Transboundary Diagnostic Analysis

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CANARY CURRENT LARGE MARINE ECOSYSTEM

CCLME

ADVANCE COPY

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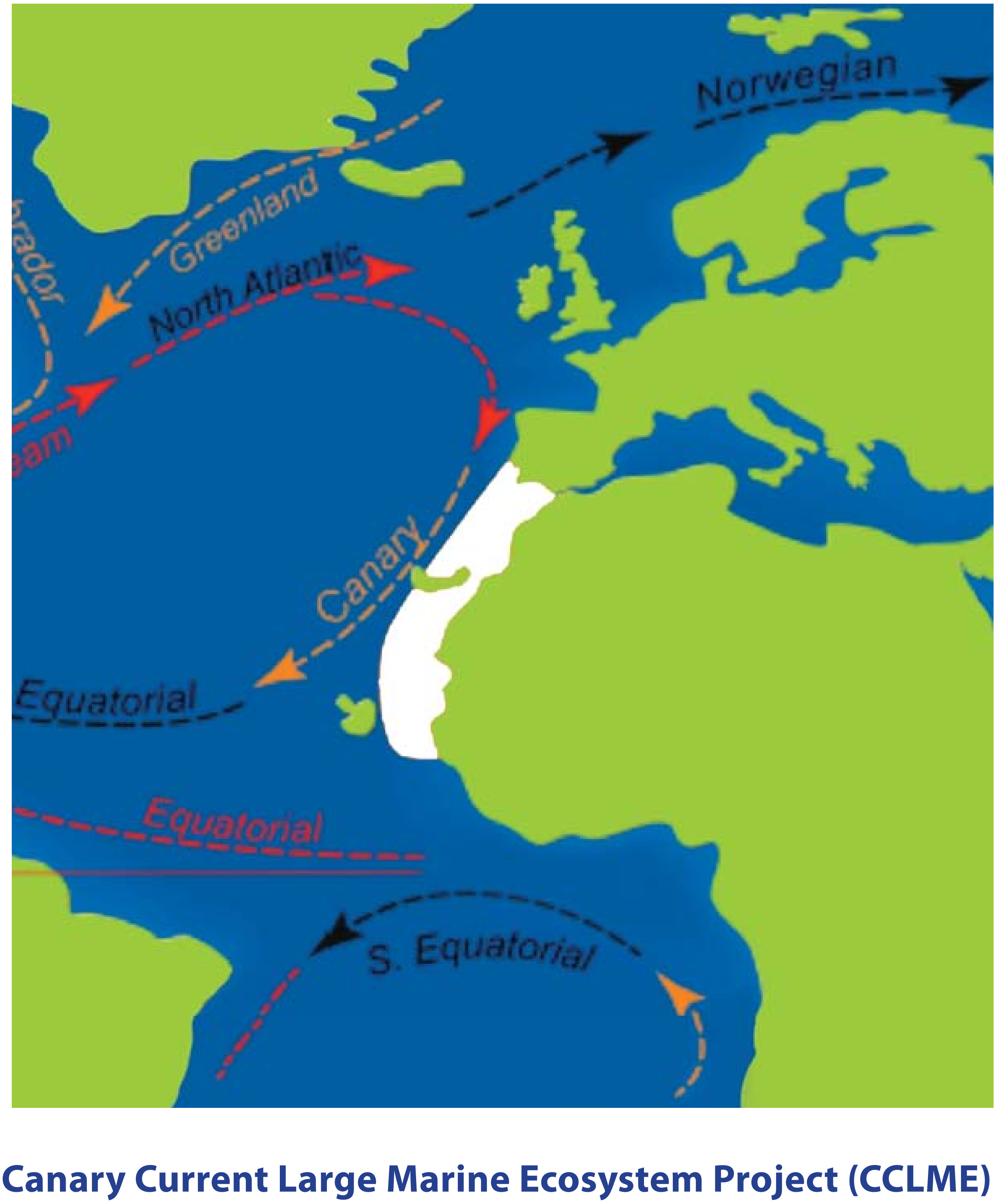
- Assessing global, regional and national environmental conditions and trends.
- Developing international and national environmental instruments.
- Strengthening institutions for the wise management of the environment.

Prepared by the FAO and UNEP as part of the GEF-financed Canary Current Large Marine Ecosystem (CCLME) Project.

Website: www.canarycurrent.org

CCLME, 2015

Cover photo: Reidar Toresen



Canary Current Large Marine Ecosystem Project (CCLME)

Preparation of this document

This document is the result of a process involving several workshops and specific inputs from many organizations and people. The current Transboundary Diagnostic Analysis (TDA) presents an analysis of the "ecosystem status" of the Canary Current Large Marine Ecosystem (CCLME) and threats to the long-term sustainability of coastal and marine processes. The document has evolved out of the Preliminary TDA developed during the preparatory phase of the CCLME Project (2004–2006) and concluded during the project's implementation phase (Phase 1). This document is thus the result of consultations and contributions spanning more than10 years, amounting to thousands of working hours and involving hundreds of stakeholders (including government employees, scientists, representatives from civil society, international experts and consultants, representatives from regional institutions and projects, international institutions and other LME projects). Birane Sambe (CCLME Regional Project Coordinator), Merete Tandstad (Fishery Resources Officer, FAO), Rebecca Klaus (Consultant), Aboubacar Sidibé (Coordinator Marine Living Resources, CCLME Project), Khallahi Brahim (Coordinator Biodiversity, Water Quality and Habitat, CCLME Project) and Brad Brown (Consultant) wrote certain sections of the document and were responsible for the compilation of all contributions and conducted a first review of the document with the assistance of Ndèye Fatou Tamba (Administrative Assistant, CCLME Project) and Birgitta Liss Lymer (Project Expert). Kelly West (UNEP expert) undertook a comprehensive review of the document and provided valuable comments for its improvement. Final editing of the document was completed by Birane Sambe, Merete Tandstad and Birgitta Liss Lymer, with proofreading and layout by Sacha Lomnitz and Chantal Zanettin.

Citation

This document should be cited as:
CCLME Project, 2015. Canary Current Large Marine Ecosystem (CCLME) Transboundary Diagnostic Analysis (TDA). CCLME Project Coordination Unit, Dakar, Senegal. 140 pp. Also available in French.

Acknowledgements

This Transboundary Diagnostic Analysis (TDA) is the product of the efforts of many people and the Project Team of the "Protection of the Canary Current Large Marine Ecosystem (CCLME Project)" would like to thank all the contributors from participating countries, associated projects and other experts who have contributed to it. Special acknowledgments are extended to all those who have contributed to the realization of this document including the direct contributors, reviewers, revisers and layout specialists. Our thanks also go to Mr Ken Sherman and Ms Ana Maria Caramelo, Mr Alioune Kane and Ms Ana Ramos for kindly reviewing parts of this document. The information included in this TDA was drawn from, amongst others, regional specialist reports as well as meetings of the projects. All efforts to ensure the delivery of these components are acknowledged with gratitude. In particular, we would like to thank the country representatives, partners of international institutions, independent experts and consultants mentioned below:

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EXECUTIVE SUMMARY

The majority of our planet is covered by water (oceans, rivers, lakes, and groundwater systems). These shared water bodies are a common global resource that provide valuable ecosystem goods and services and support the food security and livelihoods of billions of people. Their boundaries rarely respect political borders, yet the resources they provide are often managed within national borders. Competing demands and the overuse or abuse of these common resources at the national level is often a source of tension between neighbouring countries. Developing management strategies and a framework within which countries can collaboratively formulate and implement solutions to address the main threats to these shared resources would help to alleviate such conflicts, reduce poverty and improve sustainability.

Large Marine Ecosystems (LMEs) were first proposed as a possible unit for promoting regional collaboration in the assessment, monitoring and management of shared coastal and marine resources in the early 1980s. These regions encompass the highly productive and heavily utilized coastal and marine waters of the world and extend from the river basins to the seaward reaches of the major ocean currents. The geographical boundary of each LME region is defined using four interlinked ecological criteria (bathymetry, hydrography, productivity and trophically linked populations). Using these criteria resulted in the delineation and definition of 64 distinct LMEs, including the Canary Current LME.

The CCLME contains various marine and coastal ecosystems

The LME approach aims to address transboundary issues through the use of science-based assessment and monitoring to inform the development of regional ecosystem-based management approaches. The approach is structured around five modules which include: (1) productivity; (2) fish and fisheries; (3) pollution and ecosystem health; (4) socio-economics; and (5) governance. Each of the five modules has an associated suite of indicators and it is these indicators that provide the basis for measuring and monitoring the status of LMEs, which can then be used to reflect both ecosystem health and management effectiveness. Results are used to identify drivers of change and to design remedial actions to aid ecosystem recovery, when required, and promote sustainability.

The Global Environment Facility (GEF) is an international financial organization that funds projects to benefit the global environment and promote sustainable livelihoods in local communities. GEF funds projects within six focal areas, one of which is International Waters. The GEF International Waters focal area was established with the goal of promoting the collaborative management of transboundary water systems and the implementation of policy, legal and institutional reforms and investments that contribute towards the sustainable use and maintenance of the ecosystem services.

In the early 1990s the GEF and its associated UN implementing agencies (at that time UNEP, UNDP and the World Bank) recognized the potential benefits of LMEs as a means to promote and improve regional collaboration in marine assessment and management and thus GEF began implementing LME projects through the GEF

SUMMARY

International Waters focal area. GEF International Waters has since supported countries throughout the world to develop regional governance strategies, using the LME approach to help the people living within these regions to maintain and recover the critical ecological goods and services provided by LMEs.

In recent years, there has been increased recognition by GEF of the need to develop the capacity of countries to adapt to climate variability and change, including coastal climatic variability, sea-level rise, ocean warming, protection of coastal carbon sinks and ecosystem resilience. Particular emphasis is placed on avoiding the loss of "blue forests" through habitat restoration and conservation associated with integrated and ecosystem-based approaches to management of oceanic and coastal ecosystems.

A core component of all GEF-funded LME projects is the preparation of a Transboundary Diagnostic Analysis (TDA). The purpose of a TDA is to present an up-to-date regional synthesis of the ecosystem status and current threats to the long-term sustainability of coastal and marine processes and resources in a region. The relative importance of the immediate and root causes of the problems are assessed with a view to identifying potential preventive and remedial actions. As such, the TDA provides the technical basis for development of a Strategic Action Programme (SAP) for the region. The SAP is a negotiated policy document that should be endorsed at the highest level of all relevant sectors. It establishes clear priorities for action (for example, policy, legal, institutional reforms, or investments) to resolve the priority problems identified in the TDA. The preparation of a SAP should be a highly cooperative and collaborative process by the countries of the region.

The Canary Current Large Marine Ecosystem (CCLME) Project is a multi-country and multi-agency project aimed at institutionalizing cooperative and adaptive management of the Canary Current LME. Morocco, Mauritania, Senegal, Cape Verde, the Gambia, Guinea-Bissau and Guinea are full participants in the project activities, while Spain is an active partner in the CCLME Project. The CCLME TDA has been developed by the CCLME Project and project partners through an eight-year process of data collection, national and regional reviews and engagement with stakeholders in the CCLME countries, from community to ministerial level. Inputs to the TDA have been developed by the countries through the preparation of national reports by regional and international technical specialists who contributed directly, through working groups, scientific surveys and/or from demonstration projects. The specific objectives of the CCLME TDA are to:

- Present the current state of knowledge on the CCLME.
- Advocate the importance and value of the CCLME.
- Identify and prioritize the main challenges and issues facing the CCLME, and their root causes.
- Recommend areas of intervention to improve the state of the CCLME.

Section 1 of the CCLME TDA introduces the region and presents background information on the CCLME Project and partner activities to date. Section 2 summarizes the current state of knowledge about the coastal and marine ecosystem, associated living marine resources, socio-econonic situation and governance arrangements within the CCLME. Section 3 discusses the major perceived transboundary problems in the CCLME, including issues related to living marine resources, deterioration of habitats and the quality of the coastal waters of the CCLME region.

Table of Contents

Preparation of this document ii
Acknowledgements iii
Executive summary vi
Table of contents viii
List of figures xii
List of tables xiii
Acronyms and abbreviations xiv
List of CCLME Project meetings and survey reports xvi

Section 1: Introduction 1
1.1 The Canary Current Large Marine Ecosystem 1
1.2 Canary Current LME Project (FAO-UNEP-GEF) 3
1.2.1 CCLME Project preparatory phase (2004 to 2006) 3
1.2.2 CCLME Full Sized Project (2010 to 2015) 3
1.2.2.1 Expected outputs of the CCLME Project 4
1.2.2.2 Progress to date 4
1.2.3 TDA Development process 5
1.2.3.1 Demonstration projects 6
1.2.3.2 Surveys conducted 9
1.3 References 11

Section 2: State of knowledge 13
2.1 General considerations 13
2.1.1 A brief history of the CCLME 13
2.1.2 Physical characteristics 14
2.1.2.1 Coastal topography 14
2.1.2.2 Coastal geology 14
2.1.2.3 Topography and geology of the seafloor (seamounts and mud volcanoes) 15
2.1.3 Sediment composition in the CCLME area 16
2.1.4 Climate 18
2.1.5 References 19
2.2 Productivity 20
2.2.1 Oceanography 20
2.2.1.1 The Canary Current 20
2.2.1.2 Surface circulation 20
2.2.1.3 Seasonal variability 21
2.2.1.4 Sea water temperature 21
2.2.1.5 Salinity 22

2.2.2 Upwelling 22
2.2.2.1 Permanent upwelling 22
2.2.2.2 Seasonal upwelling 22
2.2.2.3 Coastal filaments....22
2.2.2.4 Island effects eddies 23
2.2.2.5 Guinea dome 23
2.2.2.6 Sea surface anomalies....23
2.2.3 Enrichment mechanisms....24
2.2.3.1 Nutrient levels....24
2.2.3.2 Primary production 25
2.2.3.3 Secondary production 25
2.2.3.4 Input from land-based sources....27
2.2.3.5 Aeolian input....27
2.2.4 Climate variability and long-term effects of climate change....28
2.2.5 References....31
2.3 Living Marine Resources and fisheries....36
2.3.1 Distribution of fish species in the CCLME region 39
2.3.1.1 Dentex....39
2.3.1.2 Hake....41
2.3.1.3 Small pelagics 42
2.3.2 Highly migratory species....44
2.3.2.1 Large tuna 44
2.3.2.2 Small tuna and tuna-like species 44
2.3.2.3 Associated species (billfish)....44
2.3.2.4 Fisheries for tuna and tuna-like species....44
2.3.3 Deepwater species 47
2.3.3.1 Deepwater fishery 47
2.3.4 Pelagic species 47
2.3.4.1 Pelagic fisheries 48
2.3.5 Demersal species....50
2.3.5.1 Demersal fisheries....50
2.3.6 Elasmobranchs (sharks and rays) 52
2.3.6.1 Elasmobranch fisheries....53
2.3.7 Crustaceans....53
2.3.7.1 Crustacean fisheries 53
2.3.8 Cephalopods....55
2.3.8.1 Cephalopod fisheries 55

2.3.9 Vulnerable and/or threatened species....56
2.3.9.1 Marine mammals....57
2.3.9.2 Seabirds....59
2.3.9.3 Marine reptiles....59
2.3.9.4 Sharks and rays....59
2.3.9.5 Fishes....60
2.3.10 Climate change and the living marine resources of the CCLME....62
2.3.11 References....62
2.4 Pollution, biodiversity and ecosystem health....65
2.4.1 Pollution....65
2.4.1.1 Contaminants....65
2.4.1.2 Sources of pollution....66
2.4 2 Diversity and important habitats....70
2.4.2.1 Macrobenthos....71
2.4.2.2 Algae....72
2.4.2.3 Seamounts....72
2.4.2.4 Seagrasses....72
2.4.2.5 Coral communities....73
2.4.2.6 Mangroves....74
2.4.2.7 Rivers and estuaries....75
2.4.3 Climate change and ecosystems of the CCLME....77
2.4.4 References....77
2.5 Socio-economic importance of the CCLME....81
2.5.1 Human development and demography....81
2.5.2 Regional economic characteristics....83
2.5.3 The principal economic sectors in the countries of the CCLME....84
2.5.3.1 Fisheries....84
2.5.3.2 Aquaculture....86
2.5.3.3 Agriculture....86
2.5.3.4 Mining....86
2.5.3.5 Oil and gas....87
2.5.3.6 Salt production....87
2.5.3.7 Sand extraction....87

2.3.5.8 Tourism 88
2.5.3.9 Shipping and maritime transport 89
2.5.4 Evaluation of the goods and services of the ecosystem 90
2.5.5 References....91
2.6 Governance 92
2.6.1 International framework on fisheries and environment....93
2.6.2 National institutional framework....93
2.6.2.1 National policies....94
2.6.3 Regional cooperation 95
2.6.4 Governance of transboundary problems....97
2.6.5 References....98

Section 3: Major perceived transboundary problems in the CCLME....101
3.1 Living marine resources....102
3.1.1 Decline and/or vulnerability of small pelagic resources....102
3.1.2 Decline of demersal resources (finfish, cephalopods, crustaceans) 103
3.1.3 Threats to vulnerable species (elasmobranchs, marine turtles, marine mammals)....105
3.1.3.1 Elasmobranchs....105
3.1.3.2 Cetaceans....106
3.1.3.3 Marine turtles....106
3.1.4 Vulnerability of tuna resources....107
3.2 Biodiversity and habitats 107
3.2.1 Disappearance and destruction of mangroves....107
3.2.2 Degradation and modification of seabed habitats and seamounts 108
3.2.3 Degradation and modification of wetlands 109
3.3 Water quality 109
3.3.1 Modified transport of sands and sediments 110
3.3.2 Alien invasive species....110
3.3.3 Salinity changes upstream of river mouths 111
3.3.4 Increased levels of microcontaminants in fishery products....111
3.3.5 Pollution 112
3.4 References 113

Annex 1. Marine protected areas in the CCLME region....115

List of Figures

Figure 1: Map showing the location of the CCLME 1

Figure 2: Countries participating in the CCLME Project 1

Figure 3: Bottom types in the CCLME 17

Figure 4: Surface current for (a) summer and (b) winter 21

Figure 5: Circulation patterns. 23

Figure 6a and b: Nutrient concentrations (µmol/L) of nitrate, phosphate, silicate and nitrite in relation to depth (m) 24

Figure 7: Satellite derived chlorophyll-a (chl-a) concentrations (mg/m³) for the CCLME from September 1997 to December 2012 26

Figure 8a and b: Zooplankton biomass recorded at different depths in the CCLME ecosystem surveys and classified by size of organism 27

Figure 9: Decadal trends in sea-surface temperature and surface chl-a (mg/m^3) 30

Figure 10: Landings of the main species groups in the CCLME region from 1970 to 2014 38

Figure 11: Average percentage of annual catches from 2000 to 2010 in the CCLME region 38

Figure 12: Dentex distribution as determined by the 2011 and 2012 surveys of R/V *Dr Fridtjof Nansen* 40

Figure 13: Hake distribution from R/V *Dr Fridtjof Nansen* surveys in 2011 and 2012. 41

Figure 14: Distribution of sardine and sardinella according to the surveys undertaken by R/V *Dr Fridtjof Nansen* in 2011 and 2012. 42

Figure 15: Changes in the annual catch of large tuna in the eastern Atlantic 46

Figure 16: Mediterranean monk seal. 58

Figure 17a, b and c: Biodiversity, abundance and weight of the principal benthic taxa by country 71

Figure 18: Bathymetric map, based on 3-D seismic data 72

Figure 19: Trawl scars recorded in 120 kHz side scan sonar data collected over the Chinguetti well site 73

Figure 20a–d: Maps of four of the major river basins in the CCLME 76

Figure 21: The location of oil exploration blocks and the Chinguetti and Banda oil and gas fields off the coast of Mauritania 87

Figure 22: Illustration of the CCLME area according to NOAA and the area of influence in relation to the arc of 200 nautical miles 92

List of Tables

Table 1: CCLME Full Sized Project components, technical working groups and demonstration projects 4

Table 2: Renewable water resources and freshwater withdrawal in the CCLME region 18

Table 3: Number of marine species in the CCLME Project countries 36

Table 4: Total annual catch (tonnes) of the artisanal and industrial fisheries in each country of the CCLME area 37

Table 5. Number of species of hake, sparids and clupeids identified in Northwest African countries during two surveys undertaken by R/V *Dr Fridtjof Nansen* in 2011 and 2012. 43

Table 6: Stock status assessments of highly migratory tuna and tuna-like resources. 47

Table 7: Stock status assessments of small pelagic resources 49

Table 8: Stock status assessments of demersal fish resources 52

Table 9: Stock status assessments of shrimp resources 54

Table 10: Stock status assessments of cephalopod resources 56

Table 11: Summary statistics for the IUCN Red List for CCLME countries 57

Table 12: Threatened marine species included on the IUCN Red List 60

Table 13: The area of mangroves in each country of the CCLME 74

Table 14: Social and economic characteristics of the Canary Current LME region. 82

Table 15: Agriculture and livestock production in the CCLME countries 86

Table 16: Industries in the CCLME countries 86

Table 17: Arrivals of non-resident tourists/visitors, departures and tourism expenditure in the CCLME countries 88

Table 18: Preliminary economic valuation of the ecosystem goods and services provided by the CCLME 90

Table 19: CCLME country membership of the regional organizations related to fisheries and the environment 96

Table 20: Governance factors identified in the workshop on the Preliminary TDA and confirmed in the full project phase 97

Table 21: Priority transboundary issues for the CCLME identified by the Preliminary TDA and refined through subsequent consultations 101

Acronyms and abbreviations

ACCC	IOC-UNESCO/UNDP/GEF project "Adaptation to Coastal and Climate Change in West Africa"
AGC	Management and Cooperation Agency between Senegal and Guinea-Bissau
AfDB	African Development Bank
AMO	Atlantic Multi-decadal Oscillation
ATLAFCO	Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean
AU	African Union
BP	Before present
CBD	Convention on Biological Diversity
CCLME	Canary Current Large Marine Ecosystem
CECAF	Fishery Committee for the Eastern Central Atlantic
chl-a	Chlorophyll-a
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon dioxide
CPUE	Catch Per Unit Effort
CR	Species classified as Critically Endangered on the IUCN Red List
DFe	Dissolved iron
DWF	Distant Water Fleets
EAF	Ecosystem Approach to Fisheries
EAF-Nansen	EAF-Nansen Project: Improving the knowledge base and support for implementation of an ecosystem approach to fisheries in developing countries
EBUS	Eastern Boundary Upwelling Systems
ECOWAS	Economic Community of West African States
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EN	Species classified as Endangered on the IUCN Red List
ES	Ecosystem Services
EU	European Union
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
FIBA	International foundation for the Banc d'Arguin
GCLME	Guinea Current Large Marine Ecosystem
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GOOS-AFRICA	Global Ocean Observing System for Africa (IOC-UNESCO)
HAP	Hazardous Air Pollutants
HDI	Human Development Index
HNS	Hazardous and Noxious Substances
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICZM	Integrated Coastal Zone Management
IMF	International Monetary Fund
IMO	International Maritime Organization
INRH	National Institute of Fisheries Research (Morocco)
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unreported and Unregulated (fishing)
LME	Large Marine Ecosystem
MCS	Monitoring, Control and Surveillance
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MT	Metric tonnes
mya	Million years ago
N_2	Nitrogen

NACW	North Atlantic Central Water
NEC	North Equatorial Current
NECC	North Equatorial Counter Current
NGO	Non-Governmental Organization
NICs	National Inter-Ministry Committees
OMVG	Organization for the Development of the Gambia River Basin
OMVS	Organization for the Development of the Senegal River
OMZ	Oxygen Minimum Zone
P	Phosphorus
PARTAGE	Project for Support for the Management of Traditional Cross-border Fishing
Ppt	Parts per thousand
PRAO	Regional Programme for West African Fisheries
PRCM	West African Regional Marine and Coastal Conservation Programme
PSC	Project Steering Committee
RAMPAO	Network of Marine Protected Areas in West Africa
RCU	Regional Coordination Unit
REC	Regional Economic Community
RFMO	Regional Fisheries Management Organization
R/V	Research Vessel
SACW	South Atlantic Central Water
SAP	Strategic Action Programme
SCRS	Standing Committe on Research and Statistics (of ICCAT)
SRFC	Sub-regional Fisheries Commission
SST	Sea Surface Temperature
TEV	Total Economic Value
TDA	Transboundary Diagnostic Analysis
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-MAB	Man and the Biosphere Programme of UNESCO
VOC	Volatile Organic Compounds
VU	Species classified as Vulnerable on the IUCN Red List
WAEMU	West African Economic and Monetary Union
WWF	Worldwide Fund for Nature

Acronyms of participating organizations

AtlantNIRO	Atlantic Institute for Marine Fisheries and Oceanographic Research
CAOPA	African Confederation of Artisanal Fisheries Professional Organizations
CERESCOR	Scientific Research Centre of Conakry-Rogbane
DARO	Directorate of Resources Management and Oceanography (Mauritania)
DEEC	Directorate of the Environment and Protected Areas (Senegal)
DPAC	Directorate of Artisanal Fisheries and Coastal Management (Senegal)
DPM	Directorate of Marine Fisheries (Senegal)
FIBA	The International Foundation for Banc D'Arguin
GIZ	German Agency for International Cooperation (Mauritania)
IBAP	Institute of Biodiversity and Protected Areas (Guinea-Bissau)
IMROP	Institute of Fisheries and Oceanographic Research (Mauritania)
IRD	Institute for Research and Development
REPAO	Fisheries Policy Network of West Africa
WIA	Wetlands International Africa

List of CCLME Project meetings and survey reports

	Report	Title
1	CCLME 2010a	Minutes of coordination meeting of the FAO/UNEP/URC CCLME (5–6 July 2010, Dakar, Senegal)
2	CCLME 2010b	Report of the CCLME Inception Workshop (2–3 November 2010, Dakar, Senegal)
3	CCLME 2010c	Report of the first CCLME Project Steering Committee meeting (4 November 2010, Dakar, Senegal)
4	CCLME 2010d	Minutes of the first meeting of the working group on the planning and analysis of ecosystem surveys in the CCLME area (29–30 October 2010, Dakar, Senegal)
5	CCLME 2011a	CCLME demonstration project 5: Report of the coordination meeting on the CCLME demonstration project 5 "mangroves", (5–6 May, 2011, Dakar, Senegal)
6	CCLME 2011b	Report on the first meeting of the working group on climate change (11–13 May 2011, Saly, Senegal)
7	CCLME 2011c	Report of the first meeting of the working group on Transboundary Diagnostic Analysis (19–20 May 2011, Saly, Senegal)
8	CCLME 2011d	Report of the second meeting of the working group on ecosystem survey planning and analysis in the CCLME area (30–31 May 2011, Casablanca, Morocco)
9	CCLME 2011e	Report of the second meeting of the Project Steering Committee (28–29 November 2011, Casablanca, Morocco)
10	CCLME 2011f	Cape Verde ecosystem survey, 04–20 June 2011. Survey report
11	CCLME 2011g	CCLME demonstration project 1: survey of the pelagic fish resources off Northwest Africa: Senegal, the Gambia, Guinea-Bissau, Guinea, 22 June to 7 July 2011. Survey report
12	CCLME 2011h	Northwest Africa ecosystem survey: Guinea to Morocco, 20 October to 21 December 2011. Survey report
13	CCLME 2012a	Report on the CCLME side event at the sixth forum of PRCM (21–24 February 2012, Banjul, the Gambia)
14	CCLME 2012b	Report of the third meeting of the working group on the planning and analysis of ecosystem surveys in the CCLME area (29–30 March 2012, Casablanca, Morocco)
15	CCLME 2012c	CCLME demonstration project 5: report of the meeting of the monitoring committee for the project on development of a plan for the restoration and conservation of the mangroves in the CCLME area (2 April 2012, Dakar, Senegal)
16	CCLME 2012d	Report of the first meeting of the working group on biodiversity, habitat and water quality (11–12 April 2012, Nouakchott, Mauritania)
17	CCLME 2012e	Report of the meeting on the coordination of the activities of the partners in the framework of the CCLME Project (9 May 2012, Dakar, Senegal)
18	CCLME 2012f	Report of the second meeting of the working group on Transboundary Diagnostic Analysis (13–15 June 2012, Dakar, Senegal)
19	CCLME 2012g	Report of the meeting on the review of activities, financial estimates and budget for component 3 of the CCLME Project (26–27 June 2012, Abidjan, Côte d'Ivoire)

20	CCLME 2012h	CCLME demonstration project 5: minutes of the meeting of the monitoring committee of the CCLME/Wetlands Project (12 July 2012, Dakar, Senegal)
21	CCLME 2012i	CCLME demonstration project 3: report of the partner coordination meeting for CCLME demonstration project no. 3: co-management of transboundary coastal migratory species that are important for benthopelagic coastal artisanal fisheries (mullet, croaker and bluefish) in Mauritania and Senegal (30–31 August 2012, Dakar, Senegal)
22	CCLME 2012j	CCLME demonstration project 1: report of the workshop of the regional ecosystem baseline report and risk assessment for the development of management plans for small pelagic fisheries in Northwest Africa (9–11 October 2012, Dakar, Senegal)
23	CCLME 2012k	Report of the second meeting of the working group on climate change (16–18 October 2012, Praia, Cape Verde)
24	CCLME 2012l	CCLME demonstration project 4: regional workshop report on the implementation of the FAO Technical Guidelines on MPAs and Fisheries and planning of the activities of CCLME demonstration project no. 4 "demonstration of marine protected areas (MPAs) as a tool to identify benefits of managing multiple resources" (5–7 November 2012, Dakar, Senegal)
25	CCLME 2012m	First meeting of the National Interministerial Committee of Senegal (20 November 2012, Dakar, Senegal)
26	CCLME 2012n	Report of CCLME third Project Steering Committee meeting (29–30 November 2012, Santa Cruz, Tenerife, Spain)
27	CCLME 2012o	Northwest Africa ecosystem survey Guinea to Morocco, 5 May to 22 July 2012. Survey report.
28	CCLME 2013a	Report of the first meeting of the National Interministerial Committee of the Gambia (22 January 2013, Banjul, the Gambia)
29	CCLME 2013b	Report of the second meeting of the working group on biodiversity, habitat and water quality (12–14 March 2013, Banjul, the Gambia)
30	CCLME 2013c	CCLME demonstration project 2: report of the regional workshop on "Developing a common standard methodology for recording of bycatch and discards on board commercial fishing vessels in West Africa" (20–21 March 2013, Dakar, Senegal)
31	CCLME 2013d	CCLME demonstration project 3: report of the workshop on the evaluation of benefits from the fisheries on coastal benthopelagic resources in Mauritania and Senegal and their distributions (17–18 April 2013, Nouakchott, Mauritania)
32	CCLME 2013e	CCLME demonstration project 1: report of the second workshop on the evaluation of the risks for the development of a management plan for the small pelagic fisheries (EAF) in Northwest Africa (27–30 May 2013, Casablanca, Morocco)
33	CCLME 2013f	Survey on the study of the reproduction of pelagic fishes in the coastal waters of Guinea, Guinea-Bissau, Senegal and the Gambia (1–23 May 2013)
34	CCLME 2013g	Report of CCLME fourth Project Steering Committee meeting
35	CCLME 2014	Assessment of the state of marine biodiversity in the CCLME region. Consultation document presented during the third meeting of the working group on biodiversity, habitat and water quality (23–25 September 2014, Casablanca, Morocco)

CANARY CURRENT LARGE MARINE ECOSYSTEM

CCLME

Section 1: Introduction

1.1 The Canary Current Large Marine Ecosystem

Figure 1:
Map showing the location of the CCLME

The Canary Current Large Marine Ecosystem (CCLME) is situated in the Atlantic Ocean on the northwestern coast of Africa (Figure 1).

The boundaries of the CCLME extend from the northern Atlantic coast of Morocco (36°N, 5°W at the Strait of Gibraltar), south to the Bijagos archipelago of Guinea-Bissau (11°N, 16°W) and west to the Canary Islands (Spain). The countries within the recognized limits of the CCLME include Spain (Canary Islands), Morocco, Mauritania, Senegal, the Gambia and Guinea-Bissau. Both Cape Verde and the waters of Guinea are considered adjacent waters within the zone of influence of the CCLME. The beneficiary countries of the CCLME Project include those listed above, with the exception of Spain.

Figure 2:
Countries participating in the CCLME Project

The seven CCLME beneficiary countries (Figure 2) are collectively responsible for a coastline of > 5 400 km[1] and a sea area of > 2 million km² within their exclusive economic zones (EEZs)[2]. The Cape Verde Islands, situated 570 km off the coast of Senegal, have the largest EEZ of all these countries. The current population of CCLME countries is estimated to be 62 million, and while population growth rates have dropped over the past 20 years, they remain at > 2 percent per annum (2011 estimate, World Bank 2013[3]). Socio-economic conditions in the CCLME Project beneficiary countries vary and according to the 2013 Human Development Report (UNDP, 2013), Morocco (0.591) and Cape Verde (0.586) had the highest human development index of the countries of the region, followed by Senegal (0.470), Mauritania (0.467), the Gambia (0.439), Guinea-Bissau (0.364) and Guinea (0.355).

The CCLME comprises a diverse assemblage of marine and coastal ecosystems and three distinct zones: **1**) a northern, sub-tropical, upwelling zone centred off northern Mauritania with minimal river inputs; **2**) a southern, tropical zone, centred off Guinea-Bissau and extending from Senegal to Guinea, dominated by estuaries and mangroves; and **3**) a western, sub-tropical to tropical, oceanic zone (including the Canaries and the adjacent waters of Cape Verde).

The CCLME encapsulates one of the world's Eastern Boundary Upwelling Systems (EBUS) and is renowned for its high biological productivity. While the region only covers 2 to 3 percent of the global ocean surface area, it supports 8 percent of the global surface primary productivity (Heileman and Tandstad, 2008). The nutrient-rich upwelling stimulates seasonal bursts of primary productivity, which are fed upon by zooplankton and small pelagic fishes, attracting opportunistic feeders and predators. The CCLME supports important fish populations of small pelagic, demersal and tuna resources, which together constitute around 20 to 30 percent of the world fisheries production. Annual production ranges from 2 to 3 million tonnes (Heileman and Tandstad, 2008), the highest fisheries production of any African LME.

[1] (http://world.bymap.org/Coastlines.html)
[2] (World EEZ v7, 2012-11-20, http://www.marineregions.org/downloads.php#eez)
[3] http://databank.worldbank.org/data/home.aspx

Fisheries in the CCLME currently support an estimated one million jobs (FAO, 2009)[4], and are the basis for the livelihoods of > 150 000 artisanal fishers (Sambe, 2009 and FAO, 2009) many of whom migrate widely within and outside the region, fishing and trading fish and fish products across national borders.

Covering different climatic zones, from the temperate north to the tropical south, the CCLME features a wide range of coastal and marine habitat types, including critical wetland habitats, estuaries, seagrass beds, mangroves and diverse coral communities. The main estuaries include those of the rivers Sebou, Senegal, the Gambia, Casamance, Cacheu and Corubal. Main mangrove areas are found in the southern part of the CCLME, mainly in Guinea (2 999 km²), Guinea-Bissau (2 039 km²), Senegal (1 287 km²) and the Gambia (591 km²)[5]. The extent of seagrass areas in the CCLME is less well known, but both Guinea-Bissau and Guinea are known to have extensive seagrass areas (14 559 km² and 12 631 km² respectively), whereas information from Senegal indicates a seagrass area of 1 473 km².[6] These habitats together with the high productivity support a globally significant diversity of species, which includes a high proportion of endemic and migratory species such as birds, sea turtles and cetaceans.

The CCLME is a vital resource not only for coastal populations bordering the LME, but also for much of western Africa. An initial economic valuation of the ecosystem goods and services carried out by the CCLME Project (Interwies and Görlitz, 2013) indicates that the CCLME generates a yearly economic value of around US$11.7 billion. One hectare of mangroves alone provides ecosystem services valued at US$2 235 per year, most of it credited to coastal protection (against storms and erosion), the provision of fish nurseries and climate regulation.

While the CCLME is a critical contributor to the social and economic well-being of many people, it is faced by multiple threats from a range of natural and anthropogenic impacts.

Overfishing is one of the most immediate threats. Many of the commercially important demersal resources are overexploited and some stocks, such as the white grouper (*Epinephelus aeneus*), have been considered seriously overexploited in parts of the CCLME area for quite some time (FAO, 2015a). Some pelagic resources, such as the round sardinella (*Sardinella aurita*) between Morocco and the southern part of Senegal, the Cunene horse mackerel (*Trachurus trecae*) both in the northern and southern part of the CCLME, anchovy (*Engraulis encrasicolus*) and bonga (*Ethmalosa fimbriata*) in Northwest Africa are also overexploited (FAO, 2015b). On the other hand, other resources are not fully exploited, such as sardine in Zone A+B and Zone C (from Cape Boujador in the north to the southern extent of the species) or fully exploited such as sardinella species in Guinea and Guinea-Bissau (FAO, 2015c). Many of these resources are vulnerable to the influence of environmental factors including climate variability and change and many are shared between two or more countries, posing additional challenges for their management.

Some of the underlying causes of the declining fish resources identified through the TDA process include the over-capacity of fishing fleets (both industrial and artisanal); ecosystem complexity and variability; weak management including weak monitoring, control and surveillance; insufficient scientific and technical capacity for management; poor stakeholder participation in management decisions; absence of mechanisms for management of shared fishery resources and increasingly high demand for fish products, accompanied by increasing prices (CCLME, 2012f).

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[4] excluding Morocco.
[5] The Global Distribution of Mangroves, USGS, 2011, http://data.unep-wcmc.org/
[6] The Global Distribution of Seagrasses (V2.0 2005), http://data.unep-wcmc.org/

The unknown magnitude of illegal, unreported and unregulated (IUU) fishing adds another management challenge (Caramelo, 2010). These causes are compounded by the destruction of critical habitats such as mangroves, salt marshes and coral reefs, as well as by pollution, discards and the impacts of climate change.

Coastal areas within the CCLME are under increasing pressure from expanding coastal populations. The spread of urbanization, unplanned tourist developments and expansion of agricultural areas and other changes in land-use have resulted in the degradation, fragmentation and loss of critical habitats, including estuaries, wetlands, mangroves and benthic habitats. There is also the likelihood of increased pollution from land-based sources, which could pose threats to biodiversity, as well as to key species of cetaceans, seals, sea turtles, sharks, sawfish and manatees. Land-use practices have also changed and resulted in increased extraction and use of both ground and surface waters. Changes in water-use patterns have affected rivers, resulted in localized eutrophication, salinity changes and sedimentation, all of which are contributing to the degradation of estuaries, wetlands and mangroves. Mangrove coverage in the CCLME has already declined by 19 percent since 1980 (FAO, 2007).

1.2 Canary Current LME Project (FAO-UNEP-GEF)

The CCLME Project was initially conceptualised in the late 1990s, when the countries in the region (with the support of UNEP) first sought assistance from GEF International Waters for a project to address the transboundary issues affecting the CCLME. Recognizing the importance of fisheries in the CCLME region, GEF encouraged the involvement of FAO as an implementing partner to develop an ecosystem-based approach to address declining fisheries and the degradation of coastal habitats.

GEF support for the CCLME has since then been realized through two key interventions: a preparatory phase and the current CCLME Full Sized Project.

1.2.1 CCLME Project preparatory phase (2004 to 2006)

During the CCLME preparatory phase, beneficiary countries and partner organizations undertook a series of national consultations and regional meetings. The outcome of this process was a Preliminary Transboundary Diagnostic Analysis (TDA) that identified and analysed specific priority transboundary issues and their potential solutions. A long-term environmental goal was agreed for the CCLME, i.e. *"reverse the degradation of the Canary Current Large Marine Ecosystem caused by overfishing, habitat modification and changes in water quality by adoption of an ecosystem-based management approach*". The Preliminary TDA was used to derive a "precursor" Strategic Action Programme (Pre-SAP). The Preliminary TDA and Pre-SAP provided the basis for a full size project proposal. Key partners were encouraged to adopt the Preliminary TDA and Pre-SAP and the proposed project framework as the basis for their own future interventions, thereby creating a CCLME Project which was submitted to GEF for further support. Project objectives and activities were refined to ensure alignment with the new strategic objectives of the GEF 5 portfolio.

1.2.2 CCLME Full Sized Project (2010 to 2015)

The current phase of the CCLME Project commenced on 1 April 2010, with FAO and UNEP as GEF implementing agencies. The aim of the current project is to further refine the identification and analysis of common concerns and transboundary issues within the region through the development of a full TDA using the LME modular approach, and to prioritize and propose workable solutions in a SAP to be adopted by the countries.

The CCLME Full Sized Project components, the five demonstration projects and the technical working groups consulted or established by the project are shown in Table 1. Five scientific surveys have also been conducted to improve the knowledge of the Canary Current LME in support of all three components (see section 1.2.3).

Table 1: CCLME Full Sized Project components, technical working groups and demonstration projects

Component 1: Multi-country process and frameworks for understanding and addressing priority transboundary concerns	
Working groups	• Transboundary Diagnostic Analysis (TDA) working group • Strategic Action Programme (SAP) working group • Climate change working group
Component 2: Strengthened policies and management based on improved knowledge and demonstration actions, to address priority transboundary concerns on declining marine living resources of the CCLME	
Working groups	• Socio-economic and trade working group • Ecosystem surveys planning and analysis working group • Working group on assessment of pelagic resources (CECAF group) • Working group on assessment of demersal resources (CECAF group)
Demonstration projects	• Sustainable transboundary management of shared small pelagic stocks in Northwest Africa consistent with an ecosystem approach • Reduction of the impact of coastal shrimp trawling through bycatch reduction and management changes • Transboundary co-management of migratory coastal species of importance to artisanal fisheries (mullets, bluefish and meagre)
Component 3: Strengthened knowledge, capacity and policy base for transboundary assessment and management of habitat, biodiversity and water quality critical to fisheries	
Working group	• Biodiversity, habitat and water quality working group
Demonstration projects	• Demonstration of marine protected areas (MPAs) as tools for multiple resource management benefits • Development of a regional mangrove conservation plan with pilot mangrove restoration actions
Scientific surveys: Improved knowledge base	
	• Ecosystem survey in the EEZ of Cape Verde – 2011 • Regional pelagic survey (Senegal, the Gambia, Guinea-Bissau and Guinea) – 2011 • Regional ecosystem survey from Guinea to Morocco – 2011 • Regional ecosystem survey from Guinea to Morocco – 2012 • Study of the reproduction of small pelagic fish – 2013

1.2.2.1 Expected outputs of the CCLME Project

The ultimate project outputs are multi-country agreements on transboundary policy concerns, impacts and causes (a good quality TDA technically agreed by all countries), as well as on governance reforms and investments to address these priority transboundary concerns through a SAP adopted by all countries. Furthermore, it is expected that, in the process of gathering information for the TDA and SAP, considerable information will be produced and advances made in implementing the ecosystem approach.

1.2.2.2 Progress to date

The CCLME Project initially focused on building the foundations for successful project implementation, which included: establishing the Regional Coordinating Unit (RCU), recruiting staff and setting up the national teams. Countries nominated National Project Focal Points (NPFPs) and Technical Coordinators (NTCs) and the National Interministerial Committees (NICs) that were set-up during the preparatory phase were re-established in five of the seven countries and are under establishment in the other two. A communication strategy was developed and adopted by the participating countries at the start of the CCLME Full Sized Project and a bilingual project website (in English and French) was developed in collaboration with IW: LEARN and launched in June 2010[7]. Project newsletters have also been released biannually to ensure good communication with all project partners. In total eight newsletters have been circulated.

[7] http://www.canarycurrent.org/en

The CCLME Project Inception Workshop and first Project Steering Committee (PSC) meeting were held in Dakar, Senegal on 2 to 4 November 2010. The inception workshop gathered 66 participants representing over 40 organizations and seven countries involved in the CCLME Project (CCLME, 2010c). The first PSC meeting adopted the overall project work plan, the 2011 project work plan and budget, agreed on the technical working groups to be established and their terms of reference and the CCLME monitoring and evaluation plan. The PSC also revised and adopted its own terms of reference (CCLME, 2010c). To date four PSC meetings have been held in November each year to examine achievements and adopt the annual workplans for the coming year (CCLME, 2010c; 2011e; 2012n; 2013g).

To implement the project effectively and to achieve the expected outputs outlined above, the project strategy entails creating or strengthening thematic working groups that address key issues identified in the Preliminary TDA and Pre-SAP. Furthermore, to test and introduce new and innovative approaches for addressing key issues in the CCLME, and to ensure capacity development, experience sharing and training, five demonstration projects have been implemented. These activities have generated new knowledge and strengthened partnerships that can be replicated and scaled up inside or outside the CCLME. In addition, five scientific surveys have been conducted in cooperation with the EAF-Nansen project, including three ecosystem surveys which are innovative in the region. These have led to the establishment of new partnerships and capacity development in support of the establishment of an ecosystem baseline for the CCLME. As such, a series of events was organized jointly by the EAF-Nansen and CCLME projects and new initiatives started with the Spanish Institute of Oceanography (benthos research) and the University of Bergen (infauna benthos), and IOC-UNESCO for marine mammal studies. An expert on seabirds has also been associated with this work. The survey work is led by the CCLME ecosystem survey planning and analysis working group, of which the EAF-Nansen Project and the Spanish Institute of Oceanography are key partners.

1.2.3 TDA development process

All activities conducted in the context of the CCLME Project, as well as those of partners and past activities in the region, have been capitalized upon and fed into the TDA process.

The TDA is the regional scientific and technical synthesis report, the purpose of which according to GEF International Waters is: "*...to scale the relative importance of sources and causes, both immediate and root, of transboundary 'waters' problems, and to identify potential preventive and remedial actions. The TDA provides the technical basis for development of a Strategic Action Programme (SAP) in the area of international waters of the GEF*" (GEF, 2006).

The TDA for the CCLME presents an analysis of ecosystem status and threats to the long-term sustainability of coastal and marine processes. The document has evolved out of the Preliminary TDA developed during the preparatory phase. Specific steps in the development of the full TDA completed during the CCLME Full Sized Project are as follows:

- Inception Workshop (2–3 November 2010);
- Training course on TDA and SAP development (16–18 May 2011);
- First TDA working group meeting (19–20 May 2011);
- Consultants develop more in-depth analyses of socio-economic and governance factors underlying the issues affecting the CCLME (not addressed in the Preliminary TDA) (2011–2012);
- CCLME working groups review and update the analyses of the Preliminary TDA (fisheries, habitats, water quality) using new information (2011–2013);
- Advice from the Project Steering Committee on TDA development (2011–2013);
- Side event at the 6th PRCM Forum (Banjul, the Gambia) (20–24 February 2012);
- Second TDA working group meeting (13–15 May 2012) to discuss, update and validate the causal chain analysis produced during the Preliminary TDA focused on declining marine living resources, degradation of habitats and declining water quality;
- Synthesis of the results of consultancies, activities of the demonstration projects, working groups and surveys to further refine the diagnostic analyses based on all the latest available information;
- Presentation of the draft TDA at the 7th PRCM Forum (Dakar, Senegal, November 2013) and fourth CCLME Project Steering Committee meeting (Banjul, the Gambia, December 2013).

