects had some scientific input and management implications. However, the scientific input was frequently ad hoc, with no clear guidance on the use or the quality of the science. No guidance is given on how to establish the scientific advisory board, or the way to use the best available science, or how to engage in the wider regional and global community. Nor is there any provision within the standard project documents to indicate the existence of a science advisory panel (or other mechanism) or the composition of this group. If individual scientists actively engaged as project leaders during design and execution were identified, it would be possible for reviewers to note their presence and judge their competencies.

There are clear exceptions to this in some of the projects we examined, and those projects have generally been the more successful. For instance, in the Benguela LME (Project 789), multiple influences are managed through a holistic ecosystem-based approach to monitoring, assessment and management. Regional cooperation minimized the risk of wasteful use and depletion of

shared stocks, and promoted full economic potential of shared stocks. The improved awareness of issues such as fisheries, tourism, pollution, impacts of mining, and ecosystem productivity as cross-sectoral and regional concerns has led to reconsideration of the governance within and among the three countries, with the Benguela Current Commission being set up to drive the transboundary issues forward.

It is not just a question of convincing the project manager to use science but it is important to communicate the value of the science to end users, particularly the value of using science-based indicator systems as part of a strategy for sustainability. To this end the DList projects (Project 4164, 3340, 2571) have been very useful for communicating science to end users. For instance, the Benguela DList project (Project 2571) found the poor understanding of stakeholders and the lack of information and education opportunities to be critical. It is also important to maintain objectivity in regards to science; the use of a science board can avoid later suggestions that the science was somehow manipulated to achieve a particular management position. Data sources must always be clear and transparent; careful analyses such as those produced in TDAs for the Black Sea (Project 1580, 2263), Benguela (Project 789) or Rio de La Plata (Project 613) systems, among others, are extremely helpful for informing the difficult political process of setting management objectives and formulating programmes of action.

It is not clear from the documents nor in the experience of managers, how the knowledge can be integrated into the policy-making process. In addition, the assumptions made during project formulation with regard to how communication or capacity building affects the policy outcomes are not clear. It seems that most projects oversimplify the way the project will influence local, regional or international policies. The relationships between project managers, academia (scientists) policy-makers and/or practitioners are ignored or oversimplified. Communication barriers are not explicit, and successful communication strategies, like those of the Baltic or Rio de la Plata, are hard to discern among the projects.



CHAPTER FIVE

Conclusions and recommendations

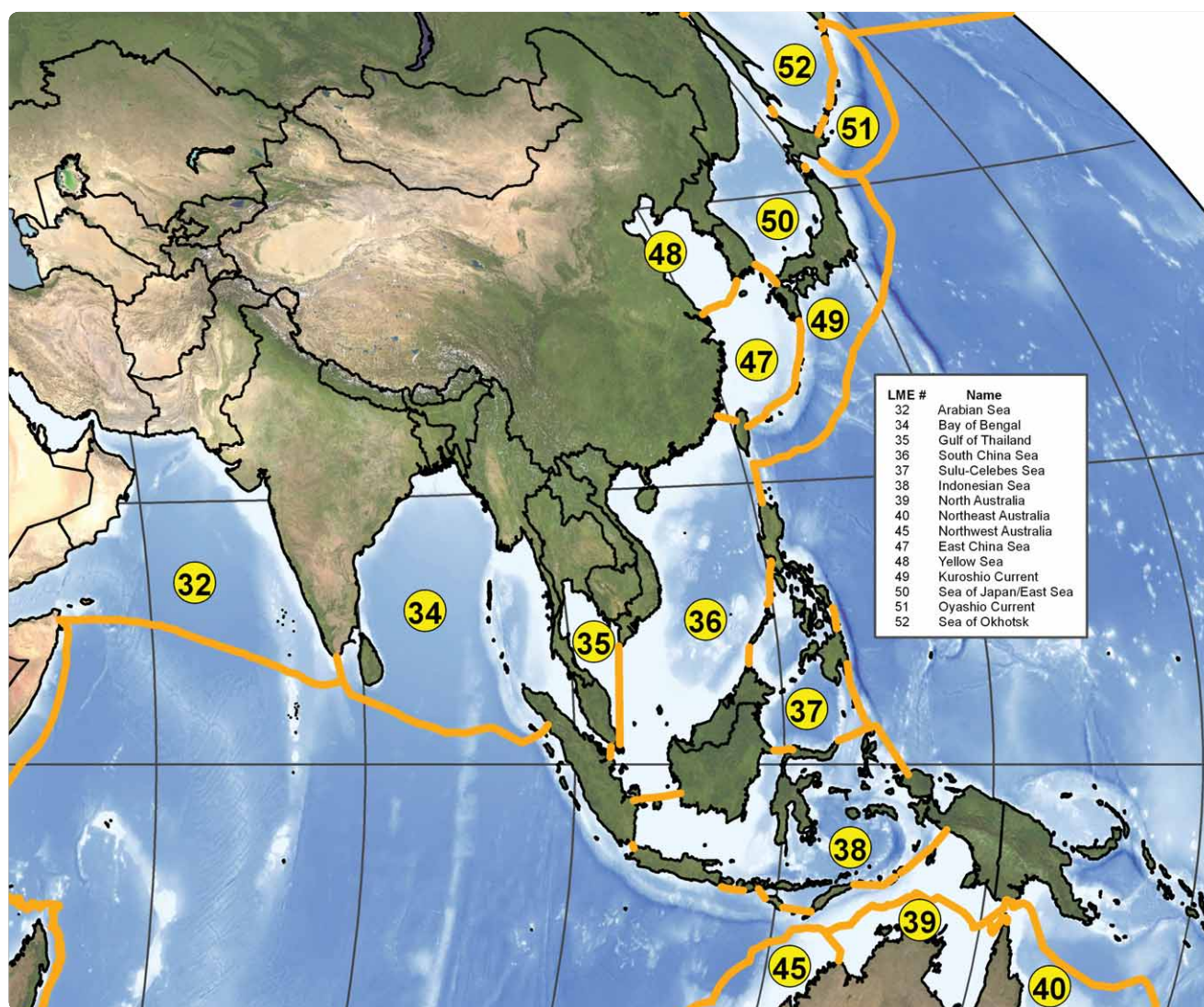
5.1 Project goals and methods:

- It proved nearly impossible to trace science in GEF projects based on the documentation, given that the internal documentation contains little to none. In terms of the project, the coordinators of the TDA, SAP, mid-term review, and final evaluation should have the science needed to do the review.
 - Most of the science is encompassed in the TDA and if the TDA is poorly prepared (as has happened in some cases where the TDA was performed by consultants) then it is extremely difficult to know how science can be used to further policy to manage the system. In some cases the extent of the science is not clear from the documentation: that is, while some science was visible we did not know the full extent of what was used. There are some projects in which the TDA was done well, such as the South China Sea, Yellow Sea, Sulu-Sulawesi and the Black Sea. Even though these were conducted by consultants, in each case the consultants were from the region. However, in others cases, the science is hard to find. Therefore if the people who put together the TDA were not part of the working group, it was not possible to know what science was included.
 - Sometimes there is a well prepared TDA but it is not incorporated into the project. It is not necessarily included in the details of what will happen after the TDA is written.
 - The SAP does not have science-into-policy information, and the mid-term review and final evaluation documentation also did not always have the science and policy information needed.
- It is not clear from any of the documentation where the science influenced the policy.
- **Suggestion to GEF:** There should be a technical science document that sets down all the science used, the scientific findings, and how these influence policy. The mid-term review and final analysis document should also have a section on the science that went into the project and the science that came out of it. This will create a scientific legacy for all GEF projects. GEF should encourage publishing in peer-reviewed literature and uploading of citations on the GEF and project websites. For this to happen, GEF needs to overtly fund targeted research, and expect to be mentioned as a funder in the primary literature.
 - Barriers to finding information: both before the IW database was constructed — and even now that we have more information — there is still not enough to judge the science. It might have been useful to look at the primary literature but there was not enough time to do that. Nor would finding it be particularly easy since scientists participating in a project are rarely identified in any of the core project documents.

5.2 Barriers to achieving goals:

- Difficult times for investment, coupled with political influences of many kinds;
- The erroneous impression that GEF does not fund research under any circumstances; GEF funds research for management purposes (e.g., research using secondary data and information for the TDA and the SAP requires the monitoring of indicators

Figure 8 Large Marine Ecosystems of South East Asia



Used with permission from the U.S. NOAA-LME Program Office 2011, <http://www.lme.noaa.gov>

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for adaptive management). GEF should promote and encourage directed research for management and for policy, as well as in the demonstration sites and for monitoring and evaluation purposes. The investment in new knowledge is a core need for these projects, and GEF should invest in new knowledge, as secondary information may be incomplete or obsolete, especially in view of the impacts of climate change on large marine ecosystems and open oceans.

- **Suggestion to GEF:** The general, and perhaps vague, impression was that effective management would be funded, but that training, capacity building and research were not required, and were not necessary for effective management. [This was reiterated when the GEF CEO rejected 33 of the 35 projects submitted for final approval in 2010]. GEF should clarify their policy on research – what they fund and what is the priority of science in the projects. Moreover, in the review of the PIF and the Project Document, the GEF Secretariat should be more stringent in evaluating (1) the science that is used in developing the project, and (2) the scientific investigations to be conducted within the project, for relevance to appropriate management interventions.

5.3 Impact of science on policy:

In the context of the International Waters Focal Area, the scientific and objective basis of policy formulation is the Transboundary Diagnostic Analysis. While it is possible to assess the scientific quality of the TDA and the extent to which the SAP has based policies for management, it is not easy to assess the impact of science on the implementation of policies. However, in a few projects it was apparent: for example, BCLME and Yellow Sea, where the projects funded cross border surveys. The reason is that very few SAPs have been implemented with funding from GEF (Black Sea LME) or are currently being implemented (BCLME). The majority of the GEF LME Projects have just formulated the SAP (South China Sea LME), or are about to formulate the SAP (YSLME, Sulu-Celebes Sea LME).

Changes in national policies also take time and it might be unreasonable to expect sustained changes in the lifetime of a five-year project. The SAP has to be translated to National Strategic Action Plans and this alone takes a long time.

The impact of GEF projects and investments has resulted in changes in governmental policies in the Baltic Sea, Benguela Current, and the South Pacific. The governments in these LMEs have agreed to manage the LME and have allocated resources for regional management. The GEF Evaluation Unit is currently evaluating the impact of GEF projects and investments in the South China Sea and Adjacent Seas, as part of the adaptive management process in GEF intervention in International Waters.

- **Suggestion to GEF:** Most current political and technical processes for using or protecting the environment are, implicitly or explicitly, reliant on science and technology. Much of the debate about management of the global commons pays considerable attention to the quality and veracity of the science base, and there are complex international mechanisms to verify the science in the case of climate change (the IPCC) and biological diversity. International Waters does not have a single accepted focus for science, and evidence underpinning GEF-IW projects is gathered through the TDA-SAP process. There is no common standard for science in this process, however. GEF should be clear about what the expectation is with regard to the effect of the science in the project on policy; and the documentation should clearly show where the impact on policy was expected (possibly longer term) and where it was shown (possibly within the term of the project). The documentation should reflect how science influenced policy during the course of the project and how it is expected to do so in future.



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