It is important to highlight the time scale and breadth of participation and contributions which have resulted in the TDA. The TDA for the CCLME is the fruit of consultations and contributions spanning 10 years and amounting to thousands of working hours involving hundreds of stakeholders from different sectors:

- Government officials – from relevant ministries contributed to both the national and regional processes.
- Scientists – national and international scientists and scientific institutions and universities have contributed throughout the TDA process – in the national working groups, at regional workshops, as authors of technical reports prepared to inform the process and as contributory authors to the final TDA document.
- International experts and consultants have contributed at various stages along the way – in project and process design and in most of the technical meetings.
- Regional institutions – staff of the Fishery Committee for the Eastern Central Atlantic (CECAF) and the Sub-regional Fisheries Commission (SRFC) were closely involved in the project preparation process; the Abidjan Convention Secretariat and the SRFC contributed to the Project Steering Committee and execution of major project activities; CECAF has been closely associated through its working groups and the work of the scientific sub-committee; others such as Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (ATLAFCO), New Partnership for Africa's Development (NEPAD) and the Management and Cooperation Agency between Senegal and Guinea-Bissau (AGC) participated at regional workshops organized by the project.
- Regional projects and partnerships – the EAF-Nansen Project has been a key partner throughout the CCLME Project; representatives of several regional programmes with relevant expertise participated in the diagnostic process [the IOC-UNESCO/UNDP/GEF project "Adaptation to Coastal and Climate Change in West Africa" (ACCC), Senegal Basin Water Resources Development Project (BFS), Fisheries Information and Analysis System (FIAS), Global Ocean Observing System for Africa (GOOS-Africa) and the West African Regional Marine and Coastal Conservation programme (PRCM)]. PRCM has been a key collaborator to ensure broader stakeholder participation and consultation, especially through the PRCM Forum.
- Intergovernmental institutions – in addition to the main project executing agencies (FAO and UNEP), the diagnostic process has benefited from input from the United Nations Development Programme (UNDP), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Maritime Organization (IMO) and the World Bank.
- Other LME projects or LME Commissions – experts from the Benguela Current Commission (BCC), the Guinea Current LME (GCLME) and the Bay of Bengal LME (BOBLME) all contributed to the diagnostic process, bringing the benefit of their own experience. The African LME Caucus serves as an important platform for exchange of experiences and knowledge.
- Civil society – national diagnostic workshops included broad participation of civil society including non-governmental organizations (NGOs) and civic associations in addition to technicians and scientists; NGOs such as Wetlands International and International Union for the Conservation of Nature (IUCN) have been key executing partners, while others e.g. Worldwide Fund for Nature (WWF) and the World Conservation Monitoring Centre of UNEP (UNEP-WCMC) were involved in regional workshops.

1.2.3.1 Demonstration projects

The demonstration projects that have been implemented as part of the CCLME Project are in various stages of implementation and it is expected that at the end of the current phase they will have contributed significantly to the achievement of the long-term objectives of the project. These projects allow for the testing of multi-country approaches addressing key transboundary issues as identified in the preparation phase. The demonstration projects have also collected new information needed for the TDA and SAP and have helped develop regionally tailored approaches and tools that can be replicated beyond this project. The objectives of the demonstration projects are as follows:

Demonstration Project 1:

Sustainable transboundary management of shared small pelagic stocks in Northwest Africa consistent with an ecosystem approach

Participating countries: Morocco, Mauritania, Senegal and the Gambia
Associated countries: Guinea and Guinea-Bissau

Small pelagic fish (such as sardine, sardinella, bonga shad, horse mackerel and mackerel) are the most abundant fish stocks in the CCLME subregion and are also extensively shared by countries within whose waters they are distributed. The demonstration project aims to provide CCLME member countries with a better understanding of the key elements of the ecosystem approach to fisheries (EAF) to facilitate management of the fisheries that exploit these resources. Specifically, the project promotes multi-country agreements on subregional resource assessment, policies and plans for the sustainable management of transboundary shared stocks of small pelagic fish species distributed in the upwelling zone between Morocco and southern Senegal (including the waters of the Gambia). With the support of the EAF-Nansen Project and the FAO Fishery Committee for the Eastern Central Atlantic (CECAF) working group on the assessment of small pelagic fish off Northwest Africa, the project is being implemented in close collaboration with SRFC in the framework of a Letter of Agreement between this institution and the FAO.

Demonstration Project 2:

Reduction of the impact of coastal shrimp trawling through bycatch reduction and management changes

Participating countries: Mauritania and Guinea-Bissau
Associated countries: Morocco, Senegal, the Gambia and Guinea

Industrial shrimp trawling is an important source of revenue for most CCLME countries and is responsible for substantial but poorly estimated bycatch, discards and ecosystem impacts. This demonstration project is developing a common method for assessing trawling impacts on bycatch and is conducting field trials of selective, low-impact gears, in order to demonstrate the feasibility and environmental benefits of selective, low-impact fishing methods.

Demonstration Project 3:

Transboundary co-management of migratory coastal species of importance to artisanal fisheries (mullets, bluefish and meagre)

Participating countries: Morocco, Mauritania, Senegal and the Gambia

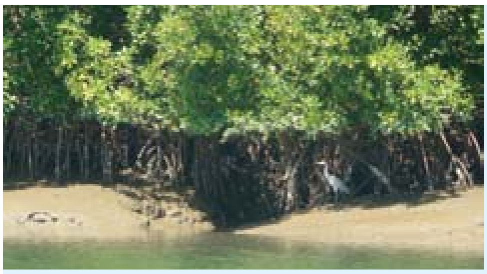
The effective management of shared fish stocks is one of the great challenges towards achieving long-term sustainable management of fisheries. The project promotes multi-country cooperation and co-management of shared stocks of three associated migratory coastal benthopelagic species of importance to artisanal fisheries (mullet, meagre and bluefish) with the aim of demonstrating the feasibility and benefits of cooperative co-management of these shared fish stocks through the establishment and evaluation of subregional cooperation mechanisms. The demonstration project is being implemented in the framework of a Letter of Agreement with IUCN Mauritania.

Demonstration Project 4:

Demonstration of Marine Protected Areas (MPAs) as tools for multiple-resource management benefits

Participating countries: Cape Verde, Mauritania, Senegal, Guinea-Bissau and Guinea

MPAs have been advocated as tools for sustainable fisheries and it has been suggested that they could play a significant role in restoring depleted fish stocks and habitats and mitigating the impact of the overexploitation of target species. The project aims to develop and test the use of MPAs as tools for sustainable demersal artisanal fisheries co-management at different locations in the CCLME. Two study areas have been selected where the demonstration project supports participatory assessments of demersal resources, participatory development of fisheries co-management regimes around the target MPAs and analysis of potential benefits of MPAs as a tool for small-scale fisheries management of demersal resources.



Demonstration Project 5:

Development of a regional mangrove conservation plan with pilot mangrove restoration actions

Participating countries: Senegal, the Gambia, Guinea-Bissau and Guinea

Mangroves are highly important ecosystems in terms of natural productivity and biodiversity and they also play an extremely important socio-economic role, as many people depend on them for their livelihoods. Mangroves are threatened throughout the world and according to FAO, 25 percent of the mangrove surface area has been lost since 1980 (FAO, 2007). In the CCLME region, generic underlying causes such as dam construction, urban development, climate change, upland deforestation, mariculture, irrigation schemes, absence of alternative energy sources and a lack of habitat conservation strategies have been linked to the degradation. This project aims to help improve the knowledge, abilities and instruments necessary for the conservation of mangrove habitats in the CCLME region. It supports the demonstration of the benefits of protecting these habitats and the testing of conservation approaches that can be replicated in other areas. This project is contributing towards the development of a regional mangrove charter to be adopted by countries as a protocol to the Abidjan Convention. The project activities are implemented in collaboration with Wetlands International, IUCN and UNEP-WCMC.

1.2.3.2 Surveys conducted

Based on the transboundary issues identified, the ecosystem surveys planning and analysis working group reviewed the available knowledge and identified critical gaps that would need to be addressed in order to improve understanding of the CCLME ecosystem at both the regional and national level. Ecosystem and specific surveys were prioritized with the R/V *Dr Fridtjof Nansen* through cooperation between the EAF-Nansen Project and the CCLME Project. The surveys conducted within the framework of the implementation of the CCLME Project and their objectives are listed below.

Survey 1: Ecosystem survey in the EEZ of Cape Verde

Survey area/countries: EEZ of Cape Verde
Survey dates: 4 to 22 June 2011

Background: in June 2011 the EAF-Nansen Project in partnership with the West African Regional Fisheries Project (WARFP-CV), the CCLME Project and the General Directorate of Fisheries of Cape Verde undertook a 16 day ecosystem baseline survey in Cape Verde with the R/V *Dr Fridtjof Nansen* to study pelagic and demersal fish resources and the marine ecosystem. The survey was financed in part by the government of Cape Verde through the Regional Programme for West African Fisheries (PRAO).

Objective: the main objectives of the survey were as follows:

- To determine the distribution and abundance of small pelagic fish resources along the coast of Cape Verde using acoustic methods and a systematic grid survey strategy.
- Obtain information on demersal fish abundance and biodiversity by demersal trawling where bottom-trawlable conditions exist.
- To use regular midwater and bottom trawls on target fish aggregations for species composition, biological information and genetic material of selected small pelagic fishes for fisheries resource assessment purposes.
- To establish as far as possible the distribution, abundance and composition of other organisms at a number of trophic levels along the shelf (phytoplankton, zooplankton, cetaceans, seabirds and benthos biodiversity).
- Capacity building of CCLME and Cape Verdean trainees and young scientists.

Survey 2: Regional pelagic survey

Survey area/countries: from Senegal to Guinea
Survey dates: 22 June to 7 July 2011
Background: The survey was conducted in collaboration with the EAF-Nansen Project as an extension of the national surveys of the small pelagic resources by the Moroccan R/V *Al-Amir* and the Mauritanian R/V *Al-Awam*.

Objective: the general objectives of the survey were to estimate biomass and map the distribution of small pelagic fish stocks off Northwest Africa (Senegal, the Gambia, Guinea-Bissau and Guinea) by hydro-acoustic methods and describe the hydrographic conditions in the region over a period of 16 days, during June to July 2011. The agreed objectives were as follows:

- To map the distribution and estimate the biomass for the main small pelagic fish using hydro-acoustic methods. The species of interest were: sardinellas (*Sardinella aurita* and *S. maderensis*), horse mackerel (*Trachurus trecae*), false scad (*Caranx rhonchus*), and anchovy (*Engraulis encrasicolus*).
- To identify and describe the size distribution of the target fish populations by midwater and bottom trawl sampling and process the catches by recording weight and number by species.
- To collect biological data of the main target species, especially *Sardinella aurita, S. maderensis* and *Trachurus trecae*.
- To sample standard hydrographical transects for temperature, salinity and oxygen.
- To train local participants in acoustic survey methodology, including fish identification and sampling, scrutinizing of echograms, hydrographic sampling and abundance estimation.

Survey 3: Regional ecosystem survey # 1

Survey area/countries: from Morocco to Guinea
Survey dates: 20 October to 21 December 2011

Background: the participants of the second meeting of the working group on planning and analysis of ecosystem surveys in the CCLME area held in Casablanca Morocco, 30 to 31 May 2011, identified the need for an ecosystem survey along the Northwest African coast to establish a regional "state of ecosystem" reference, collecting data on all major determinants of the Canary Current ecosystem. The working group outlined the specific priorities in terms of thematic sampling to be achieved during the regional ecosystem survey (CCLME, 2011d), which was the first of its kind in the region.

Objective: the main objective was to collect data on all major determinants of the Canary Current ecosystem to establish a regional state of ecosystem reference. Based on the sampling priorities set by the survey planning and analysis working group the main objectives, were as follows:

- To obtain information on demersal fish abundance and biodiversity by demersal trawling where conditions for bottom-trawling are suitable.
- To determine the distribution of small pelagic fish resources in the survey region using acoustic methods and a systematic grid survey strategy.
- Additional biological sampling from trawl catches to collect data on size distribution, further biological information and genetic material from selected species.
- To establish as far as possible the distribution, abundance and composition of other taxa at different trophic levels along the shelf (phyto- and zooplankton, egg and fish larvae, cetaceans and seabirds and benthic biodiversity).
- To map the environmental conditions in the survey area (temperature, salinity, oxygen, chlorophyll, nutrients and sediments).
- Capacity building of CCLME trainees and young scientists.

Survey 4: Regional ecosystem survey # 2

Survey area/countries: from Morocco to Guinea
Survey dates: 8 May to 18 July 2012

Background: The general objectives of the R/V *Dr Fridtjof Nansen* ecosystem surveys were established during the second meeting of the working group on planning and analysis of ecosystem surveys in the CCLME area held in Casablanca, Morocco in 2011 and further refined for the second survey based on experiences of the survey during the third meeting of the working group held in Casablanca, Morocco from 29 to 30 March 2012.

Objective:

- To obtain information on demersal fish abundance and biodiversity by demersal trawling where conditions for bottom-trawling are suitable.
- To determine the distribution and abundance of small pelagic fish resources using acoustic methods and a systematic grid survey strategy.
- Additional biological sampling from trawl catches to collect data on size distribution, further biological information and genetic material from selected species.
- To establish as far as possible the distribution, abundance and composition of other taxa at different trophic levels along the shelf (phyto-and zooplankton, egg and fish larvae, cetaceans and seabirds and benthic biodiversity).
- Map the environmental conditions in the survey area (temperature, salinity, oxygen, chlorophyll, nutrients and sediments).
- Capacity building of CCLME trainees and young scientists.

Survey 5: Reproduction study survey of pelagic fish

Survey area/countries: targeted areas in Senegal and the Gambia

Survey dates: 1 to 23 May 2013

Background: information on the distribution of eggs and larvae of sardinella and anchovy have been identified as a major gap in knowledge in the subregion. A survey addressing this issue had therefore been prioritized by the survey data and analysis working group.

Objective: the aim of the survey was to define the distribution of eggs and larvae of sardinella and anchovy in the region south of Cape Verde. The horizontal and vertical distributions of the eggs and larvae were mapped and related to mapping of water mass circulation and frontal boundaries.

Specific objectives of the survey included:
1. Identify the distribution area of sardinella and anchovy egg and larvae south of Cape Verde.
2. Identify oceanographic features that are affecting their distribution.
3. Explain the retention and distribution mechanisms of the eggs and larvae in the survey area.

1.3 References

Caramelo, A. 2010. *Resources and fisheries in the CCLME – some perspectives of management*. Paper prepared for the CCLME Inception Workshop. Dakar, Senegal, 2–3 November 2010.

CCLME Project. 2010c. Report of the first CCLME Project Steering Committee meeting. November 4, 2010, Dakar, Senegal.

CCLME Project. 2011d. Report of the second meeting of the working group on ecosystem survey planning and analysis in the CCLME area. 30–31 May 2011, Casablanca, Morocco.

CCLME Project. 2011e. Report of the second meeting of the Project Steering Committee. 28–29 November 2011, Casablanca, Morocco.

CCLME Project. 2012f. Report of the second meeting of the working group on Transboundary Diagnostic Analysis. 13 to 15 June 2012, Dakar, Senegal.

CCLME Project. 2012n. Report of the CCLME third Project Steering Committee. 29–30 November 2012, Santa Cruz de Tenerife, Spain.

CCLME Project. 2013g. Report of CCLME fourth Project Steering Committee. 2–4 December 2013, Banjul, the Gambia.

FAO. 2007. The world´s mangroves. FAO: Forests. No. 153. Rome, FAO.

FAO. 2009. Protection of the Canary Current Large Marine Ecosystem. FAO/GEF Project Document. Project GCP/INT/023/GFF.

FAO. 2015a. FAO Fishery Committee for the Eastern Central Atlantic. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – subgroup north. Fuengirola, Spain, 18 to 27 November 2013. CECAF/ECAF Series. Rome, FAO.

FAO. 2015b. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Casablanca, Morocco from 20 to 25 July 2015. FAO Fisheries and Aquaculture Report. No. 1122. Rome, FAO. 173 pp.

FAO. 2015c. Report of the FAO/CECAF Working Group on the Assessment of Small Pelagic Fish – subgroup south. Pointe Noire, Congo, 17–23 March 2014. CECAF/ECAF Series No. 15/75. Rome, FAO. 157 pp.

GEF. 2006. *International Waters Resource Guide*. New York, 29 March 2006.

Heileman, S.S.W. & Tandstad, M. 2008. Canary Current LME. *In* The UNEP Large Marine Ecosystem report: a perspective on changing conditions in LMEs of the world's regional seas. UNEP Regional Seas Report and Studies No. 182. Nairobi, United Nations Environment Programme. p. 131–141.

Interwies, E. & Görlitz, S. 2013. Economic and social valuation of the CCLME ecosystem services. *Rapport du Groupe de travail socio-économie et commerce du CCLME*. 50 pp.

Sambe, B. 2009. *État des pêcheries et des stocks des pays. Projet Bonne gouvernance et gestion durable des pêches au sein de la CSRP – Document de consultation.* FAO/Banque Mondiale (in French only).

UNDP. 2013. Human Development Report. Washington, United Nations Development Programme.


CANARY CURRENT LARGE MARINE ECOSYSTEM
CCLME

Section 2: State of knowledge

The LME approach, which is structured around five modules including: **1)** productivity, **2)** fish and fisheries, **3)** pollution and ecosystem health, **4)** socio-economics and **5)** governance will be used to present the state of knowledge in the ecosystem. By way of introduction, general considerations are provided with respect to the history, physical characteristics, sediment composition and climate of the CCLME region.

2.1 General considerations

2.1.1 A brief history of the CCLME

Before the Holocene, it is likely that the global circulation of the Atlantic Ocean was very different from the one we know today. An ice sheet covered almost all of Europe and North America and the sea level was more than 100 m below present levels. The Canary Current, as derived from the Gulf Stream, is thought to have been established around 10 000 BP (before present) at the end of the last glaciation. As with all surface currents, the Canary Current is closely connected to the wind conditions, whose regime has also changed over the ages. Shifts in the climatic conditions through the millennia will have influenced the productivity and availability of marine natural resources to coastal populations along the northwest coast of Africa (Vernet and Barusseau, 2011). Key charactercteristics included:

- Climatic optimum period between 10 000 and 7 000 BP, with significant rainfall and a weak Canary Current south of 21 °N.
- Period of pronounced aridity between 7 500 and 7 000 BP, characterized by strong Canary Current and prevailing north winds, accompanied by an intense upwelling.
- Between 7 000 and 6 000 BP, the region experienced a climate marked by an alternation of dry and rainy seasons, similar to the current situation.
- From 5 500 BP, the climate became more wet and hot again, dominated by the monsoon, with a weakening of the Canary Current and an increase in river discharge, in particular in Senegal.
- Since 4 000 BP until today, arid and humid episodes have alternated, the first being significantly longer and more intense than the latter, preventing a return to the conditions of climatic optimum and suggesting that the regime of the Canary Current remained important, although of varying intensity.

The marine natural resources have varied accordingly, as coastal populations were faced with quite different living conditions during different periods and in different regions.

In the Canary archipelago, inhabited as early as 3 000 BP, pre-Hispanic populations have fished and consumed fish regularly, according to the accessibility and seasonal availability of the different species. On Gran Canaria island, the small pelagic species (clupeidae, anchovies, mackerel) constituted the vast majority of fish consumed, whereas on the island of Tenerife, coastal demersal species including parrotfish and sparidae were dominant in the diet (Rodríguez-Santana, 1995).

The Holocene has been little studied in Morocco, but coastal fishes of the mid-Atlantic have been fished on a regular basis, while molluscs were little exploited.

In Mauritania, which is the most studied area for the Holocene, the economies of coastal populations have clearly adapted to the succession of arid and humid episodes over the past 7 000 years. In Lévrier Bay, for example, fishers intensively exploited croaker (*Argyrosomus regius*) around 6 750 BP, while also consuming land snails. From 6 000 BP, Lévrier Bay and the Banc d'Arguin became the site of an intense consumption of ark clams (*Anadara senilis*) and mangrove oysters. These species are considered indicators of warm waters and taken as a sign of a significant slowdown of the upwelling of the Canary Current at this latitude during this period. Around 2 800 BP, an important fish weir was built East of Lévrier Bay allowing for the exploitation of primarily warm water species.

Shell clusters consisting of ark shells underwent a considerable expansion throughout the Nouakchottien period (6 000–4 000 BP), extending all the way to the south of the Senegal River. Subsequently, and especially from 3 000 BP, analysis of the remains of shell molluscs consumed by humans found between Cape Timiris and the estuary of the river Senegal consisted primarily of *Donax rugosus*, a telline species found on highly dynamic shorelines, proof that the hydrological system changed significantly, and not only in terms of temperature (Vernet and Barusseau, 2011).

In Senegal, and especially south of Cape Verde, these shell clusters continued to be discovered, containing mixtures of ark clams and mangrove swamp oysters, as documented in the Sine-Saloum (Descamps *et al*., 1974) and Guinea-Bissau. Fishing does not seem to have appeared until 2 000 BP, but experienced an exceptional growth in the present era, especially in the coastal area north of Dakar North, where the combined effects of the Canary Current and the wind regime contribute to an increased abundance of small pelagic fishes.

There is a long history of marine and coastal resource use and trade between the countries within the CCLME region that dates back to the dawn of civilization. The northern part of this region was part of the Roman Empire and accounts suggest that the Romans also knew of the Cape Verde islands and areas further south, because there were trade routes through western Morocco. Between 400 and 700 AD various kingdoms were established in the Sahel that led to the formation of large empires: first the Ghana Empire, followed by the Mali Empire and finally the Songhai Empire, all of which extended to the coast. Accounts suggest that fishers from the region knew of the Cape Verde islands and that there were also links and attempts to establish trade between these kingdoms and the Americas (El Fasi and Hrbek, 1992; Ki-Zerbo and Niane, 1997; Van Sertima, 1976; Ogot, 1999).

The expansion of Islam along the trade routes through the 7th to 9th century increased the connectivity within the CCLME region. The fall of the Songhai Empire in 1591, following an invasion from Morocco with superior firepower, led to the formation of a number of smaller kingdoms which proved vulnerable to the European slave trade, followed by colonization. This further expanded trade connections, introduced new languages and new religions. The boundaries created during European occupation split ethnic groups and cultural connections within and between these groups. Fishing and trade continue to transgress these national boundaries as they have done for centuries.

2.1.2 Physical characteristics

2.1.2.1 Coastal topography

The vast plateaus and the Atlas Mountains in Morocco that border the Atlantic constitute the highest elevation in the region, with peaks that can reach between 3 000 and 4 000 m above sea level. They are separated from the coast by a narrow coastal plain, which then widens into the low-lying areas in the Sahelian zone to the south. There are a few hilly outcrops in Mauritania and some low foothills in the southeast of Senegal, with the highest point above sea level being 581 m near Nepen Diakha. From the Sine Saloum Delta southwards the coastal topography is generally low lying and this continues, with the addition of an increasing number of flood plains, further south. The Gambia is almost entirely composed of floodplains flanked by low hills with a maximum elevation of 53 m above sea level. Guinea-Bissau is also dominated by low coastal plains, with savannah in the northeast and a maximum elevation of 300 m above sea level. Guinea has low coastal plains and hills and a mountainous interior rising to 1 752 m above sea level at Mount Nimba. The Cape Verde and Canary Islands are contrastingly steep, rugged and rocky volcanic terrain.

2.1.2.2 Coastal geology

The geology of the northwest coast of Africa, as far north as the Anti-Atlas Mountains in Morocco, consists of a precambrian granitic basement rock (dated at 2 700 to 1 600 mya) covered by a thin sedimentary blanket layer (some of which formed 1 000 mya). The basement rock is part of the African shield, the largest shield in the world (Dillon and Sougy, 1974).

Sediment deposition apparently occurred during the Paleozoic, when ancient seas overlaid the continent. Basin sediments are generally (epicontinental) marine and continental types and include a mixture of shales, sandstones and stromatolite limestones (1 000 to 650 mya), tillites, green shales, red beds, and Lower Ordovician sandstone (650 to 440 mya), and Silurian black graptolitic shale, which was deposited during a eustatic transgression (440 mya) (Dillon and Sougy, 1974).

Large structural plate movements (500–650 mya) resulted in the separation of Africa, North America and South America. This split created a paleo-Atlantic ocean, which later closed due to subduction. The movements, however, affected the borders of the West African massif and resulted in the folding of the sedimentary layers along the Atlantic coast eastwards, forming the Mauritanides mountain chain and the high plains and plateaus of the Morroccan Meseta (Dillon and Sougy, 1974).

The present North Atlantic basin was created later by rifting during the Late Permian and Triassic and these expansion movements also resulted in volcanic activity. The rift zone subsided below sea level and sea water invaded, bringing about deposition of salt and the formation of diapirs. Relatively unrestricted oceanic circulation was established in the Jurassic and true marine deposits began to accumulate. The Senegal basin, for example, contains both thick Jurassic limestones and sands to the east. Mesozoic sedimentation continued on the present continental shelf area and the coastal basins (Dillon and Sougy, 1974).

The Cape Verde and Canary Islands are oceanic volcanoes. The islands probably began to form by submarine volcanic processes prior to the end of the Jurassic, because there are deposits of limestone and sediments from the Late Cretaceous. From the middle Cretaceous and upper Miocene times a major tectonic disturbance caused upwarping of the islands. The basement rock of both island groups is comparable and both are covered largely by Tertiary and Quaternary coastal sediments. The more recent volcanic rocks were probably erupted in Miocene and Quaternary times and Fogo island last erupted in 1951 (Dillon and Sougy, 1974).

The west coast shelves of West Africa were eroded during the late Tertiary and Pleistocene. The present shelves are covered mainly by relict sands with a few areas of Holocene silts on the midshelf and some Holocene deltas (submarine river basins) where silt and clay accumulate in the southern, tropical zone (Dillon and Sougy, 1974).

2.1.2.3 Topography and geology of the seafloor (seamounts and mud volcanoes)

Seamounts, underwater knolls, hills, ridges and mud volcanoes are prominent topographic features on the seabed. Such features are often classified by their elevation: seamounts are generally > 1 000 m, while knolls and hills are between 500 to 1 000 m and hills c. 500 m. Seamounts usually originate as volcanoes, and most are associated with tectonic hotspots, mid-ocean ridges or island arcs. Mud volcanoes are by comparison constructed by the extrusion of cold fluids containing mud, saline water and/or gases, which are expelled upwards from a deep pressurized source.

Out of 34 seamounts listed by the Regional Network of Marine Protected Areas in West Africa and covering Mauritania, Senegal, Cape Verde, the Gambia, Guinea-Bissau, Guinea and Sierra Leone, 65 percent are located in Cape Verde, 15 percent in Guinea, 12 percent in Guinea-Bissau and 9 percent in Senegal (Tendeng *et al*., 2012).

Many mud volcanoes have been discovered in the CCLME region. A first group was discovered in 1999, during surveys off the coast of Morocco in the Gulf of Cádiz (Ivanov *et al*., 2000; Gardner, 2001). Since then, more mud volcanoes have been found in the adjacent areas (Somoza *et al*., 2003; Pinheiro *et al*., 2003; Van Rensbergen *et al*., 2005). Another cluster of mud volcanoes was discovered in 2002 also off the coast of Morocco (Van Rensbergen *et al*., 2005; Foubert *et al*., 2008) and a further eight volcanoes were discovered more recently further west (Leon *et al*., 2012). Mud volcanoes in this area form a continuous cluster of cone-shaped morphologies and support cold-water corals (Foubert *et al*., 2008).

2.1.3 Sediment composition in the CCLME area

During two ecosystem surveys organized by the CCLME and EAF-Nansen projects covering the continental part of the CCLME area between Morocco in the north to Guinea in the south, sediment samples were collected to analyse their composition. The sediment composition influences species distribution, because some species are associated with sandy bottoms while others are associated with rocky or muddy substrates. A total of 189 samples were collected using a sediment trap located in the trawl net. These samples were sifted by distinguishing the following grain sizes: > 4 mm, > 2 mm, > 1 mm, > 0.5 mm, > 0.25 mm, > 0.125 mm, > 0.063 mm, < 0.063 mm. Only spectra defined by size were used to distinguish between different types of sediment.

For the Mauritanian continental slope area additional information from 68 sediment samples collected during four surveys conducted by the project ECOAFRIK in 2007, 2008, 2009 and 2010 (MAURIT-1107, MAURIT-0811, MAURIT-0911 and MAURIT-1011 surveys) together with the reflectivity images obtained from the multibeam echosounder was also available. Finally, information was compiled by geo-referencing different historical maps that existed in the region:

- Sedimentological map of the Guinean continental shelf (1:200 000), National Centre of Fishery Resources of Boussoura (1993);
- Sedimentological map of the Mauritanian continental shelf (1:200 000), National Oceanographic Research and Fisheries Centre (1985);
- Map of the seabeds of the Senegambian continental shelf, Senegalese Institute of Agricultural Research, Oceanographic Research Centre of Dakar – Thiaroye (1974);
- Map of the seabeds of the Senegalo-Mauritanian continental shelf, Senegalese Institute of Agricultural Research, Oceanographic Research Centre of Dakar – Thiaroye;
- Sedimentological map of the Senegambian continental shelf (1:200 000), Office of Scientific and Technical Research Overseas, Oceanographic Research Centre of Dakar – Thiaroye (1977).

All of the above information, including the analysis of the sediment samples, was included in a geographic information system database. Five sediment classes (mud, sandy mud, muddy sand, sand and gravel) have thus been distinguished, using the Folks´s triangle (Folk, 1954) and the results are shown in Figure 3. Furthermore, two additional classes: coral and rock have been added and are also shown.

Figure 3 shows that the area south of the Cape Verde peninsula is dominated by sand, muddy sand and sandy mud sediments. The northern part of Senegal and Mauritania are dominated by muddy sand and sandy mud. Some coral-dominated areas were also identified. In the northern zone, the dominant bottom type is sand.

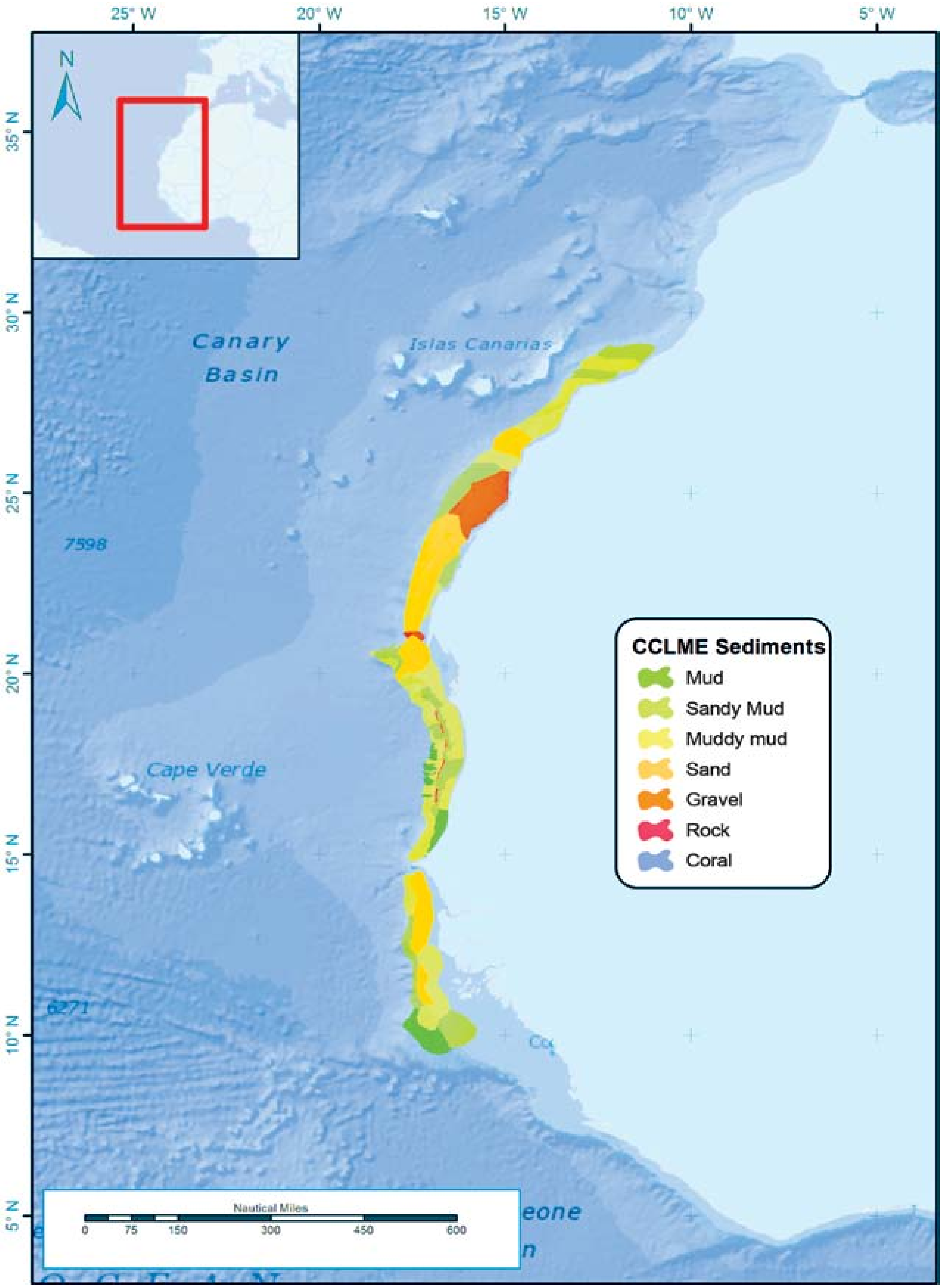


Figure 3: Bottom types in the CCLME

2.1.4 Climate

In general the CCLME is subject to two alternating seasons: a dry or cold season (January to May) and a wet or hot season (July to October), marked by shorter inter-seasonal transitions. During the cold winter season, trade winds blow from the northeast. During the transitional months before summer (May and June), the Inter-Tropical Convergence Zone (ITCZ) moves north and the trade winds gradually weaken. The wet (hot) season commences in July, when the more variable and weaker monsoon wind regime starts blowing from the southwest. As the trade winds start to blow again from the northeast during the transitional months at the end of the year (October and November), temperatures begin to cool, signalling the start of the cold (dry) season.

Together with these seasonal changes there are also significant latitudinal variations in climatic conditions that influence marine and coastal environments and the availability of resources within the CCLME. The climate ranges from an arid and semi-arid Mediterranean climate in the north, to a semi-arid and arid desert in the far south of Morocco, to a Sahelian climate which starts from the Senegal River Valley, shifting to a wet tropical climate that extends from the Sine Saloum Valley to the southern border of the CCLME Project area. The Canary and Cape Verde Islands have a more characteristically temperate climate, with warm dry summers and low rainfall.

Rainfall over the region exhibits high spatial and temporal variability. The mean annual rainfall ranges from as little as 10 mm in Mauritania to more than 2 000 mm in parts of the equatorial regions of Guinea, Guinea-Bissau and the Gambia (UNEP, 2005). The coefficient of rainfall variability in the CCLME area exceeds 200 percent in the deserts, whereas it is about 40 percent in most semi-arid areas and between 5 and 20 percent in the wettest areas (IPCC, 2001).

The region has several significant drainage systems, some of which are highly seasonal and dependent on rainfall patterns (UNEP, 2005). In the south there are the major rivers of Senegal and the Gambia and in the north there are the Loukkos, Sebou, Bouregreg, Nefifikh, Mellah, Oum Errabia, Tessaout, Lakhdar, Tensift, Ksob, Tamri, Souss, Massa, Noun and Drâa rivers. The total renewable fresh water resources within the CCLME region are about 342 km³ per year. The highest volume is received by Guinea (226 km³ per year), while the Cape Verde Islands receive the lowest (0.3 km³ per year) (Table 2). The total freshwater withdrawal is approximately 15 km³ per year and agriculture accounts for more than 80 percent of the water withdrawals, with Morocco having the highest withdrawal rate (Table 2).

Table 2: Renewable water resources and freshwater withdrawal in the CCLME region (Gleick, 1998)

	Renewable water resources (km³/year[1])	Total freshwater withdrawal (km³/year[1])	Use (%)		
			Domestic	Industrial	Agricultural
Morocco	30,0	11,05	5	3	92
Mauritania	11,4	1,63	6	2	92
Senegal	39,4	1,36	5	3	92
The Gambia	8,0	0,02	7	2	91
Cape Verde	0,3	0,03	10	2	88
Guinea	226,0	0,74	10	3	87
Guinea-Bissau	27,0	0,02	60	4	36
Total	**342**	**15**	-	-	-
Average			**15**	**5**	**83**

2.1.5 References

Descamps, C., Thilmans, G. & Thommerand, Y. 1974. *Données sur l'édification de l'amas coquillier de Dioron Boumak (Sénégal). Bulletin de liaison no 41 (juin 1974). Association sénégalaise pour l'étude du quaternaire de l'Ouest africain.*

Dillon, W.P. & Sougy, J.M.A. 1974. Geology of West Africa and Canary and Cape Verde Islands. *In* A.E.M Nairns *et al*., eds. *The Ocean Basins and Margins*. New York, Plenum Press, p. 315–390.

El Fasi, M. & Hrbek, I. 1988. General history of Africa, III: Africa from the seventh to the eleventh century. Paris, UNESCO. 870 pp.

Folk, R.L. 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. *Journal of Geology,* 62 (4): 344–359.

Foubert, A., Depreiter, D., Beck, T., Maignien, L., Pannemans, B., Frank, N., Blamart, D. & Henriand, J.P. 2008. Carbonate mounds in a mud volcano province off north-west Morocco: key to processes and controls. *Marine Geology*, 248: 74–96.

Gleick, P.H. 1998. The world's water. *Issues in science and technology*, 14(4): 80–88.

Gardner, J.M. 2001. Mud volcanoes revealed and sampled on the Western Moroccan continental margin. *Geophysical Research Letters*, 28: 339–342.

Ivanov, M.K., Kenyon, N., Nielsen, T., Wheeler, A., Monteiro, H., Gardner, J., Comas, M., Akhmanov, A. & Akhmandzhanov, G. 2000. Goals and principal results of the TTR-9 cruise. *Rapport de l'atelier COI*., 168: 3–4. Paris. UNESCO.

IPCC. 2001. *Full Assessment Report of the IPCC* (Intergovernmental Panel on Climate Change).

Ki-Zerbo, J. & Niane, D.T. 1997. General history of Africa, IV: Africa from the twelfth to the sixteenth century. Paris, UNESCO. 294 pp.

Leon, J.X., Phinn, S.R., Hamylton, S. & Saunders, M.I. 2013. Filling the "white ribbon" – a multisource seamless digital elevation model for Lizard Island, northern Great Barrier Reef. *International Journal of Remote Sensing*, 34 (18):6337–6354. DOI:10.1080/01431161.2013.800659.

Ogot, B.A. 1992. General history of Africa, V. Africa from the sixteenth to the eighteenth century. Paris, UNESCO. 1046 pp.

Pinheiro, L.M., Ivanov, M.K., Sautkin, A., Akhmanov, G., Magalhães, V.H., Volkonskaya, A., Monteiro, J.H., Somoza, L., Gardner, J., Hamoumi, N. & Cunha, M.R. 2003. Mud volcanism in the Gulf of Cadiz: results from the TTR-10 cruise.. *Marine Geology,*195(1–4): 131–151.

Rodriguez-Santana, C. 1995. Fishing in the Hispanic economies Canary Islands. Prehistoric man and the sea. *120e congrès du Comité des travaux historiques et scientifiques* (CTHS). Aix-en-Provence, France, 23–26 October 1995.

Somoza, L., Diaz-del-Rio, V., León, R., Ivanov, M., Fernández-Puga, M.C., Gardner, J.M., Hernández-Molina, F.J., Pinheiro, L.M., Rodero, J., Lobato, M., Maestro, A., Vázquez, J.T., Medialdea, T. & Fernández-Salas, L.M. 2003. Seabed morphology and hydrocarbon seepage in the Gulf of Cadiz mud volcano area: acoustic imagery, multibeam and ultra-high resolution seismic data. *Marine Geology,* 195(1– 4): 153–176.

Tendeng, P.S., Ba, T. & Karibuhoye, C. 2012. *Analyse des lacunes écologiques du réseau régional d'aires marines protégées en Afrique de l'Ouest (RAMPAO)*. Final report.

UNEP. 2005. *Canary Current, GIWA regional assessment 41*. *In* M. Tayaa, A. Saine, G. Ndiaye & M. Deme, eds. Global international waters assessment. University of Kalmar, Kalmar, Sweden. 76 pp. + appendices.

Van Rensbergen, P., Depreiter, D., Pannemans, B. & Henriet, J.P., 2005. Seafloor expression of sediment extrusion and intrusion at the El Arraiche mud volcano field, Gulf of Cadiz. *Journal of Geophysical Research-Earth Surface*, 110 (F2). F02010, 13 p.

Van Sertitma. 1976. *They came before Columbus.* New York, Random House.

Vernet, R., Barusseau, J.P., *et al*. 2011. *L'économie du littoral atlantique saharien au Néolithique In Boulay S. and Lecoquierre B., eds. Le littoral Mauritanian à l'aube du XXIe siècle: Peuplement, gouvernance de la nature, dynamiques sociales and culturelles.* Karthala, Paris. 430 pp.

2.2 Productivity

The Canary Current is a wind-driven surface current that flows continuously north to south connecting the countries along the northwest coast of Africa. As the trade winds blow parallel to the coast, they generate coastal upwelling, drawing cooler, nutrient laden deeper waters to enrich the surface ecosystem. The interaction between this current and seasonal change in the ocean-atmospheric dynamics drives the productivity in the CCLME area. The interaction between the current and coastal topographic and bathymetric features introduces further mesoscale variability. An area of permanent upwelling exists from Morocco to Senegal. The Canary and Cape Verde islands deflect the currents, creating variability in the productivity regime around the islands. Furthermore, the estuaries and near-coastal waters from the Gambia to Guinea introduce additional nutrients from land-based sources driving coastal processes.

2.2.1 Oceanography

2.2.1.1 The Canary Current

The Canary Current forms the eastern branch of the North East Atlantic subtropical gyre and runs along the coast of Northwest Africa. Typically located between the surface and 500 m depth, the Canary Current has an average speed of 0.5 knots (10–30 cm/s). The width of influence of this current can extend 1 000 km offshore and its flow rate is 16 106 m^3/s (Orbi *et al*., 1998). While the speed of the Canary Current is strongest near the coast and weaker offshore, the width of the current is such that its influence extends to the Canary Islands (Bas, 1993). It can reach a speed of two or more knots when the winds blow from the north or northeast.

The Canary Current is characteristically cold (~18 °C in summer), as it is fed by waters originating from more northern latitudes and by the upwelling of cold, deep, nutrient enriched waters. The cooler waters that well up along the Atlantic coast of Northwest Africa are brought along with the current and transported towards the equator, driving productivity southwards (Mittelstaedt, 1991). The cooler waters are mixed with warmer water masses as they move past the coast of Mauritania and Senegal.

2.2.1.2 Surface circulation

The Canary Current flowing south towards the equator along the African coast leaves the coast at Cape Blanc near 21°N to flow west into the North Equatorial Current (NEC) (Figure 4a and b), fed from the north by both a weak southward Portugal Current (PC) and the eastward Azores Current, which brings water from the North Atlantic Central Water (NACW).

Like all Eastern upwelling areas the CCLME is connected to the equatorial counter-currents flowing on the surface/sub-surface along the subtropical convergence (between the latitudes 4°N and 10°N). This current system divides into two branches as it approaches the African continent (around 20°W and 15°W). One of the branches flows round the eastern flank of the Guinea Dome and flows along the Northwest African coast towards the north and the other branch flows towards the southeast to form the Guinea Current (Voiturier and Herblanc, 1982). The northern branch of this system transports the South Atlantic Central Water (SACW) flowing towards the continental slope in a relatively narrow band (30–60 km wide) located at a shallow depth off Senegal and sinking as it progresses northwards. Its core is located at depths of 100 to 200 m south of Cape Blanc, at 400 to 500 m around 25°N and 500 to 1 000 m around 30–34°N (Mittelstaedt, 1983). The undercurrent transport represents an important source of upwelling at the coast in the places where it has not yet dropped below the maximum depth of the upwelling cell, notably south of Cape Blanc (Mittelstaedt, 1983; Voiturier and Herbland, 1982). This recirculation feature is sometimes referred to as the "Guinea Dome". Part of the northward flow from this system continues beyond the water mass at Cape Blanc as an undercurrent, trapped against the continental slope, travelling possibly as far north as the Iberian Peninsula.

South of 10°N, the currents are generally oriented eastwards and they are well developed in the upper 50 m. Currents south and southeast of the Guinea Dome interact with and are intensified by the North Equatorial Counter Current (NECC). The flow of water easterly from the NECC then splits into two branches at around 22 to 23°W. The southern branch flows into the Guinea Current, feeding warm tropical waters eastwards. The flow of the northern branch is below the southern branch and the intensity drops sharply with depth.

2.2.1.3 Seasonal variability

Oceanography and productivity in a large part of the CCLME (notably south of Cape Blanc) shifts with the two main seasons, associated with the movement of the Intertropical Convergence Zone (ITCZ) and the trade winds as follows (Figure 4a and b):

- **Cold season (January to May):** the northeast trade winds blow in the dry season and the cooler waters in the northern area start to expand and spread southwards. The winds are deflected by the Coriolis force and push the surface coastal waters offshore, which create upwelling that draws the cooler, deeper water to the surface. Upwelling spreads along the entire coast of Mauritania and Senegal as far south as the Bijagos Archipelago in Guinea-Bissau. These cooler waters tend to remain over the continental shelf, while offshore temperatures around the Canary Islands are between 24 and 27 °C.
- **Transition (May to June):** during the transitional months of May and June, the ITCZ moves north, and the trade winds weaken as the area of influence of the ITCZ retracts northwards. As the winds drop, the cold water is gradually covered by the warmer, salty, tropical waters of the NECC (T > 24 °C, S < 35‰) to the south of 16°N in May.
- **Hot season (July to October):** the hot season commences in July when the more variable and weaker monsoon wind regime starts blowing from the southwest. The influence of the NECC increases in the wet season and the Canary Current does not extend south of 15°N and east of 20°W. The warm waters reach their maximum extension north. In September and October the onset of the Cape Blanc upwelling cools surface waters.
- **Transition (November to December):** warm waters continue to withdraw to the south and coastal upwellings (Cape Blanc, Cape Timiris, Cape Vert) appear with the return of the trade winds.

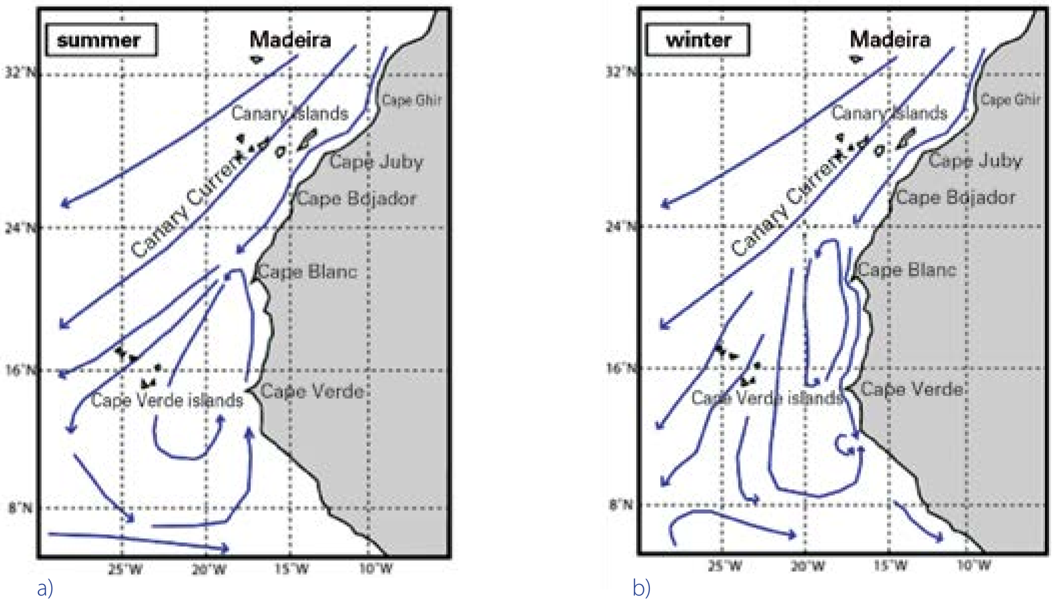


Figure 4: Surface current for (a) summer and (b) winter (after Barton *et al.*, 1998)

2.2.1.4 Sea water temperature

Sea water temperatures exhibit strong seasonal variability, varying by more than 12 °C (Rébert, 1983). In the southern zone of the CCLME, temperatures vary from 16 to 18 °C in February to March and then rise to 26 to 28 °C in September to November. Persistent upwelling of cold water mixed with the warmer tropical waters carried by the equatorial counter current gradually expands across the entire region from June to November.

2.2.1.5 Salinity

Seasonal climatic variability influences the salinity as well as the temperature regimes (Berrit and Rebert, 1977; Rossignol and Aboussouan, 1965). During the cold season, cool saline water (T < 24 °C, S > 35 parts per thousand, ‰) spreads over the northern area and expands over the continental shelf of Morocco and Mauritania by January. Salinity may decrease in some coastal areas owing to mixing with freshwater inflows. Through the summer months, salinity steadily increases as a result of evaporation (36 ppt) until June or until the start of the rainy season. Salinity then declines at the start of the rainy season, as the tropical waters mix with rainwater and freshwater inflows (T > 24 °C, S < 35 ‰) from major rivers in the Guinean region. Strong longitudinal variations in temperature and surface salinity may be observed in coastal areas during upwelling because the mixed water layers are found at the surface.

2.2.2 Upwelling

Coastal upwelling along the eastern boundary of the North Atlantic sub-tropical gyre enhances the productivity along the northwest coast of Africa. The upwelling is present throughout the year from Morocco to Cape Blanc and seasonal south of Cape Blanc (Wooster *et al*.,1976). Factors that influence the mesoscale variation in the upwelling include the formation of upwelling filaments, the coastline configuration, shelf width, nutrient fertilization and retentive versus dispersive physical mechanisms. These different factors influence variations in primary and secondary productivity, fish distribution and abundance patterns in the CCLME.

2.2.2.1 Permanent upwelling

In the extreme north of the CCLME area, the Gulf of Cadiz is sheltered from Cape Vincent to Cape Beddouza. While there is the weak local upwelling on the northern Portuguese coast, the orientation of the southern Moroccan coastline within the Gulf of Cadiz is not conducive to upwelling, depending on the wind direction (Nykjaer and Van Camp, 1994). South of the Gulf of Cadiz on the Atlantic Coast is an area of permanent year-round upwelling that extends from 32 to 20°N. The upwelling in this region is driven by the winds constantly blowing north-south and is strongest in late summer (July to September) (Wooster *et al*., 1976).

2.2.2.2 Seasonal upwelling

The upwelling zone expands south of 20°N in winter (October), following the shift in the atmospheric pressure systems, and reaches its maximum extent (5°N) in January to March, before retracting north (15°N) in late summer (September). The upwelling also migrates meridionally as the season progresses, exporting upwelled waters rich in organic and plankton matter into the open ocean, through the development of strong upwelling filaments (Barton *et al*., 1998). The migration of the upwelling north-south and seaward can exhibit significant seasonal and inter-annual variations owing to seasonal variation in atmospheric pressure systems.

In the region between Mauritania and Senegal, both coastal upwelling and shelf-edge upwelling can occur depending on whether the continental shelf is narrow or broad (Barton *et al*., 1977). The shelf-edge upwelling occurs where there is weak stratification of surface waters, a wide shelf and persistent favourable winds that produce a progressive separation of the main upwelling from the coast. In this region, SACW arriving via the NECC is advected northwards between 15 and 20°N by cyclonic recirculation, thereby producing an intense front (Hernández-Guerra *et al*., 2005).

A poleward undercurrent 100 km wide at 300 m depth has been found in this region. The normally equatorward surface flow is also reversed between the Canary Islands and Morocco during autumn and winter (Navarro-Pérez and Barton, 2001; Hernández-Guerra *et al*., 2005), probably caused by a weakening of the trade winds south of Cape Ghir. The upwelling, which develops in winter in the coastal waters of the northward flow, is variable (Mittelstaedt, 1983).

2.2.2.3 Coastal filaments

Upwelling filaments form along the Atlantic coast of Northwest Africa and protrude several hundred kilometres offshore, as in the case of the filaments at Cape Ghir, Cape Juby, Cape Bojador and Cape Blanc. These filaments often form as a result of the interaction between the upwelling and a coastal or underwater topographic feature or irregularity, such as the presence of capes or underwater canyons (Gabric *et al*., 1993; Hagen *et al*., 1996; Pelegrí *et al*., 2005; Karakas *et al*., 2006).

The Cape Ghir filament is thought to export a large amount of organic material into the open ocean in autumn (Pelegrí *et al*., 2005, 2006). At Cape Blanc on the Mauritanian coast, there is a giant upwelling filament at the junction between the subtropical gyre and gyre circulation (Van Camp *et al*., 1991; Gabric *et al*., 1993; Fisher *et al*., 2009). Chlorophyll within this filament is transported up to 400 km offshore. Other modelling studies suggest that particles may be carried over 600 km offshore (Fisher *et al*., 2009).

2.2.2.4 Island effects eddies

The Canary Islands, which are situated on the continental slope, create an obstruction to the southward flow of the Canary Current. Large scale circulation is forced through the straits between islands and/or between the islands and Africa. The Canary Islands thus promote the creation of eddies in the wake of the islands.

There is a permanent cyclonic eddy south of Gran Canaria that interacts with the coastal jet (Barton *et al*., 1998, 2004). Furthermore, near Cape Juby, there are downstream eddies caused by the Canary Islands (Arístegui *et al*., 1994) and these entrain waters from the Cape Juby filament, effectively extending it further offshore and enhancing cross-slope exchanges (Barton *et al*., 2004).

The Cape Verde peninsula in Senegal also produces a strong downstream upwelling plume, which is separated from shore because the extended peninsula juts out into the shelf (Demarcq and Sambe, 1991). The front between upwelled and poleward flowing waters is marked by surface convergence (Mittelstaedt, 1991).

2.2.2.5 Guinea Dome

The southern part of the CCLME is subject to a permanent cyclonic recirculation gyre, known as the Guinea Dome (Figure 5) (Mittelstaedt, 1991).

2.2.2.6 Sea surface anomalies

Sea surface anomalies are observed especially near the coast. Moujane *et al*. (2011) recorded a maximum surface elevation (0.35 m) near Cape Ghir (30°37' N, 9°52' W) and between the islands of the western Canary Islands, owing to the effect of the islands and coastal topography on the sea surface circulation. After the winds pass the capes, they directly affect the elevation of the surface of the sea. The weakening of winds in the wake of the Canary Islands results in a low surface sea level anomaly, indicative of a surface current flowing west to east (see Figure 5).

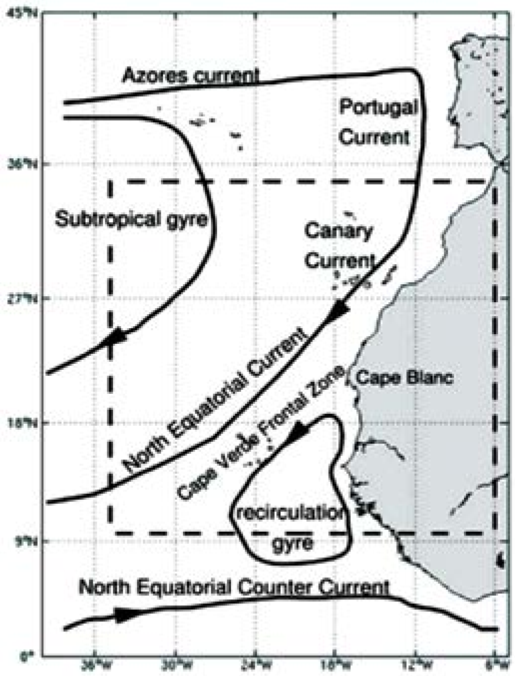


Figure 5: Circulation patterns (adapted from Mittelstaedt, 1991, in Stramma *et al*., 2005)

2.2.3 Enrichment mechanisms

The CCLME is one of four major areas of coastal upwelling in the world's oceans. While the hydrographic and climatic conditions described above play a major role in the productivity of this LME, riverine inputs and aeolian dust are also thought to contribute to the productivity of the system.

2.2.3.1 Nutrient levels

Water samples collected during the CCLME ecosystem surveys in 2011 and 2012 along the Northwest African coast, show that the CCLME region is particularly rich in nitrate and silicate. Nitrate, phosphate and silicate all displayed increasing trends in concentration with increasing depth (Figure 6a and b). The overall trend was an increase in nutrients over deep water furthest from the coastline and a decrease in nutrient concentrations when moving to the most northern latitudes of the study area.

a)

b)

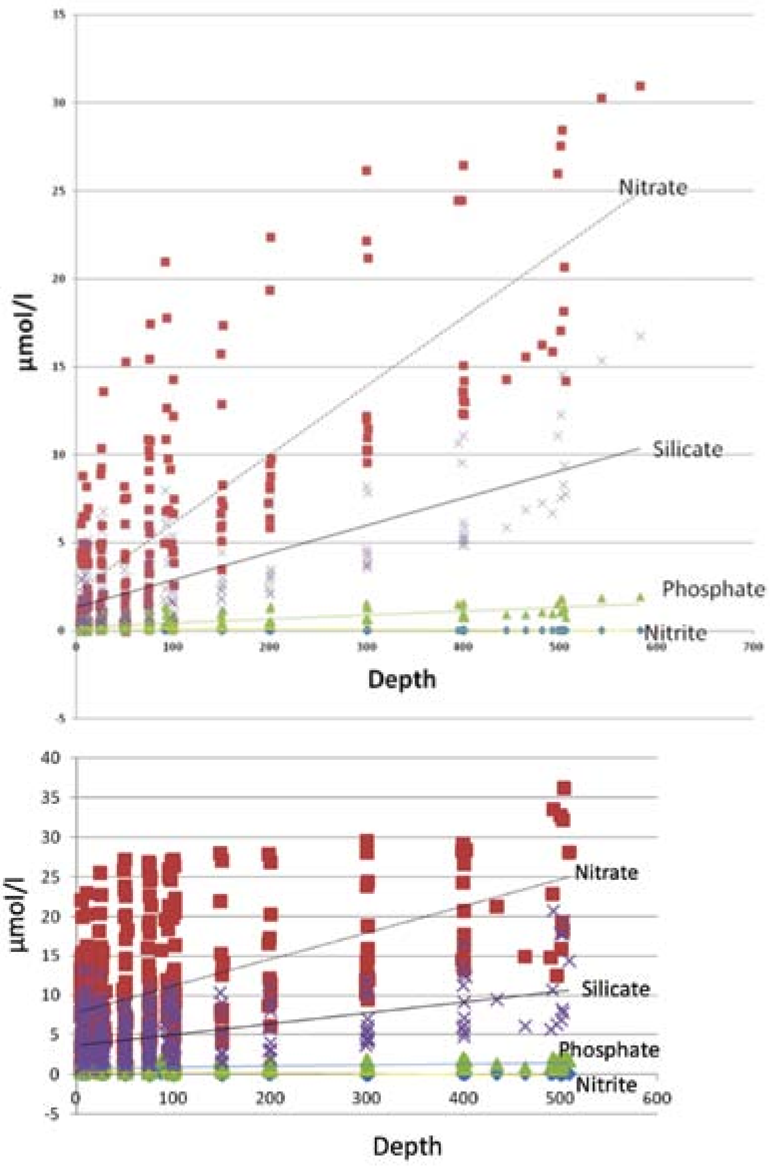


Figure 6a and b: Nutrient concentrations (µmol/L) of nitrate, phosphate, silicate and nitrite in relation to depth (m) (Krafft, 2011 and 2012)

2.2.3.2 Primary production

The CCLME is a Class I, highly productive ecosystem, with a mean annual value for chlorophyll of 1.31 mg chl-a/m^3 and 372 g C m^2/yr for primary productivity, according to SeaWiFS satellite data (Sherman and Hempel, 2008). The Canary Current is one of the LMEs that display a high primary productivity supporting significant fisheries catches (Chassot *et al*., 2010).

Mean monthly chlorophyll variations from satellite, derived from averages of daily chlorophyll values for the CCLME region from 1997 to 2012 (Figure 7a-e), were developed for this document by J. O'Reilly (NOAA LME Programme[8]). Chlorophyll-a concentrations vary considerably both seasonally and annually (Figure 7a). Chlorophyll concentrations in the region start to increase from October and continue steadily, until they peak between mid-February and mid-March (Figure 7b) during the period studied, with the highest peak levels being recorded in 1999 and 2009. The annual span in chlorophyll (min-max) also demonstrates inter-annual variability with the greatest span occurring between 2000 and 2001 and again between 2009 and 2010 (Figure 7c). Annual mean concentrations were highest in 1999, 2005, 2007 and 2009 (Figure 7d). Chlorophyll anomalies between 1997 and 2012 demonstrate a downward trend (0.0137 per year) (Figure 7e).

The arrival of cold water and nutrients in the surface water layers contributes to the development of several phytoplankton organisms (diatoms, dinoflagellates, coccolithophores and cyanobacteria) at the base of the food chain.

Primary production can locally reach values of three to four times higher than those of other areas in the open ocean (Huc, 1988). These resurgences provide adequate conditions for the development of phytoplankton and subsequently of zooplankton.

In the Northwest African region, the largest productions are observed after the upwelling of deep water to the surface (Grall *et al*., 1982). Thus, the transfer from primary to secondary production depends on the upwelling cycle.

In northern Morocco (north of Cape Juby, 28 °N) where upwelling is seasonal, there is a significant delay between the development of phytoplankton and zooplankton (Furnestin, 1957, 1976). Moreover, south of Cape Juby, where upwelling is permanent, peaks of phytoplankton abundance occur on the fringes of the resurgent water plume and the highest availability of phytoplankton for use by zooplankton occurs at a long distance from the centre of the upwelling (Grall *et al*., 1974; Dupouy *et al*., 1986 in Binet, 1991). In this case, the transfer between the primary and secondary production is poor over the continental shelf because of the slow developmental life cycle of copepods (Binet, 1991). Hence, only species of very rapid development, such as salps and water fleas, can use the primary production of the strong upwelling plumes (Le Borgne, 1983).

2.2.3.3 Secondary production

The zooplankton community is normally composed of copepods, but mysid shrimps are also very important in this LME (Bas, 1993). Zooplankton samples collected during the CCLME ecosystem surveys in 2011 and 2012 along the Northwest African coast, show that there was a general trend of decreasing zooplankton biomass with increasing depth. The smallest size fraction of plankton (180–1 000 µm) was the most common and this size fraction was most common in the upper water layers (Figure 8), which is consistent with the results of Blackburn from 1975. The spatial distributional trend was a decrease in plankton size with decreasing latitudes.

The Cape Ghir filament is characterized by localized coastal upwelling taking place all year round, intensified especially during summer. This process is verified and the filament is clearly present throughout the year, with a maximum intensity accentuated in summer (June) (Salah *et al*., 2012).

Both the physical and biological processes contribute to the formation and maintenance of the spatial patterns of zooplankton (Lewis and Boer, 1991; Hill, 1995; Alvarez-Cadena *et al*., 1998; Smith *et al*., 2001).

The distribution of different species of copepods along the filamentary structures at Cape Gir (30°N) and Cape Juby (28°N) shows that the general appearance of neritic species offshore reflects the existence of a large coastal displacement.

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[8] Naragansett Laboratory, Northeast Fisheries Centre, NOAA, 35 Tarzwell Rd, Narragansett R.I. 02882. Details of the methodology are available there.

At Cape Ghir, the copepod species distribution scheme indicates that they follow the two eddies that generate these filaments (Hagen *et al*., 1996; Stevens and Johnson, 2003). These vortices are responsible for the dispersion towards the north and south of the area. The same spatial distributions were observed for sardine and anchovy larvae along the filaments (Berraho *et al*., 2012) as well as for nutrients (Makaoui *et al*., 2012).

At Cape Juby however, the dynamic is less obvious. Some species of neritic copepods have followed the path of the filaments, whose seaward extent is very limited (with the exception of April and June). Their location is coastal, reaching out towards the sea to a limited extent. Statistical analysis confirmed a clear distinction between the coastal area compared to the offshore area.

Furthermore, for particular areas characterized by the presence of a permanent upwelling filament like the region off Cape Blanc, observations of the composition of copepods from the CCLME surveys revealed a dominance of species such as *Acartia clause* (24.6 percent) and *Calanoides carinatus* (13.4 percent) during the summer and species such as *Oncaea venusta* (32.9 percent), *Oncaea mediterranea* (15.4 percent) and *Clausocalanus arcuicornus* (16.8 percent) in the autumn. In addition to copepods, the chaetognaths, euphausiids and siphonophores are well represented.

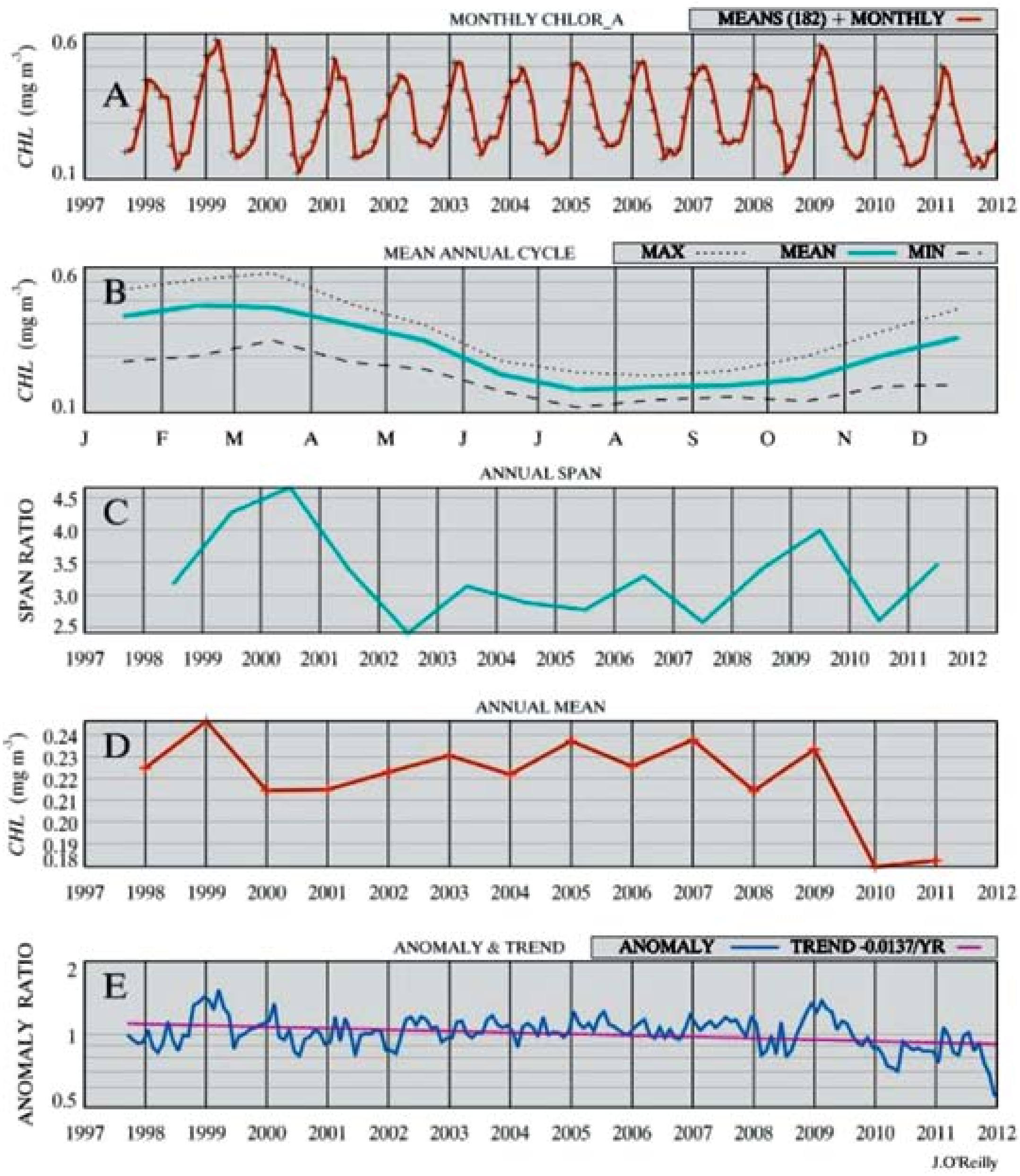
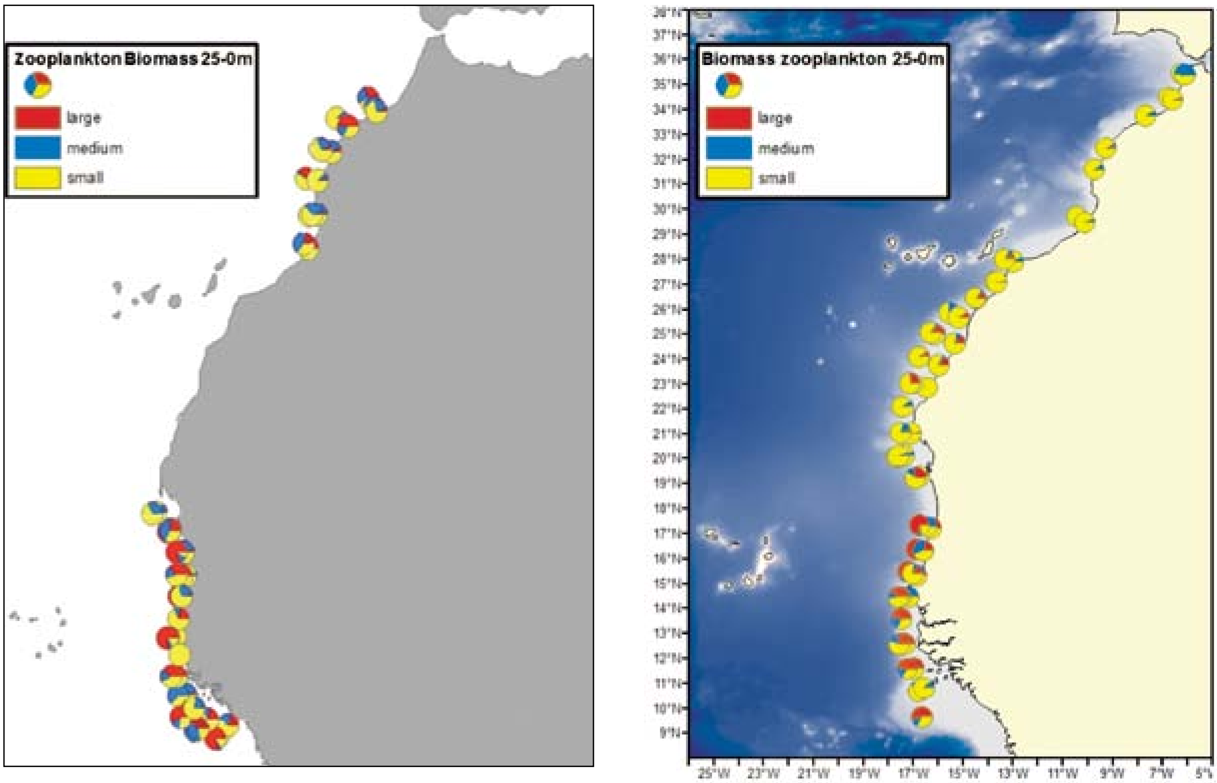


Figure 7: Satellite derived chlorophyll-a (chl-a) concentrations (mg m-³) for the CCLME from September 1997 to December 2012 showing: (a) monthly chl-a time-series, (b) mean monthly chl-a values, (c) annual variation in minimum and maximum chl-a values (d) annual mean and (e) anomalies and trend in chlorophyll-a concentrations (source: J.O'Reilly, personal communication)



a) 2011 b) 2012

Figure 8a and b: Zooplankton biomass recorded at different depths in the CCLME ecosystem surveys and classified by size of organism

2.2.3.4 Input from land-based sources

Within the CCLME region, there are eight major estuaries and river systems that discharge into the Atlantic Ocean, including the Sebou, Oum Errabia, Souss, Massa, Senegal, the Gambia, Casamance and Caceu Rivers. These rivers provide a source of nutrients which contribute to the enrichment of the CCLME region and help drive productivity.

2.2.3.5 Aeolian input

The North Atlantic Ocean receives about 43 percent of the global oceanic dust inputs and its main sources are the Sahara desert and the Sahel region (Duce *et al*., 1991; Jickells *et al*., 2005). Mineral or desert dust typically contains substantial amounts of micronutrients such as iron (Fe) and phosphorus (P). Iron is an important micronutrient for marine phytoplankton and the major limiting factor controlling primary productivity and dinitrogen (N_2) fixation (de Baar *et al*., 1990; Moore *et al*., 2009). Thus mineral dusts have a significant influence on primary productivity.

The CCLME region has become a focus for research into the biogeochemical effects of Saharan dust inputs (Dall'Osto *et al*., 2010; Hill *et al*., 2010; Rijkenberg *et al*., 2008; Ye *et al*., 2009; Rijkenberg *et al*., 2012). Aeolian dust transported from the Sahara/Sahel desert regions is believed to be the dominant external source of iron (Fe) into the surface waters of the CCLME. Continental shelves also contribute dissolved Fe (DFe) (Johnson *et al*., 1997). In the CCLME, studies have confirmed this link and identified declines in surface DFe further away from the Northwest African coast (Ussher *et al*., 2010). In addition, upwelling of deep waters enhanced with DFe or the release of Fe from upwelled biogenic and lithogenic particles along the Northwest African coast (Neuer *et al*., 2002) may explain the gradient of surface DFe concentration with distance from the African continent.

Suboxic or anoxic conditions can further enhance the release of DFe into the overlying water (Elrod *et al*., 2004). There is a pronounced oxygen minimum zone (OMZ) south of the NEC and north of the NECC in the North Atlantic, which is strongest at 400 to 500 m depth (Stramma *et al*., 2008). OMZs are the result of limited ocean mixing which limits the provision of atmospheric oxygen, combined with enhanced organic matter respiration which consumes oxygen. OMZs are common in highly productive oceanic regions (Karstensen *et al*., 2008). DFe concentrations may be enhanced in OMZs owing to the remineralization of organic matter, but also because the conditions prevent the oxidation of highly soluble Fe (Hopkinson and Barbeau, 2007).

Dust deposition in the (sub-) tropical northeast Atlantic reaches a maximum in winter when the ITCZ is located south of 5°N and dust is transported in the lower air masses by the north-easterly trade winds (Chiapello *et al*., 1995). A recent study by Rijkenberg *et al*. (2012) attempted to establish the distribution and importance of the different sources of DFe in the CCLME region. The authors distinguished three inputs of DFe to the surface waters in the region including: (i) lateral diffusion from the continental shelf; (ii) atmospheric dust deposition; and (iii) vertical diffusion from below the thermocline. Although Aeolian dust transport from the Sahara/Sahel desert is considered to be the dominant external input of iron, the authors found that while dust was a more important source offshore, lateral diffusion of DFe from the African continental shelf was dominant in the northern area. Further south, vertical diffusion of DFe over the thermocline provided a comparable or higher contribution of DFe than Aeolian inputs, particularly where there were higher concentrations of dissolved iron below the wind mixed layer (i.e. associated with the OMZs).

The CCLME region exhibits some of the highest N_2 fixation rates and diazotroph abundances (Langlois *et al*., 2008), particularly south of Cape Verde (Rijkenberg *et al*., 2011). Iron may limit N_2 fixation (Mills *et al*., 2004) and it is thought that it is a major factor controlling the large scale distribution of diazotrophs (Moore *et al*., 2009). The maintenance of OMZs may depend on N_2 fixation driven export (Moore and Doney, 2007), so a feedback loop may exist where Fe forms a significant contribution to N_2 fixation driven export, enhancing remineralization and strengthening the OMZ.

2.2.4 Climate variability and long-term effects of climate change

Climate variability and change are known or anticipated to impact upwelling regions. Global warming may increase the strength of equatorial winds and upwelling intensity, leading to cooling of seawater in major upwelling areas. Climate change is likely to modify sea water temperature, salinity and other physical and chemical parameters of the Canary Current on a longer term. In areas further south (e.g. Guinea), significant annual fluctuations in the amount of recorded rainfall and delays in the start of the rainy season have been observed in recent years. It has, however, not yet been possible scientifically to attribute these changes as consequences of climate change (Bangoura and Hamoud, 2013).

In contrast to other eastern boundary current systems, such as the California Current and Humboldt Current LMEs, the Canary Current appears to be warming, with sea water temperatures having risen by 1.5 °C over the last 25 years (Bangoura and Hamoud, 2013). This warming could be the likely cause of the observed slight decrease in productivity over the last decades as observed by Aristegui *et al*. (2009). This is in contrast to the positive trend in productivity observed in other upwelling regions (Chavez and Messie, 2009; Demarcq, 2009). Observations over the last decade suggest that these changes are part of a pattern of long-term variability of

surface temperatures in the region, as a result of the Atlantic Multi-decadal Oscillation (AMO). The AMO is one of the dominant variations in the climate system of the Atlantic, representative of the thermohaline circulation (Kerr, 2000; Knight *et al*., 2005), and it has been linked to a range of weather events affecting the Canary Current ecosystem, including the trade winds, displacement of the ITCZ and rainfall in the Sahel (Lamb and Peppler, 1992; Marshall *et al*., 2001; Knight *et al*., 2005).

Over the past six decades, the CCLME has passed through a warm phase from the 1930s to 1960, a cold phase from the 1960s to 1980, followed by a new warming which has continued into the 2000s. The pattern appears to reflect the oscillations in the AMO. When in the negative phase, the AMO is associated with cold temperatures in the north Atlantic and relatively warm temperatures in the south Atlantic. The situation is reversed during the positive phase of the AMO, with a warming of the north Atlantic and a cooling of the south Atlantic (Kifani, personal communication).

Bode *et al*. (2009) observed a continuous decrease in the upwelling intensity of the northern region of the Canary Current over the last 40 years, associated with a trend of warming surface waters. No significant trends were observed in phytoplankton biomass during the same period, but zooplankton biomass decreased offshore and increased near the coast. Diatom abundance decreased regionally and the increase in zooplankton biomass was predominantly as a result of warm-water species. They concluded that plankton dynamics reflected the variability of climatic patterns.

There is a lack of historical measurements of primary production in the CCLME, except during the last decade for which continuous satellite measurements exist. Satellite derived measurements reveal a downward trend in primary production during the observation period (Sherman *et al*., 2007). This decline is accompanied by a net warming of the system (Sherman *et al*., 2007) and a decrease in the upwelling and Ekman tranport in the region (Gomez-Gesteira *et al*., 2008).

Previous studies (Domanevsky and Barkova, 1978; Caveriviere, 1982; Belveze, 1984; Gulland and Garcia, 1984; Binet, 1988, among others) provide evidence of a change in abundance and distribution limits of a number of species (e.g. sardine, sardinella, triggerfish and snipefish) during a period of intense cooling in the late 1960s to early 1970s. More recently, Semionova and Kudersky (2006) and Semionova and Kudersky (*in prep*.) noted a reduction in the abundance of diatoms and an increase in dinoflagellates during warm years. It is suggested that warming could be unfavourable for exploited resources. A flagellate dominance extends the food chain and reduces the transfer to harvestable species, while less beneficial species such as comb jellies and jellyfish thrive (Greve and Parsons, 1977; Verity *et al*., 2002). The dominance of diatoms, however, allows greater production of exploitable resources (Verity *et al*., 2002). In contrast, the ongoing warming in Mauritanian waters appears to be beneficial for round sardinella (*Sardinella aurita*) (Zeeberg *et al*., 2006).

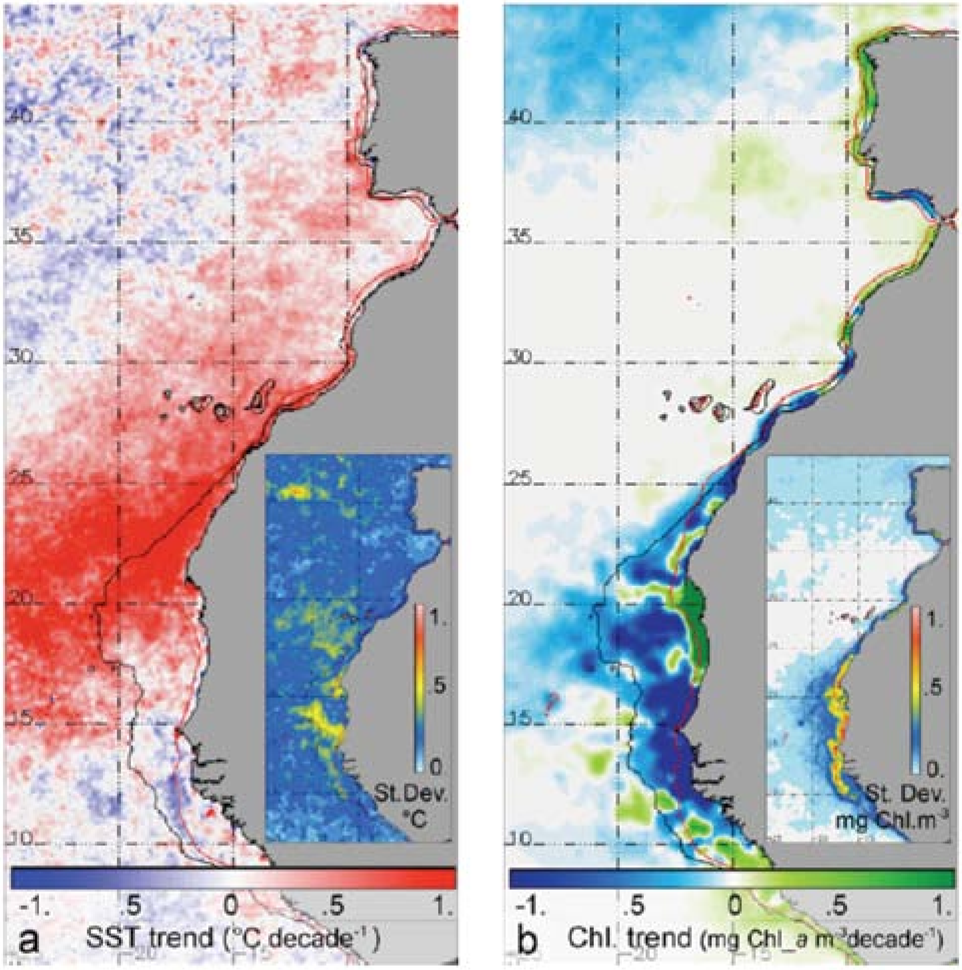


Figure 9: Decadal trends in (a) sea-surface temperature (SST; °C) and (b) surface chlorophyll-a (Chl-a, mg/m³), computed from AVHRR and SeaWiFS data, for the period 1998 to 2007. The standard deviations of trends for both variables are shown as inserts. The 200 m isobath and the average position of the isopleth of 1 mg/m³ Chl-a are depicted as red and black lines, respectively (Source: Arístegui *et al.*, 2009).

Ocean acidification occurs when carbon dioxide (CO_2) is absorbed into the ocean and forms carbonic acid. The phenomenon will increase if emissions of carbon dioxide are not reduced. Furthermore, the OMZ – often occurring at depths of 200 to 800 m – may also be impacted. The lower layers of the ocean are likly to have lower oxygen concentrations (Stramma *et al.*, 2012). If this trend were to continue, it would be of particular importance for the CCLME because oxygen levels in the water layers between 200 and 800 m are already low. Stramma *et al.* (2012) found a decrease in oxygen in the upper layers of the ocean with an oxygen level of around 3.5 mg/L in the tropical northeast Atlantic which could lead to a reduction of the habitat for the large pelagic fish.

The productivity of the CCLME already appears to be negatively impacted by the transboundary climate warming effects of winds, current dynamics, chlorophyll, nutrients, oxygen and primary productivity (Figure 9). The observed downward trend in primary productivity requires mitigation and adaptation activities to be undertaken. Given the overall trends of accelerated warming of LME surface waters and the apparent encroachment of the deeper OMZ towards pockets of upwelling, countries sharing the services rendered by the productivity of the CCLME will need to consider ways and means for establishing and operating an early warning system of key ecosystem indicators. Two recent papers underscore the importance of primary productivity in supporting marine ecosystem goods and services (Falkowski, 2012) and in initiating and maintaining broadscale temporal and spatial time-series of key ecosystem indicators for plankton and oceanographic processes (Koslow and Couture, 2013).

2.2.5 References

Alvarez-Cadena, J.N., Suarez-Morales, E. & Gasca, R. 1998. Copepod assemblages from a reef-related environment in the Mexican Caribbean Sea. *Crustaceana*, 71: 411–433.

Arístegui, J., Sangra, P., Hernández-Leon, S., Canton, M., Hernández-Guerra, A. & Kerling, J.L. 1994. Island induced eddies in the Canary Islands. *Deep-Sea Research*, 41: 1509–1525.

Arístegui, J., Barton, E.D., Álvarez-Salgado, X.A., Santos, A.M.P., Figueiras, F.G., Kifani, S., Hernández-León, S., Mason, E., Machu, E., Demarcqand, H. 2009. Subregional ecosystem variability in the Canary Current upwelling. *Progress in Oceanography,* 83: 33-48. Doi:10.1016/j.pocean.2009.07.031.

Bangoura, K. & Hamoud, T. 2013. *Le Courant des Canaries: Dynamique hydrologique and océanographique. Contribution aux travaux du CCLME dans le cadre du groupe de travail CCLME changement climatique*.

Barton, E.D., Huyer, A. & Smith, R.L. 1977. Temporal variation observed in the hydrographic regime near Cabo Corveiro in the northwest African upwelling region, February to April 1974. *Deep-Sea Research*, 24: 7–23.

Barton, E.D., Arístegui, J., Tett, P., Cantón, M., García-Braun, J., Hernández-León, S., Nykjaer, L., Almeida, C., Almunia, J., Ballesteros, S., Basterretxea, G., Escánez, J., García-Weill, L, Hernández-Guerra, A., López-Laatzen, F., Molina, R., Montero, M.F., Navarro-Pérez, E., Rodríguez, J.M., Van Lenning, K., Vélez, H. & Wild, K. 1998. The transition zone of the Canary Current upwelling region. *Progress in Oceanography,* 41: 455–504. DOI: 10.1016/S0079-6611(98)00023-8.

Barton, E.D. & Arístegui, J. 2004. The Canary islands coastal transition zone: upwelling, eddies and filaments. *Progress in Oceanography*, 62: 67–69. Doi:10.1016/j.pocean.2004.08.003

Barton, E., Arístegui, J., Tett, P. & Navarro-Pérez, E. 2004. Variability in the Canary Islands area of filament-eddy exchanges. *Progress in Oceanography,* 62: 71–94.

Bas, C. 1993. Long-term variability in the food-chains, biomass yields, and oceanography of the Canary Current ecosystem. *In* K. Sherman, L.M. Alexander & B.D. Gold, eds. *Large Marine Ecosystems: stress, mitigation and sustainability.* Washington DC, AAAS Press, p. 94–103.

Belvèze, H. 1984. *Biologie et dynamique des populations de sardine (Sardina pilchardus) peuplant les côtes Atlantiques marocaines et propositions pour un aménagement des pêcheries. Thèse de doctorat d'État, Université de Bretagne Occidentale*. 532 pp.

Berraho, A., Ettahiri, O., Brochier, T., Benazzouz, A., Larissi, J., Makaoui, A., Somoue, L., Salah, S., Hilmi, K. & Orbi, A. 2012. *Distribution des larves de sardine and d'anchois le long du filament de Cap Ghir (région nord-ouest Africaine). Halieutique Journal,* 6: 178–193.

Berrit, G.R. & Rebert, J.P. 1977. Océanographie physique et productivité primaire, p. 1–60. *In* G.R. Berri (ed.) *Le milieu marin de la Guinée Bissau et ses ressources vivantes. ORSTOM, Ministère de la Coopération, République Française*.

Binet, D. 1988. Rôle possible d'une intensification des alizés sur le changement de répartition des sardines et sardinelles de long de la côte ouest-africaine. *Aquatic Living Resources*, 1: 115–132.

Binet, D. 1991. Dynamique du plancton dans les eaux côtières ouest-africaines: écosystèmes équilibrés et déséquilibrés. *In* P. Cury & C. Roy, eds. *Pêcheries ouest africaines: variabilité, instabilité et changement. Paris: ORSTOM, 1991, p. 117–136. Groupes de Travail, Dakar; Casablanca (SEN; MAR), 1988/12/12–17*. ISBN 2-7099-1040-3.

Blackburn, M. 1975. *Summary of existing information on nekton off Spanish Sahara and adjacent regions, North West Africa CUEA.* Technical report No. 8. 49 pp.

Bode, A., Alvarez-Ossorio, M.T., Cabanas, J.M., Miranda, A. & Varela, M. 2009. Recent trends in plankton and upwelling intensity off Galicia (NW Spain). *Progress in Oceanography*, 83(1–4): 342–350.

Caverivière, A. 1982. The west-african trigger-fish (*Balistes carolinensis*) – biology, proliferation and potential exploitation. *Oceanologica Acta,* 5(4): 453–459.

Chassot, E., Bonhommeau, S., Dulvy, N.K., Mélin, F., Watson, R., Gascuel, D. & Le Pape, O. 2010. Global marine primary production constrains fisheries catches. *Ecology Letters*, 13(4): 495–505.

Chavez, F.P. & Messie, M. 2009. A comparison of eastern boundary upwelling ecosystems. *Progress in Oceanography*, 83: 80–96.

Chiapello, I., Bergametti, G., Gomes, L., Chatenet, B., Dulac, F., Pimenta, J. & Suares, E.S., 1995. An additional low layer transport of Sahelian and Saharan dust over the north-eastern tropical Atlantic. *Geophysical Research Letters,* 22(23): 3191–3194.

Dall'Osto, M., Harrison, R.M., Highwood, E.J., O'Dowd, C., Ceburnis, D., Querol, X. & Achterberg, E.P. 2010. Variation of the mixing state of Saharan dust particles with atmospheric transport. *Atmospheric Environment*, 44(26), 3135–3146.

de Baar, H.J.W., Buma, A.G.J., Nolting, R.F., Cadee, G.C., Jacques, G. & Treguer, P.J. 1990. On iron limitation of the Southern Ocean: experimental observation in the Weddell and Scotia Seas. *Marine Ecology Progress Series,* 65(2), 105–122. Doi:10.3354/meps065105.

Demarcq, H. 2009. Trends in primary production, sea surface temperature and wind in upwelling systems (1998–2007). *Progress in Oceanography,* 83 (1–4): 376–385.

Demarcq, H. & Samb, B. 1991. *Influence des variations de l'upwelling sur la répartition des poissons pélagiques au Sénégal. In* Cury Philippe (éd.), Roy Claude (éd.). Pêcheries ouest-africaines: variabilité, instabilité et changement. Paris, ORSTOM, p.290–306.

Domanevsky, L.N. & Barkova, N.A. 1978. *Particularités de la répartition et état des stocks de sardine (Sardina pilchardus) au large de l'Afrique nord-occidentale. Rapport du Groupe de travail ad hoc sur les poissons pélagiques côtiers ouest-africains de la Mauritania au Libéria (de 26°N à 5°N). Dakar, 19–24 juin 1978.* CECAF/ECAF Series/78/10.

Duce, R.A., Liss, P.S., Merrill, J.T., Atlas, E.L., Buat-Menard, P., Hicks, B.B., Miller, J.M., Prospero, J.M., Arimoto, R., Church, T.M., Ellis, W., Galloway, J.N., Hansen, L., Jickells, T.D., Knap, A.H., Reinhardt, K.H., Schneider, B., Soudine, A., Tokos, J.J., Tsunogai, S., Wollast, R. & Zhou, M. 1991. The atmospheric input of trace species to the world ocean. Global Biogeochem. Cycles, 5(3): 193–259. DOI: 10.1029/91GB01778

Dupouy C., Rébert J.P. & Touré D. 1986. Nimbus 7 coastal zone color scanner pictures of phytoplankton growth on an upwelling front in Senegal. *In*: Liège colloquium, May 1985, *Biological processes at marine physical interfaces*, Nihoul (edition), 26 pp.

Elrod, V.A., Berelson, W.M., Coale, K.H. & Johnson, K.S. 2004. The flux of iron from continental shelf sediments: a missing source for global budgets. *Geophysical Research Letters*, 31: L12307.

Falkowski, P. 2012. Ocean science: the power of plankton. *Nature*, 483:17–20. DOI:10.1038/483S17a.

Fischer, G., Reuter, C., Karakas, G., Nowald, N. & Wefer, G. 2009. Offshore advection of particles within the Cape Blanc filament, Mauritania: results from observational and modelling studies. *Progress in Oceanography*, 83: 322–330.

Furnestin, M.L., 1957. *Chaetognathes et zooplancton du secteur atlantique moroccoain. Rev. Trau. Inst. Pêches marit.,* 21: 356 p.

Furnestin, M.L. 1976. *Les copépodes du plateau continental moroccoain et du détroit canarien. I. Répartition quantitative. Con. Int. Explor. Mer*, 8, 22–46.

Gabric, A.J., García, C.M., Van Camp, L., Nykjaer, L., Eifler, W. & Schrimpf, W. 1993. Offshore export of shelf production in the Cape Blanc (Mauritania) giant filament as derived from coastal zone color scanner imagery. *Journal of Geophysical Research*, 98: 4697–4712.

Gomez-Gesteira, M., deCastro, M., Alvarez, I. & Gomez-Gesteira, J.L. 2008. Coastal sea surface temperature warming trend along the continental part of the Atlantic Arc (1985–2005). *Journal of Geophysical Research*, 113, C04010. Doi:10.1029/2007JC004315.

Grall J.R., Laborde, P., Le Core, P., Neveux, J., Tréguer, P & Thiriot, A. 1974. *Caractéristiques trophiques et production planctonique dans la région sud de l'atlantique marocain. TETYS,* 6 (1−2):11−28.

Grall, J.R., Le Corre, P. & Tréguer, P. 1982. Short-term variability of primary production in coastal upwelling of Morocco. Rapp. *P.-v. Réun. Comm. Int. Explor. Sci. Mer. Méditerr*., 180: 221−227.

Greve, W. & Parsons, T.R. 1977. Photosynthesis and fish production: hypothetical effects of climatic change and pollution. *Helgoländer wiss. Meeresunters,* 30: 66–72.

Gulland, J.A. & Garcia, S. 1984. Observed patterns in multispecies fisheries. *In* R.M. May, ed. *Exploitation of marine communities*. Dahlem Konferenzen. Berlin, Heidelberg, New-York, Tokyo. Springler-Verlag. p. 155–190.

Hagen, E., Zülicke, C. & Feistal, R. 1996. Near surface structures in the Cape Ghir filament off Morocco. *Oceanologica Acta*, 19: 577–598.

Hernández-Guerra, A., Fraile-Nuez, E., Lopez-Laatzen, F., Martínez, A., Parrilla, G. & Vélez-Belchí, P. 2005. Canary Current and North Equatorial Current from an inverse box model. *Journal of Geophysical Research*,110: C12019. Doi:10.1029/ 2005JC003032.

Hill, A.E. 1995. The kinematical principles governing horizontal transport induced by vertical migration in tidal flows. *J. Mar. Biol. Assoc. UK*, 75: 3–13.

Hill, P.G., Zubkov, M.V. & Purdie, D.A. 2010. Differential responses of *Prochlorococcus* and SAR11-dominated bacterioplankton groups to atmospheric dust inputs in the tropical Northeast Atlantic Ocean. *FEMS Microbiol. Lett*., 306(1): 82–89.

Hopkinson, B.M. & Barbeau, K.A. 2007. Organic and redox speciation of iron in the eastern tropical North Pacific suboxic zone. *Marine Chemistry*, 106: 2–17.

Huc, A.Y. 1988. Sedimentology of organic matter. *In*: F.H. Frimmel & R.F. Christmas, eds. *Humic substances and their role in the environment*. Chichester, John Wiley and sons, 215–243.

Jickells, T.D., An, Z.S., Andersen, K.K., Baker, A.R., Bergametti, G., Brooks, N., Cao, J.J., Boyd, P.W., Duce R.A., Hunter, K.A., Kawahata, H., Kubilay, N., la Roche, J., Liss, P.S., Mahowald, N., Prospero, J.M., Ridgwell, A.J., Tegen, I. & Torres, R. 2005. Global iron connections between desert dust, ocean biogeochemistry and climate. *Science*, 308(5718): 67–71. DOI: 10.1126/science.1105959.

Johnson, K.S., Gordon, R.M. & Coale, K.H. 1997. What controls dissolved iron concentrations in the world ocean? *Marine Chemistry*, 57(3–4): 137–161.

Karakas, G., Nowald, N., Blaas, M., Marchesiello, P., Frickenhaus, S. & Schlitzer, R. 2006. High-resolution modelling of sediment erosion and particle transport across the NW African shelf. *Journal of Geophysical Research*, 11: 1. Doi:10.1029/2005JC003296.

Karstensen, J., Stramma, L. & Visbeck, M. 2008. Oxygen minimum zones in the eastern tropical Atlantic and Pacific Oceans. *Prog. Oceanogr*, 77: 331–350.

Kerr, R.A. 2000. A North Atlantic climate pacemaker for the centuries. *Science magazine,* no. 288.

Knight, J.R., Allan, R.J., Folland, C.K., Vellinga, M. & Mann, M.E. 2005. A signature of persistent natural thermohaline circulation cycles in observed climate. *Geophysical Research Letters*, 32(20): L20708.

Koslow, J.A., Couture, J. 2013. Follow the fish. *Nature*, 502: 163–164.

Krafft, B. 2011. Preliminary results from zooplankton biomass and nutrient samples collected during CCLME North West Africa ecosystem survey Guinea to Morocco, 20 October – 21 December 2011. Bergen, Norway. Institute of Marine Research.

Krafft, B. 2012. Preliminary results from zooplankton biomass and nutrient samples collected during CCLME North West Africa ecosystem survey Guinea to Morocco, 05 May – 22 July 2012. Bergen, Norway. Institute of Marine Research.

Lamb, P.J. & Peppler, R.A. 1992. Further case studies of tropical Atlantic surface atmospheric and oceanic patterns associated with sub-Saharan drought. *Journal of Climate,* 5: 476–488.

Langlois, R.J., Hummer, D. & LaRoche, J. 2008. Abundances and distributions of the dominant nifH phylotypes in the northern Atlantic Ocean. *Appl. Environ. Microbiol*., 74(6): 1922–1931.

Le Borgne, R. 1983. *Note sur les proliférations de Thaliacés dans le golfe de Guinée. Oceanogr. trop*., 18(1): 49–54.

Lewis, J.B. & Boers, J.J. 1991. Patchiness and composition of coral reef demersal zooplankton. *J. Plankton Res*., 13: 1273–1289.

Makaoui, A., Orbi, A., Arístegui, J., Ben Azzouz, A., Laarissi, J., Agouzouk, A. & Hilmi, K. 2012. Hydrological seasonality of Cape Ghir filament in Morocco. *Natural Science*, 4 (1): 5–13.

Marshall, J., Kushnir, Y., Battisti, D., Chang, C., Czaja, A., Dickson, B., Hurrell, J., McCartney, M., Saravanan, R. & Visbeck, M. 2001. North Atlantic climate variability: phenomena, impacts and mechanisms. I*nternational Journal of Climatology,* 21: 1863–1898.

Mills, M.M., Ridame, C., Davey, M., La Roche, J. & Geider, R.J. 2004. Iron and phosphorus co-limit nitrogen fixation in the eastern tropical North Atlantic. *Nature*, 429(6989): 292–294.

Mittelstaedt, E. 1983. The upwelling area off Northwest Africa: a description of phenomena related to coastal upwelling. *Progress in Oceanography,* 12(3): 307–331.

Mittelstaedt, E. 1991.The ocean boundary along the northwest African coast. *Progress in Oceanography,* 26: 307–355.

Moore, C.M., Mills, M.M., Achterberg, E.P., Geider, R.J., LaRoche, J., Lucas, M.I., McDonagh, E.L., Pan, X., Poulton, A.J., Rijkenberg, M.J.A., Suggett, D.J., Ussher, S.J. & Woodward, E.M.S. 2009. Large-scale distribution of Atlantic nitrogen fixation controlled by iron availability. *Nature Geoscience,* 2(12): 867–871. DOI:10.1038/ngeo667.

Moore, J.K. & Doney, S.C. 2007. Iron availability limits the ocean nitrogen inventory stabilizing feedbacks between marine denitrification and nitrogen fixation. *Global Biogeochemical Cycles*, 21: GB2001.

Moujane, A., Chagdali, M., Blanke, B. & Mourdane, S. 2011. *Impact des vents sur l'upwelling au sud du Maroc; apport du modèle ROMS forcé par les données ALADIN et QuikSCAT. Bulletin de l'Institut scientifique, Rabat, section Sciences de la Terre*, 2011(33): 53–64.

Navarro-Pérez, E. & Barton, E.D. 2001. Seasonal and interannual variability of the Canary Current. *Scientia Marina,* 65: 205–213.

Neuer, S., Freudenthal, T., Davenport, R., Llinás, O. & Rueda, M. 2002. Seasonality of surface water properties and particle flux along a productivity gradient off NW Africa. *Deep Sea Research Part II: topical studies in oceanography*, 49(17): 3561-3576. Doi:10.1016/S0967-0645(02)00098-X.

Nykjaer, L. & Van Camp, L. 1994. Seasonal and interannual variability of coastal upwelling along Northwest Africa and Portugal from 1981 to 1991. *Journal of Geophysical Research,* 99 (C7): 14197–14207.

Orbi, A., Hilmi, K., Larissi, J., Zidane, H., Zizah, S., El Moussaoui, N., Lakhdar, J.I. & Sarf, F. 1998. *Hydrologie et hydrodynamique des côtes marocaines: milieux paraliques et zones côtières. Commissariat général Expo'98, Lisbonne*. 68 pp.

Pelegri, J.L., Arístegui, J., Cana, L., Gonzalez-Davila, M., Hernandez-Guerra, A., Hernandez-Leon, S., Marrero-Diaz, A., Montero, M.F., Sangra, P. & Santana-Casino, M. 2005. Coupling between the open ocean and coastal upwelling region off Northwest Africa: water circulation and offshore pumping of organic matter. *Journal of Marine Systems,* 54: 3–7.

Pelegri, J.L., Marrero-Diaz, A. & Ratsimandresy, A.W. 2006. Nutrient irrigation of the North Atlantic. *Progress in Oceanography,* 70: 366–406.

Rébert, J.P. 1983. *Hydrologie et dynamique des eaux du plateau continental sénégalais. Document scientifique du Centre de recherches océanographiques de Dakar-Thiaroye*, 50: 86 pp.

Rijkenberg, M.J.A., Powell, C.F., Dall'Osto, M., Nielsdottir, M.C., Patey, M.D., Hill, P.G., Baker, A.R., Jickells, T.D., Harrison, R.M. & Achterberg E.P. 2008. Changes in iron speciation following a Saharan dust event in the tropical North Atlantic Ocean. *Marine Chemistry,* 110(1–2): 56–67.

Rijkenberg, M.J.A., Langlois, R.J., Mills, M.M., Patey, M.D., Hill, P.G., Nielsdóttir, M.C., Compton, T.J., LaRoche, J. & Achterberg, E.P. 2011. Environmental forcing of nitrogen fixation in the eastern tropical and sub-tropical North Atlantic Ocean. *PLoS ONE*, 6(12): e28989.

Rijkenberg, M.J.A., Steigenberger, S., Powell, C.F., Van Haren, H., Patey, M.D., Baker, A.R. & Achterberg, E.P. 2012. Fluxes and distribution of dissolved iron in the eastern (sub-) tropical North Atlantic Ocean. *Global Biogeochemichal Cycles,* 26: GB3004. Doi:10.1029/2011GB004264.

Rossignol, M. & Aboussouan M.T. 1965. *Hydrologie marine côtière de la presqu'île du Cap-Vert. Contribution à l'étude de la productivité des eaux. Doc. Sci. CRODT*, 2: 166 pp.

Salah, S., Ettahiri, O., Berraho, A., Benazzouz, A., Elkalay, K. & Errhif, A. 2012. *Distribution des copépodes en relation avec la dynamique du filament de Cap Ghir (Côte atlantique du Maroc). 2011. C. R. Biologies*, 335 (2012): 155–167.

Semionova, S.N. & Kudersky, S.K. 2006. Interannual phytoplankton fluctuations under the impact of upwelling development off Northwest Africa from 16° 00′ N to 20° 30′ N in the warm seasons of 1997–2000. *Ninth congress of Hydrobiology Society of RAS*. Abstracts of reports of scientific conference. Toljatti, September, 18–22, 2006. Toljatti, 2006. 150 pp.

Semionova, S.N. & Kudersky, S.K. *Caractéristique de l'état du phytocène au large des côtes atlantiques du royaume du Maroc. In K.G. Koukhorenko & A. Berraho, eds. Étude de l'écosystème pélagique de la côte atlantique marocaine.*

Sherman, K. & Hempel, G. 2008. The UNEP Large Marine Ecosystem report: a perspective on changing conditions in LMEs of the world's regional seas. UNEP Regional Seas Report and Studies No. 182. Nairobi, Kenya. United Nations Environment Programme.

Sherman, K., Belkin, I., O'Reilly, J. & Hyde, K. 2007. Variability of Large Marine Ecosystems in response to global climate change. *ICES CM 2007*/D:20.

Smith, C.L., Hill, A.E., Foreman, M.G.G. & Peña, M.A. 2001. Horizontal transport of marine organisms resulting from interactions between diel vertical migration and tidal currents off the west coast of Vancouver Island. *Can J. Fish Aquat Sci*, 58: 736–748.

Stevens, I. & Johnson, J. 2003. A numerical modeling study of upwelling filaments off the NW African coast. *Oceanologica Acta*, 26: 549–564.

Stramma, L., Huttl, S. & Schafstall, J. 2005. Water masses and currents in the upper tropical northeast Atlantic off Northwest Africa. *Journal of Geophysical Research.* 110: C12006.

Stramma, L., Johnson, G.C., Sprintall, J. & Mohrholz, V. 2008. Expanding oxygen minimum zones in the tropical oceans. *Science,* 320: 655–658.

Stramma, L., Prince, E.D., Schmidtko, S., Luo, J., Hoolihan, J.P., Visbeck, M., Wallace, D.R.W., Brandt, P. & Kortzinger, A. 2012. Expansion of oxygen minimum zones may reduce available habitat for tropical pelagic fishes. *Nature Climate Change*, 2:33–37.

Ussher, S.J., Achterberg, E.P. Sarthou, G., Laan, P., De Baar, H.J.W. & Worsfold, P.J. 2010. Distribution of size fractionated dissolved iron in the Canary Basin. *Marine Environmental Research.* 70(1): 46–55.

Van Camp, L., Nykjaer, L., Mittelstadt, E. & Schlittenhardt, P. 1991. Upwelling and boundary circulation off Northwest Africa as depicted by infrared and visible satellite observations. *Progress in Oceanography,* 26: 357–402.

Verity, P.G, Smetacek, V. & Smayda, T.J. 2002. Status, trends and the future of the marine pelagic ecosystem. *Environmental Conservation,* 29(2): 207–237.

Voituriez, B. & Herbland, A. 1982. Comparaisons des systèmes productifs de l'Atlantique Tropical est: dômes thermiques, upwellings côtiers et upwelling équatorial. *In* The Canary student: studies of an upwelling system. *Copenhague: CIEM, 1982, 180, p.107–123. (Rapports et Procès-Verbaux des Réunions du Conseil International pour l'Exploration de la Mer).*

Wooster, W.S., Bakun, A. & McLain, D.R. 1976. The seasonal upwelling cycle along the eastern boundary of the North Atlantic. *Journal of Marine Research,* 34: 131–140.

Ye, Y., Volker, C. & Wolf-Gladrow, D.A. 2009. A model of Fe speciation and biogeochemistry at the tropical eastern North Atlantic time-series observatory site. *Biogeosciences*, 6(10): 2041–2061.

Zeeberg, J.J., Corten, A. & De Graaf, E. 2006. By-catch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. *Fisheries Research*, 78 (2-3): 186–195.

2.3 Living marine resources and fisheries

As described in Section 1, the CCLME is one of the richest aquatic ecosystems in the world. The combination of the transition between temperate and tropical systems and the enrichment of the waters from upwelling and riverine sources provide the basis for a highly productive and biologically diverse ecosystem (Table 3). As a result, coastal and oceanic waters host a wide diversity of species including algae, seagrasses, invertebrates and abundant fishery resources including pelagic, demersal and deepwater species, highly migratory species such as tuna, as well as marine mammals, seabirds and sea turtles.

An assessment of the state of marine biological diversity in the CCLME region was carried out as part of a study conducted by the CCLME Project (CCLME, 2014). An inventory of species was made from international data bases, national studies and bibliographic information available worldwide. The total biological diversity was estimated at about 12 500 species. As in the case of global biodiversity, it is primarily dominated by arthropods, molluscs and chordates. The numbers of phyla and listed species varies depending on the country. The countries with the most information are the Canary Islands (Spain) and Morocco, where specific studies have been conducted since the beginning of the twentieth century, especially in recent decades.

Chordates are subject to the greatest exploitation, with catches in the CCLME around 2 to 3.5 million tonnes over the last decades (FAO Fishstat, 2015). Fish comprise 1 344 known species in the region, of which 6 to 8 percent are in a status ranging from "vulnerable" to "endangered". (CCLME, 2014)

The number of endemic species is highest in the Canary Islands, Cape Verde and Morocco. This is consistent with the characteristics of the region, reflecting the island character of Cape Verde and the Canary Islands and the location of Morocco, whose flora and fauna are also influenced by the Mediterranean. According to the National Study on Biodiversity in Morocco (Menioui, 1998), marine wildlife includes 7 140 species dominated by three groups: arthopods (1 930 species – mainly crustaceans), molluscs (1 600 species) and fish (1 150 species).

The main source of information on the status of fishery resources is the scientific deliberations of CECAF through the results of the regional working groups on stock assessment and the scientific sub-committee. In addition, regional scientists contributed to this chapter with their expert knowledge provided at various CCLME meetings and through contributions on specific topics to the CCLME Regional Coordinating Unit (Table 3).

Table 3: Number of marine species in the CCLME Project countries (data collected from the countries by the Regional Coordination Unit of the CCLME Project)

Country	Marine plants	Seagrass	Coral	Fish	Turtles	Mammals
Morocco	689[1]	4[1]	108[1]			21[1]
Mauritania		3[2]		483[2]	6[2]	
Senegal				619[3]	6[2]	
Cape Verde			8[4]	670[5]	5[4]	22[4]
The Gambia				490[5]	4[6]	
Guinea-Bissau				590[5]	5[7]	
Guinea	393[8]			578[5]		

[1] Chafik, M.A. (2012). *Qualité, Salubrité et Biodiversité au Morocco. Première réunion du Groupe de Travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11–12 April 2012, Nouakchott, Mauritania.*

[2] *République Islamique de Mauritania (2009). Quatrième Rapport National CDB - Version finale* (http://www.cdb.int/doc/world/mr/mr-nr-04-fr.pdf).

[3] *République du Senegal (2012). Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME*, 11–12 April 2012, Nouakchott, Mauritania.

[4] Monteiro, V. (2012). *Rapport National – Cape Verde. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME*, 11–12 April 2012, Nouakchott, Mauritania.

[5] Froese, R. et Pauly, D. (éd.) (2013). FishBase www.fishbase.org.

[6] Cham, A.M. (2012). *Rapport national – The Gambia. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau», du CCLME,* 11–12 April 2012, Nouakchott, Mauritania.

[7] Robalo, M.H. (2012). *Rapport national - Guinea-Bissau. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME*, 11–12 April 2012, Nouakchott, Mauritania.

[8] Bah, E.M. (2012). *Rapport national – Guinea. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau», du CCLME*, 11–12 April 2012, Nouakchott, Mauritania.

Throughout the region, the diverse fishery resources are exploited by artisanal, semi-industrial and industrial fisheries, both local and foreign (Table 4). Industrial distant water fleets (DWFs) started operating in the Eastern Central Atlantic during the 1960s and catches reached a peak of over 2 million tonnes in 1977, some years after they peaked globally (in 1972). Since the early 1990s, catches by foreign fleets have been around 30 to 40 percent in the northern CECAF (Eastern Central Atlantic) Zone. Coastal states have been steadily developing their national fisheries and their contribution increased from 22 to 69 percent of total catches between 1970 and 2008 (FAO FishStat Plus, 2010; Caramelo, 2010). The artisanal fisheries sector represented 97 percent of all reported catches in 2013 in Senegal and more than 58 percent of what was reported in 2012 in Guinea (Table 4). In contrast, industrial fisheries were responsible for the majority of total catches in Morocco and Cape Verde in 2014. In Mauritania in past years, the industrial fisheries have been responsible for the majority of the catch. However in 2013, the artisanal fishery represented 53% of total catch. The year 2013 is an exceptional year because of the withdrawal of foreign vessels operating within the framework of fisheries agreements with the European Union, and a change in exploitation patterns.

Table 4: Total annual catch (tonnes) of the artisanal and industrial fisheries in each country of the CCLME area (data collected by CCLME Regional Coordination Unit)

	Artisanal (PA)	Industrial (PI)	Total	% of artisanal catches	Source
Morocco	58 162	1 165 210	1 223 372	5	INRH
Mauritania	332 687	299 820	632 507	53	IMROP
Senegal	485 444	16 417	501 861	97	CRODT
The Gambia	11 426	4 000	15 426	74	FD
Cape Verde	4 417	9 838	14 255	31	INDP
Guinea-Bissau	35 000	72 239	107 239	33	CIPA
Guinea	94 000	69 000	163 000	58	CNSHB
Total	1 021 136	1 636 525	2 657 661	38	

Morocco data for 2014; PA = boats and Pi = industrial vessels

Mauritania data for 2013, with a massive withdrawal of foreign vessels from the EEZ of Mauritania

Senegal data for 2013

Gambia data of artisanal sector for 2014; industrial sector for 2010

Cape Verde data for 2014

Guinea-Bissau data of artisanal sector for 2009; industrial sector for 2013

Guinea data for 2012

Typically catches landed in the CCLME area (Figures 10 and 11) are dominated by the small pelagics, especially sardine (*Sardina pilchardus*), sardinellas (*Sardinella aurita* and *S. maderensis*) and horse mackerel (*Trachurus trachurus* and *T. trecae*) and other clupeids, which have constituted 87 percent of total nominal catches in recent years (2000 to 2010). Other important groups include demersal fish (7 percent) and cephalopods (4 percent). Total catch of demersal resources in the region was estimated at around 331 000 tonnes in 2004, decreasing since 2000 (Figure 11). The most important demersal resource in the region is the octopus (*Octopus vulgaris*), which can constitute around 30 percent of the catches of demersal resources. (Figures 10 and 11).

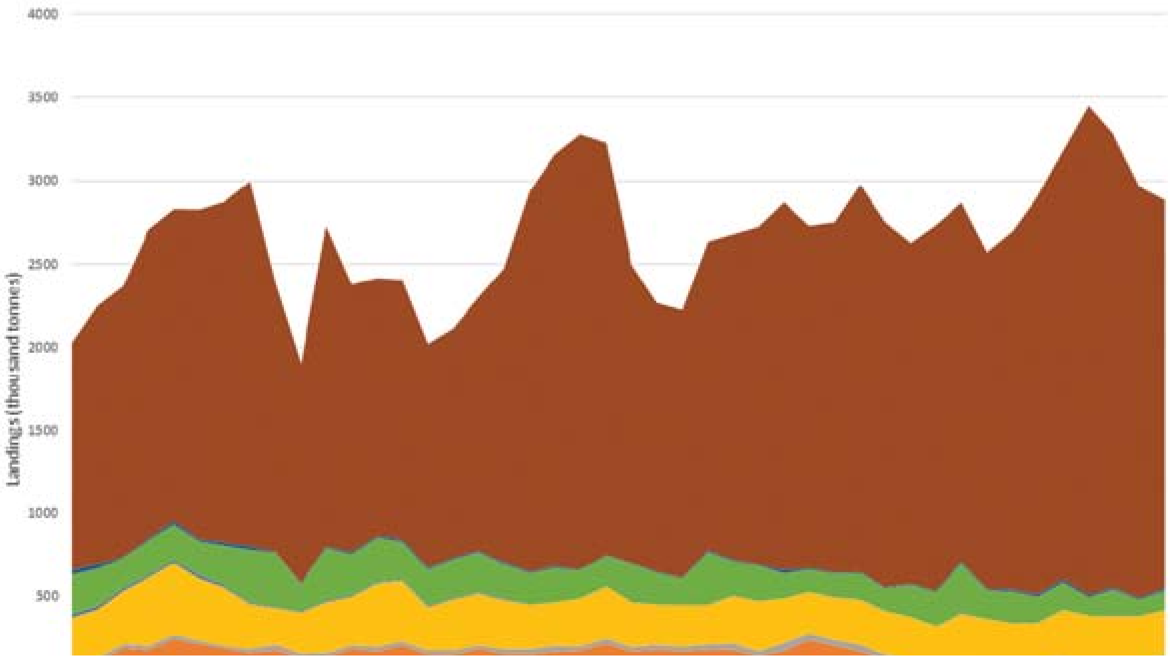


Figure 10: Landings of the main species groups in the CCLME region from 1970 to 2014 (Source: FAO)

The assessment of the main transboundary fisheries resources within the region has been carried out through the various FAO/CECAF working groups for both pelagic and demersal resources, which have members from the various research institutes in the CCLME area and have been supported by different projects including the CCLME Project. The results of the assessments indicate that many important coastal demersal resources are presently overexploited. The status of the pelagic resources is somewhat less serious, although the most recent assessments indicate overexploitation of some pelagic resources, such as the round sardinella (*Sardinella aurita*) between Morocco and the southern part of Senegal and the Cunene horse mackerel (*Trachurus trecae*) both in the northern and southern part of the CCLME (Tandstad, personal communication).

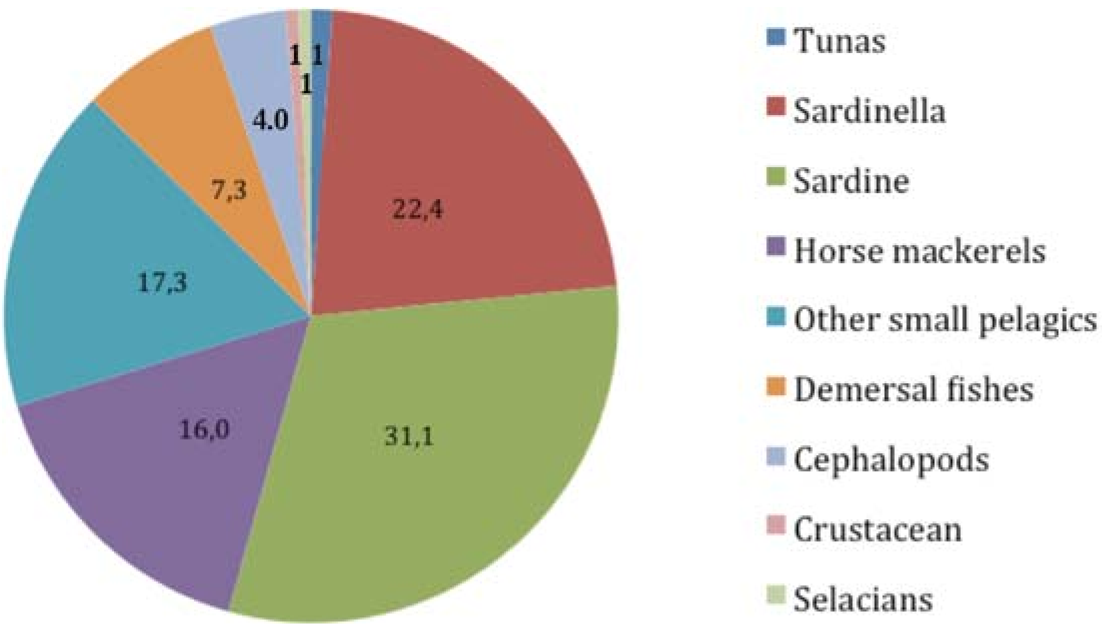


Figure 11: Average percentage of annual catches between 2000 and 2010 in the CCLME region (FAO, Fishstat and FAO, 2011)

2.3.1. Distribution of fish species in the CCLME region

The distribution maps are based on information obtained from two ecosystem surveys with the R/V *Dr Fridtjof Nansen* conducted from October to December 2011 and from May to July 2012, covering an area from the southern border of Guinea to the north of Morocco (to Casablanca in 2011 and to Tangier in 2012). These surveys covered the continental shelf at depths of 20 m to over 500 m. Owing to the extent of the covered area, the maps are separated into two parts: north and south of Cape Blanc. The distribution of the most important species groups are presented below, namely hake, dentex and the main species of small pelagics (sardine and sardinella).

2.3.1.1 Dentex

In the CCLME region, the genus Dentex is characterised by its diversity of species and their large area of spatial distribution. Many of these species were omnipresent during the surveys in 2011 and 2012, while others were characterized by a narrower distribution across depth and latitude (Figure 12 and Table 5).

During the 2011 survey, the distribution of the Angolan dentex (*Dentex angolensis*) extended to the south of Cape Blanc with a continuous distribution from Cape Timiris to Saint Louis, from Dakar to Banjul and from Ziguinchor (12°50'N) to Conakry. During the 2012 survey, the species was also markedly prevalent further north, especially off Cape Barbas (22°N), Cape Juby (27°N) and north of Tan Tan (28°30'N). To the south of Cape Blanc, *Dentex angolensis* was found between Cape Timiris and Dakar, off Banjul, in the waters of Guinea-Bissau and off Conakry. The species usually lives near the edge of the continental shelf.

In 2011, the Canarian dentex (*Dentex canariensis*) was encountered off the coast of Guinea-Bissau between Banjul and Dakar, in the area around Nouakchott and Cape Timiris and off Cape Blanc and Dakhla (23°30'N). In 2012, recorded densities were lower south of Nouakchott and detections were recorded respectively off Saint Louis, Dakar, Ziguinchor and Conakry. North of Nouakchott, the species was found continuously between Nouakchott and the Bay of Cintra (23°N). *D. canariensis* usually lives in the centre of the shelf.

In both surveys, the Morocco dentex (*Dentex maroccanus*) was reported in locations from Nouakchott in the south to Cape Cantin (32°30'N) further north and in particular in the area between Cape Blanc and Tan Tan. Weak detections were also recorded further north at Cape Ghir (31°N) and Cape Cantin and in the south off Dakar in 2012. The species lives on the edge of the shelf and mixes with *Dentex angolensis* in parts of its distribution area. The two species are very similar and it is easy to confuse them.

During the 2011 survey, the presence of large-eye dentex (*Dentex macrophthalmus*) was reported continuously at depths between 150 and 300 m between Tan Tan and the Bay of Cintra and between Cape Blanc and Cape Timiris. Lower concentrations were detected further north, in the area between Tan Tan and Agadir (30°30'N) and south of Guinea-Bissau. The distribution area was significantly enlarged in 2012 and extended from Conakry to Agadir. The highest densities were detected between Cape Blanc and Tan Tan, between Cape Timiris and Saint Louis and between Dakar and Ziguinchor.

The red dentex (*Dentex gibbosus*) is generally observed on banks, mainly in the northern part of the region from Banc d'Arguin to Tan Tan. The highest densities were found in the area between Cape Bojador (26°N) and Cape Juby, off Dakhla, from Cape Barbas and on both sides of Cape Blanc. Some individuals have also been reported further south, off Joal (14°10'N) in 2011 and off Bissau in 2012.

The distribution area of the Congo dentex (*Dentex congoensis*) is limited to the southern part of the CCLME region, between Dakar and Conakry. The species was found in three stations in 2012, off the coast of Dakar, Kamsar (10°40'N) and Conakry. In 2011, there was only one single detection recorded, near Conakry.

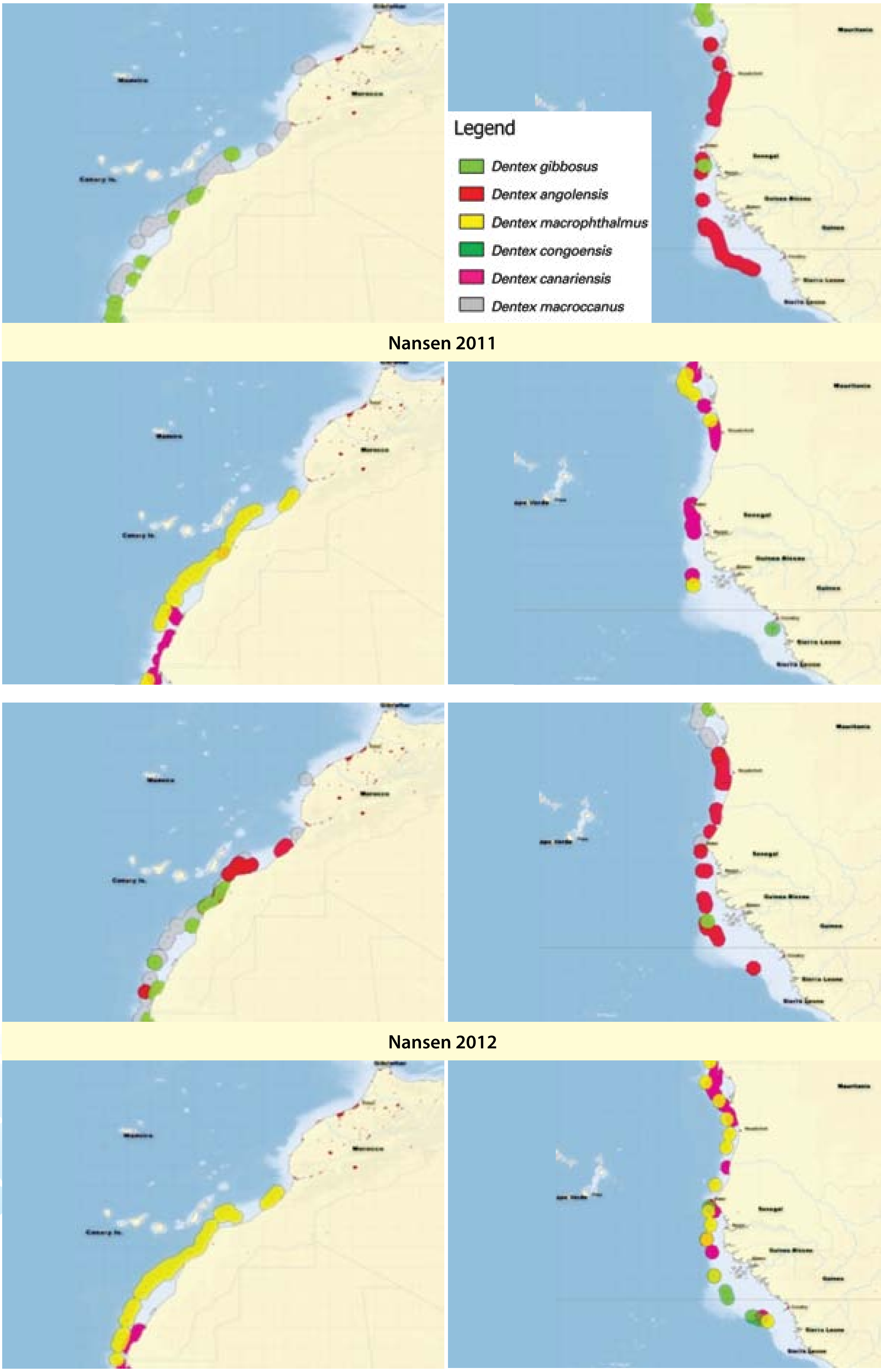


Figure 12: Dentex distribution as determined by the 2011 and 2012 surveys of R/V *Dr Fridtjof Nansen*

2.3.1.2 Hake

The distribution and occurrence of hake is shown in Figure 13 and Table 5. In 2011, the European or white hake (*Merluccius merluccius*) was detected in a vast area at great depths to the north of Cape Bojador. The Benguela hake or black hake (*Merluccius polli*) was found from Cape Bojador to the southern border of Guinea. This species was almost omnipresent between Cape Blanc and Banjul, but detected in a discontinuous pattern at depths beyond 200 m north of Cape Blanc and south of Banjul. The Senegalese hake, also known as black hake (*Merluccius senegalensis*), was found over large areas to the north and south of Nouakchott, from Saint Louis to Banjul, and in low quantities from Cape Barbas to Dakhla and further north, from Cape Bojador to Cape Ghir.

In 2012, *Merluccius merluccius* was more spread out, from Tangier to Cape Barbas. The distribution area was, however, discontinued at Cape Ghir and Cape Bojador, and limited to the waters off Cape Bojador and Cape Barbas. Compared to 2011, *Merluccius polli* was almost absent north of Cape Barbas, while its distribution area continued in the south with relatively high densities from Cape Blanc to the south of Sierra Leone. In Guinea and Guinea-Bissau it was was found further offshore. *Merluccius senegalensis* was found from Cape Cantin in the north to Banjul in the south and the highest densities were observed in Mauritania between Cape Timris and Saint Louis.

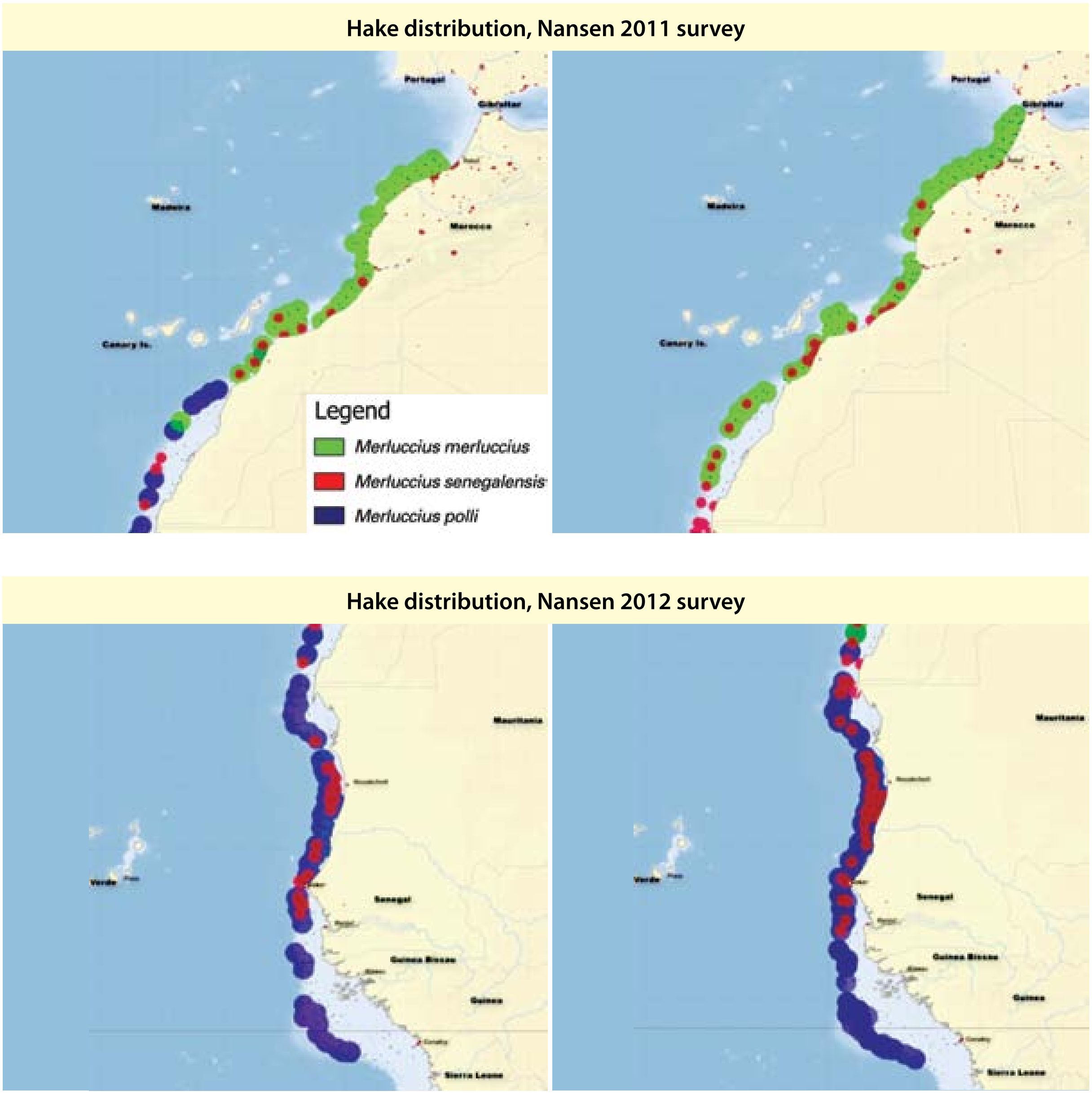


Figure 13: Hake distribution from R/V *Dr Fridtjof Nansen* surveys in 2011 and 2012.

2.3.1.3 Small pelagics

Sardine (*Sardina pilchardus*), round sardinella (*S. aurita*) and flat sardinella (*S. maderensis*) are among the predominant pelagic species of the CCLME region (Figure 14 and Table 5).

In the 2011 survey, a continued presence of *Sardina pilchardus* was observed from Cape Timiris to Dakhla (at 24°N). Between 24°00'N and and Cape Boujdour the species was almost absent before it became widespread again on the continental shelf, from Cape Boujdour to the northern boundary of the study area. Round sardinella were found continuously in the regions between Dakhla and Nouakchott and between Banjul and Saint Louis and showed a high concentration to the north and south of Dakar and off Nouakchott at Cape Barbas. Further south, low densities were recorded between Conakry and Banjul. Flat sardinella was less frequent and it was limited to some aggregation areas off the coast of the Gambia, off Casamance and to the north and south of Guinea-Bissau, as well as off Conakry.

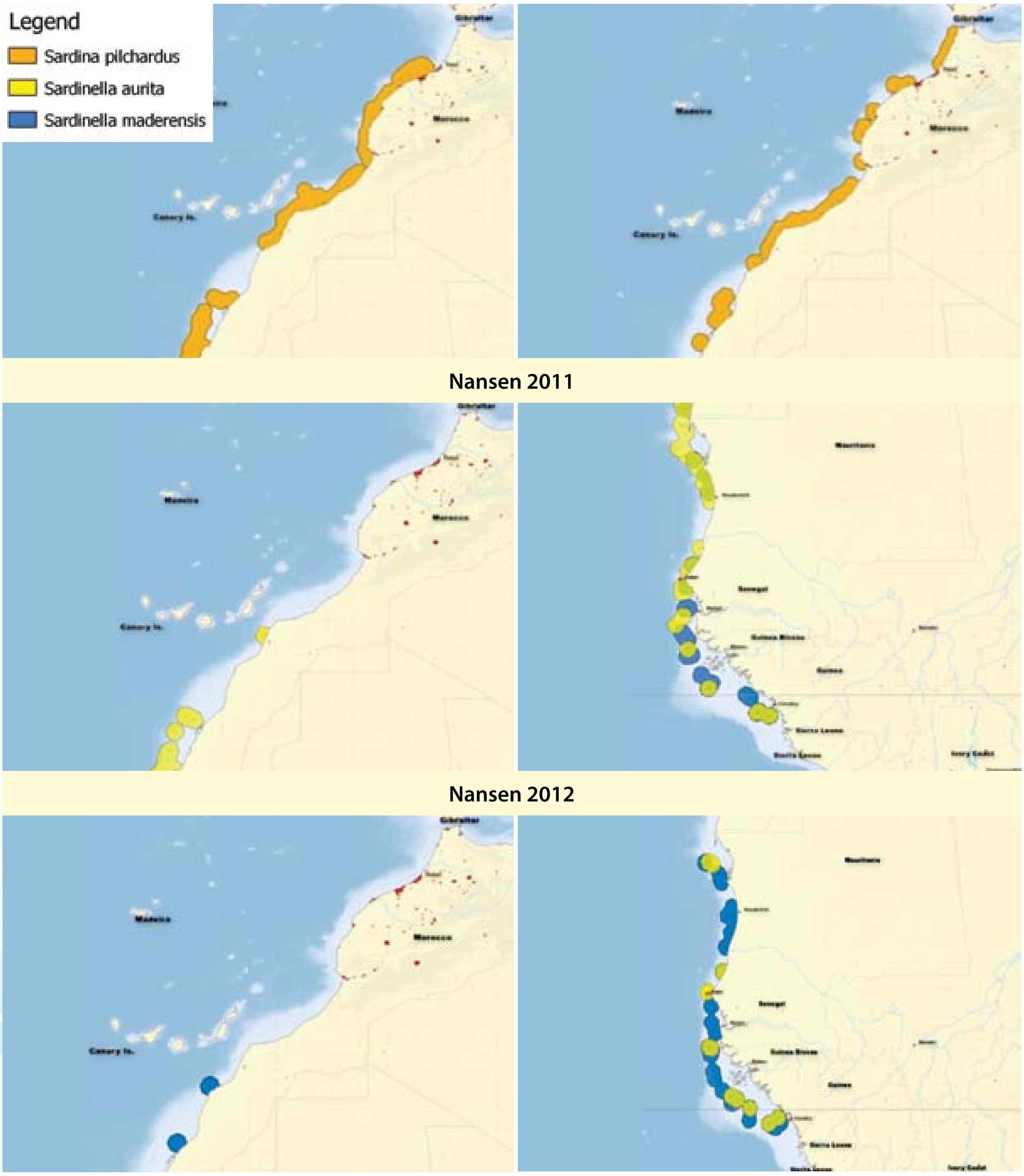


Figure 14: Distribution of sardine and sardinella according to the surveys undertaken by R/V *Dr Fridtjof Nansen* in 2011 and 2012

During the 2012 survey, the distribution of sardine extended from Cape Timiris to Tangier, but some areas showed a discontinuation in the distribution, in particular between Dakhla and Cape Barbas, off the coast of Cape Boujdour, Cape Cantin and the northern part of Casablanca. The highest concentrations of round sardinella were encountered in the south between Conakry and Bissau. Lower densities were found off the coast of Ziguinchor, Dakar and North of Kayar (14°60'N) and Banc d'Arguin (20°00'N). During the 2012 survey round sardinella was not found north of Cape Blanc. Flat sardinella was reported more frequently during the 2012 survey as compared with 2011, and the species was found from the border of Sierra Leone to Dakar, from Saint Louis to Nouakchott and from Cape Timiris to Cape Blanc. The presence of the flat sardinella north of Cape Blanc is limited to three observations, off the coast of the Bay of Cintra, Dakhla and Cape Boujdour.

Table 5. Number of species of hake, sparids and clupeids identified in Northwest African countries during two surveys undertaken by R/V *Dr Fridtjof Nansen* in 2011 and 2012

Species	2011						2012					
	Guniea	Guinea-Bissau	The Gambia	Senegal	Mauritania	Morocco	Guinea	Guinea-Bissau	The Gambia	Senegal	Mauritania	Morocco
Hakes (total species)	**1**	**1**	**1**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**2**
Merluccius merluccius						1						1
Merluccius polli	1	1	1	1	1	1	1	1	1	1	1	
Merluccius senegalensis				1	1	1			1	1	1	1
Sparids (total species)	**5**	**6**	**7**	**10**	**15**	**16**	**7**	**6**	**5**	**9**	**9**	**16**
Boops boops	1	1	1	1	1	1	1		1	1	1	1
Dentex angolensis	1	1	1	1	1		1	1	1	1	1	1
Dentex canariensis		1	1	1	1	1	1			1	1	1
Dentex congoensis	1						1	1		1		
Dentex gibbosus				1	1	1		1				1
Dentex macrophthalmus		1			1	1	1	1	1	1	1	1
Dentex moroccocanus					1	1				1	1	1
Diplodus bellottii				1	1	1					1	1
Diplodus capensis											1	1
Diplodus cervinus cervinus			1			1						
Diplodus puntazzo					1	1						1
Diplodus sargus				1	1	1				1		1
Diplodus vulgaris				1	1	1						1
Lithognathus mormyrus			1	1	1							1
Pagellus acarne					1	1						1
Pagellus bellottii	1	1	1	1	1	1	1	1	1	1	1	1
Pagellus erythrinus						1						1
Pagrus africanus		1										
Pagrus auriga					1	1						
Pagrus caeruleostictus	1		1	1	1	1	1	1	1	1	1	1
Pagrus pagrus						1						
Clupeids (total species)	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**1**	**2**	**3**	**2**
Sardina pilchardus					1	1					1	1
Sardinella aurita	1	1	1	1	1	1	1	1	1	1	1	1
Sardinella maderensis	1	1	1	1	1	1	1	1		1	1	

2.3.2 Highly migratory species

The offshore pelagic fish stocks, which include large tuna, small tuna and closely associated species, are distributed throughout the inter-tropical Atlantic region between the coasts of Africa and America. These types of fish typically perform large migrations, covering long distances and passing through both shallow waters and over the abyssal plain (Tandstad *et al.*, 2006; ICCAT, 2013[9]).

2.3.2.1 Large tuna

All the large tuna species known to occur in the Atlantic are found in the CCLME region. Bluefin tuna (*Thunnus thynnus*) is typically found off northwest Morocco (during its migration to the Mediterranean) and Cape Verde. Albacore (*Thunnus alalunga*) is a more temperate species typically found in the northwest. Bigeye tuna (*Thunnus obesus*) is found throughout the region and juveniles are common. Both Skipjack (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) are also abundant. The three principal tropical tuna species found in the CCLME (yellowfin, skipjack and bigeye) generally represent 90 percent of the declared tuna catches and are targeted by DWFs, mostly outside countries' EEZs (Tandstad *et al.*, 2006). Within the CCLME, skipjack tuna are dominant, with the average catch between 2005 and 2009 estimated to be 13 230 tonnes. Yellowfin and bigeye tuna averages for the project area were 3 800 tonnes each[10]. Because a significant proportion of the latter were likely juveniles, the nearshore catches could have a major impact on recruitment and spawning stock size.

2.3.2.2 Small tuna and tuna-like species

Small tunas and tuna-like species are widely distributed in the tropical and subtropical waters of the Atlantic. There are more than ten species within this group, all of which tend to form large shoals with other larger tunas and tuna-like species in coastal and oceanic waters. These species are regularly taken as bycatch and discarded. During the period 1990 to 2001, an average of 40 percent of the catch of small tunas was composed of five species: little tunny (*Euthynnus alleteratus*), frigate tunas (*Auxis* spp.), bonito (*Sarda sarda*), West Africa Spanish mackerel (*Scomberomorus tritor*) and wahoo (*Acanthocybium solandri*). Other species include chub mackerel (*Scomber japonicus*), plain bonito (*Orcynopsis unicolor*), Atlantic bonito (*Sarda sarda*) and the common dolphinfish (*Coryphaena hippurus*)[11]. A review of the ICCAT website indicates that this situation has not changed.

2.3.2.3 Associated species (*billfish*)

All the billfish known to occur in the Atlantic are found in the CCLME area. Blue marlin (*Makaria nigricans*), Atlantic sailfish *(Istiophorus albicans*) and swordfish (*Xiphias gladius*) are the species most commonly targeted by recreational fishing (Tandstad *et al.*, 2006). Marlin is of particular interest to recreational fishers off Cape Verde, where fish of 200 to 300 kg are caught regularly in the deep waters between Santo Antão and São Vicente; wahoo (*Acanthocybium solandri*) are also caught by recreational fishers in these waters. Swordfish is the most commonly targeted commercial species and these are found throughout the region but tend to occur offshore. Sailfish and blue marlin are also taken as bycatch in tuna longline fisheries.

2.3.2.4 Fisheries for tuna and tuna-like species

Tuna and tuna-like species are exploited by industrial fisheries, primarily DWFs, and artisanal fisheries, particularly in Northwest Africa. The artisanal exploitation of tuna is most likely an ancient tradition on the African coast but its origins are difficult to trace. The artisanal fisheries targeting tuna use poles and lines and the main fisheries are situated in Senegal and in the Cape Verde islands. Historical catches appear to be relatively modest. The industrial tuna fishery, which operates in the central eastern Atlantic, is carried out by three types of fleets: pole and line vessels and purse seiners, both of which catch fish close to the surface, and the longline fishery which exploits fish at greater depths.

The first industrial tuna fishery in Northwest Africa to target tuna was the refrigerated pole and line fishery with vessels originating from France and Spain. These vessels undertook seasonal fishing activities in the EEZs of Senegal and Mauritania between 1953 and 1956, with excellent yields. The fishery subsequently expanded with

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9 See http://www.iccat.int/en/

10 Catches in the CCLME area were estimated for this TDA by taking the catch from 5° squares extracted from the ICCAT database by Papa Kebe (retired ICCAT statistician) and assigning them to the CCLME proportionally by the percentage of each 5° square within the CCLME area.

11 See http://www.iccat.int/en/

the French and Japanese refrigerated pole and line fleets operating across the Atlantic, including around the Cape Verde islands. By the 1990s, the pole and line fishery developed a special strategy of concentrating the shoal of tuna under the boat in order to exploit them more efficiently. The pole and line vessels then started targeting concentrations of juvenile yellowfin tuna in mixed shoals with bigeye and skipjack tuna and were able to take on average 15 percent of yellowfin tuna.

In 1964, purse seine fishing vessels from France and Spain began to exploit the waters of the CCLME for the first time. These were small boats with limited capacity of around 100 tonnes, equipped with a small net of 800 m length and 100 m depth. The revolution of the purse seine fishery occurred in 1967 with the increase in the size of the seiners to a capacity of 400 to 1 500 tonnes; there was also a seaward expansion of the fishing area from 1975 onwards. Since 1991, the technique has been to target shoals with fish aggregating devices (FADs), which has increased catches of skipjack, juvenile bigeye and yellowfin tuna, and bycatch. Purse seine effort in the tropical Atlantic has decreased and catches fell from 100 000 tonnes in 1990 to 70 000 tonnes in 2000. The effective effort is however stable owing to the effectiveness of the technique. Purse seiners catch on average 80 percent yellowfin tuna (Tandstad *et al*., 2006).

The first Japanese longliners appeared in 1957. These vessels obtained excellent yields especially of large yellowfin tuna, which quickly led to an increase in the size of the fleet. The Japanese longliners were gradually replaced by vessels from Taiwan (1966), Korea (1968) and Cuba (1970). The fishing area has expanded seawards from the coast. In the early 1980s, the longliners began targeting bigeye rather than yellowfin tuna. Currently, Cape Verde has a national industrial fishery targeting tuna and other offshore pelagics such as small tunas and wahoo. The fishery is conducted by vessels of 11 to 76 m in length, belonging to public, private or individual operators. Catches are for the domestic market, canning and fresh or frozen export. Cape Verde also has a reciprocal agreement with Senegal and a partnership agreement with the European Union, which allows vessels from Spain, Portugal and France to fish its waters. In other countries such as Senegal, Mauritania and the Gambia, tuna are mainly exploited by Asian fleets, particularly the Japanese.

Atlantic tuna and tuna-like species are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). The Regional Fisheries Management Organization (RFMO) serves as a repository for catch statistics (summaries of which are submitted to FAO). At its annual meeting, ICCAT receives the report of the Standing Committee on Research and Statistics (SCRS) which summarizes the scientific information on the status of the various stocks. This information is then used to establish regulations such as TACs. The 2013 report of the SCRS was used in the preparation of this document. Periodically, a working group of the SCRS will perform a full stock assessment. It should be noted that the data available for analysis includes the year prior to the assessment, i.e. an assessment conducted in 2011 will use data up to and including 2010. In most cases however, the annual SCRS meeting considers all stocks in the context of the information and advice that has become available since the full assessment was completed. The material in the discussion that follows is taken from the ICCAT website,[12] except where otherwise indicated.

The 2010 assessment for bigeye tuna indicated that the current replacement yield is 86 000 tonnes with an estimated maximum sustainable yield (MSY) of 92 000 tonnes. Even though the medium value of B/BMSY for all model runs was above 1(1.01) ICCAT did not make a specific stock status indication due to considerable uncertainties in the data assessment. Concern is expressed over the potential impact on MSY of catches of small bigeye sold as "false tuna". Yellowfin tuna are considered to be overfished based on the 2011 assessment, but current catches below the total allowable catch (TAC) of 110 000 tonnes indicate that the stock is recovering to a point where, in the future, it could support a MSY of 144 600 tonnes. The use of FADs is however, increasing the catch of small fish and this could reduce the probability of recovery. Skipjack tuna are both difficult to assess and more resistant to overfishing than other tuna species. The last full assessment was in 2008. At that point, it was likely that there had been overfishing. MSY is estimated to be between 143 000 and 170 000 tonnes for the Eastern Atlantic (although some mixing with the stock to the west is known to occur) and landing of undersized fish and unreported catches remains a concern. Many landings are reported as "false tuna" but the mixture between small tuna species and juveniles of large tunas is not well documented. The expansion of the area of the fishery is a confounding factor in analysing these data. Recent catches above the MSY estimates have raised concerns and the SCRS called for a new full assessment in 2014. IUU fishing has been a particular concern in all the tuna fisheries and efforts are being made to address it internationally. Figure 15 shows the change in large tuna catches in the eastern Atlantic between 1980 and 2011 using data available from the ICCAT Statistical Bulletin[13].

[12] See http://www.iccat.int/en/
[13] www.ICCAT.int/documents/SCRS/Other/StatBull

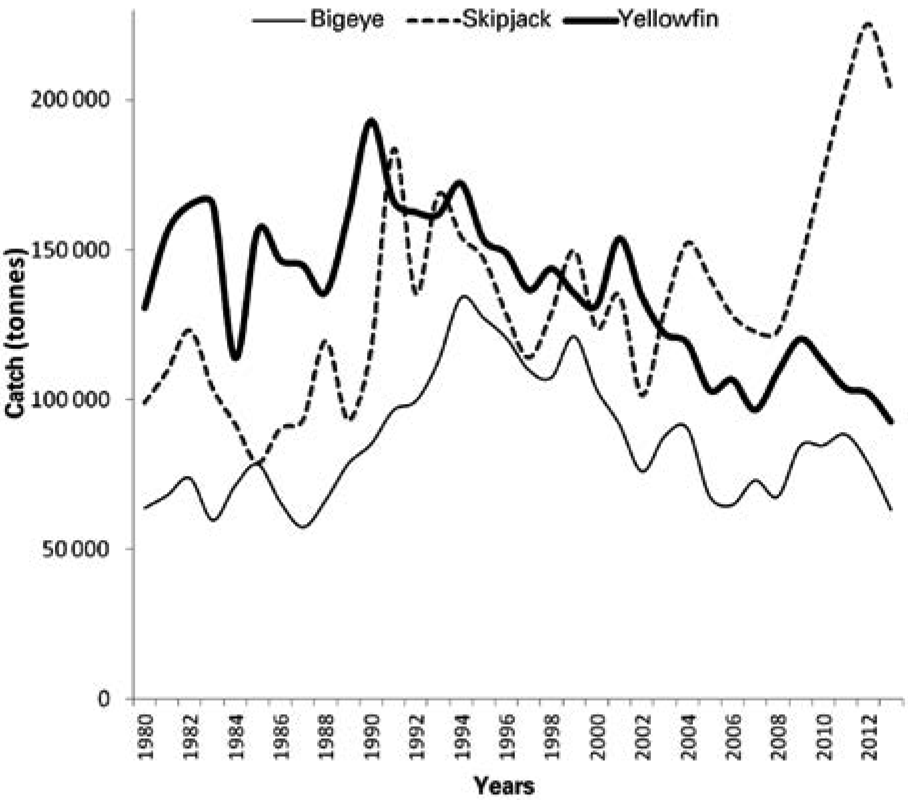

Figure 15: Changes in the annual catch of large tunas in the eastern Atlantic (source ICCAT: www.ICCAT.int/documents/SCRS/Other/StatBull)

The stock status of albacore tuna (north Atlantic stock) is most likely overexploited based on the 2011 assessment (Table 6). Production was 19 995 tonnes, 85 percent of which was from surface fisheries and the remainder from longliners; MSY was estimated to be 29 000 tonnes. Catches at or below the current TAC of 28 000 tonnes (catch in 2012 was 26 000 tonnes) are expected to slowly allow the stock to rebuild. In the CCLME region, the catch came from the waters off Morocco. The landings by Morocco were generally less than 100 tonnes and the total catch in the CCLME is not much larger. The stock status of bluefin tuna in the Eastern Atlantic and Mediterranean is considered to be overexploited based on the 2012 update of the 2010 full assessment. The global production of Eastern Atlantic-Mediterranean bluefin tuna in 2012 was 10 852 tonnes under a TAC of 12 900 tonnes or less, with the MSY between 21 500 and 52 900 tonnes (depending on whether there was a period of low or high recruitment). The average catch in the CCLME Project area was 1 594 tonnes for the years 2005 to 2009, primarily in Morocco, where they are caught mostly by "*madrague*", an artisanal non-specific gear. Regarding bluefin tuna, SCRS noted in its 2014 opinion that keeping the TAC stable or moderately and gradually increasing it under the current management programme should not jeopardize the success of the recovery programme and that, although there are still uncertainties regarding the assessment, according to the latest scientific advice from the SRFC the goal of the recovery strategy may already have been reached, or will be reached soon. Pending the outcome of the next stock assessment, the quantitative estimate of MSY was set at 23 256 tonnes. This quantitative estimate will be revised based on the results of the stock assessments planned for 2016. Similarly, the TACs for the years 2015, 2016 and 2017 were fixed at 16 142, 19 296 and 23 155 tonnes respectively, in accordance with ICCAT Recommendation 14–04 adopted at the 19th Special Meeting of ICCAT in Genoa (Italy) in November 2014.

Catches in Cape Verde are smaller. If catches are maintained at current levels the stock is likely to increase. In accordance with ICCAT Recommendation 13–17 adopted in November 2013, the electronic documentation programme (eBCD) should be fully implemented as soon as possible and no later than 1 March 2015 to support management by rapid exchange of data. A 15-year recovery programme was established with an estimated 60 percent probability of success.

There is little stock assessment information worldwide for small tuna and tuna-like species, an exception being king mackerel (*Scomberomorus cavalla*) off the southern United States, which was overfished but is now well managed. Blue marlin and Atlantic sailfish are overfished according to the 2008 and 2011 ICCAT assessments, respectively (see Table 6). The MSY for sailfish is between 1 250 and 1 950 tonnes with 30 to 40 percent taken in the CCLME. The MSY for blue marlin is estimated at between 2 343 and 3 331 tonnes, with about 90 tonnes taken in the CCLME Project area. North Atlantic swordfish are an ICCAT fisheries management success story, having recovered from overfishing. The TAC is now set at the MSY level of 13 700 tonnes (13 250 to 14 080 tonnes with 80 percent confidence limits) based on the 2011 assessment with 5 percent of the average catch taken in the CCLME Project area. The 2012 reported catch was 13 972 tonnes.

Recreational fishing for highly migratory species such as blue marlin and sailfish is receiving increased attention in the CCLME area. Senegal and Cape Verde are already well known for sailfish and blue marlin respectively, with the sector becoming increasingly important in the Gambia. Recreational fishing activities have the potential to provide some alternative livelihood opportunities for artisanal fishers.

Table 6: Stock status assessments of highly migratory tuna and tuna-like resources (source: http://www.iccat.int/en/)

Species	Assessment
Bigeye tuna	No status indicated (2010)
Yellowfin tuna	Overfished (2011)
Skipjack tuna	Overfished (2008)
Bluefin tuna	Overfished (2012)
Albacore tuna	Overfished (2011)
Blue marlin	Overfished (2011)
Atlantic sailfish	Overfished (2008)

2.3.3 Deepwater species

Deepwater species have diverse life history strategies and there is very little information available about the structure of stocks, migration, biology and ecology of these species in the CCLME region. As they live in a low productivity environment, they commonly have low growth rates and late maturity. Important commercial species such as the orange roughy (*Hoplostethus atlanticus*) have been reported in Morocco (Nakamura *et al*., 1986). Other important species, such as the alfonsino (*Beryx splendens* and *B. decadactylus*) have also been reported in the CCLME area (Maul, 1986, 1990).

2.3.3.1 Deepwater fishery

There is still no significant deepwater fishery at the national level in the coastal countries of the CCLME. This is probably as a result of a lack of commercial interest in these species and a lack of proficiency in the required fishing techniques.

2.3.4. Pelagic species

Coastal pelagic fish are planktivores and live in shoals in the upper layers of the ocean. Changes in water temperature and salinity cause seasonal shifts in their abundance and distribution patterns. Coastal pelagic fish are the most important marine resource in terms of landings and many stocks are transboundary owing to their migration patterns (Garcia *et al*., 1982). Data from 2000 to 2010 indicate that the composition of the exploited coastal pelagic species is, on average, 63 percent clupeids, 18 percent carangids, 9 percent scombrids and 6 percent engraulids (FAO/FishStat, FAO 2011).

During the decade from 2000 to 2010, the dominant species in the catches of clupeids in the CCLME area were, on average, 56 percent sardines, 41 percent sardinellas and 3 percent *Ethmalosa*. Sardine (*Sardina pilchardus*) is found mostly in the temperate waters in the north of the Canary Current region. Round sardinella (*S. aurita*) is found in the upwelling zones and the Madeiran sardinella (*S. maderensis*) generally lives in brackish coastal areas and at the mouths of rivers. The West African ilisha (*Ilisha africana*) and the Bonga shad (*Ethmalosa fimbriata*), which live in estuaries, lagoons and the sea and prefer warm and turbid waters, also belong to this group.

The exploited carangids include the Atlantic and Cunene horse mackerels (*Trachurus trachurus* and *T. trecae*) and other species of Carangidae (*Caranx rhonchus, D. macarellus, Selar crumenophthalmus*). The chub mackerel (*Scomber japonicus*), which are caught along the entire west African coast and the Atlantic mackerel (*S. scomberus*) are the main Scombridae caught in the region. The Engraulidae are represented by the European anchovy (*Engraulis encrasicolus*), which is present in the region, especially when the water is very cold.

Mullet (*Mugil* spp.) and meagre (*Argyrosomus regius*) are widely distributed across the west coast of Africa. These two species are exploited when they congregate in large schools and migrate to spawning areas. Yellow mullet (*Mugil cephalus*) and meagre stocks are shared between Mauritania and Senegal. Yellow mullet undertakes a seasonal north-south migration, feeding on the Banc d'Arguin from June to November and then moving south into Senegal to spawn during April to May. The Mauritanian zone and particularly Banc d'Arguin and Lévrier Bay are important spawning areas for meagre, which migrate south to Senegal between January and March. A recent study on the demographic structure of populations of meagre caught in Senegal and Mauritania confirm the likely existence of a shared stock (Kinadjian, 2013).

2.3.4.1 Pelagic fisheries

Small pelagic resources are exploited by both the artisanal and industrial fisheries in the CCLME area. Artisanal fishing is practised from small motorized (outboard motors) or non-motorized boats (canoes south of Cape Blanc and small boats north of Cape Blanc) using a variety of fishing gears. In Morocco artisanal boats are all motorized and the coastal vessels (trawlers, seiners, longliners) are small vessels under 150 gross tonnes. Industrial fishing consists of trawlers and purse seiners, some of which are foreign vessels operating mainly under fishing agreements. The largest of the coastal pelagic fisheries is in the Mauritanian EEZ. On average for the CCLME region, coastal pelagic species may represent almost 71 percent of the total catch (Tandstad *et al*., 2006).

The characteristics of the pelagic fisheries vary within the CCLME region. In Morocco, the pelagic fishery was created at the beginning of the twentieth century by and for industry, particularly for the export of canned products. The most important targeted species is the sardine. The availability of other species varies from one area to another and between years and includes anchovy, horse mackerels, Chub mackerel and round sardinella. The pelagic fishery has developed along the Moroccan coast with a shift in the fishing area towards the south (from exploiting the stocks in the northern parts during the 1930s, and in the Safi region during the 1970s, towards the more southern Sidi Ifni-Boujdour during the 1980s). The small pelagic fishery covers the whole Moroccan shelf and is conducted primarily by a national coastal fleet (coastal seiners and pelagic refrigerated sea water (RSW) trawlers and by a foreign fleet (pelagic trawlers and seiners) under the framework of the fisheries agreement with the European Union and charter agreements with the Russian Federation.

The industrial fishery in Mauritania is almost exclusively foreign, including fleets from the European Union (e.g. the Netherlands) and the Russian Federation, targeting mainly round sardinella and horse mackerel respectively (FAO, 2013). The artisanal fleet consists of wooden pirogues and artisanal purse seiners, targeting sardinellas and bonga as well as mullet (and croaker). Yellow mullet is mainly exploited by artisanal fisheries in the coastal zone near Nouakchott and the Banc d'Arguin National Park between September and February. The species is mostly caught using purse seines deployed from pirogues, surrounding gill nets and fishing on foot using cast nets. In the early 1990s, the opening of a high value export market for frozen mullet eggs led to the development of an important fishery aimed exclusively at export, but the mullet has now also become very popular in the domestic market. Fishing for meagre in Mauritania dates back to the 19th century and the species makes up a significant proportion of coastal and artisanal landings. Meagre are caught using set nets, handlines and trammel nets; they are also taken as bycatch by industrial trawlers and approximately 3 500 tonnes were landed in 2010 (Kinadjian, 2013).

In Senegal, the industrial pelagic fleet has almost disappeared; the large seiners disappeared in 1994 and the pelagic trawlers left in 1999. In recent years, the industrial fleet was composed of Russian trawlers and small local seiners called "*sardiniers Dakarois*" (FAO, 2013), targeting sardinellas (96 percent of landed species). The average catch in the last decade is around 3 100 tonnes, of which 51 percent were round sardinella. The artisanal fleet consists of motorized pirogues, employing a range of different gears including purse seines, surrounding gill nets and beach seines. Yellow mullet is caught in the north of Senegal from Kayar to St Louis using purse seines, drift nets, cast nets and beach seines.

In the Gambia, there was an industrial pelagic fishery between 1985 and 1998 but now only the artisanal fishery remains. The majority of boats target bonga shad, although recently artisanal fishers have started using encircling gill nets to target sardinellas.

Bonga shad are also targeted by artisanal fishers in Guinea, particularly in the north of the country, and in Guinea-Bissau. Other species caught in the artisanal fishery in Guinea-Bissau (*Sardinella maderensis* and *Ilisha africana*) are caught in the estuary of the Rio Grande de Buba. The industrial fishery is operated by foreign vessels within the framework of fisheries agreements and the main species are round sardinella, Atlantic and Cunene horse mackerels and Chub mackerel. In Guinea, industrial pelagic fisheries target horse mackerel, mackerel and Madeiran sardinella (*S. maderensis*). The Cape Verde pelagic fishery was described as the oldest fishery in the country (Edelmira and Caramelo, 1999). Artisanal fishers use handlines, beach seines, purse seines and gill nets to catch small pelagics (horse mackerel and mackerel) as well as tuna and demersal species. In 2001, the industrial fishing fleet was 66 boats and landed 3 240 tonnes of fish, of which 54 percent were small pelagics (Tandstad *et al*., 2006).

Stock assessments by the FAO working group on the assessment of small pelagic fish off Northwest Africa in 2015 (FAO, 2015b) found the sardine (*Sardina pilchardus*) stock in zones A and B continuing to improve, and the stock is now not considered to be fully exploited as is the case with the southern stock (Zone C) (Table 7). The assessment of sardinella species (*Sardinella aurita* and *S. maderensis*) continued to pose a problem for the working group due to the absence of abundance indices. The results of the assessments show that the stock is overexploited. The working group maintains its recommendation of reducing the fishing effort for all segments of the fleet (FAO, 2015b). The Cunene horse mackerel (*Trachurus trecae*) remains overexploited, while the Atlantic horse mackerel (*Trachurus trachurus*) is considered to be fully exploited. The assessment of chub mackerel (*Scomber japonicus*) indicates that the mackerel stock is fully exploited. The anchovy (*Engraulis encrasicolus*) is considered to be overexploited. The working group recommends that current fishing effort should be reduced and that in the long term effort should be adjusted in line with the natural fluctuations of this stock. The results of the assessment show that bonga (*Ethmalosa fimbriata*) is overexploited at a subregional level. The working group recommended that fishing effort should not be increased for these species (FAO, 2015b) (Table 7).

The assessments carried out by the FAO/CECAF working group on small pelagic resources (subgroup south) indicate that the stock of sardinella from Guinea-Bissau to Liberia, and of bonga shad in Guinea, are fully exploited (FAO, 2015c). The stock of Cunene horse mackerel found in Guinea-Bissau to Liberia, as well as the false scad (*Decapterus rhonchus*) in Guinea were found to be overexploited (FAO, 2015c).

The rapid development of the artisanal fishery in Mauritania and Senegal targeting breeding mullet for export of frozen eggs, led to the collapse of this species along its migration route. An evaluation by the scientific working group of the PARTAGE project (Project for Support to the Management of Traditional Cross-border Fishing) showed that the current fishing effort is about 2.7 times greater than the effort needed to achieve MSY and that the stock is overexploited; a 30 percent reduction in fishing effort was recommended (Kinadjian, 2013).

Table 7: Stock status assessments of small pelagic resources (FAO, 2015b and c)

Stock	Species	Assessment	Ref.
Sardine	*Sardina pilchardus*	Non-fully exploited (Zone A+B)	1
		Non-fully exploited (Zone C)	1
Sardinelle	*Sardinella aurita*	Overexploited (2011)	1
	Sardinella maderensis	Overexploited (2011)	1
	Sardinella spp.	Fully exploited (2014, Guinea-Bissau, Guinea, Sierra Leone, Liberia)	3
Horse mackerel	*Trachurus trachurus*	Fully exploited (whole NW Africa subregion)	1
	Trachurus trecae	Overexploited (whole NW Africa subregion)	1
		Overexploited (2014, Guinea-Bissau Guinea, Sierra Leone, Liberia)	3
	Decapterus spp.	Overexploited 2014 Guinea	3
Chub mackerel	*Scomber japonicus*	Fully exploited (whole NW Africa subregion)	1
Anchovy	*Engraulis encrasicolus*	Overexploited (whole NW Africa subregion)	1
Bonga	*Ethmalosa fimbriata*	Overexploited (whole NW Africa subregion)	1
		Fully exploited (2009, Guinea and Sierra Leone) Fully exploited (2014, Guinea)	2 3

1: 20 – 25 July 2015/Casablanca, Morocco.
2: 19–28 October 2009, in Accra, Ghana. Last year of data for assessments 2008.
3: 7–23 March 2014, Pointe Noire, Congo. Last year for assessments 2012 or 2013.

2.3.5 Demersal species

The CCLME region supports significant and diverse demersal living marine resources. The main species of demersal fish exploited in the region include: hake (*Merluccius merluccius, M. polli* and *M. senegalensis*), sea bream (including *Sparus aurata, Pagrius. auriga, Pagellus bellottii, P. acarne, Pagrus caeruleostictus, Dentex macrophthalmus* and *D. angolensis*), croaker (*Pseudotolithus elongatus, P. senegalensis, P. typus* and *P. brachygnatus*), threadfins (*Galeoides decadactylus*), groupers [(*Epinephelus aeneus* and the bluespotted seabass (*Cephalopholis taeniops*)], grunt (*Pomadasys* spp.), catfish (including *Carlarius leudelotii* and *Arius latiscutatus*), sole (mainly belonging to the genus *Cynoglossus*) and goatfish (*Pseudupeneus prayensis*). These species constitute 59 percent of the total demersal catch in the CCLME zone. The demersal fauna of the Cape Verde islands is distinct with the main species fished being: bluespotted seabass (*Cephalopholis taeniops*), Muraenidae, West African goatfish (*Pseudupeneus prayensis*), sea bream (*Diplodus* spp.) and *Seriola* spp. (FAO, 2015d and 2015e).

Hake species are exploited within the northern part of the CCLME at depths of 100 to 500 m. The main species of hake caught off the Atlantic Moroccan coast is the white hake and this population is treated as a separate stock. The other two species of black hake are found along the coast from Morocco to Senegal. Sea bream are generally associated with sandy and rocky hard bottoms to a depth of up to 500 m. The red Pandora (*Pagellus bellotti*) and the bluespotted seabream (*Pagrius caeruleostictus*) are the most important bream caught on the coast of West Africa from Morocco to Sierra Leone. Species of marine catfish (*Arius* spp.) have a wide distribution from Mauritania to Gabon and Angola. The species *Arius latiscutatus* and *C. heudelotii* are the main exploited species. Croakers (*Pseudotolithus* spp.) are a group of demersal fishes found off the coast from Morocco to Namibia that have been traditionally exploited within the CCLME area, particularly in the southern region. *Pseudotolithus senegalensis, P. typus* and *P. elongatus* are important species in both the artisanal and industrial fisheries in West Africa where they are fished throughout the year.

The white grouper (*Epinephelus aeneus*) is one of the most sought after demersal species in the region owing to its quality of flesh and high market value. It is found along the west coast of Africa, as far south as Angola, from 20 m to 200 m depth. The bluespotted seabass (*C. taeniops*) is found on rocky and sandy bottoms at depths of 20 m to 200 m. There are as yet insufficient data on their population abundance in the CCLME area, but they are considered relatively common and abundant in the Cape Verde Islands. The lesser African threadfin (*Galeoides decadactylus*) is found along the coast of West Africa between the Canary Islands and Angola. It is fished by both artisanal and industrial fisheries and is a major component of the bycatch of shrimp trawlers. *Pomadasys jubelini* and *P. incisus* are the main species of grunt and have a coastal distribution from the Strait of Gibraltar to the south of Angola. The sompat grunt (*P. jubelini*) is the most abundant and is caught on sandy and muddy bottoms at depths which may exceed 30 m, and sometimes in estuaries. All species of grunt are exploited by both industrial and artisanal demersal fishing and these species are present in landings from some pelagic fishing gear such as artisanal nets. The name "sole" given to the genus *Cynoglossus* caught in the CCLME area includes three species (*C. senegalensis, C. canariensis* and *C. monodi*). The latter two species are less coastal than the first, *C. senegalensis*, which is the most abundant and most fished. These species are found from Mauritania to Angola on coastal muddy bottoms from 4 to 35 m depth (FAO, 2015d).

2.3.5.1 Demersal fisheries

Demersal finfish are fished by industrial (national and foreign) trawlers, longliners and coastal trawlers, as well as artisanal fisheries. The stocks exploited are mainly found at depths of 0 to 200 m. These fisheries are often multispecies, with certain species being more important than others, either in terms of value or total catch size. The fish species are often caught as bycatch in other specialized fisheries, such as the cephalopod or shrimp fisheries. There is also a specialized fishery for hake in the northern part of the area (Morocco to Senegal).

The hake fishery in Morocco was, until the end of 1999, exploited by Morocco, Spain and Portugal. However, only the national fleet now operates in these waters. The fleet is composed of around 450 small coastal vessels, trawlers and low range longliners which exploit white hake (*M. merluccius*) and pink shrimp on the continental shelf at depths of less than 150 m. Exploitation of hake in Mauritania began in the 1950s, targeting black hake (*M. senegalensis* and *M. polli*). There are two fleets: the Mauritanian trawler fleet and the Spanish trawler and fresh fish longline fleet which operates under a fishing agreement. Pelagic trawlers also catch hake as a bycatch, which represents 10 percent of the total declared volume. In Senegal and the Gambia, the main fleet targeting black hake is composed of Spanish trawlers which have been operating since 1985 (but were suspended in Senegal in 2006).

In Cape Verde, the demersal fish stocks are mainly exploited by the artisanal fisheries using handlines in rocky areas between 50 to 200 m depth. Annual production is estimated at 1 000 tonnes per year composed of *Cephalopholis taeniops*, (27 percent), *Muraenidae*, (14 percent), *Pseudupeneus prayensis,* (11 percent), *Diplodus* spp. and *Seriola* spp. (6 percent) (FAO, 2015d).

In Senegal, demersal resources are exploited by both the artisanal and industrial fisheries. The main types of artisanal vessels targeting demersal resources are pirogues, which are either rowed or have an engine, some of which are equipped with ice blocks and set gillnets. Demersal resources are also landed as bycatch in purse seine, ringnets, beach seines and other gears. The industrial fleets operating in Senegal in 2007 consisted of 96 vessels with coastal demersal fishery licences and 20 vessels with deep water demersal fishery licences. The European trawling fleet left Senegal towards the end of 2006 when the European Union-Senegal fishing agreement was not renewed (FAO, 2013).

In Guinea-Bissau and Guinea, demersal fish species are targeted by both the artisanal and industrial (mainly foreign) fisheries. In Guinea, the artisanal fishery is either carried out traditionally or with motorized pirogues using six main types of gear (driftnets, encircling gillnets, longlines, set gillnets, handlines and purse seines). Since 1985, the industrial trawlers are mainly foreign-owned, operating under licensing agreements, except for around 10 freezer trawlers of Guinean nationality. In 2000, 75 industrial vessels targeting demersal fish operated in Guinean waters. In addition, the vessels fishing for cephalopods and shrimps, which fished in Guinea in the same year, accounted for between 20 to 30 percent of the demersal fish catch (FAO, 2015e).

Stock assessments conducted by the FAO/CECAF demersal working group subgroup north (FAO, 2015a and d) and subgroup south (FAO, 2015e) provide information related to the state of the main demersal species in the CCLME region. The latest assessments (Table 8) indicate that the following stocks are overexploited: white hake (*Merluccius merluccius*) in Morocco, various seabreams (*Pagrus* spp., *Pagellus acarne, Pagellus* spp.) in Morocco, the white grouper (*Epinephelus aeneus*) in Mauritania, Senegal and the Gambia, the rubberlip grunt (*Plectorhinchus mediterraneus*) in Morocco and croakers (*Pseudotolithus* spp.) in Guinea and Guinea-Bissau.

The bobo croaker (*Pseudotolithus elongatus*), the threadfins (*Galeoides decadactylus*) and the grunts (*Pomadasys* spp.) in Guinea and Guinea-Bissau are all considered to be fully exploited.

The species which are not fully exploited included the black hakes (*M. polli* and *M. senegalensis*) in Mauritania, red pandora (*Pagellus bellottii*) off Mauritania, Senegal and the Gambia, *Sparidae* in Guinea and Guinea-Bissau, catfish (*Arius* spp.) in Senegal and the Gambia and in Guinea and Guinea-Bissau and soles (*Cynoglossus* spp) in Guinea and Guinea-Bissau.

For some species and stocks no conclusive results could be drawn from the assessments (Table 8).

Table 8: Stock status assessments of demersal fish resources (Source FAO, 2015a and e)

<table>
<tr><th>Stock</th><th>Species</th><th>Assessment</th><th>Ref.</th></tr>
<tr><td>White hake</td><td>Merluccius merluccius</td><td>Overexploited (2013, Morocco)</td><td>1</td></tr>
<tr><td>Black hake</td><td>Merluccius polli and M. Senegalensis</td><td>Not fully exploited (2013, Mauritania)</td><td>1</td></tr>
<tr><td rowspan="8">Sea bream</td><td>Pagellus bellottii</td><td>Not fully exploited (2013, Mauritania, Senegal & the Gambia)</td><td>1</td></tr>
<tr><td>Pagellus acarne</td><td>Overexploited (2013, Morocco)</td><td>1</td></tr>
<tr><td>Pagellus spp.</td><td>Overexploited (2013, Morocco)</td><td>1</td></tr>
<tr><td>Pagrus caeruleostictus</td><td>Uncertainties in the assessment (2013, Mauritania, Senegal and the Gambia</td><td>1</td></tr>
<tr><td>Pagrus spp.</td><td>Overexploited (2013, Morocco)</td><td>1</td></tr>
<tr><td rowspan="2">Sparidae</td><td>Not fully exploited (2008, Guinea+ Sierra Léone)</td><td>2</td></tr>
<tr><td>Not fully exploited (2011, Guinea+Guinea-Bissau)</td><td>3</td></tr>
<tr><td>Dentex macrophtalmus</td><td>No conclusive results (2013, Mauritania, Senegal, and the Gambia)</td><td>1</td></tr>
<tr><td rowspan="2">Grunt</td><td>Epinephelus aeneus</td><td>Overexploited (2013, Mauritania, Senegal and the Gambia)</td><td>1</td></tr>
<tr><td>Plectorhinchus mediterraneus</td><td>Overexploited (2013, Morocco)</td><td>1</td></tr>
<tr><td rowspan="3">Croaker</td><td>Pseudotolithus elongatus</td><td>Fully exploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
<tr><td rowspan="2">Pseudotolithus spp.</td><td>Overexploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
<tr><td>The assessments were not conclusive because of insufficient catch and effort data available to the Working Group (2013, Senegal and the Gambia)</td><td>1</td></tr>
<tr><td>Threadfins</td><td>Galeoides decadactylus</td><td>Fully exploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
<tr><td rowspan="3">Catfish</td><td rowspan="2">Arius spp.</td><td>Not fully exploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
<tr><td>Not fully exploited (2013, Senegal and the Gambia)</td><td>1</td></tr>
<tr><td>Pomadasys spp.</td><td>Fully exploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
<tr><td>Sole</td><td>Cynoglossus spp.</td><td>Not fully exploited (2011, Guinea+Guinea-Bissau)</td><td>2</td></tr>
</table>

1: 18 – 27 November 2013, Fuengirola, Spain; last year data for assessments 2012 if no other specific remark.
2: 15 – 24 November 2011, Accra, Ghana. Last year data for assessment 2010 or 2009.
3: 9 – 18 October 2008, Freetown, Sierra Leone.

2.3.6 Elasmobranchs (sharks and rays)

The CCLME supports a significant number of elasmobranchs including 43 species of sharks, 24 species of rays, three species of angel sharks, five species of guitarfish and three species of sawfish.

The coastal species found on the shallow continental shelf (*Carcharhinidae, Sphyrnidae, Triakidae, Ginglymostomatidae, Hemigaleidae, Leptochariidae, Rhinobatidae, Dasyatidae, Myliobatidae, Gymnuridae,* and *Pristidae*) are more accessible to artisanal fishers. Species living at greater depths on the slope (*Squalidae, Rajidae, Squatinidae, Echinorhinidae, Oxynotidae, Torpedinidae* and *Scyliorhinidae*) are often caught by demersal trawlers, whereas pelagic species (*Alopiidae, Lamnidae, Carcharhinus longimanus, Prionace glauca* and *Mobulidae*) are more common in the catches of the pelagic trawlers and surface longliners.

2.3.6.1 Elasmobranch fisheries

Sharks were abundant in the region in the 1970s and frequently caught as bycatch in various fisheries, but not subject to stock assessments. The development of the shark fisheries in the CCLME was driven by the demand for dried salted shark, which has been eaten in Ghana for many years. Ghanaian fishers living in the Gambia set up specialized businesses to exploit sharks and produce dried salted meat for export to Ghana. By the mid 1970s, Ghanaians started to repurchase shark catches from Senegalese fishers caught in the Saloum Delta and along the Gambian coast. This system of buying back carcasses of sharks and rays from other fisheries spread and Ghanaian traders can be found from Mauritania to Guinea (Tandstad *et al*., 2006).

The shark fin market for export to South East Asia was unknown to operators of the artisanal fisheries until the early 1980s, but its development has affected all coastal fisheries. Sharks suddenly became an important source of foreign currency. Traders developed an informal credit system to encourage fishers to exploit them. Fishers from the "*Grande*" and "*Petite*" coasts of Senegal became interested in adding value through maximizing the bycatch of sharks and guitarfish. Techniques used to fish from canoes were modified to increase catches of elasmobranchs. As fishing effort increased, yields from the northern fishing areas declined and shark fishers were forced to move south and return to selling the salted meat to Ghanaians.

In Mauritania in the late 1980s, traders made contact with the Imraguen fishers in the Banc d'Arguin National Park via wholesalers who traditionally practised in the area. The extremely rich elasmobranch resources, including Carcharhinidae and Rhinobatidae, allowed the rapid development of targeted exploitation. The wholesalers again used an informal credit system and this accelerated the pace of development and increased fishing effort. In 1996, Mauritanian traders came into contact with Ghanaian traders and set up processing teams for salting and drying in the Imraguen villages (Tandstad *et al*., 2006).

Guitarfish fins also command a high price and targeted artisanal fisheries have developed in the region. The blackchin guitarfish (*Rhinobatos cemiculus*) is targeted by specialized fishing teams using bottom set nets in Guinea-Bissau and in the Banc d'Arguin National Park in Mauritania. A total ban on elasmobranch fishing has since been implemented in the Banc d'Arguin and the species is now found along the entire length of the Mauritanian coast. It is, however, still caught as incidental bycatch in artisanal gillnet fisheries and industrial demersal trawl fisheries targeting cephalopods, which operate throughout its range. The common guitarfish (*R. rhinobatos*) is another common bycatch in shrimp trawl fisheries in shallow inshore waters. This species is also targeted in artisanal bottom set-net fisheries and dried for export to Ghana for human consumption (Notarbartolo di Sciara *et al*., 2013). In Senegal, landings of guitarfish species peaked in 1997 at 4 218 tonnes but decreased to an estimated 821 tonnes by 2005. In Guinea-Bissau specialized shark fishing teams target *Rhinobatos spp*. using gillnets in water depths of 1 to 40 m and they are also caught as bycatch in the mullet fisheries. *R. rhinobatos* is also caught as bycatch by bottom trawlers in Mauritania.

2.3.7 Crustaceans

Catches of crustaceans represent, on average, 6 percent of catches of demersal species in the CCLME region. Crustaceans are mainly represented by shrimps and to a lesser extent lobsters, spiny lobsters and crabs.

Two main groups of shrimps are important in the region: the coastal shrimps represented principally by the southern pink shrimp, *Penaeus notialis*, and the deepwater shrimps represented mainly by the deepwater rose shrimp *Parapenaeus longirostris*. Other less abundant shrimp species are also caught in the area: *Penaeus kerathurus, Aristeus antennatus, Holthuispemaeopsis atlantica, Aristeus varidens, Plesionika heterocarpus, Aristaeopsis edwardsiana* and *Aristaeomorpha sp.* (FAO, 2015a and 2015e).

Four species of lobster are caught on the continental shelf of Cape Verde: the Cape Verde spiny lobster[14] (*Palinurus charlestoni*) the green spiny lobster (*Panulirus regius*), brown spiny lobster (*Panulirus echinatus*) and the pink spiny lobster (*Palinurus mauritanicus*). Species of crab found include *Sanquerus validus* which are found along the coast, *Callinectes Amnicola* which is abundant in estuaries and lagoons and *Liocarcinus corrugates* and *Chaceon maritae* which tend to be found offshore (Tanstad *et al*., 2006).

2.3.7.1 Crustacean fisheries

Both shrimps and lobsters are exploited within the CCLME and these high value species are generally exported to foreign markets. Lobsters are normally exported alive to markets mostly in Europe (e.g. France) and generate

[14] In Cape Verde also referred to as the pink spiny lobster

high incomes. The main species of shrimp caught in the CCLME region are the pink shrimp and the deepwater rose shrimp. Deepwater shrimps are predominantly exploited by foreign fleets and sold mainly on the European market.

In Morocco, shrimps are exploited by the national fleet, composed of coastal trawlers, which operate on the continental shelf at depths shallower than 150 m, and deepsea trawlers with a larger scope of activity.

Exploitation of shrimp in Mauritania commenced in the 1960s with a Spanish industrial fleet. By 2004, the industrial crustacean fleet was composed of 81 vessels of different nationalities. The shrimps *P. longirostis,* (46 percent) and *P. notialis,* (40 percent) were primarily exploited by Spanish vessels (Tandstad *et al*., 2006).

In Senegal and the Gambia, the crustacean fishery targeting the coastal shrimp, *P. notialis*, consists of 61 vessels. The shrimp resources in Senegal were initially exploited almost exclusively by Spanish trawlers. From 1982, a number of Spanish vessels took Senegalese nationality, giving rise to a national fleet operating in deep waters; *P. longirostris* is the main target species and makes up 80 percent of the total landings of crustaceans. In Guinea-Bissau and Guinea the main shrimp species exploited by the commercial fleets are *P. notialis, Holthuispenaeopsis atlantica* and *P. longirostris*. These shrimps are caught by demersal industrial trawlers – including the specialized shrimpers that target them, and the demersal fish and cephalopod trawlers that harvest them as bycatch.

Thiaw *et al*. (2009) used a wind-based coastal upwelling index and satellite-derived primary production estimates to compute MSY and associated fishing effort (EMSY) in white shrimp (*Penaeus duorarum notialis*) off Senegal, based on environmental limits. In northern Senegal the authors found that upwelling is highly variable from year to year and constitutes the major factor determining shrimp productivity. In the south, where fishing effort has strongly increased over the past 10 years, hydrodynamic processes seem to dominate and determine the levels of primary production, as well as the reproduction and biomass of white shrimp.

Assessments were carried out by the FAO/CECAF Demersal Working Group (subgroup north and south) in 2008, 2010, 2011 and 2013. The latest asseements (Table 9) indicated that the stocks of the pink shrimp (*P. notialis*) in Mauritania, Senegal and the Gambia seem to be overexploited, whereas no conclusive results were obtained for the stocks in Guinea and Guinea-Bissau. For the deep water rose shrimp, the assessments indicated that the stock in Morocco seems to be overexploited and it was recommended to reduce the level of catches and fishing effort. In Guinea-Bissau, the stock was found fully exploited, whereas in Mauritania, Senegal and the Gambia the stocks seem not to be fully-exploited. As a precautionary measure it was recommended that fishing effort is not incrreased for these stocks. For some species and stocks no conclusive results could be drawn from the assessments.

Table 9: Stock status assessments of shrimp resources (Source FAO, 2008; FAO, 2015a, d and e)

Stock	Species	Assessment	Ref.
Shrimps	*Parapeneus longirostris*	Overexploited (2010, Morocco)	4
		Not fully exploited (2010, Mauritania, Senegal and the Gambia) Not fully exploited (2013, Mauritania) Not fully exploited (2013, Senegal and the Gambia)	1, 4
		Fully exploited (2011, Guinea-Bissau)	3
	Penaeus notialis	Overexploited (2010, Mauritania, Senegal and the Gambia) Overexploited (2013, Mauritania) Overexploited (2013, Senegal and the Gambia)	1, 4
		Overexploited (2008, Guinea) No conclusive results (2011, Guinea) No conclusive results (2011, Guinea-Bissau)	2, 3

1: 8 – 17 February 2010, Agadir, Morocco. Last year of data 2008 if no other specific remark.
2: 9 – 18 October 2008, Freetown, Sierra Leone. Last year of data 2007 if no other specific remark.
3: 15 – 24 November 2011, Accra, Ghana. Last year of data for assessment 2010 or 2009.
4: 18 – 27 November 2013, Funegirola, Spain. Last year of data for assessment 2012 if no other specific remark.

The exploitation of the coastal lobsters (*Panulirus regius, P. echinatus* and *Scyllarides latus*) in Cape Verde began in the 1960s. In Cape Verde, *P. regius* (*lagosta verde* – green lobster) is heavily fished at most of the islands (Foueré, 1981; Dias, 1993; Reis, 1997). At present, it accounts for 71 percent of the catch of shallow-water lobster species in the northwest islands. These coastal lobsters are exploited by a commercial dive fishery that operates from small boats normally with four divers each. A very small-scale fishery also exists to supply restaurants and tourists (Latrouite and Alfama, 1999). The Cape Verde spiny lobster *Palinurus charlestoni* is caught at depths between 100 and 350 m by an industrial trap fishery. Catches of *P. charlestoni* declined by 85 tonnes from 1991 to 1992 and a closed season is enforced between July and September. The species is considered overexploited and a freeze in fishing effort has been recommended. Little information exists for the coastal lobsters (*P. reguis, P. echinatus* and *S. latus*).

In Mauritania, fixed gillnets are the main gear used to fish the royal (or green) spiny lobster (*P. regius*). This species is now rarely encountered in the northern zone and is believed to be on the way to extinction (Tandstad *et al*., 2006).

In Morocco, exploited species consist of pink lobster (*Panulirius mauriticanus*), green lobster (*P. regius*), red lobster (*Palinurus elephas*), the lobster *Homarus glammarus* and some crab species. The fleet that operates in this fishery consists of artisanal boats, longliners and trawlers.

2.3.8 Cephalopods

The main target species in the cephalopod fisheries are octopus (*Octopus vulgaris*), cuttlefish (*Sepia* spp. of which most are *Sepia hierredda* and a southwards decreasing proportion of *Sepia officinalis*) and squid (*Loligo vulgaris*). These species make up an average of 35 percent of landings of demersal resources. The common octopus (*O. vulgaris*) can be found from Guinea in the south to Morocco in the north and is typically found in coastal waters at depths ranging from 0 to 400 m (Caverivière *et al*., 2002). The cuttlefish (*S. officinalis, S. hierredda* and *S. bertheloti*) are found on sandy and muddy seabeds from the coast to about 200 m depth. *Loligo vulgaris* is the most common species of squid in coastal waters from the North Sea to the west coast of Africa and lives at depths of 500 m. Its abundance is often sporadic in the CCLME area and catches are relatively low (Tandstad *et al*., 2006).

2.3.8.1 Cephalopod fisheries

Cephalopods are caught both as target species and as bycatch in non-directed fisheries within the CCLME. These fisheries are conducted by a wide range of vessels, from small canoes to trawlers, using different types of fishing gears such as pots, jigs and bottom trawls.

In the northern part of the CCLME, fishing for cephalopods started in the 1960s by a Japanese fleet targeting octopus. This fleet was taken over by Spanish trawlers in 1963 and increased to a maximum of 279 vessels in 1980. Fishing agreements imposed a gradual decrease in the size of the Spanish fleet, which left the zone at the end of 1999. The development of the Moroccan industrial fleet began in 1978 and increased rapidly as local vessels replaced the Spanish vessels leaving the fishery. More recently, an important part of the Moroccan artisanal fleet, formerly fishing for demersal finfish, has evolved into a very specialized fishery targeting octopus, using passive gears such as pots and hand jigs. About a hundred coastal trawlers also fish for cephalopods in Morocco.

At the start of the 1960s, in the central part of the CCLME region, Japanese vessels opened another cephalopod fishery. Twenty years later, in the early 1980s, Mauritania introduced an industrial fleet comprising both ice and freezer trawlers that exploited the cephalopod resources exclusively for more than a decade. In 1996, a fisheries agreement was signed between Mauritania and the European Union allowing the entry of a number of European vessels into the fishery, the majority of which were Spanish. The number of cephalopod trawlers was around 193 in 2003 and 130 in 2012, a third of which were foreign. An artisanal cephalopod fishery targeting both octopus and cuttlefish developed along the Mauritanian coast around 1989. The fishery consists of small open, wooden vessels of different types and sizes. In recent years the fishing gear deployed in the fishery has diversified away from the squid net, octopus trap and pots.

In the southern part of the CCLME, fishing for cephalopods is a relatively recent activity, mostly practised by Spanish freezer trawlers formerly working under the framework of the European Union–Senegal fisheries agreement. Another important component of the fishery is the Senegalese artisanal fleet, a part of which is increasingly and seasonally targeting cephalopods using hand jigs and traps; the main target species is cuttlefish. In Guinea and Guinea-Bissau cephalopods are targeted by the industrial and artisanal fisheries, the main fleet being of Spanish origin in both countries.

Most of the cephalopod species caught in the region are exported. Cephalopods are usually marketed fresh and frozen and are a highly appreciated food item, particularly in Japan, the Republic of Korea, Italy and Spain. In Mauritania in 1999, the fisheries sector contributed about 45 percent of total exports, with cephalopods alone representing about 55 percent of the total value of fisheries products declared for export (Failler *et al.*, 2006).

Assessments were carried out by the FAO/CECAF demersal working groups (subgroup north and south) in 2008, 2010, 2011 and 2013. The latest assessments indicated that for the common octopus (*Octopus vulgaris*), the Dakhla stock and the Cape Blanc stock are overexploited and it is necessary to reduce the fishing effort. The Senegal-Gambia stock was considered not fully exploited in the last (2013) assessment. All of the cuttlefish stocks assessed by the northern subgroup were found to be not fully exploited at the last assessment, an improvement as compared to the previous assessment. In Guinea Bissau no conclusive results were reached based on the last (2011) assessment. The squid stock at Cape Blanc was found to be not fully exploited (Table 10).

Table 10: Stock status assessments of cephalopod resources (Source FAO, 2008; FAO, 2015a, d and e)

Stock	Species	Assessment	Ref.
Cephalopods	*Octopus vulgaris*	Overexploited (2010, Dakhla from Cape Bojador to Lagouira 26°N–20°50'N; Cape Blanc 20°N–16°N; Senegal and the Gambia) Not fully exploited (2011, Guinea-Bissau) Overexploited (2013, Dakhla) Overexploited (2013, Cape Blanc) Not fully exploited (2013, Senegal and the Gambia)	1, 4
	Sepia spp.	Overexploited (2010, Dakhla from Cape Bojador to Lagouira 26°N–20°50'N; Cape Blanc 20°N–16°N (uncertainty in the assessments); survey indices in Mauritania show a decrease; 2008, overexploited in Senegal and the Gambia) Not fully exploited (2013, Dakhla) Not fully exploited (2013, Cape Blanc) Not fully exploited (2013, Senegal and the Gambia)	1, 4
		Not fully exploited (2008, Guinea-Bissau) No conclusive results (2011, Guinea- Bissau)	2, 3
	Loligo vulgaris	Results of the model are not conclusive (2010, Dakhla from Cape Bojador to Lagouira 26°N–20°50'N) Not fully exploited (2013, Cape Blanc) No conclusive assessments in the other areas (subgroup north) (2013)	1, 4

1: 8 – 17 February 2010, Agadir, Morocco. Last year of data 2008 if no other specific remark.
2: 9 – 18 October 2008, Freetown, Sierra Leone. Last year of data 2007 if no other explicit remark.
3: 15 – 24 November 2011, Accra, Ghana. Last year of data for assessments 2010 or 2009.
4: 18 – 27 November 2013, Funegirola, Spain; Last year of data for assessments 2012 if no other specific remark.

2.3.9 Vulnerable and/or threatened species

A total of 675 marine plant and animal species are included on the IUCN Red List for the CCLME participating countries (IUCN, 2013). While no marine species from the region have yet to be reported as extinct, there are 94 species that are classified as either "Vulnerable" (VU), "Endangered" (EN), or "Critically Endangered" (CR) (Table 11). The most threatened species include: 20 species of gastropod mollusc (VU = 8 species, EN = 11 species and CR = 1 species), 12 species of bony fish (VN = 7 species, EN = 3 species and CR = 2 species), 43 species of sharks and rays (VU = 29 species, EN = 8 species and CR = 6 species), 9 species of bird (VU = 4 species, EN = 2 species and CR = 3 species), 3 species of turtle (VU = 1 species, EN = 1 species and CR = 1 species) and 8 species of mammal (VU = 4 species, EN = 3 species and CR = 1 species) (Table 12).

Table 11: Summary statistics for the IUCN Red List for CCLME countries (IUCN, 2013)

IUCN Red List status	Number of species in CCLME
Extinct	0
Extinct in the wild	0
Critically endangered	15
Endangered	27
Vulnerable	52
Near threatened	58
Least concern	415
Data deficient	108

2.3.9.1 Marine mammals

Marine mammals recorded in the CCLME include whales (*Megaptera novaeangliae, Balaenoptera edeni* and others), dolphins (*genera Delphinus, Tursiops, Stenella* and others), manatees (*Trichechus senegalensis*) (CNHB, 2002) and the Mediterranean monk seal (*Monachus monachus*).

Cetacean sightings were recorded during surveys in the CCLME conducted onboard the R/V *Dr Fridtjof Nansen* in 2011 and 2012. Between the Cape Verde Islands and Dakar, there were 18 cetacean sightings of at least three species, including a humpback whale (*Megaptera novaeangliae*), a rough-toothed dolphin (*Steno bredanensis*) and a killer whale (*Orcinus orca*) in 2011. There were also 11 distinct groups of small unidentified delphinidae observed, probably belonging to the *genera Delphinus, Stenella* and *Tursiops*. From Morocco to Guinea, there were 118 unique observations of cetacean groups. The short-beaked common dolphin (*Delphinus delphis*) was by the far most commonly encountered cetacean in the study area, both in the number of observations and the average size of the group (180). The second most commonly observed groups were those of unidentified delphinids and balaenopterids, including Bryde's whales (*Balaenoptera edeni*) and sei whales (*B. borealis*). Less common species included the common bottlenose dolphin (*Tursiops truncatus*), the short-finned pilot whale (*Globicephala macrorhynchus*), the Atlantic spotted dolphin (*Stenella frontalis*), the pan-tropical spotted dolphin (*S. attenuata*) and the rough-toothed dolphin (*S. bredanensis*). The presence of a minimum of five pairs of adult and calf humpback whales, of which at least two were new-borns, indicates a wintering and breeding location. An important consequence for management and conservation is that Guinea-Bissau, the Gambia and Senegal are now confirmed as new states in the humpback whale's distribution range.

There are four species of marine mammal classified as either "Endangered" or "Critically Endangered" on the IUCN Red List, found within the waters of the CCLME. These are the sei whale (*Balaenoptera borealis*), blue whale (*B. musculus*), fin whale (*B. physalus*) and the Mediterranean monk seal (*Monachus monachus*).

The Mediterranean monk seal is currently the most threatened marine mammal in the CCLME region and is the world's most endangered seal species (UNEP-MAP-RAC/SPA, 2013). There are fewer than 600 individuals remaining throughout the species distribution range, from the Black Sea, Mediterranean and North East Atlantic. The species is listed as "Critically Endangered" on the IUCN Red List and is included on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Cape Blanc hosts the largest surviving population of monk seals (Figure 16).

The African manatee (*T. senegalensis*) is found in West Africa, from Senegal to Angola in marine, brackish and freshwater habitats, from the open ocean, to coastal lagoons, estuaries, rivers and lakes. Guinea-Bissau is the country with the largest population of manatees within the CCLME, as their number in other countries in the region has been declining. In recognition of the threatened status of the African manatee, the species is now classified as "Vulnerable" on the IUCN Red List and listed on Appendix II of CITES. The manatee was hunted traditionally in many countries in the region for meat, hide, oil and bones and is now also targeted deliberately by fishers because it is perceived to be a threat, especially when damaging fishing nets. Other threats to the manatee include habitat disturbance and loss owing to the expansion of urban and agricultural areas, damming and increased use of hydroelectric power in the region. Boat strikes and accidental catch by fishing trawls and shark nets have also been reported as causes of mortality.

Another large mammal found in the coastal zone of the CCLME region is the common hippopotamus (*Hippopotamus amphibius*). This species is not common in West Africa and the populations are at risk because their distribution is fragmented. The three CCLME countries that have the largest populations of hippopotami are Guinea, Guinea-Bissau and Senegal, and the total number of individuals is only a few thousand. Hippopotami are typically found near large rivers and estuarine habitats, although one of the more substantial populations is found in the sea in the Bijagos Archipelago off Guinea-Bissau and along the numerous inland rivers. The species is common in most of the rivers in Guinea and in the east and south of Senegal with an estimated country-wide population of between 500 and 700 individuals (Lewison and Oliver, 2008). The Gambia contains no more than about 40 animals. The primary threats to the hippopotamus are IUU hunting for meat and ivory (found in the canine teeth) and habitat loss.

During the second CCLME regional ecosystem survey off the northwestern African coast (9 May to 22 July 2012), sighting effort was maintained for a duration of 519 h over 57 effective observation days at sea. Either one or two observers were present on the ship on each of four legs and covered a total distance of 6 278 km. The study area covered continental shelf and slope waters ranging from Conakry, Guinea, to Tangier, northern Morocco, with two deep-water transits to and from Las Palmas de Gran Canaria. A total of 105 sightings of cetaceans were registered, 99 unique records and six resightings, in the EEZs of the coastal states covered (excluding Cape Verde) and offshore. However, the many sampling stations during the survey precluded an abundance estimate. About half the sightings (51.5 percent) could be positively identified to species, most supported by photographs, while for another 9 percent "probable" identification was applicable. The high rate (39.5 percent) of unidentified records was as a result of the passing-mode cruise protocol not allowing closing on distant sightings, too few observers and a lack of high-powered binoculars. The three most frequently observed species were short-beaked common dolphin (*Delphinus delphis*), common bottlenose dolphin (*Tursiops truncatus*) and rorquals (*Balaenoptera* spp.), mostly Bryde's whales as it is unlikely some of these would have been sei whales. Other sightings include confirmed Bryde's whale, Risso's dolphin (*Grampus griseus*), rough-toothed dolphin (*Steno bredanensis*) and Atlantic spotted dolphin (*Stenella frontalis*). Single sightings were registered for short-finned pilot whale (*Globicephala macrorhynchus*) striped dolphin (*Stenella coeruleoalba*) and an unidentified beaked whale (*Ziphiidae*). The absence of records of Atlantic humpback dolphin (*Sousa teuszii*), despite full coverage of continental shelf waters in five known range states, is the first firm evidence that habitat is not merely "neritic", but circalittoral. The fact that 22 groups of humpback whales were documented in October to November 2011, while none were documented in May to July of 2012, further supports a seasonal movement consistent with a population migrating from the southern hemisphere.

The single morphotype observed of common dolphin was very similar to the Mediterranean *D. delphis*. It was both the most frequently sighted species and the one that schooled with the largest group sizes. Off-effort observations recorded short-beaked common dolphins foraging around the vessel on four different nights. Thus, in 2011 and 2012 surveys, *D. delphis* showed by far the highest abundance of any cetacean, irrespective of season. Moreover, many unidentified small delphinids were also thought to be common dolphins. This contrasts with a single striped dolphin sighting off Morocco in July 2012. The large-bodied and heavily spotted coastal form of *S. frontalis*, as well as the smallish, slender and almost unspotted oceanic form were observed off Guinea/Guinea-Bissau and in offshore waters, respectively. Five baleen plates of a sei whale, *B. borealis*, were collected from a bottom trawl haul, but no live sei whales could be confirmed. In contrast with many other regions, no cetaceans with cutaneous diseases were observed.

During the CCLME reproduction study survey of pelagic fish (1 to 22 May 2013), the total visual search effort for marine mammals amounted to 190 h for an effective survey distance of 2 081 km, covering coastal waters from central Senegal in the north to northern Guinea-Bissau in the south. For 99.4 percent of the time, the Beaufort sea state ranged from 2 to 4, with visibility good to moderate. As in prior (2011–2012) surveys, the regions covered were the continental shelf and some slope areas. A total of 52 cetacean sightings, one of which was a potential resighting, were registered in the EEZ of Senegal, the Gambia and Guinea-Bissau, including sightings of common

Figure 16: Mediterranean monk seal

dolphins, bottlenose dolphins, killer whales (first record for the Gambia), short-finned pilot whales, a Clymene dolphin, *Stenella clymene*, (first sighting record for Senegal), pantropical spotted dolphin (*Stenella attenuata*), blue whale (*Balaenoptera musculus*), unidentified rorquals, unidentified delphinids and unidentified large baleen whales. Additional land-based sightings of bottlenose dolphins made at Ngor Island suggested an apparently local community resident in the immediate vicinity of Dakar. All bottlenose dolphins sighted appeared to be the inshore ecotype. No skin diseases were detected in cetaceans close to the vessel. A rapid survey of fishing ports at Kayar and Joal and fish landing sites at Palmarin and Rufisque resulted in evidence documenting the utilization of marine mammals taken from net-entanglements, or captured or live-stranded dolphins and whales. The magnitude, however, is unknown. The flensing of cetacean carcasses occurs largely covertly, posing a major challenge to any attempts to monitor and evaluate the extent, composition and trend of exploitation.

2.3.9.2 Seabirds

Seabirds in the northwest Atlantic region are mainly migratory species and mostly observed between November and March. During ecosystem surveys in the CCLME conducted onboard the R/V *Dr Fridtjof Nansen* during 2011, a total of 1 049 birds were recorded from 480 observations between the Cape Verde Islands and Dakar. Among the 11 species, nine reproduce in the Cape Verde Islands, whereas the common tern (*Sterna hirundo*) and the great skua (*Stercorarius skua*) are classified as rare visitors. Two of the most abundant seabirds in the Cape Verde Islands, Cape Verde shearwater (*Calonectris edwardsii*), which is endemic and the white-faced storm petrel (*Pelagodroma marina*) were often seen around small fishing boats. From Morocco to Guinea, there were significant changes in the abundance and species composition of seabirds, e.g. the pomarine skua (*Stercorarius pomarinus*) was replaced by the great skua (*S. skua*) as the top predator and the northern gannet (*Morus bassanus*) was less abundant in the south, although the species remained dominant. The presence of hundreds of sooty shearwaters was a surprise and the winter behaviour of the Mediterranean gull (*Larus melanocephalus*) is not well known. However, many individuals were observed feeding around the trawl on the continental shelf. The Balearic shearwater (*Puffinus mauretanicus*) is the most threatened species of seabird in the CCLME area, being classified as "Critically Endangered" on the IUCN Red List, and its presence is of particular interest. Time-stamped seabird photographs were provided for analysis at the University of Dakar during the May 2013 CCLME reproduction study survey of pelagic fish.

2.3.9.3 Marine reptiles

There are five species of sea turtles that have been reported from within the CCLME region: green (*Chelonia mydas*), loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys cariacea*). The green turtle and loggerhead are listed as "Endangered" on the IUCN Red List, while the leatherback and hawksbill turtles are both listed as "Critically Endangered" and the olive ridley as "Vulnerable"[15]. Green turtles are known to nest on the beaches in the Gambia, whilst Cape Verde is the second most important site in the North Atlantic for breeding loggerhead turtles. Of three sea turtles seen during the May 2013 CCLME reproduction study survey of pelagic fish, at least two were loggerheads.

2.3.9.4 Sharks and rays

Fourteen species of shark and ray found within the waters of the CCLME are classified as either "Endangered" or "Critically Endangered" on the IUCN Red List. This includes two of the three species of sawfish (*Pristis pectinata* and *P. perotteti*). The smalltooth sawfish (*P. pectinata*) was historically found along the coast of western Africa from Angola to Mauritania (Faria *et al*., 2013). There has been only one confirmed record for the region in the last ten years (Sierra Leone in 2003) and there have also been unconfirmed records (*Pristis* sp.) from Guinea-Bissau in 2011 and in Mauritania in 2010. It is likely that the waters off Guinea-Bissau represent the last areas where sawfish can be found in western Africa (M. Diop, personal communication 2012 in Carlson *et al*., 2013). The principal threats to this species are from fishing and although it is no longer targeted, it is caught accidentally in a broad-spectrum of fisheries (CITES 2007), particularly artisanal gillnet fisheries (Carlson *et al*., 2013). Three species of guitarfish are listed as "Endangered"; these species are targeted throughout their range by artisanal fisheries and are also caught as bycatch by bottom trawlers.

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[15] Only three of these species, namely the olive ridley, green and leatherback turtle, are included on the IUCN Red List (IUCN 2013) for the beneficiary countries, suggesting there is some discrepancy in the records, which may require updating.

2.3.9.5 Fishes

The species of fish included on the IUCN Red List include three species of grouper (*Epinephelus itajara, E. marginatus* and *Mycteroperca fusca*), marlin (*Kajikia albida*), the barred hogfish (*Bodianus scrofa*), green wrasse (*Labrus viridis*), bigeye (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*) and the West African seahorse (*Hippocampus algiricus*). The IUCN acknowledges that the population trend of the seahorse is not known.

Table 12: Threatened marine species included on the IUCN Red List as either Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) (IUCN 2013). The full list of IUCN Red List species for CCLME beneficiary countries is included in Annex 2

	Family	Species	Common name (English; French)	Red List status	Year assessed	Population trend
ACTINOPTERYGII						
ANGUILLIFORMES	ANGUILLIDAE	*Anguilla anguilla*	European eel; anguille d'Europe	CR	2010	decreasing
ELOPIFORMES	MEGALOPIDAE	*Megalops atlanticus*	Tarpon; tarpon de l'Atlantique	VU	2012	decreasing
PERCIFORMES	SERRANIDAE	*Epinephelus itajara*	Atlantic goliath grouper, jewish; mérou, mérou géant, têtard	CR	2011	unknown
		Epinephelus marginatus	Dusky grouper; mérou noir	EN	2004	decreasing
		Mycteroperca fusca	Comb grouper, island grouper; mérou d'Ile	EN	2008	decreasing
	ISTIOPHORIDAE	*Kajikia albida*	Marlin, skilligalee, white marlin; espadon, makaire blanc	VU	2011	decreasing
		Makaira nigricans	Blue marlin; empereur, empereur bleu, marlin bleu	VU	2011	decreasing
	LABRIDAE	*Bodianus scrofa*	Barred hogfish; pourceau	VU	2010	decreasing
		Labrus viridis	Green wrasse; labre vert	VU	2010	decreasing
	SCOMBRIDAE	*Thunnus obesus*	Bigeye tuna; thon aux grands yeux, thon aux gros yeux	VU	2011	decreasing
		Thunnus thynnus	Atlantic bluefin tuna; thon rouge de l'Atlantique	EN	2011	decreasing
SYNGNATHIFORMES	SYNGNATHIDAE	*Hippocampus algiricus*	West african seahorse	VU	2012	unknown
CHONDRICHTHYENS						
CARCHARHINIFORMES	CARCHARHINIDAE	*Carcharhinus longimanus*	Oceanic whitetip shark, whitetip shark; requin océanique	VU	2006	decreasing
		Carcharhinus obscurus	Dusky shark; requin de sable	VU	2009	decreasing
		Carcharhinus plumbeus	Sandbar shark; requin gris	VU	2009	decreasing
		Carcharhinus signatus	Night shark; requin de nuit	VU	2006	decreasing
	SPHYRNIDAE	*Sphyrna lewini*	Scalloped hammerhead; requin-marteau halicorne	EN	2007	unknown
		Sphyrna mokarran	Hammerhead shark; grand requin-marteau	EN	2007	decreasing
		Sphyrna zygaena	Smooth hammerhead; requin-marteau commun	VU	2005	decreasing
	TRIAKIDAE	*Galeorhinus galeus*	Liver-oil shark, snapper shark; cagnot, canicule, chien de mer	VU	2006	decreasing
		Mustelus mustelus	Common smoothhound; émissole lisse	VU	2009	decreasing
LAMNIFORMES	ALOPIIDAE	*Alopias superciliosus*	Bigeye thresher shark, false thresher; renard à gros yeux	VU	2009	decreasing
		Alopias vulpinus	Common thresher shark; renard	VU	2009	decreasing
	CETORHINIDAE	*Cetorhinus maximus*	Basking shark; pelerin	VU	2005	decreasing
	LAMNIDAE	*Carcharodon carcharias*	Great white shark; grand requin blanc	VU	2009	unknown
		Isurus oxyrinchus	Shortfin mako; taupe bleue	VU	2009	decreasing
		Isurus paucus	Longfin mako; petit taupe, taupe longue aile	VU	2006	decreasing
		Lamna nasus	Porbeagle; requin-taupe commun	VU	2006	decreasing
	ODONTASPIDIDAE	*Carcharias taurus*	Grey nurse shark, sand tiger, sand tiger shark; requin taureau	VU	2009	unknown
		Odontaspis ferox	Herbst's nurse shark; requin féroce	VU	2009	decreasing
ORECTOLOBIFORMES	RHINCODONTIDAE	*Rhincodon typus*	Whale shark; requin baleine	VU	2005	decreasing

	Family	Species	Common name (English; French)	Red List status	Year assessed	Population trend
RAJIFORMES	DASYATIDAE	*Dasyatis margarita*	Daisy stingray	EN	2009	decreasing
	GYMNURIDAE	*Gymnura altavela*	Spiny butterfly ray; raie-papillon épineuse	VU	2007	decreasing
	MYCIOBATIDAE	*Manta alfredi*	Coastal manta ray, reef manta ray	VU	2011	decreasing
		Manta birostris	Giant manta ray, oceanic manta ray, mante géante	VU	2011	decreasing
		Mobula rochebrunei	Lesser guinean devil ray; petit diable de Guinea	VU	2009	unknown
	PRISTIDAE	*Pristis pectinata*	Smalltooth sawfish, wide sawfish; poisson-scie	CR	2013	decreasing
		Pristis pristis	Largetooth sawfish	CR	2013	decreasing
	RAJIDAE	*Dipturus batis*	Blue skate; flotte, pocheteau gris, pochette	CR	2006	decreasing
		Leucoraja circularis		VU	2009	decreasing
		Raja undulata	Undulate ray; raie brunette	EN	2009	decreasing
		Rostroraja alba	Bottlenose skate, spearnose skate, white skate; raie blanche	EN	2006	decreasing
	RHINOBATIDAE	*Rhinobatos cemiculus*	Blackchin guitarfish; guitare de mer fouisseuse	EN	2007	decreasing
		Rhinobatos albomaculatus	White-spotted guitarfish; poisson-guitare à lunaires	VU	2009	decreasing
		Rhinobatos irvinei	Spineback guitarfish; raie-guitare d'Irvine	VU	2009	decreasing
		Rhinobatos rhinobatos	Common guitarfish, violinfish; guitare de mer commune	EN	2007	decreasing
	RHYNCHOBATIDAE	*Rhynchobatus luebberti*	African wedgefish, lubberts guitarfish; guitare à taches	EN	2006	decreasing
SQUALIFORMES	CENTROPHORIDAE	*Centrophorus granulosus*	Gulper shark; squale-chagrin commun	VU	2006	decreasing
		Centrophorus lusitanicus	Lowfin gulper shark; squale-chagrin àlongue dorsale	VU	2009	unknown
		Centrophorus squamosus	Deepwater spiny dogfish; squale-chagrin de l'Atlantique	VU	2003	decreasing
	OXYNOTIDAE	*Oxynotus centrina*	Angular rough shark; centrine commune	VU	2007	unknown
	SQUALIDAE	*Squalus acanthias*	Cape shark, piked dogfish, spurdog; aiguillat commun	VU	2006	decreasing
SQUATINIFORMES	SQUATINIDAE	*Squatina aculeata*	Monkfish, sawback angelshark; ange de mer épineux	CR	2007	decreasing
		Squatina oculata	Monkfish, smoothback angel shark; ange de mer de Bonaparte	CR	2007	decreasing
		Squatina squatina	Angel shark; ange, ange de mer, angel, antjou, bourgeois, martrame, mordacle	CR	2006	decreasing
AVES						
ANSERIFORMES	ANATIDAE	*Marmaronetta angustirostris*	Marbled duck, marbled teal; sarcelle marbrée	VU	2012	decreasing
CHARADRIIFORMES	SCOLOPACIDAE	*Numenius tenuirostris*	Slender-billed curlew; courlis à bec grèle	CR	2012	decreasing
FALCONIFORMES	FALCONIDAE	*Falco cherrug*	Saker, saker falcon; faucon sacre	EN	2012	decreasing
GRUIFORMES	GRUIDAE	*Balearica pavonina*	Black crowned-crane; grue couronnée	VU	2012	decreasing
PROCELLARIIFORMES	PROCELLARIIDAE	*Puffinus mauretanicus*	Balearic shearwater; puffin des Baléares	CR	2012	decreasing
		Puffinus yelkouan	Yelkouan shearwater; puffin de Méditerranée	VU	2012	decreasing
REPTILIA						
TESTUDINES	CHELONIIDAE	*Chelonia mydas*	Green turtle; tortue verte	EN	2004	decreasing
		Lepidochelys olivacea	Olive ridley; tortue de Ridley, tortue olivâtre	VU	2008	decreasing
	DERMOCHELYIDAE	*Dermochelys coriacea*	Leatherback turtle; tortue luth	CR	2000	decreasing
MAMMALIA						
CARNIVORA	PHOCIDAE	*Monachus monachus*	Mediterranean monk seal; phoque-moine méditerranéen	CR	2013	decreasing
CETARTIODACTYLA	BALAENOPTERIDAE	*Balaenoptera borealis*	Sei whale; rorqual de Rudolphi, rorqual boréal, rorqual sei	EN	2008	unknown
		Balaenoptera musculus	Blue whale; baleine bleue	EN	2008	en hausse
		Balaenoptera physalus	Common rorqual; rorqual commun	EN	2013	unknown
	DELPHINIDAE	*Sousa teuszii*	Atlantic hump-backed dolphin; dauphin à bosse de l'Atlantique	VU	2012	decreasing
	HIPPOPOTAMIDAE	*Hippopotamus amphibius*	Hippopotamus; hippopotame	VU	2008	decreasing
	PHYSETERIDAE	*Physeter macrocephalus*	Sperm whale; cachalot	VU	2008	unknown
SIRENIA	TRICHECHIDAE	*Trichechus senegalensis*	African manatee; lamantin d'Afrique, lamantin du Senegal	VU	2008	unknown

2.3.10 Climate change and the living marine resources of the CCLME

Climate change may influence fisheries production by altering primary production, disrupting food webs and impacting upon life histories and target species distribution patterns. Primary production will be directly influenced by changes in the physical and chemical environment. Food web effects and impacts on life history and distribution patterns will be harder to predict owing to the potentially synergistic or antagonistic influence of climate change impacts on marine ecosystems.

Allison *et al*. (2009) analysed the vulnerability of national economies to the impacts of climate change on fisheries. Under two International Panel of Climate Change (IPCC) scenarios, although warming is predicted to be greater in other parts of the world than in parts of sub-Saharan Africa, the regions most vulnerable to climate-induced changes in fisheries were in Africa, particularly in northwestern Africa. This is because the national economies are heavily dependent on fisheries. A comprehensive comparative study (Allison *et al*., 2009) reported that, among 133 countries, the economies of CCLME countries are highly vulnerable to the impacts of climate change on fisheries – five countries are placed among the 33 most vulnerable countries (Mauritania – 4th place, Senegal – 5th, Morocco – 11th, Guinea-Bissau – 26th and the Gambia – 32nd). In addition, all CCLME countries were classified as having "high sensitivity" and "very low" adaptive capacity to impacts of climate change on fisheries, with the exception of Morocco which was ranked as having "low" adaptive capacity, as a result of the country having a more diverse economic base.

Evidence to date indicates that the waters of the Canary Current ecosystem have warmed faster than all other EBUS over the past three decades. The observed increased in seawater temperature is thought to be the most probable cause of observed (small) declines in productivity (Arístegui *et al*., 2009), especially when contrasted with the positive trend in productivity in other EBUS (Chavez and Messie, 2009; Demarcq, 2009). The observed increased seawater temperatures are not directly reflected in the fish catches of the CCLME and the relative contribution of natural versus human-induced variability in the populations of at least small pelagic fish continues to be difficult to disentangle.

According to both scientists and policy makers (Orbi, 2011), the important decline of the sardine stock in 1997, 2006 and 2010 and the migration of sardinella to the north were related to the impacts of climate variability, but extreme hydroclimatic events causing the intertropical front to move further north than its average position are probably also important. Another issue that is already occurring in parallel with increasing ocean temperatures is the expansion of the OMZ in the tropical Eastern Atlantic (Stramma *et al*., 2012). The expanding OMZ is compressing the habitat available for large pelagics and the fish they feed on. The impact on populations is not yet known, but it is important not to confuse the compression of habitat with increased abundance.

2.3.11 References

Allison, E.H., Perry, A.L., Badjeck, M.-C., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. & Dulvy, N.K. 2009. Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and fisheries*, 10: 173–196. DOI: 10.1111/j 1467-2979.2008.00310.x

Arístegui, J., Barton, E.D., Álvarez-Salgado, X.A., Santos, A.M.P., Figueiras, F.G., Kifani, S., Hernández-León, S., Mason, E., Machu, E. & Demarcq, H. 2009. Subregional ecosystem variability in the Canary Current upwelling. *Progress in Oceanography* 83: 33–48.

Bah, E.M. 2012. *Rapport national – Guinea. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11-12 avril 2012, Nouakchott, Mauritania.*

Caramelo, A. 2010. Resources and fisheries in the CCLME – some perspectives of management. *Document préparé pour l'Atelier de démarrage du CCLME, Dakar, Senegal, 2–3 novembre 2010.*

Carlson, J., Wiley, T. & Smith, K. 2013. *Pristis pectinata.* In: *Liste rouge des Species menacées de l'UICN. Version 2013.1. www.iucnredlist.org. Téléchargé les 2 juillet 2013 et 22 août 2013.*

CCLME. 2014. *Assessment of the state of marine biodiversity in the CCLME region*. Consultation document presented during the third meeting of the working group on biodiversity, habitat and water quality. Casablanca, 23–25 September 2014, Morocco.

Chafik, M.A. 2012. *Qualité, Salubrité et Biodiversité au Morocco. Première réunion du Groupe de Travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11-12 avril 2012, Nouakchott, Mauritania*.

Cham, A.M. 2012. *Rapport national – The Gambia. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau», du CCLME 11-12 avril 2012, Nouakchott, Mauritania*.

Chavez, F.P. & Messie, M. 2009. A comparison of Eastern Boundary Upwelling Ecosystems. *Progress in Oceanography,* 83: 80–96.

CITES. 2007. *Proposal 17: inclusion of all species of the family Pristidae in Appendix I of CITES.* (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Fourteenth meeting of the Conference of the Parties. The Hague, Netherlands, 3–15 June, 2007. Available at: http://www.cites.org/sites/default/files/eng/cop/14/prop/E14-P17.pdf

CNHB. 2002. *Campagne d'observation des cétacés dans les eaux nord-ouest africaines de la Guinea au Senegal du 7 au 20 décembre 2002*.

Demarcq, H. 2009. Trends in primary production, sea surface temperature and wind in upwelling systems (1998–2007). *Progress in Oceanography,* 83 (1–4): 376–385.

Dias, J.M.A. 1993. *A pesca das lagostas costeiras em Cabo Verde. Boletim Técnico-científico do INDP,* n° 0. 45 pp.

Edelmira, M.M.C. & Caramelo, A.M. 1999. *Assessment de l'état de la pêcherie de maquereau noir et du chinchard au Cap-Vert. In Recherche et gestion halieutiques au Cap-Vert. Actes de la réunion réalisée à Mindelo, 10–11 décembre 1996. INDP, Mindelo-Cap Vert, July* 1999.

Failler, P., Diop, M., Dia, M.A., O/Inejih, C.A. & Tous, P. 2006. *Évaluation des stocks et aménagement des pêcheries de la ZEE mauritanienne. Rapport du cinquième Groupe de travail IMROP. Nouadhibou, Mauritanie, 9–17 December 2002. COPACE/PACE Séries n° 05/66.* Rome, Italy. 197 pp.

FAO. 2006. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Banjul, Gambia, 2–11 May 2006. FAO Fisheries Report. No. 811. Rome, FAO. 2006. 192 pp.

FAO. 2008. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – subgroup south. Freetown, Sierra Leone, 9–18 October 2008. CECAF Series. No. 11/73. Rome, FAO. 2012. 311 pp.

FAO. 2011. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Banjul, The Gambia, 18–22 May 2010. FAO Fisheries and Aquaculture Report. No. 975. Rome, FAO. 2011. 263 pp.

FAO. 2012. *Rapport du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe sud*. Freetown, Sierra Leone, 9-18 October 2008. COPACE/PACE Séries. n° 11/73 Rome, FAO. 311 pp.

FAO. 2013. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Casablanca, Morocco, 24–28 May 2011. FAO Fisheries and Aquaculture Report. No. 1026. Rome, FAO. 253 pp.

FAO. 2015a. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – subgroup north. Fuengirola, Spain, from 18 to 27 November 2013. CECAF Series. No. 15/77. Rome, FAO. 336 pp.

FAO. 2015b. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Casablanca, Morocco, 20–25 July 2015. FAO Fisheries and Aquaculture Report. No. 1122. Rome, FAO. 173 pp.

FAO. 2015c. Report of the FAO/CECAF Working Group on the Assessment of Small Pelagic Fish – subgroup south. Pointe Noire, Congo, 17–23 March 2014. CECAF/ECAF Series. No. 15/75. Rome, FAO. 157 pp.

FAO. 2015d. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – subgroup north. Agadir, Morocco, 8–17 February 2010. CECAF/ECAF Series. No. 11/72. Rome, FAO. 342 pp.

FAO. 2015e. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – subgroup south. Accra, Ghana, 15–24 November 2011. CECAF/ECAF Series. No. 15/76. Rome, FAO. 251 pp.

Faria, V.V., McDavitt, M.T., Charvet, P., Wiley, T.R., Simpfendorfer, C.A. & Naylor, G.J.P. 2013. Species delineation and global population structure of Critically Endangered sawfishes (Pristidae). *Zoological Journal of the Linnean Society,* 167: 136–164.

Foueré, J. 1981. *Rapport sur propositions visant à accroître les exportations de langoustes vivantes de la République du Cap-Vert. Département des pêches de la FAO*, CVI/77/001/FAO.

Froese, R. & Pauly, D., eds. 2013. FishBase. Available at www.fishbase.org

Garcia, S. 1982. Distribution, migration and spawning of the main fish resources in the northern CECAF area. FAO CECAF/ECAF Series 82/25 (Eng). Rome, FAO. 9 pp +11 charts.

IUCN. 2013. *Liste rouge de l'UICN des Species marines de la région du CCLME. Consulté en ligne le 13 août 2013.* http://www.iucnredlist.org/search/link/51ffc322-2428e955

Kinadjian, L. 2013. *Évaluation des bénéfices tirés des pêcheries des ressources bentho-pélagiques (à partir des exemples des pêcheries de mulet et courbine), leurs répartitions et l'identification de voies et moyens pour améliorer ces bénéfices de façon durable. Projet du Grand écosystème marin du courant des Canaries (CCLME): Projet de démonstration n° 3 «Cogestion transfrontalière des poissons pélagiques côtiers migratoires importants pour les pêches artisanales (mulets, courbine, tassergal)». Projet d'appui à la gestion des pêches artisanales transfrontalières – PARTAGE/UICN. 113 pp.*

Latrouite, D. & Alfama, P. *1999. Point sur les ressources, l'exploitation et la gestion des langoustes du Cap-Vert. In: INDP. 1999. Investigaçao e gestão haliêuticas em Cabo Verde. Actas da reunião realizada em Mindelo, 10 e 11 de Dezembro de 1996. INDP, Mindelo, Cabo Verde: 153–162.*

Lewison, R. & Oliver, W. 2008. *Hippopotamus amphibius*. In. *Liste rouge des Species menacées de l'UICN 2012. Version 2012.2*. www.iucnredlist.org. Téléchargé le 29 juin 2013.

Maul, G.E. 1986. Berycidae. *In* P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, eds. *Fishes of the north-eastern Atlantic and the Mediterranean.* Paris, UNESCO. Vol. 2. p. 740–742.

Maul, G.E. 1990. Berycidae. *In* J.C. Quero, J.C. Hureau, C. Karrer, A. Post & L. Saldanha, eds. *Check-list of the fishes of the eastern tropical Atlantic (CLOFETA).* Lisbon, JNICT. Paris, SEI and Paris, UNESCO. Vol. 2. p. 626.

Menioui, M. 1998. *Étude Nationale sur la Biodiversité, Projet GEF/6105-92, Biodiversité de la Faune Marine, DOEC et Pr.*

Monteiro, V. 2012. *Rapport National – Cap-Vert. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11–12 avril 2012, Nouakchott, Mauritania.*

Nakamura, I., Inada, T., Takeda, M. & Hatanaka, H. 1986. Important fishes trawled off Patagonia. Japan Marine Fishery Resource Research Center, Tokyo. 369 pp.

Notarbartolo di Sciara, G., Bradai, M.N., Morey, G., Marshall, A.D., Compagno, L.J.V., Mouni, A., Hicham, M., Bucal, D., Dulvy, N., Heenan, A. & Rui Coelho. 2007. *Rhinobatos rhinobatos.* In *Liste rouge des Species menacées de l'UICN 2012. Version 2012.2*. www.iucnredlist.org. *Téléchargé le 29 juin 2013.*

Orbi, A. 2011. Subregional review of climate change and ecosystem based approach to fisheries and marine aquaculture for Mauritania and Morocco. *Groupe de travail Changement climatique CCLME. Mai 2011*. Saly (Sénégal).

Reis, D.C.C. 1997. *Estudo da pescaria de lagosta verde (*Panulirus regius*, De Brito Capello, 1864) do Arquipélago de Cabo Verde. Relatório de estágio de licenciatura em Biologia Marinha e Pescas, Universidade do Algarve, Portugal.*

République du Senegal. 2012. *Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11–12 avril 2012, Nouakchott, Mauritania.*

République Islamique de Mauritania. 2009. *Quatrième Rapport National CDB - Version finale* Available at: http://www.cdb.int/doc/world/mr/mr-nr-04-fr.pdf

Robalo, M.H. 2012. *Rapport national - Guinea-Bissau. Première réunion du Groupe de travail «Biodiversité, Habitat et Qualité de l'eau» du CCLME, 11–12 avril 2012, Nouakchott, Mauritania.*

Stramma, L., Prince, E.D., Schmidtko, S., Luo, J., Hoolihan, J.P., Visbeck, M., Wallace, D.W.R., Brandt, P. & Körtzinger, A. 2012. Expansion of oxygen minimum zones may reduce available habitat for tropical pelagic fishes. *Nature Climate Change.* 2: 33–37.

Tandstad, M., Sambe, B., Mendy, A., Caramelo, A.M., Diop, M. & Cooke, A. 2006. *Rapport n° 2: Ressources, pêche et problèmes transfrontaliers dans le Grand écosystème marin du courant des Canaries. Atelier sous-régional d'Analyse diagnostique transfrontalière (ADT). Projet de Protection du Grand écosystème marin du courant des Canaries.*

Thiaw, M., Gascuel, D., Jouffre, D. & Thiaw, O.T. 2009. A surplus production model including environmental effects: application to the Senegalese white shrimp stocks. *Progress in Oceanography,* 83 (1–4): 351–360.

UNEP-MAP-RAC/SPA. 2013. Draft regional strategy for the conservation of monk seals in the Mediterranean (2014–2019). Mediterranean action plan. Eleventh Meeting of Focal Points for SPA. Rabat, Morocco, 2–5 July, 2013.

2.4 Pollution, biodiversity and ecosystem health

2.4.1 Pollution

A study evaluating the land-based activities that may constitute sources of coastal and marine pollution was carried out as part of the CCLME Project, taking into account national reports of the countries in the region (Chafik, 2014; Kidé, 2014; Kane, 2014; Monteiro and Vito, 2014; Cham, 2014; Robalo, 2014; Keita, 2014). The information provided in this chapter is primarily derived from this study, which indicates that the CCLME is impacted by pollution from many sources, of both anthropogenic and natural origin. The main sources of pollution include wastewater, persistent organic pollutants, heavy metals, hydrocarbons, nutrients, alteration of sediment flow and waste.

2.4.1.1 Contaminants

Wastewater from domestic, urban and industrial sources and ports is the main source of pollution of the coastal and marine aquatic environment. According to GESAMP (2001) cited by UNEP (2002, p. 181) "*Globally, sewage remains the largest source of contamination, by volume, of the coastal and marine environment*". These discharges have increased significantly in recent decades owing to the high concentration of people and industries along the coast, poor wastewater management (absence and/or lack of control and treatment facilities) and the high demand for water in urban areas. Inadequate or lack of adequate sanitation is observed in all CCLME Project countries. As a result, most of the wastewater from various sources is discharged into coastal environments leading to their contamination. The wastewater may contain many pollutants (heavy metals, nutrients, coliforms and fecal streptococci, dyes, etc.) that have adverse effects on receiving ecosystems, notably in Guinea and Morocco (ME, 2010). The most industrialized area along the Moroccan Atlantic coast is Axis Kénitra-Safi with 80 percent of the industrial units covering three large complexes of which 34 percent are located in Casablanca.

Persistent organic pollutants (POPs) come from industrial and agricultural effluents; mainly used in agriculture to improve yields and to fight against insects and pests (*Anopheles* mosquitoes, rodents, locusts, etc.). Their presence has been reported in Morocco, Senegal, the Gambia and Guinea. These toxic substances have harmful effects on the environment and human health because they accumulate in living organisms and natural habitats. POPs are transported by air, water and/or migratory species. Owing to their properties of bioaccumulation, persistence in the environment, transport over long distances, the entire food chain and the coastal sedimentary environments, which are receiving environments, are likely to be contaminated by these substances, even if they are located far from emission sites. POPs management is therefore a major issue for scientists and environmental managers.

The pollution of the environment by heavy metals is a major 21st century problem in both the developed and developing world. The source of these metals, including lead and cadmium, is both natural, because they are part of the Earth's crust, and anthropogenic, because of their widespread use in various industrial processes. In Morocco, as in most countries, the use of leaded gasoline is causing air pollution in large cities and waterways. Accumulation of heavy metals in the environment threatens all life forms, because of the many biological and physiological dysfunctions they may cause. The issue of heavy metals is raised by most CCLME countries. For example, significant accumulation of cadmium was observed in bivalve molluscs in some areas along the coastline from El Jadida to Dakhla (Benbrahim *et al*., 2006), compared with those collected along the Mediterranean and the coastline from Moulay Bousselham to Casablanca. In Senegal, the work of Ndiaye (2007) revealed high levels of metals in marine sediments and groundwater aquifers. In Mauritania, heavy metals have been reported in zooplankton, benthic species and fish, notably in the Konkouré estuary.

Hydrocarbon pollution is generally a problem around ports owing to port traffic, maintenance of boats, discharges and the emptying of ballast tanks of ships, and oil spills during oil exploration and exploitation offshore. Benzene, toluene and xylene, aromatic content in crude oil, are highly toxic (Ndiaye, 2007) and are therefore harmful to marine and coastal wildlife. Cases of environmental contamination with hydrocarbons have been identified in Morocco (Semlali *et al*., 2012), Senegal and the Gambia. For example, Morocco has experienced two oil spills causing significant damage: the explosion of the oil tanker *Kharq 5* in December 1989 and the collision between the oil tanker *Sea Spirit* and the LNG super tanker *Hesperus* on August 6 1990. The first caused a spill of 90 000 tonnes of oil into the marine waters of Morocco affecting nearly 500 km of coast from Moulay Bousselham to Safi; the second caused a spill of 20 000 tonnes of heavy fuel oil out of the total 55 000 tonnes that the tanker was carrying (SIPEM, 1991). In addition, 550 tonnes of phosphoric acid were spilled in the port of Jorf Lasfar, following a failure of the Moroccan phosphorus plant facilities. Since then, a decree has been put in place regarding oil spill preparedness to combat accidental marine pollution incidences (1996). In Senegal, Ndiaye (2007) also observed oil slicks in the port of Dakar caused by either deliberate or accidental spills of petroleum products.

According to GESAMP (2001) nutrient input in marine and coastal waters is a major concern. In Senegal, as in Guinea and Guinea-Bissau, the main sources of nutrients are urban and industrial wastewater discharges, agricultural runoff and atmospheric deposition. In Senegal, for example, occasionally excessive nitrate levels were found in the groundwater of the quaternary sands (about 400 mg/l) and in areas near garbage dumps or gardening plots. Especially in the Thiaroye aquifer, values higher than accepted standards were identified for nitrate, nitrite and ammonium, which could compromise the quality of drinking water resources of the Thiaroye aquifer. The massive introduction of organic matter and nutrients (nitrogen, phosphorus) in surface water and groundwater in coastal and marine environments degrade the quality of aquifers and drinking water resources, potentially causing eutrophication, excessive growth of algae and oxygen depletion, leading to increased risk of mortality in aquatic organisms.

Agriculture is one of the main sources of income of most countries in the region and its intensification has led to the excessive use of pesticides, fertilizers, herbicides and other substances to increase yields.

Contamination of marine sediments by metals from both human activities or remobilization of diagenetic metals is a major problem that deserves special attention. Metals present in industrial and domestic wastewater, precipitation and water from agricultural activity accumulate in sediments and can be released into the water column through different activities like dredging or physicochemical processes, causing resuspension of contaminated and toxic sediments, thus impairing water quality and causing damage to aquatic resources. This is the case at the port of Dakar, Senegal.

Socio-economic activities, population growth and changes in consumption patterns generate significant solid waste from industries, households and hospitals, composed of both degradable organic materials and non-organic material. In Morocco, Senegal, the Gambia and Guinea, these hazardous wastes are often stored in landfills where the disposal method is sub-optimal. The management of this waste is not always effective and there are numerous uncontrolled landfills. The average daily rate of waste generated per capita varies by country and by region within a country. Inadequacies in waste management have negative impacts on the environment through, for example, pollution of surface and groundwater, spread of rodents, release of noxious odours, negative impacts on the health of citizens, degradation of landscapes and urban and suburban areas, soil contamination, reduced fertility of agricultural land and even risks of fires and explosions. In addition, plastic waste and fishing materials contribute to the litter and marine debris found in coastal waters, negatively impacting the tourism industry, the aesthetics of beaches, marine biodiversity and posing challenges for marine safety.

2.4.1.2 Sources of pollution

Point sources (coastal and inland)

Wastewater treatment facilities

Although there are collective sanitation systems in most countries of the CCLME area, they are still insufficient and sometimes ineffective. In most countries in the region, people use individual sanitary solutions (latrines, septic tanks) and most of the residues are released into the environment without any treatment. The many diseases linked to poor sanitation and wastewater include diarrhea, dysentery, parasites and skin diseases that are quite common in contaminated areas.

Industrial facilities

The industrial sector is more or less developed in the countries of the region. It contributes greatly to the economic growth of developing countries and provides many job opportunities. However, manufacturers often do not sufficiently address the impacts of their activities on the environment.

In Morocco, the processing industry is by far the most harmful of the industrial activities. Chemical and para-chemical industries, including phosphate processing, remain the largest source of wastewater discharge (931 million m³ of which 22.7 million m³ does not come from phosphate-related activities) (Chafik, 2014). Cases of industrial pollution from the cement factory in Dakar and chemical industries are also observed in Senegal. The main sites of industrial pollution in Guinea are in Siguiri and Kérouané in the Niger basin, in the prefecture of Boke (Compagnie des Bauxites the Guinée [CBG] - Kamsar), in Sangarédi, in Fria (Rusal-Friguia aluminum plant) and in Kindia (Compagnie des Bauxites de Kindia [CBK]). The various companies that operate mines pollute the lakes, streams and the marine environment, which are also contaminated by polluted water originating from diamond and gold extraction processes.

In Mauritania, the facilities of the National Company of the Mining Industry (SNIM) located next to the mineral port and the industrial facilities for treatment of fishery products in Noadhibou generate large quantities of wastewater that are the main sources of pollutants in Lévrier Bay in Noadhibhou. In relation to port facilities, it is also worth mentioning the pollution resulting from oil, fuel and antifouling paints in the port of Noadhibhou.

In Cape Verde, there are production plants and processing industries related to food, footwear, beverages, clothing, canned fish, production of soaps, paints and drugs, located close to the coast mainly in the cities of São Vicente and Santiago. Although some industrial companies in the country are trying to comply with the standards required at the national and international levels, others discard industrial waste that may contain various pollutants such as heavy metals and hydrocarbons into the environment.

In Guinea-Bissau, industrial activities (12.8 percent of the GDP) are primarily related to the transformation of cashew nuts. The exploitation of bauxite in Boe requires investment in port infrastructure and water before its implementation. There are, however, no major industrial facilities in the coastal zone.

Power plants

Power plants in Mauritania (SOMELEC power plant), Senegal (Cape des Biches power plant, located on the coast of the Dakar peninsula) and Guinea (Conakry thermal plants, Fria and Kamsar) represent sources of pollution that degrade the coastal zone, affect ecosystems and contaminate the marine fauna and flora through discharges of drainage water and cooling gases. Preventive measures must be adopted to deal with any eventuality. Cape Verde depends mainly on imported fossil fuels whose residues can generate high concentrations of heavy metals. Power plants in Praia and Vicente are currently not in use. In Guinea-Bissau, electricity is generated by three power plants running on diesel located in Bissau, Bafatá and Canchungo. The operation of these plants has significant environmental impacts such as air emissions, gases (NO_2, SO_2, VOCs, HAPs, etc.), noise pollution and the generation of effluents consisting of oil sludge, waste oil, waste water from the engine rooms and settling tanks.

Landfill sites and hazardous waste deposit sites

Environmental management of landfills and deposits of hazardous wastes is not effective enough in most countries of the region. The lack of garbage collection causes the emergence of illegal dumping and uncontrolled landfills in many localities, as shown by the number of uncontrolled discharges in cities and urban centres.

Non-point sources (diffuse, coastal and river)

Runoff is one of the main sources of pollution and one of the main factors contributing to the degradation of the marine and coastal environment. Many pollutants (nutrients, heavy metals, pesticides, POPs, solid waste, micro-organisms, etc.) are transported from land to the marine environment through runoff. The lack of studies of environmental impacts during the implementation of projects contributes to the continued degradation of coastal ecosystems.

This is the case regarding the city of Agadir in Morocco, where serious damage to the environment is observed, and in the Oualidia lagoon where both organic and bacterial contamination is noted during the summer, as well as during the rainy period. This contamination is largely attributed to seepage of sewage from septic tanks in urban and rural areas, the massive use of fertilizers on agricultural lands bordering the lagoon and to animal pastures inside the lagoon during dry periods (deposition of organic waste). These phenomena have contributed to environmental degradation and may slow or even prevent the development of oyster farming in the lagoon. Currently, a project to safeguard the Oualidia lagoon is being completed to rehabilitate and preserve the site while promoting oyster farming. Since Morocco's adoption of the law No. 12-03 relating to EIAs, the environmental performance of the EIA system has entered a new phase.

In Mauritania, the consequences of runoff are observed in Nouakchott during the rainy season, which can result in health risks for the population. For example, stagnant water is frequently pumped by garbage trucks and dumped directly into the sea.

Atmospheric deposition

Transport (vehicle exhaust gases)

According to the observations of UNEP, Africa's air pollution is attributable to motor vehicles (UNEP, 2011). Air pollution is reported as an issue in Morocco, Senegal, Mauritania and the Gambia. Carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxide (NO), nitrogen dioxide (NO_2), polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOC) are the main pollutants from activities of the land transport sector. Secondary pollutants such as ozone (O_3) and fine particles that penetrate deep into the lungs also have adverse effects on health. In Senegal, analyses recently carried out in Dakar showed that 96 percent of the particles produced by urban traffic are less than 2.5 µm. Based on work done in 2002, WHO considers that a quarter of premature deaths in Africa are as a result of poor air quality. The situation is aggravated by the poor state of the car fleet and the poor quality of the fuel used.

Industrial electrical installations and power plants

Air pollution from power plants and industrial facilities has been reported in some parts of Morocco, Mauritania, Senegal and Guinea. Industrial plants observed in the area include facilities representing the chemical and para-chemical industry, textiles and leather industry, food processing industries, electrical and electronic industries, metal and metallurgical industries, cement industry, energy facilities (including thermal power plants) and petroleum refineries. The activities of all these industries produce air pollution, leading to many diseases (asthma, bronchitis, respiratory infections in children under five years and conjunctivitis). Eco-epidemiological studies have shown that in Casablanca (Morocco), air pollution caused significant increases in certain diseases and in mortality. The effects of pollution are also felt on natural capital, including forests and inland and marine waters.

Incinerators

In Guinea, incinerators were found to contribute to air pollution. Mauritania only has six incinerators for biomedical waste, the vast majority of biomedical waste being discharged into public bins and dumps. Uncontrolled waste is most often burned in open dumps, with more pollutants being released into the air. These discharges may cause many diseases. Incinerators also exist in Morocco and Senegal.

Agricultural activities

Bushfires are a scourge that devastates the forest canopy every year. These wildfires are generally started by people and may destroy all forest resources in an area, sometimes including whole villages, sparing neither domestic animals nor human life. About 5 000 000 ha of savannah woodland and grassland are ravaged every year in Guinea (Keita, *et al*., 2013). The causes of fires are several and include honey collectors, hunters, fishers, brick kilns, charcoal producers, farmers, collectors of palm wine, herders and fish processors who smoke fish in the Upper Niger and Badiar. Burning vegetation releases many chemicals into the atmosphere (trace gases, greenhouse gases, reactive gases, particles) that influence the photochemistry of the troposphere and stratosphere and have global impacts. Village fire management committees have been put in place in Guinea and awareness meetings organized. Awareness and collaboration between villagers' committees for fire management and technical services, media and non-governmental organizations (NGOs) have promoted the practice of early fire warnings and the setting in place of firewalls. Among the CCLME countries, only Guinea has provided information on this issue.

Other activities impacting habitats and biodiversity

Habitat modification (dredging, filling of wetlands and clearing of mangroves)

Human actions that constitute threats to the marine and coastal environment include the destruction of mangroves by cutting wood for charcoal and firewood, itinerant agriculture, hunting and illegal fishing methods used in artisanal fisheries (one of the main forms of livelihoods in coastal communities). Road construction in protected areas, sand mining for construction materials and rocks, urban sprawl, solid waste and domestic and industrial wastewater and sewage, contribute significantly to the degradation of marine and coastal resources. Agricultural expansion and urban settlements also contribute to the degradation of freshwater fish habitat. Such cases of habitat destruction are observed in Senegal, the Gambia and Guinea-Bissau. One of the major problems concerning agriculture in coastal areas – aside from the problems of habitat destruction, loss of biodiversity and soil erosion – is the potential for drought which may worsen with climate variability and change.

Construction (dams, coastal structures, port facilities and expansion of urban areas)

Activities that have serious consequences for the environment are the construction and development of irrigation schemes, hydroelectric power plants, the expansion of ports, removal of timber and the extraction of sand for construction purposes. All these activities weaken the natural protection offered by coastal features and contribute to ecosystem degradation. The consequences of irresponsible construction and development have been noted in all CCLME countries and include the silting of lagoons and bays, degradation of mangroves (e.g. around the Gambia River), salinization of coastal aquifers, deforestation (e.g. weakened trees at the Bintang Bolong Dam in the Gambia), submergence of large areas and loss of biota.

Resorts and tourism

Most countries in the region have enormous tourism potential owing to to their natural resources and landscapes, the diversity of coastal habitats (rocky and sandy coastline, mudflats and mangroves, beaches, dunes and wetlands), which contain an impressive wealth of flora and fauna.

The effects of population growth and significant development of the building sector that accompanies tourism are detrimental to the coastal environment. In 1997 in Senegal, following investigations conducted throughout the territory, the Ministry of the Economy, Finance and Planning identified a number of shortcomings in the protection of water and coastal resources. In the Gambia, the development of the tourism sector has impacted much of the habitat, affecting most notably fishing activities (including the gathering of wood for the smoking of fish). In addition, sand dunes have been weakened in several locations in Mauritania, Cape Verde and the Gambia because of sand extraction for the construction of tourism infrastructure (hotels, campsites, etc.). This disturbance of the function of the the beach as a natural barrier against the dynamic exchanges between the dune and the sea has altered and degraded the coastal environment and led to habitat modification and alteration of environmental functions (DGA, 2014).

Erosion resulting from physical alteration of the profile of the coast

The problems caused by erosion are increasingly becoming a concern in the CCLME region. This phenomenon is observed in Morocco, Senegal, Mauritania and the Gambia. Coastal erosion associated with floods can compromise the length of life of infrastructure and damage businesses and natural heritage sites, which is why the countries considered "vulnerable" to this phenomenon offer programmes for the implementation of coastal protection structures. Besides beaches and dunes, the hinterland of some countries in the region, such as Morocco, is also threatened by erosion. This situation is not only detrimental to the coastal and marine environment, but also negatively impacts agricultural activities. Loss of topsoil can also cause declines in fertility and productivity and result in a loss of income for the local rural population, in turn contributing to the abandonment of land, increasing poverty with associated negative impacts on terrestrial, coastal and marine environments and the quality of life of the population. A large part of the acceleration of coastal erosion is as a result of the hydrodynamic and morphosedimentary effects of anthropogenic activities. Examples include the construction of a breakwater at the port of Conakry, dredging of access channels, extraction of coastal and marine sand, uncontrolled construction in coastal areas and excessive cutting of mangroves. These natural and anthropogenic environmental changes can, if they persist, lead to loss of biodiversity and sometimes complete degradation of the ecosystem.

Sand mining is the biggest cause of coastal erosion and is mainly a result of increasing demand for construction materials, especially sand for the building industry. This demand, estimated at nearly 13 million tonnes in Morocco and expected to more than double in 2015, is often met by illegal and inexpensive mining of beaches and coastal dunes. It is estimated that out of 160 locations of identified mining in Morocco, only a few seem to be officially authorized. This is a problem that concerns 11 of the 16 administrative regions of the country and almost 30 municipalities. As a result, many beaches are sand-deprived (Tangier Bay, Moulay Bousselham, Monica, Kariat Arekmane) and, according to some studies, out of a sample of 47 beaches, 7 beaches have disappeared and 19 are subject to acute deterioration. The causes are many, but the most important are urbanization, over-extraction and illegal harvesting of sand (ME, 1997).

In Mauritania, the Nouakchott coastline is about 30 km long, and comprises relatively wide beaches backed by narrow, fragile and poorly vegetated dunes. North of the fishing port, where the dunes are volatile and loosely attached to the shore, some alteration of the dune line is noted as a result of sand extraction.

In Senegal, where the urban growth rate is very high (5 percent according to the United Nations, 1995), an extension of the urban environment is today one of the main sources of deterioration of coastal ecosystems. Such expansion is not limited to the capital, ports and coastal cities but also associated with the tourism industry where expansion is progressing rapidly in some coastal areas, such as the Petite Côte (Diagne and Yamamura, 2000; Balde, 2003; Ackerman *et al*., 2003). Nearshore property development does not only cause extension of the artificial land cover, but frequently causes an accentuation of coastal erosion either by inadequate construction and facilities or by the increasing extraction of sand for construction purposes (Cesaraccio *et al*., 2004; Sakho *et al*., 2011). Both these practices can lead to catastrophic results as is currently feared in the Langue de Barbarie, St Louis. The primary cause of the retreat of the coastline in Senegal is attributed to looting of sand and also the sediment deposited on the beaches of the entire coastline from St Louis to Joal via the Cape Verde peninsula. The accelerated urban expansion in the capital also puts pressure on the beaches, a typical example being the *Mbeubeuss* site that can be easily observed from the air.

Construction and building in Cape Verde is one of the activities that impacts the coastal and marine environment. The plans for development of cities and villages consume large amounts of construction material from nature (MAAP, 2004). Illegal extraction of materials from rivers and beaches is an economic, environmental and social problem in all islands of the archipelago. This requires alternative solutions that address the critical economic developments and the need to protect the ecological functions of beaches and rivers. The government has tried to resolve the matter by seeking alternative measures such as importing sand from Mauritania and, more recently, also from other parts of West Africa. Despite the Decree No. 2/2002 prohibiting the extraction and exploitation of sand dunes of the beaches and inland waters of the coast and the territorial sea, a gradual increase in the use of this dune sand has been noted, even after the entry into force of the above mentioned Decree, demonstrating its inability to solve the problem of illegal sand mining (Lopes, 2010). A few cases of complete disappearance of beaches have been found, which increases the vulnerability of the coast to erosion, leading to habitat loss and saline intrusion, and results in the loss of some species.

In Guinea-Bissau there is also mining of construction materials such as gravel, sand, clay and dolerite for use by companies and local people. The operations at the quarry of Petit Bond Nhagra and Quinhamelest are in full swing. In Guinea-Bissau, the quantities of sand extracted by human activity are very high, if one refers to the extractions performed in rivers, estuaries and beaches. This has had a significant socio-economic impact in the São Domingo region, especially in the town of Varela and around the islands of Bubaque and Melo.

Introduction of invasive species

In Senegal, alien invasive species are mainly present in the delta and valley of the Senegal River. The plant *Salvinia molesta* is currently a social and environmental problem that concerns all people of the delta. This plant invades bodies of water, especially in the park Djoudj, and is thus a threat to birds and all aquatic wildlife in the reserve. The different strategies (chemical, mechanical and biological) which have been used to combat the problem have not yet been effective in completely eradicating these invasive plants. In Guinea-Bissau, the water hyacinth (*Eichhornia crassipes*), azolla waterfern (*Azolla* spp.), Canada waterweed (*Elodea canadensis*) and watermilfoil (*Myriophillum brasiliensis*) also thrive in rivers, lakes and wells. The green alga (*Caulerpa taxifolia*) used in aquaria was accidentally introduced into estuaries through the sewers. Other invasive species include widely used ornamental plants like giant cane (*Arundo donax*) and pampas grass (*Cortaderia selloana*). In the Gambia, invasive species have also been found and are currently the subject of a research programme.

2.4.2 Diversity and important habitats

As noted in previous sections, the marine waters of the Northwest African region, from Morocco to the southern part of Senegal, are among the most productive in the world. Marine biodiversity is particularly high because of the interaction of two climatic regions, one cooler and dominated by Canary fauna and the other warmer and dominated by a more diverse Guinean fauna; the median area (Dakar) is particularly rich. Rare and iconic species are numerous and represent important conservation issues (e.g. sawfish, manatee). There is a very high diversity of invertebrates which, although largely unknown, undoubtedly conceal great pharmacological potential.

Two entities stand out on the coastal strip between Mauritania and Guinea: the Sahel and the Southern Rivers (Andrieu, 2008). The "*Sahel Maritime*" extending from the Banc d'Arguin in Mauritania to Senegal's Petite Côte is characterized by sandy coasts dotted with a few mangrove mudflats (Senegal River delta, Banc d'Arguin). The upwelling along this coast drives productivity and creates rich fishing grounds. The "Southern Rivers" region stretches from the Saloum Delta in Senegal to Sierra Leone through Guinea and is marked by successive deltas and estuaries vegetated by mangroves.

With regard to the plant kingdom, the CCLME region has three large ecosystems that are very interesting in terms of biological diversity: mangroves, seagrass and algae, for which microalgae are the basis of productivity. In addition to the mangroves and seagrass, the important marine and coastal biodiversity of the CCLME region is strongly structured and associated with a significant number of important key habitats (deltas, estuaries, coral reefs, seamounts, canyons, island complexes, etc.).

Industrial development in the coastal zone of the CCLME and migration of people from inland rural areas to the coastal zone, have increased the threats of coastal degradation and habitat modification (UNEP, 2005).

Over the last two to four decades, marshes, swamps and mangroves have been degraded and lost through natural factors such as drought, but more significantly, through the human activities that have been described in detail in the previous chapter.

2.4.2.1 Macrobenthos

During three ecosystem research cruises undertaken by the CCLME Project in 2011 and 2012 around the Cape Verde Islands and the continental shelf and slope of the region, a total of 19.5 million benthic invertebrates, totalling a mass of 89 tonnes were caught (Ramos *et al*., 2013). Although the final results are not yet available, the epibenthos of Northwest Africa appears to be composed of at least 1 000 to 2 000 species belonging to 38 different groups of marine invertebrates. Among these, the most species rich group is the decapod crustaceans represented by 259 species from over 40 families, followed by the prosobranch molluscs (119 species) and demosponges (85 species). Other taxa such as the hydrozoans, polychaetes, bivalves and gorgonians show average diversity of between 40 and 60 species.

By area, the highest overall diversity was found on the coasts of Morocco, where an average species richness of 26 to 28 species per station was found (Figure 17a) (Ramos *et al*., 2012). In terms of abundance (Figure 17b) and average mass (Figure 17c), the highest values were found in northern Senegal, Mauritania and Guinea with mean values of 300 individuals and 2 000 kg per station. Abundance and mass were lower in southern Senegal, the Gambia and Morocco. The preliminary data indicate an increase in the complexity of communities south to north, resulting in a change in the proportion of crustaceans from 55 to 60 percent in the waters from Morocco through to Mauritania, to values close to 96 percent in Guinea-Bissau and Guinea. Four species, including three shrimps (*Nematocarcinus africanus, Parapenaeus longirostris, Plesionika heterocarpus*) and one crab species (*Macropipus rugosus*) were responsible for this dominance. The abundance of sponges and cnidarian suspension-feeders was highest in the northern part of the CCLME (Morocco), where they constituted 20 percent of the number and 15 percent of the total mass sampled. Community composition is completely different in the Cape Verde Islands, where it is mainly composed of encrusting suspension-feeding fauna, especially sponges, cnidarians, black corals (antipatharia) and the large hydrozoans *Lythocarpia Myriophyllum*. The commercially exploited gastropod *Persististrombus latus* is also dominant in the archipelago.

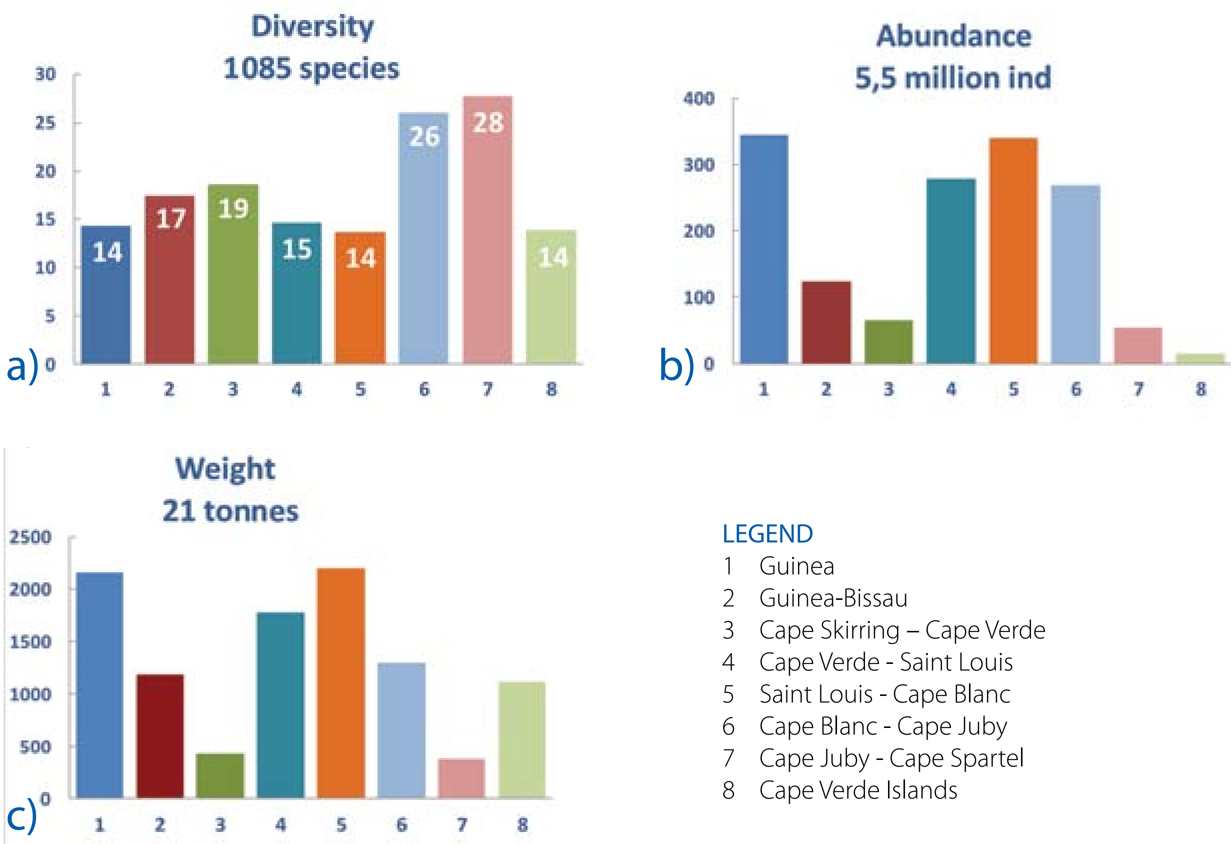

Figure 17: (a) Biodiversity, (b) abundance and (c) weight of the principal benthic taxa by area (from Ramos *et al*., 2012)

2.4.2.2 Algae

Algal diversity in the marine areas of the considered eight countries is highly variable, ranging from 1 137 species in the Canary Islands to 23 in Guinea-Bissau, with 349 and 331 species respectively in Mauritania and Senegal. Algal diversity is the highest in the islands of the region and in Morocco.

2.4.2.3 Seamounts and carbonate mounds

Seamounts and carbonate mounds can support diverse and abundant benthic communities, often dominated by suspension feeders, including deep-water coral ecosystems (Colman *et al*., 2005, Schlacher *et al*., 2010, Westphal *et al*., 2007 and 2013 and Ramos *et al*., in press). A 3-D seismic survey, undertaken in 1999 to 2000 off the coast of Mauritania, revealed the presence of buried and seabed carbonate mounds at approximately 450 to 550 m water depth on the continental slope (Colman *et al*., 2005). The mounds were approximately 100 m high and 500 m wide at the base, and estimated to extend over 190 km (Figure 18).

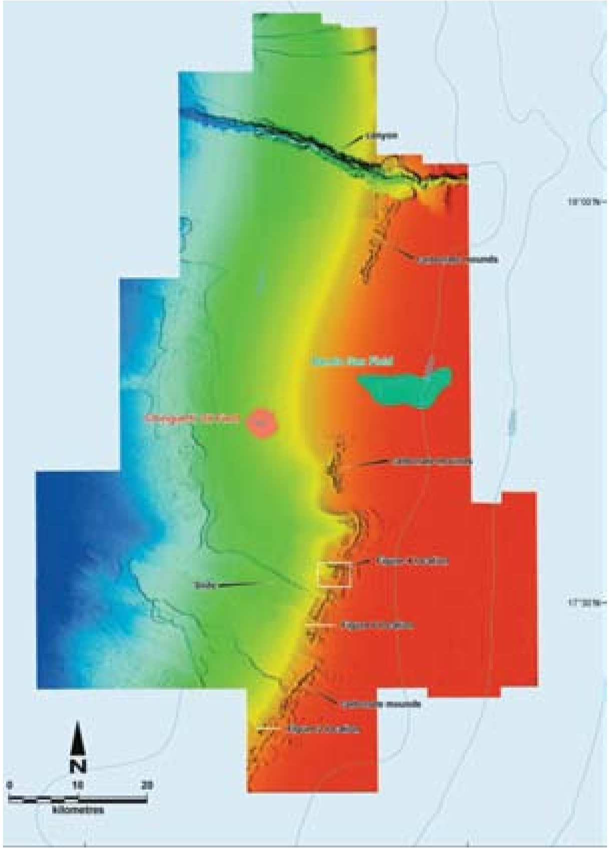

Figure 18: Bathymetric map, based on 3-D seismic data, showing carbonate mound structures, canyon system and slope slide features (Colman *et al*., 2005)

Towed camera surveys revealed that these mounds are largely composed of rubble and some small live specimens of four species of cold-water corals: *Lophelia pertusa, Madrepora oculata, Solenosmilia variabilis* and *Desmophyllum* spp., with the former two species being dominant (Colman *et al*., 2005). Live coral specimens were sampled in 2010 (Westphal *et al*., 2013) but the abundance and distribution of living deep-water corals remains uncertain. Live coral was also discovered in the canyons at Cape Timiris where they appear to be in better condition than on the seamounts (Westphal *et al*., 2013). The associated fauna is characterized by crustaceans such as *Paramola* sp., the bivalves *Acesta excavata* and *A. zibrowii* and Neopycnodote, a giant oyster species that can live up to 500 years (A. Freiwald, personal communication).

These biogenic structures were built during the last glacial period in three specific episodes (Eisele *et al*., 2011) and growth is influenced by high biological productivity generated by a strong upwelling. They feed on the contributions of surface productivity that fall in the water column as a "marine snow".

The cold water coral *Lophelia pertusa* is the dominant reef framework-building coldwater coral species in the north Atlantic and it has become a flagship species for deep-sea conservation. These complex structures create habitat for smaller mobile fauna and fish, including oceanic predators and migratory species, which congregate around these structures.

The most likely cause of the observed mortality of the corals off the coast of Northwest Africa is deep-water demersal trawling activities for crustaceans and fish, especially given the intensity of fishing effort that occurred on the continental shelf and upper slope since the 1960s, and particularly in the 1970s. Drilling for oil through or near these structures in future poses another potentially irreversible threat to these ecosystems. Figure 19 shows the difference in scale of impact between a drill (wellhead) and bottom trawls (trawl scar). While it is not known if these coral ecosystems functioned as a critical habitat for commercially important fish and crustaceans at that time, trawl scars (Figure 19), which are linear scar features in soft sediments on the seabed, have been observed in side-scan sonar and video images of the seabed close to carbonate mounds in Mauritania, and similar impacts have been recorded in other parts of the Atlantic. The frequency of trawl scars increases up the continental slope in shallower waters, which probably reflects increased activity, particularly by demersal trawlers targeting crustaceans on the seabed (Colman *et al*., 2005). If oil reserves are found beneath these habitats, horizonatal drilling underneath these sensitive areas may be required to balance the need for hydrocarbon exploitation and habitat preservation.

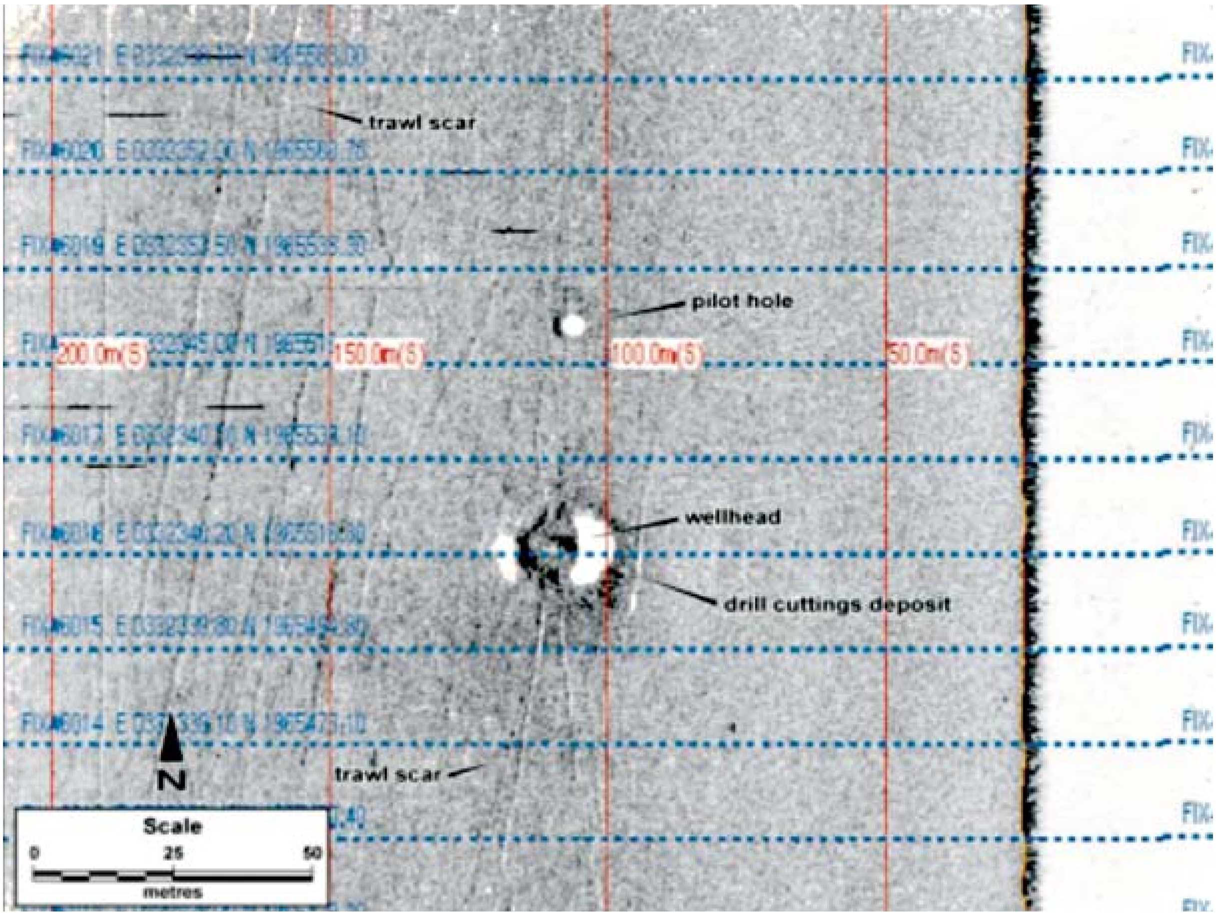

Figure 19: Trawl scars recorded in 120 kHz side scan sonar data collected over the Chinguetti well site (270 m water depth) off the coast of Mauritania (Colman *et al*., 2005)

2.4.2.4 Seagrasses

Seagrasses are marine angiosperms, widely distributed in both tropical and temperate coastal waters, creating one of the most productive aquatic ecosystems on earth. Seagrass beds may be found intertidally as well as subtidally to 40 m depth if the conditions are favourable, and often in close association with coral communities and mangroves. Seagrasses are not as abundant as mangroves because they need clearer water. Large seagrass beds that are largely unaffected by anthropogenic activities exist in Mauritania in the Banc d'Arguin National Park area and cover more than 500 km², representing one of the rare positive examples worldwide of seagrass beds avoiding the otherwise strong tendency towards habitat loss.

The three most common species of seagrass found in the CCLME region are *Cymodocea nodosa, Zostera noltei*, and *Halodule wrightii*. The tasselweed *Ruppia maritima*, is another species that forms seagrass beds, although the taxonomy is complicated. *Halophila decipiens*, has also been reported although this may require further confirmation. All these species are listed on the IUCN Red List as being of "Least Concern".

Cymodocea nodosa is a widespread species found from the Mediterranean and down the coast of West Africa, which has been reported from the Canary (Reyes *et al*., 1995; Tuya *et al*., 2001; Prez Talavera and Quesada-Ruiz, 2001) and Cape Verde Islands (Short *et al*., 2010), and from Mauritania (Monod *et al*., 1977) and Senegal (Den Hartog, 1970). The Dwarf eelgrass, *Zostera noltii*, has recently been reclassified as *Nanozostera noltii* (Tomlinson and Posluzny, 2001). This species is a small, fast growing seagrass found throughout the northern Atlantic and within the CCLME from southern Morocco (Hughes and Hughes, 1992) to northern Mauritania (Den Hartog, 1970; Monod, 1997), and around the Canary and Cape Verde Islands (Short *et al*., 2010). It typically grows in soft sediments in the intertidal and subtidal zones up to a maximum depth of 10 m. *Halodule wrightii* is found on sandy to muddy bottoms, often within mixed seagrass beds. It is a hardy species and is found around the Canary Islands and from southern Morocco to Guinea-Bissau (Monod *et al*., 1977; Short *et al*., 2010). *Halophila decipiens* is a circumglobal typically tropical species that is reportedly found in deeper waters around the Canary Islands (Den Hartog, 1989), and on the northwest coast of Africa (Short *et al*., 2010). *Ruppia maritima* has a wide salinity tolerance and occurs in fresh water, brackish water and marine environments and is reported from the Canary Islands (Short *et al*., 2010).

Seagrass species are vulnerable to mechanical damage, caused by trawling and anchoring from boats, dredging and other coastal development activities. Their environmental tolerance with respect to light, temperature, salinity, sedimentation and pollution varies between species. While *Cymodocea nodosa* is a fairly resilient species it may be threatened by mechanical damage and eutrophication. *Nanozostera noltii* is susceptible to sedimentation impacts and local declines may occur as a result of a loss of water clarity from sedimentation, coastal development and eutrophication. *H. wrightii* is a tolerant species able to survive a wide range of salinities, temperatures, turbidity, and eutrophication and will replace less tolerant species when conditions deteriorate. *Ruppia maritima* is tolerant of a wide range of environmental conditions, including various disturbances, but is threatened locally by habitat loss from industrialization and agriculture

2.4.2.5 Coral communities

No true shallow-water coral reefs exist along the West African coast or in the Cape Verde Islands but there are a number of locations which support rich coral ecosystems/communities. Environmental conditions in the region restrict significant coral growth to shallow protected bays, outside which the number of species and size of coral colonies rapidly decrease. In open waters hermatypic corals are generally limited to depths shallower than 20 m with some exceptions (Spalding *et al*., 2001; UNEP-IUCN, 1988).

Notable coral communities are found around the Cape Verde Islands. Corals are found most often in the southern islands of the archipelago where the seawater temperatures are higher; the most common species is *Millepora alcicornis*. Corals are also known to occur in Guinea around the Loose Islands, especially the islands of Corail, Blanche and Cabris. In the deeper offshore waters off Mauritania, coldwater corals occur, including *Lophelia pertusa, Madrepora oculata, Solenosmilia variabilis* and *Desmophyllum* (See section 2.4.2.3, above).

2.4.2.6 Mangroves

Eight species of mangrove are present along the coast from Mauritania in the north to Guinea in the south. The largest areas of mangroves are found in Guinea-Bissau with its Bijagos Archipelago, and in Guinea (Table 13). The mangroves of Guinea-Bissau cover an area of 2 999 km² and are one of the most important mangrove areas in Africa. Other important areas for mangroves include the Sine-Saloum Delta and the Casamance River in Senegal and the Gambia River. In many of these areas regional conditions enable mangroves to grow as far as 100 km inland.

Mangrove forests are rich in biodiversity, providing habitats for a host of animal species from endangered mammals to reptiles, amphibians and birds, and spawning grounds for a variety of fish and shellfish, including several commercial species. Mangrove forests also provide nutrients to coastal marine waters, often resulting in high fisheries yields in waters adjacent to them (UNEP-WCMC, 2006). Birds use the mangrove forests for feeding, reproduction and shelter. As an example, Banc d'Arguin National Park in Mauritania has the world's largest concentration of wintering shorebirds, numbering over two million (UNEP, 2007).

Mangroves and associated ecosystems (coastal lagoons, tidal estuaries, and deltas) are being rapidly degraded as a result of multiple human impacts, including overfishing, pollution from pesticides, fertilizers, sewage discharge, industrial waste and oil and mineral extraction, conversion of land for agriculture, fuelwood and land reclamation and freshwater diversion. All of these threats are exacerbated by the rapid expansion of the coastal human population, growing at nearly twice the mean annual rate of 2.9 percent in the region. In addition, mangroves trap and consolidate sediments (Isupova and Mikhailov, 2011) and when they are destroyed, sandy beaches and shorelines become exposed to wind and wave erosion. Mangroves have been further stressed by the steady decrease in freshwater inputs from rivers impounded upstream. The loss of such inflows affects the three most important factors in maintaining healthy mangrove ecosystems: a sufficient amount of water, an adequate supply of nutrients and substrate stability.

Table 13: The area of mangroves in each country of the CCLME (FAO, 2007)

Country	Area of mangroves (km^2)	Number of species
Morocco	0	0
Mauritania	2	3
Senegal	1 287	7
The Gambia	581	7
Cape Verde	0	0
Guinea-Bissau	2 999	6
Guinea	2 039	7

2.4.2.7 Rivers and estuaries

The CCLME region has a multitude of rivers and estuarine ecosystems, many of which are transboundary and vary in their national and international significance depending on their size. Several of the major drainage systems between Morocco and Guinea-Bissau are highly dependent on rainfall patterns, and given the significant variability, some of these rivers only flow during the rainy season.

In Morocco, there are many rivers (Loukkos, Sebou, Bouregreg, Nefifikh, Mellah, Oum Errabia, Tessaout, Lakhdar, Tensift, Ksob, Tamri, Souss, Massa, Noun, Drâa, Seguia Al Hamra), which flow into the Atlantic Ocean. The estuaries contain a high biodiversity, contributing to the richness of the Moroccan Atlantic coast. The Sebou River is one of the largest Moroccan rivers, draining approximately 40 000 km² (Figure 20a). It runs for some 600 km from its source in the middle Atlas Mountains to the Atlantic Ocean. The Sebou Basin receives a mean annual rainfall of more than 1 000 mm. The lower Sebou Basin encompasses a large plain called the Gharb plain. Presently, there are 16 dams constructed along the Sebou River. The most recently constructed dam (the Al Wahda Dam) is the second most important dam in North Africa, after the Aswan High Dam.

The Bouregreg originates from the Middle Atlas mountains at an altitude of 1 627 m and discharges into the Atlantic Ocean between the cities of Rabat and Salé. The river is 240 km long, with a tidal estuary of approximately 24 km extending upriver. Its average discharge is 23 m³/s and can reach 1 500 m³/s during periods of flooding. The estuary of this river is known as Wadi Sala and more than 400 species have been recorded in the estuary.

The Souss-Massa River Basin is located in southwestern Morocco between the Atlantic Ocean and the high Atlas Mountains and covers a total area of 27 000 km² (Figure 20b). It encompasses the Souss River and all its tributaries, which discharge to the south of Agadir, the Massa River and all its tributaries in the south, and the coastal river basins of Tamri and Tamraght in the north. Average rainfall for the Souss-Massa River Basin is about 270 mm per year, making this part of Morocco a semi-arid environment. The rainfall that does occur in the Basin comes in short storm bursts, which create serious flooding conditions. Storms in the basin result in flash floods, which create sediment problems in the rivers.

There are five major rivers in Senegal (Senegal, Saloum, Gambia, Geba and Casamance). The Senegal River is is 1 800 km long, has an area of 475 000 km² and is shared by the four West African countries of Mali, Guinea, Mauritania and Senegal (Figure 20c) (Finger and Teodoru, 2003). The Senegal River flows across the western part of Mali and Guinea. Downstream the river defines the border between Senegal and Mauritania before discharging into the Atlantic Ocean near Saint Louis in Senegal. The Senegal River is important to the countries it flows through because its waters are used for crop and livestock production. Fishing is also an important economic activity along the river's course and 115 fish species have been recorded in the river system, of which 26 are endemic.

The Senegal River is a positive estuary characterised by an upstream decrease of marine influence and salinity. The major rivers in the south (e.g. the Saloum, Gambia and Casamance Rivers) end in inverse estuaries, where the salinity increases upstream as a result of high evaporation rates. At the Gambia River mouth tidal variation is about 1.6 m and saltwater moves 70 km upstream in the wet season and 250 km upstream in the dry season on account of the flat topography and the low river discharge rates during the dry season (below 0.5 m³/s). Dense mangrove swamps fringe the lower river as far as 97 km inland, after which freshwater swamps and salt flats on low-lying stretches alternate with dense clumps of small trees and shrubs. The Saloum estuary is similarly occupied by a large mangrove forest covering an area of about 80 000 ha.

The Gambia River (Figure 20d) dominates the Gambia and is an important transboundary river shared between the Gambia, Senegal, and Guinea. The river is approximately 1 130 km long with a catchment area covering approximately 490 000 km². From its source on the Fouta Djallon plateau in north Guinea, the river flows west through Senegal and the Gambia before draining into the Atlantic Ocean at the city of Banjul near Saint Mary's Island. The flow of the River is reported to be highly seasonal, with a peak discharge of about 2 000 m³/s, but for six months the inflow at the Gambian border is less than 10 m³/s (Saine 2001). The river system abounds in fish and other wildlife, including hippopotami and crocodiles. There are about 104 200 ha of swamps in the basin, of which mangroves account for 67 000 ha. The aquatic fauna in the Gambia River Basin is closely associated with that of the Senegal River Basin. Although the species richness is moderately high, only three species of frog and one fish are endemic to this Gambia-Senegal ecoregion.

The Casamance River is the principal river in the southern part of Senegal, between the Gambia and Guinea-Bissau. The Casamance flows west for 320 km and discharges into the Atlantic. Less than half of the river is navigable. Ziguinchor in Senegal, is one of the most important towns on the river.

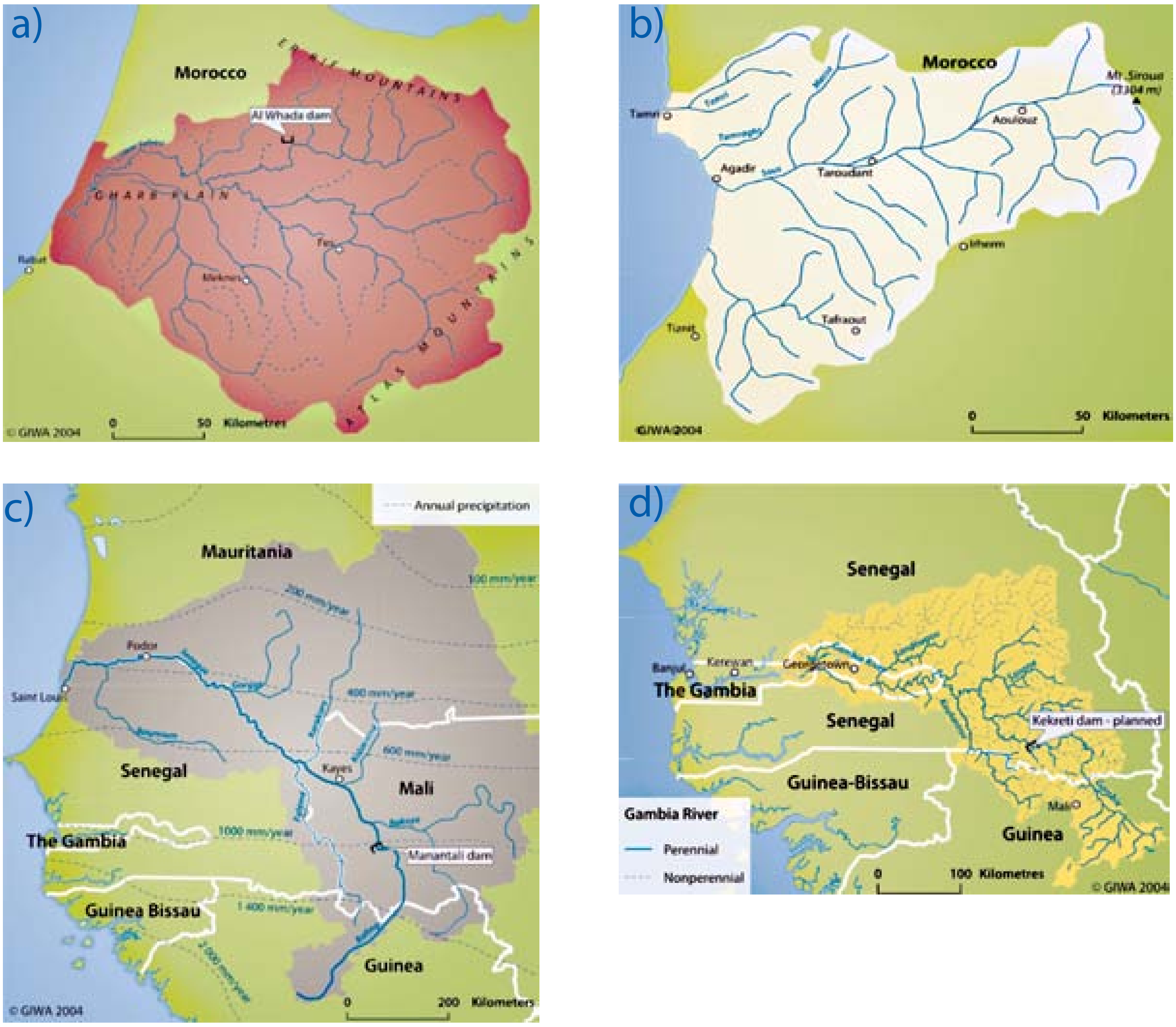

Figure 20a–d: Maps of four of the major river basins in the CCLME including the (a) Sebou River Basin (b) Souss-Massa River Basin (c) Senegal River Basin and (d) Gambia River Basin (UNEP, 2005).

The next significant estuary to the south is the Farim (Cacheu) River, which is one of the six main rivers in Guinea-Bissau (Cacheu, Mansôa, Gêba, Corubal, Cacine and Rio Grande). The Cacheu flows near the northern border with Senegal. The Mansôa flows from the centre of the country and discharges into the Atlantic near the city of Bissau. The Gêba originates in Senegal and bisects the country. The Corubal originates in Guinea and meanders close to the southern border. The Cacine runs along the southern border with Guinea. The last of the major rivers is the Rio Grande. The rivers of Guinea-Bissau provide the principal means of transportation and ocean-going vessels of shallow draught can reach most of the main towns, while flat-bottomed tugs and barges can reach the smaller settlements, except for those in the northeast. Large mangrove forests that trap nutrients drained from the watershed represent nursery and spawning grounds for shallow water fish.

Human activities such as damming, urbanization, agro-industrial development and settlements along major rivers in the region have caused erosion in coastal areas. The estuary of the Senegal River has been significantly modified and is marked by chronic salinization linked in recent years to the development of facilities in the river basin, such as the Diama Dam in 1985 and the Manantali Dam in 1987. The development of the Senegal River basin has greatly impacted on the estuarine ecosystem. The fish fauna was strongly affected, resulting in a decrease in catches of estuarine species and a change in the nature of the species (Diawara, 1997). This decrease in fishery resources, combined with the loss of nesting sites had serious consequences for the birdlife with a significant reduction in the number of migratory species. Small dams on the Gambia River (Kekret and Kouya Dams) have similar impacts on their respective river regimes (Diagana, 1994).

2.4.3 Climate change and ecosystems of the CCLME

The anticipated impacts of climate variability and change pose a serious threat to the ecosystems and habitats of the CCLME. Shifts in sea water temperatures, rainfall patterns and productivity have already been recorded and the anticipated changes in sea levels, tidal range, current patterns, salinity and other physico-chemical parameters, including ocean acidification, all pose a potential threat. Wetlands and coastal mangroves are particularly susceptible to sea level rise resulting from climate change.

In Morocco, Alibou (2002) studied wetland evolution. Using an average IPCC scenario (IPCC, 2001), seven general circulation models (GCMs) were considered for climate simulations until 2020. The results of the projections for the whole country showed: (i) a clear trend to warming of about 0.7 °C and 1 °C; (ii) a tendency of reduced average annual rainfall of around 4 percent; (iii) an increase in the frequency and intensity of droughts in the south and east of the country; (iv) a disruption of seasonal rainfall. These future changes in climatic conditions combined with future sea level rise will affect the availability of water and strongly influence the nature and functioning of some wetlands in Morocco, including the types of plant and animal species that live there. These changes are likely to affect the wetlands for waterbirds that are classified by the Ramsar Convention as sites of global significance in terms of the distribution and abundance of species and the structure and function of ecosystems.

In West and Central Africa, 20 to 30 percent of mangroves have disappeared in the past 25 years (UNEP, 2003 and 2006), owing to anthropogenic influences and climate variability. Degradation of mangroves has already been observed in Senegal and Mauritania. Prolonged droughts and salt intrusion have impacted the mangroves in Mauritania and Guinea-Bissau. In Guinea-Bissau, the flow of the Geba and Corubal rivers has decreased by 25 to 50 percent and 25 percent, respectively, since 1970 owing to drought. In Guinea, studies on the rising sea surface temperature and sea level have enabled projections to be made up to the year 2050, indicating an increase in tidal range, causing erosion from residual currents and mangrove destruction (Camara, 2006). According to the same source, flood levels in the Koba plains will cause submersion of 80 percent of the infrastructure in the lowlands along the coast. A decrease in rainfall could impact river flow and further reduce the fertility and productivity of mangrove forests. Climate change will also affect mangrove associated fauna, especially fish species for which mangroves are the preferred breeding grounds. Some species will be threatened and disappear, while others may proliferate and new species may appear as a result of the changing conditions. The loss of mangrove habitat also threatens some large species such as the African manatee, the hippopotamus and dolphins. In Senegal, studies of the flood levels as a result of climate change have predicted the complete disappearance of the Sangomar sandbar, as well as impacts on part of the Niayes and Saloum deltas by 2050. Climatic phenomena that impact on natural vegetation and soils will also cause disruption to sedimentation and siltation patterns. The poorer the health of the mangroves the more vulnerable they are to climate change.

2.4.4 References

Ackerman, T.P., Flynn, D.M. & Marchand, R.T. 2003. Quantifying the magnitude of anomalous solar absorption. *Journal of Geophysical Research* 108. DOI: 10.1029/2002JD002674. Issn: 0148-0227.

Alibou, P.J. 2002. *Impacts des changements climatiques sur les ressources en eau et les zones humides du Morocco. Rapport CERSHE-EHTP. Ministère de l'Aménagement du territoire, de l'Urbanisme, de l'Habitat et de l'Environnement, Département de l'Environnement. Rabat*.

Allison, E.H., Perry, A.L., Badjeck, M., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. & Dulvy, N.K. 2009. Vulnerability of national economies to the impact of climate change on fisheries. *Fish and Fisheries*. 10(2): 173–196.

Andrieu, J. 2008. *Dynamique des paysages dans les régions septentrionales des rivières du Sud (Senegal, The Gambia, Guinea-Bissau). Thèse de doctorat de géographie, Université de Paris*. 532 pp.

Bah, M. 2008. *Rapport sur la mise en œuvre du programme sur la biodiversité marine et côtière. Troisième rapport national sur la diversité biologique, CDB. République de Guinée*. 57p.

Baldé. 2003. Integrated management and sustainable development of coastal West Africa: the experience and the project of the UCAD Chair.

Benbrahim, S., Chafik, A., Chfiri, R., Bouthir, F.Z., Siefeddine, M., Makaoui, A. 2006. *Etude des facteurs influençant la répartition géographique et temporelle de la contamination des côtes atlantiques marocaines par les métaux lourds: cas du mercure, du plomb et du cadmium. Marine Life 16:* 37–47.

Camara, M.M.B. 2006. *Quelle gestion des pêches artisanales en Afrique de l'Ouest ? Étude de la complexité de l'espace halieutique en zone littorale Senegalaise. Thèse de doctorat de géographie, Université Cheikh Anta Diop de Dakar*. 339 pp.

Chafik, A. 2014. *Consultation nationale du Morocco dans le cadre de l'étude sur l'Assessment des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*. 78 p.

Cham, A. 2014. *Consultation nationale de la The Gambia dans le cadre de l'étude sur l'Assessment des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*. 52 p.

Cesaraccio, M., Thomas, Y-F., Diaw, A.T. & Ouegnimaoua, L. 2004. Impact of sand extractions on coastal dynamics (Sarène Point beach, Senegal). *Geomorphology: relief, processes, environment*. No 1. p. 55–64.

Colman, J.G., Gordon, D.M., Lane, A.P., Forde, M.J. & Fitzpatrick, J.F. 2005. Carbonate mounds off Mauritania, Northwest Africa: status of deep-water corals and implications for management of fishing and oil exploration activities. *In*: A. Freiwald & J.M. Roberts, eds. *Cold-water Corals and Ecosystems*. Berlin, Heidelberg, Springer, p. 417–441.

Den Hartog, C. 1970. The sea-grasses of the world. Amsterdam, North-Holland Pub. Pays-Bas, 275 p.

Den Hartog, C. 1989. Distribution of the seagrass *Halophias decipiens* Ostenfeld in the Indian Ocean. *Acta Botanica Neerlandica*, 38: (1): 81–83. DOI: 10.1111/j.1438-8677.1989.tb01915.x

DGA. 2014. *Relatório - Visão, prioridades e metas para a conservação da biodiversidade de Cabo Verde. Projecto "Revisão da Estratégia e Plano de Acção Nacional e Elaboração do 5º Relatório sobre o Estado da Biodiversidade"*. 32 pp.

Diagana, A. 1994. *Études hydrogéologiques dans la vallée du Fleuve Senegal de Bakel à Podor: relations eaux de surface/eaux souterraines. Thèse de doctorat de troisième cycle, Université Cheikh Anta Diop de Dakar*. 171 p.

Diagne A.K. & Yamamura, J. 2000. Tourism development and environmental coast laws in Senegal. The case of the Petite Côte. *The Arab World Geographer*, 3 (2): 113–131.

Diawara, Y. 1997. *Formations morphopédologiques et unités floristiques du bas delta mauritanien. In F. Colas éd. Actes du colloque« Environnement et Littoral Mauritanien » (Nouakchott, June 1995). Montpellier, France, CIRAD*. p. 47–52.

Diallo, D. *et al*. 2006 – *Rapport final cadre de gestion environnementale et sociale et Audit environnemental*. 52 p.

FAO. 2007. The world´s mangroves 1980–2005. FAO Forestry Paper 153. Forestry Department, FAO Rome. 77p. Available at http://www.fao.org/docrep/010/a1427e/a1427e00.htm

Finger, D. & Teodoru, C. 2003. *Case study Senegal River*. ETH Seminar on the Science and Politics of the International Freshwater Management. Available at http://www.eawag.ch/research_e/apec/seminars/Case%20studies/2003/Senegal%20River.pdf

GESAMP. 2001. *A sea of troubles*. IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP joint group of experts on the scientific aspects of marine environmental protection. Arendal, Norway, GRID–Arendal, United Nations Environmental Programme. Reports and Studies, No. 70.

GIEC. 2001. Climate change 2001: the scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. [Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. et Johnson C.A.(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, USA, 881 pp.

Houghton, J.T., Y. Ding, D.J., Griggs, M., Noguer, P.J., Van der Linden, X., Dai, K., Isupova, M.V. & Mikhailov, V.N. 2011. Hydrological processes in the mouth area of the Hong Ha (Red River). *Water Resources*, 38: 557–570.

Hughes, R.H. & Hughes, J.S. 1992. *A Directory of African Wetlands*. IUCN. Gland, Switzerland, UK/UNEP, Nairobi, Kenya/WCMC. Cambridge UK. 820 pp.

Kane, A. 2014. *Consultation nationale du Senegal dans le cadre de l'étude sur l'Assessment des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*, 51 pp.

Keita, A. 2014. *Consultation nationale de la Guinea dans le cadre de l'étude sur l'Assessment des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*, 106 p.

Keita, A., Hawa D., *et al*. 2013. *Définition des politiques et des stratégies de renforcement des capacités nationales pour la mise en œuvre des programmes de travail sur les aires protégées (PTAP/PoWPA).* 139 p.

Kidé, S. 2014. *Consultation nationale de la Mauritania dans le cadre de l'étude sur l'Assessment des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*, 52 p.

Lopes, E. 2010. *Mulheres e ambiente: A problemática da apanha de inertes na ilha de Santiago / Cabo Verde. Dissertação de mestrado em Geografia Física, Ambiente e Ordenamento de Território, apresentada à Faculdade de Letras da Universidade de Coimbra*. 106 p.

MAAP/GEP. 2004. *Estudo de Base: Impactes de apanha e extracção de inertes em Cabo verde. República de Cabo Verde, Ministério do Ambiente, Agricultura e Pescas, Gabinete de estudos et planeamento, Praia.* PANA II, V1, 132 p.

Ministry of Environment, Morocco. 1997. *Rapport du Ministère de l'Environnement Maroc, ME. 2010. Statistiques Ministère de l'Environnement de Maroc*.

ME. 2010. *Statistiques Ministère de l'Environnement du Maroc*.

Monod, T. 1977. *Le National Park du Banc d'Arguin et l'histoire, le cadre général, flore et végétation du PNBA.* In *Association de soutien du National Park du Banc d'Arguin. Richesse du National Park du Banc d'Arguin (Mauritanie)*. *Versailles, France*.

Monteiro, V. & Vito, R. 2014. *Consultation nationale du Cabo Verde dans le cadre de l'étude sur l'évaluation des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*. 38 p.

Ndiaye, C.O. 2007. *Pollution du littoral par les activités du port autonome de Dakar. Mémoire de maîtrise de géographie, Université Gaston Berger de Saint Louis (Sénégal). 105 p. et annexes*.

Prez Talavera, J.L. & Quesada Ruiz, J.J. 2001. Identification of the mixing processes in brine discharges carried out in Barranco del Toro Beach, south of Gran Canaria (Canary Islands). *Desalination* 139(1-3): 277–286.

Ramos, A., Ramil, F., Garcia-Isarch, E., Soto, S., Muñoz, I., Barry, A.O., Mohamed, S. & Zidane, H. 2013. *Biodiversité de l'épibenthos du Nord-ouest de l'Afrique: Résultats préliminaires des campagnes écosystémiques dans la région du CCLME*. *Rapport non publié*, 3 p.

Ramos, A., Sanz, J.L. & Ramil, F. In press. *Deep-sea ecosystems off Mauritania: researching marine biodiversity and habitats in West African deep.*

Reyes, J., Sanson, M. & Afonso-Carillo, J. 1995. Distribution and reproductive phenology of the seagrass *Cymodocea nodosa* (Urcia) Ascherson in the Canary Islands. *Aquatic Botany,* 50(2):171–180.

Robalo, H. 2014. *Consultation nationale de la Guinée Bissau dans le cadre de l'étude sur l'évaluation des activités terrestres pouvant constituer des sources de pollution marine et côtière dans la zone du CCLME*, 62 p.

Saine, A. 2001. *General report about Gambia*. Prepared for the GIWA Scaling & Scoping Workshop, Rabat, Morocco.

Sakho, I., Mesnage, V., Deloffre, J., Lafite, R., Niang, I.& Faye, G. 2011. The influence of natural and anthropogenic factors on mangrove dynamics over 60 years: the Somone Estuary, Senegal. *Estuarine, Coastal and Shelf Science,* 94(1): 93–101.

Schlacher, T.A., Rowden, A.A., Dower, J.F. *et al*. 2010. Seamount science scales undersea mountains: new research and outlook. *Marine Ecology. An Evolutionary Perspective,* 31(S1): 1–13.

Semlali, A., Chafik, A., Talbi M. & Budzinski, H. 2012. Origin and distribution of polycyclic aromatic hydrocarbons in lagoon ecosystems of Morocco. *The Open Environmental Pollution & Toxicology Journal*, (Sp 1-M5): 37–46.

Short, F.T., Carruthers, T.J.R., Waycott, M., Kendrick, G.A., Fourqurean, J.W., Callabine, A., Kenworthy, W.J. & Dennison, W.C. 2010. *Zostera noltii. In*: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. Available at: www.iucnredlist.org. Downloaded on 5 August 2013.

SIPEM. 1991. *Impact de la pollution accidentelle par les hydrocarbures sur le littoral morocain; Symposium International sur la Pollution des Eaux Marines (SIPEM).*

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A. & Robertson, J. 2007. Marine ecoregions of the world: A bioregionalization of coastal and shelf areas. *BioScience* 57(7): 573–583.

Tamba J. 2012. *Congresso dos Engenheiros da Língua Portuguesa, Sessão: Industria Extrativa, Potencialidade Mineira da República da Guiné-Bissau, Lisboa, 18 a 20 de Outubro 2012, República da Guiné-Bissau, Ministério dos Recursos Naturais e da Energia, Direcção Geral de Geologia e Minas.*

Tomlinson, P.B. & Posluzny, U. 2001. Generic limits in the seagrass family Zosteraceae. *Taxon* 50(2): 429–437.

Tuya, F., Perez, J., Medina, L. & Luque, A. 2001. Seasonal variation of the macrofauna from three seagrass meadows of *Cymodocea nodosa* off Gran Canaria (Central-eastern Atlantic Ocean). *Ciencias Marinas, 27:* 23–234.

UNEP. 2002. Global environment outlook 3 (GEO-3): past, present and future perspectives. UNDP, Earthscan Publication Ltd, London, 416 pp.

UNEP. 2003. *Mangroves of East Africa*. UNEP Regional Seas Programme, UNEP-WCMC. Available at: http://www.unepwcmc.org/resources/publications/UNEP WCMC bio series/index.aspx

UNEP. 2005. *Canary Current, GIWA regional assessment* 41. *In* M. Tayaa, A. Saine, G. Ndiaye & M. Deme, eds. Global international waters assessment. University of Kalmar, Kalmar, Sweden.76 pp. + appendices.

UNEP. 2006. Regional Seas Programme. UNEP-WCMC. 83 pp.

UNEP. 2007. *Mangroves in Western and Central Africa*. Report produced for UNEP-DEPI under the UNEP Biodiversity related projects in Africa. Nairobi, UNEP. 74 pp.

UNEP. 2011. Rapport de la Conférence des Parties à la Convention de Stockholm sur les polluants organiques persistants sur les travaux de sa cinquième réunion. Genève, 25–29 avril 2011, UNEP/POPS/COP. 142p.

UNEP-WCMC. 2006. In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs. *UNEP-WCMC biodiversity Series 24. Cambridge, UK.* 44 pp. Available at: https://archive.org/details/infrontlineshore06well

UNEP/IUCN. 1988. *Coral reefs of the world. Volume 2; Indian Ocean, Red Sea and Gulf*. UNEP Regional Seas directories and bibliographies. Gland, Switzerland/Nairobi, Kenya. UNEP/IUCN.

Watson, R. & T. Morato. 2004. Exploitation patterns in seamount fisheries: a preliminary analysis. *In* T. Morato & D. Pauly, eds. *Seamounts: biodiversity and fisheries. Fisheries Centre Research Report*, 12(5): 61–66.

Westphal, H., Beuck, L., Braun, S., Freiwald, A., Hanebuth, T.J.J., Hetzinger, S., Klicpera, A., Kudrass,H., Lantzsch, H., Lundälv, T., Mateu-Vicens, G., Preto, N., Reumont, J.V., Schilling, S., Taviani, M. & Wienberg, C. 2013. *Report of Cruise Maria S. Merian 16/3 – Phaeton – Paleoceanographic and paleo-climatic record on the Mauritanian shelf*. 13 October to 20 November, 2010, Bremerhaven (Allemagne) – Mindelo (Cape Verde). Maria S. Merian- Berichte, Leibniz-ZMT, Brême, Allemagne, 136 pp.

Westphal, H., Freiwald, A., Hanebuth, T.J.J., Eisele, M., Gürs, K., Heindel, K., Michel, J. & Reumont, J.V. 2007. *Report and preliminary results of Poseidon cruise 346 - MACUMA: integrating carbonates, siliciclastics and deep-water reefs for understanding a complex environment, Las Palmas (Spain)*, 28 December, 2006 to15 January 2007. Reports of the Dept of Geosciences, Université de Brême. Allemagne, Germany. 49 pp.

2.5 Socio-economic importance of the CCLME

The current population of CCLME countries is estimated to be 64.5 million (CIA, 2013). While growth rates have dropped over the past 20 years globally, over the whole region the population is still growing at > 2 percent per year. The majority of people live in the coastal areas where most cities and industrial infrastructure are located (UNEP, 2002). Most countries' economies are based on agriculture and fisheries, with a very weak industrial sector contribution to GDP (Table 14). The expansion of coastal populations has led to unplanned urbanization and the proliferation of coastal tourism facilities, changes in land-use patterns, over-harvesting of wood, expansion of agricultural areas and increased extraction and use of both ground and surface waters. This section presents socio-economic statistics to give a better understanding of the overall situation in the CCLME countries and to complement the information provided on ecosystems, marine living resources and fisheries. Statistical data, including information on the sources used, have been presented in Table 14. Other information has been derived from national reports produced by the socio-economic working group of the CCLME Project (Dia, 2013; Diallo, 2013; Gomes, 2013; Kamili, 2013; Deme, 2013; Ba, 2013).

2.5.1 Human development and demography

Populations and population densities range considerably between the countries of the CCLME. Cape Verde has the smallest population and this is the only country in the region with a resident population of less than 1 million (531 046 people). Both Guinea-Bissau and the Gambia have populations of between 1.5 to 2 million, while all the other countries have populations of > 3 million people. Morocco has the highest population (32.6 million), followed by Senegal (13.3 million) and Guinea (11.2 million). Mauritania has a population of 3.4 million people, but this vast country also has the lowest population density, with only 3.4 people per km^2. Population densities in the other countries range from 176 people per km^2 in the Gambia and 124 per km^2 in Cape Verde, to 72 in Morocco, 66 in Senegal, 55 in Guinea-Bissau and 42 in Guinea (Table 14).

Population growth rates fluctuate between the countries (Table 14), from 1 percent (Morocco), 1.4 percent (Cape Verde) to 2.3 percent (the Gambia), with an average of 1.9 percent for the region. An average of 58 percent of the population in the region falls in the 15 to 64 years age group. Approximately 37.5 percent of the population is younger than 14 years of age and only about 4 percent are above 65 years of age. The age composition is more skewed in Cape Verde and Morocco, where there is a higher percentage of people within the 15 to 64 age range (> 60 percent), and a lower percentage of the population aged 0 to 14 (~ 30 percent). The other countries have a higher percentage (~ 40 percent) of younger people aged 0 to 14, which is likely due to the higher birth rates in those countries.

Fertility rates have fallen by a third on average across all countries in the CCLME over the past 30 years, from an average of 6.5 to 4.1 births per woman between 1980 and 2011 (Table 14). Countries with the lowest fertility rates are Cape Verde (2.34) and Morocco (2.24), whereas fertility rates remain high in Guinea (5.2), the Gambia (4.8) and Senegal (4.7).

Death rates have fallen within the region from 17.34 to 9.66 per 1 000 people between 1980 and 2011. Life expectancy is highest in Cape Verde and Morocco (> 72 years) and lowest in Guinea-Bissau (48.1) and Guinea (54,1). However, infant mortality rates are above 100 per 1 000 live births in Guinea-Bissau (160), Guinea (126), Mauritania (112) and the Gambia (101). Health expenditure is low and there is less than one physician per 1 000 people in all countries.

The Human Development Report of UNDP has combined the indicators of life expectancy, educational attainment and income into a composite human development index, the HDI. The purpose of the HDI is to create a single statistic which could serve as a frame of reference for both social and economic development, thus providing an

alternative to GDP and Gross National Income (GNI) measurements of socio-economic progress. Looking at the HDI, two of the CCLME countries (Morocco and Cape Verde) were ranked as medium-developed countries and the remainder were ranked low (UNDP, 2013).

Overall, Morocco and Cape Verde stand out from the other countries in the CCLME region in terms of level of social and economic development. Being the most and least populous countries in the region, respectively, Morocco and Cape Verde are the countries with the highest per capita income (over US$3 000/inhabitant). Moreover, in these countries, life expectancy is longer, the mortality rate of children under five is the lowest (less than 1 percent) and population growth is the lowest (this is also reflected in the age composition in those countries).

Table 14: Social and economic characteristics of the Canary Current LME region (CIA, 2013; World Bank, 2013)

	Year	Morocco	Mauritania	Senegal	The Gambia	Cape Verde	Guinea-Bissau	Guinea	Average (CCLME)
GDP (PPP US$ millions)[a]	2012 (est.)	174 000	7 820	27 000	3 460	2 214	1 963	12 370	**32 690**
GDP growth (annual %)[a]	2012 (est.)	3,00	6,40	3,50	3,90	4,30	-1,50	3,90	**3,36**
GDP per capita (PPP US$)[a]	2012 (est.)	5 400	2 200	2 100	1 900	4 200	1 200	1 100	**2 586**
GDP per capita (current US$)[b]	2011	3 054	1 189	1 119	506	3 798	626	498	**1 541**
GDP per capita growth (annual %)[b]	2011	3,47	1,55	-0,05	-6,87	4,08	3,52	1,47	**1,03**
GDP agriculture % GDP[a]	2012 (est.)	15,1	14,9	15,2	22,3	10,1	55,7	22,0	**22**
GDP industry % GDP[a]	2012 (est.)	31,7	48,0	22,6	18,3	17,7	13,2	45,0	**28**
GDP services % GDP[a]	2012 (est.)	53,2	37,1	62,2	59,5	72,2	31,0	33,0	**50**
Labour force (millions)[a]	2012	11,53	1,318	5,906	0,777	0,196	0,632	4,771	**4**
Agriculture % labour force[a]	2012 (est.)	44,6	50	77,5	75		82	76	**68**
Industry % labour force[a]	2012 (est.)	19,8	10	22,5	19		18	24	**19**
Services % labour force[a]	2012 (est.)	35,5	40		6				**27**
Employment to population ratio, 15+, total (%) [b]	2011	45,2	36,1	69,3	72,5	62,4	68,5	69,7	**60,53**
Human Development Index (HDI) value [b]	2000	1,3	2,8	2,5	2,8	2	2	2	**2,20**
Population, total (July 2013 est.) [a]	2013(est.)	32 649 130	3 437 610	13 300 410	1 883 051	531 046	1 660 870	11 176 026	**64 638 143**
	1980	19 566 920	1 517 817	5 414 070	629 786	300 047	834 611	4 406 831	**32 670 082**
Population ages 0-14 (% of total) [a]	2013 (est.)	27,1	39,8	42,7	39,2	31,2	40	42,2	**37,46**
Population ages 15-24 (% of total) [a]	2013 (est.)	18	20	20,5	21,1	21,8	20,2	19,4	**20,14**
Population ages 25-55 (% of total) [a]	2013 (est.)	41,7	32,2	30,1	32,5	37,3	31,9	30,4	**33,73**
Population ages 56-64 (% of total)[a]	2013 (est.)	7	4,5	3,7	4	4,5	4,7	4,4	**4,69**
Population ages 65 and above (% of total)[a]	2013 (est.)	6,3	3,5	2,9	3,2	5,2	3,2	3,6	**3,99**
Median age total [a]	2013 (est.)	27,7	19,8	18,2	19,9	23,5	19,7	18,6	**21,06**
Median age male[a]	2013 (est.)	27,1	18,8	17,4	19,6	22,7	19,1	18,4	**20,44**
Median age female[a]	2013 (est.)	28,2	20,7	19,1	20,2	24,4	20,2	18,8	**21,66**
Population growth (annual %)[a]	2013 (est.)	1,04	2,29		2,29	1,41	1,95	2,64	**1,94**
Population density (people per sq. km of land)[b]	2011	72,31	3,44	66,31	175,5	124,21	55,02	41,6	**76,91**
Fertility rate, total (births per woman)[b]	2011	2,24	4,46	4,74	4,81	2,34	4,99	5,16	**4,11**
	1980	5,65	6,43	7,43	6,34	6,38	6,32	6,94	**6,50**
Birth rate, crude (per 1 000 people)[b]	2011	19,21	33,32	36,84	37,59	20,31	37,95	38,38	**31,94**
	1980	38,27	43,57	48,23	51,8	41,53	46,22	48,15	**45,39**
Death rate, crude (per 1 000 people)[b]	2011	5,81	9,5	8,76	9,04	5,37	16,41	12,77	**9,66**
	1980	11,82	13,21	17,63	18,15	10,91	24,35	25,3	**17,34**
Life expectancy at birth, total (years)[b]	2011	72,13	58,55	59,27	58,48	73,92	48,11	54,09	**60,65**
Life expectancy at birth, male (years)[b]	2011	69,91	56,86	58,22	57,29	70,29	46,62	52,54	**58,82**
Life expectancy at birth, female (years)[b]	2011	74,47	60,32	60,38	59,74	77,73	49,68	55,72	**62,58**

	Year	Morocco	Mauritania	Senegal	The Gambia	Cape Verde	Guinea-Bissau	Guinea	Average (CCLME)
Infant mortality rate, under-5 (per 1 000 live births)[b]	2011	32,8	112,1	64,8	100,6	21,3	160,6	125,8	**88,29**
Health expenditure, total (% of GDP) [b]	2011	6	5	6	4	5	6	6	**5,54**
Physicians density (per 1 000 population)[a]	2013	0,62	0,13 (2009)	0,06 (2008)	0,04(2008)	0,57	0,05	0,1	0,22
Ratio of girls to boys in primary and secondary education (%)[b]	2011	90,87	101,39	101,5	99,35 (2010)	103,38	65,60 (2000)	79,38	95,30
Literacy age 15 and over read and write) [a]	2009	56,1	58	39,3	50 (2010)	84,3	54,2	41	54,70
Male[a]		68,9	64,9	51,1	60	89,3	68,2	52	**64,91**
Female[a]		43,9	51,2	29,2	40,4	79,4	40,6	30	**44,96**
Education expenditures (% GDP)[b]	2009	5,4	3,9	5,6	3,9	5,6 (2010)	n. d.	3,1	4,58
School life expectancy (years primary to tertiary)[a]	2011	11	8	8 (2010)	8,6 (2008)	13	9,5 (2006)	10	9,73
Internet users (per 100 people)[b]	2011	51	4,5	17,5	10,87	32	2,67	1,3	**17,12**

Source:
[a] CIA, 2013: https://www.cia.gov/library/publications/the-world-factbook/geos/gv.html
[b] World Bank, 2013: http://databank.worldbank.org/data/home.aspx

2.5.2 Regional economic characteristics

The countries of the CCLME are rich in biological resources but they are amongst the poorest in Africa. Morocco has by far the highest GDP among all the CCLME countries, (US$174 billion in 2012) followed by Senegal (US$27 billion US$) and Guinea (US$12,4 billion) (Table 14). The estimated GDP growth rate (2012) is positive in all countries, suggesting a positive shift in the economy of these countries, with the exception of Guinea-Bissau (- 1.5 percent). The GDP growth rate is highest in Mauritania (6.4 percent) and Cape Verde (4.3 percent) and remains above 3 percent in Morocco, Senegal, the Gambia and Guinea.

Despite the apparent positive trend in GDP growth rates, GDP per capita remains low, and the regional average is US$2 586 (2012). Countries where the GDP per capita is below the regional average include Guinea (US$1 100), Guinea-Bissau (US$1 200), the Gambia (US$1 900), Senegal (US$2 100) and Mauritania (US$2 200). Cape Verde has a comparatively small GDP (US$2 214 million in 2012), yet this small island nation has the highest GDP per capita and per capita growth rate (US$4 200 and 4.08 percent in 2011). Corresponding figures for Morocco are US$5 400 and 3.47 percent.

Unemployment is moderate to high in most countries. In Mauritania, less than half the population (over 15 years of age) is employed (36,1 percent), whereas in Morocco the situation is slightly better (45.2 percent). This is one of the main economic challenges that the countries of the CCLME face.

Morocco has built a diverse, open, market-oriented economy by capitalizing on its proximity to Europe and relatively low labour costs (Kamili, 2013). Morocco has also entered into bilateral trade agreements with the United States, and the European Union. Key economic sectors include agriculture, tourism, phosphates, textiles and clothing. Over the last decade there has been steady growth, low inflation, and falling unemployment. Nevertheless, high unemployment, poverty and illiteracy in rural areas are still a challenge. Other economic challenges relate to the areas of education, the legal system and subsidy programmes. Fuel is imported and subsidized and increased prices in recent years have contributed to the country's budget deficit. Industrial development strategies and infrastructure improvements, including a new port and free trade zone near Tangier, have the potential to improve Morocco's competitiveness.

In Mauritania over 50 percent of the population remains dependent on agriculture, livestock and fishing for a livelihood. Recurrent droughts in the 1970s and 1980s meant that the nomads and subsistence farmers were forced into the cities (Dia, 2013). Although coastal waters provide rich fishing grounds, overexploitation threatens this key source of revenue. Droughts and economic issues have contributed to a build-up of foreign debt. However, most foreign debt has been written off and, following the election in July 2009, donors resumed assistance and interest from foreign investors increased. Oil prospects are now a key growth sector.

As with many other countries in the CCLME region, Senegal remains heavily reliant on donor assistance and foreign direct investment. Since 1993, donor-supported economic reforms resulted in a GDP growth rate of

5 percent per year in the period 1995 to 2007, before the global economic downturn (Deme, 2013). The economy started to recover in 2012, but unreliable power supply, public protests and high unemployment and migration to Europe continue to affect the country. Key export industries include phosphate mining, fertilizer production and commercial fishing. New iron ore and oil exploration projects are underway.

In the Gambia approximately 75 percent of the population depends on the agricultural sector for its livelihood and the sector contributes about 22 percent of GDP (Table 14), although less than half the arable land is cultivated. Small-scale manufacturing activity includes the processing of peanuts, fish and hides. Government and private sector investment in high-end tourism and eco-tourism has meant that this sector contributes 20 percent of GDP, although tourism is vulnerable to global trends (Ba, 2013). Unemployment and underemployment rates remain high and international donors and lenders continue to be concerned about the quality of fiscal management and the Gambia's debt burden.

Guinea-Bissau is one of the world's poorest countries. Farming and fishing contribute 55.7 percent of the GDP. Rice is the major crop and staple food and exports include fish and seafood, peanuts, cashews, palm kernels and timber. Civil war has been disruptive since 1998 with partial recovery in 1999 to 2002. The World Bank, the IMF and UNDP provided emergency budgetary support in 2004, and since then the country has been provided with an extended credit arrangement. In 2011, members of the Paris Club opted to write-off much of the country's debts.

Guinea is also a poor country but rich in agricultural, hydropower and mineral resources, including nearly half the world's bauxite reserves and significant iron ore, gold and diamond reserves. Fisheries contribute only about 2.5 percent to the GDP. In September 2011, the government put forward a new mining code that includes provisions to combat corruption, protect the environment and review all existing mining contracts.

In Cape Verde the economy is almost entirely service-oriented with commerce, transport, tourism, and public services accounting for about 75 percent of GDP (Gomes, 2013). As an island nation the country suffers serious water shortages, exacerbated by long-term drought and limited availability of agricultural land. Over 82 percent of food is imported and Cape Verde runs a high trade deficit financed by foreign aid and emigrant remittances. Economic management has produced steadily improving incomes and further reforms aim to develop the private sector, attract foreign investment, diversify the economy and mitigate unemployment.

Diversification of the economies of some countries in the CCLME has led to the establishment of major industries. In comparison with agriculture, the industrial sector only employs 19 percent of the labour force, but contributes an average of 28 percent to the GDP of the countries. Industry is the biggest sector in both Guinea (45 percent) and Mauritania (48 percent), although it only employs 24 percent and 10 percent of the labour force, respectively.

2.5.3 The principle economic sectors in the countries of the CCLME

2.5.3.1 Fisheries

As described in earlier sections, the abundant marine living resources in the CCLME make the contribution of the marine fisheries sector important for employment, food security, nutrition and, in general terms, for the national economies of the CCLME countries. Revenues from fisheries are often used for servicing local and foreign debts. Marine fisheries resources are exploited by artisanal, semi-industrial and industrial operators, both local and foreign.

The countries of the CCLME have developed different strategies to maintain and/or increase the sustainable contribution of fisheries to national economies. Looking towards 2020, these strategies typically include the implementation of management plans, the development of aquaculture and enhancement of fishery products.

Contribution to economic growth

The contribution of the marine fisheries sector to the national economies of countries within the CCLME varies.

In Mauritania, fish landings were 202 000 tonnes in 2009, contributing 4.2 percent to GDP and providing over 45 000 jobs representing 4 percent of the active population (Dia, 2013). The relative contribution of the fisheries sector to the national economy has fallen sharply in recent years owing to the development of the mining sector, and the exploitation of oil, gold and copper in the north the country. However, fishing still generates significant wealth, approximately US$175 million per year. In 2009, it contributed 16 percent of fiscal revenues and 13.3 percent to the country's export revenues. The share of the artisanal sub-sector in 2009 represented about 71 percent of direct value added, which represents 88 percent of GDP generated from the fisheries sector.

In Senegal, the fisheries sector contributes nearly 11 percent of primary GDP and 2.3 percent of total GDP. Earnings from the export of fishery products exceeded US$240 million (average for the period 2008–2012), representing about 8 percent of the total earnings from exports (Deme, 2013). With annual fish landings of over 400 000 tonnes (75 percent caught by artisanal fishers), the Senegalese marine fisheries provide over 81 000 direct employment opportunities, the value of which is estimated at between US$160 and 200 million (Deme, 2013).

In the Gambia, the fisheries sector's contribution to the total GDP averaged 2.2 percent in 2012 (Ba, 2013). The share of fisheries in the GDP of Cape Verde is about 2 percent, but this does not adequately reflect the social and economic importance of fisheries, which contribute to the provision of jobs (about 21 000 people live off fisheries), and to the trade balance (through exports of fishery products). When it comes to Guinea, the contribution of the fisheries sector to national GDP remains low: 1.3 percent in 1997 against 0.5 percent in 1991 (Diallo, 2013).

In general in CCLME countries, the fisheries sector plays an important social role, creating significant direct and indirect employment opportunities. This sector also contributes to national earnings through various bilateral agreements and fishing licence fees. The fisheries agreement between Cape Verde and the European Union (2011–2014), for example, involves a financial contribution of €435 000 (US$576 923) (Gomes, 2013). In Senegal, revenues from fisheries agreements have contributed towards the building of facilities for fishing, the financing of fisheries research, training and monitoring of fisheries, as well as institutional support for the different structures of the ministry responsible for the sector (Deme, 2013). In Guinea, the fishery sector contributes about 2.5 percent to the GDP particularly through fishing agreements with the European Union and China, to a value of nearly 30 billion Guinean francs in 2012 (about US$23.2 million).

Contribution to food security and nutrition

Despite relatively abundant resources and long coastlines, the consumption of fish products is low in some of the CCLME countries.

In Mauritania, the vast majority of fish production is exported. However, fish consumption has grown rapidly in recent years and is now on average 4.3 kg per capita per year at national level. Per capita consumption varies by area as follows: from 17.1 kg at Nouadhibou to 9.2 kg at Nouakchott and only 3.2 kg in inland cities. Recent studies suggest that consumption has risen lately owing to the increased volume of supply to the domestic market (Dia, 2013). In Guinea, the average annual catch is 156 000 tonnes and annual consumption is estimated at 13 kg per capita per year. Consumption reached 20 kg for the maritime region, but is no more than 5 kg in the forests and Upper Guinea (Diallo, 2013). In Morocco, fish consumption is estimated at 13.3 kg per capita for 2012 (Kamili, 2013).

In Senegal, although exports of fishery products are important (86 000 tonnes per year on average), the sector provides 75 percent of the needs of animal protein of the Senegalese people. The Senegalese are among the largest consumers of fishery products in the region with an annual consumption estimated at around 30 kg per capita (Deme, 2013). In Cape Verde, fish consumption is also important (26.5 kg) despite relatively low landings (8 673 tonnes in 2011) (Gomes, 2013). In the Gambia the average per capita fish consumption for the period 1994 to 2003 increased from 25 kg to 28.4 kg per capita per year (Ba, 2013), which is far above the 8.2 kg per person average for Africa.

Contribution to livelihoods

In most CCLME countries, artisanal fishing is the main livelihood of coastal populations. However, there are very few data on the contribution of the fisheries sector to improving the livelihoods of the people and to reducing poverty. Women are heavily involved in the post-harvest sub-sector: processing and marketing of fishery products. In addition, small-scale fishing continues to attract rural people who invest in related activities in the main landing centres such as transportation, handling, petty trade, food and crafts. In Senegal, for example, nearly 6 000 women are active in artisanal fish processing and there are over 40 000 people who derive their income from this activity.

Cultural importance

Religious festivals have a significant influence over the development of the sector. Cultural values influence the willingness of artisanal fishers to transmit their knowledge of fishing to their children. However, there is limited documentation on these cultural matters to be able to properly estimate their importance.

2.5.3.2 Aquaculture

Aquaculture is practised primarily in Morocco and the Gambia, both at sea and in estuaries. Cultivated species are used either for commercial purposes (shellfish, fish, oysters, etc.) or as an alternative to fishing in order to reduce poverty and improve the nutritional status of the population.

2.5.3.3 Agriculture

Agriculture remains the most important sector in terms of employment in the CCLME region, employing 68 percent of the labour force and contributing about 22 percent to national GDPs. The countries produce a range of products for export (Table 15) including grains such as barley, wheat, millet, sorghum and rice, a range of vegetables and nuts, including peanuts and cashews, and livestock. Morocco also produces citrus fruits, grapes, olives and wine, which are exported to Europe. Countries further south in the region produce bananas, pineapples and cassava, and Cape Verde produces coffee.

Table 15: Agriculture and livestock production in the CCLME countries

	Agricultural products
Morocco	Barley, wheat, citrus fruits, grapes, vegetables, olives, livestock, wine
Mauritania	Dates, millet, sorghum, rice, corn, cattle, sheep
Senegal	Peanuts, millet, corn, sorghum, rice, cotton, tomatoes, green vegetables, cattle, poultry, pigs, fish
The Gambia	Rice, millet, sorghum, peanuts, corn, sesame, cassava (manioc), palm kernels, cattle, sheep, goats
Cape Verde	Bananas, corn, beans, sweet potatoes, sugarcane, coffee, peanuts, fish
Guinea	Rice, coffee, pineapples, palm kernels, cassava (manioc), bananas, sweet potatoes, cattle, sheep, goats, timber
Guinea-Bissau	Rice, corn, beans, cassava, cashew nuts, peanuts, palm kernels, cotton, timber, fish

2.5.3.4 Mining

Extractive industries that take place in the CCLME region include mining and oil and gas production. Mining activities occur in Morocco (phosphates), Mauritania (iron ore, gold and copper), Senegal (phosphates, iron ore, zircon and gold), Cape Verde (salt) and Guinea (bauxite, gold, diamonds, iron). Mauritania has extensive deposits of iron ore and these account for nearly 40 percent of total exports. Indeed, economic growth in the country remained at around 5 percent in 2010 to 2012, because of rising prices of gold, copper, iron ore, and oil. Mining and processing of phosphates for fertilizer production occurs in Morocco and Senegal. Guinea has one of the world's largest bauxite deposits, alongside Australia, Brazil and Jamaica. Bauxite ore is mined and then transferred to a refinery for processing and extraction of alumina (aluminium).

Table 16: Industries in the CCLME countries (CIA, 2013)

	Industries
Morocco	Phosphate rock mining and processing, food processing, leather goods, textiles, construction, energy, tourism
Mauritania	Fish processing, oil production, mining (iron ore, gold, and copper). Gypsum deposits have never been exploited
Senegal	Agricultural and fish processing, phosphate mining, fertilizer production, petroleum refining, iron ore, zircon, gold mining, construction materials, ship construction and repair
The Gambia	Processing peanuts, fish, hides, tourism, beverages, agricultural machinery assembly, woodworking, metalworking, clothing
Cape Verde	Food and beverages, fish processing, shoes and garments, salt mining, ship repair
Guinea-Bissau	Agricultural products processing, beer, soft drinks
Guinea	Bauxite, gold, diamonds, iron, alumina refining, light manufacturing and agricultural processing

2.5.3.5 Oil and gas

Oil and gas were first discovered in the marine and coastal areas of Northwest Africa in 2001, by the Australian company Woodside. The first commercially exploitable deposit was found off the coast of Mauritania (Chinguetti oil field) (Figure 21), and was estimated to have a life span of between eight and 15 years once exploitation commenced. Other companies such as Tullow have now made other finds off the coast of Mauritania. The British oil company Premier opened an office in Guinea-Bissau following the discovery of the offshore oilfield Sinape. Oil and gas exploration also continues off the coast of Senegal.

2.5.3.6 Salt production

Salt production in the Northwest African region is ancient. Two methods of salt production are used:

1. salt extracted from mineral deposits (rock salt);
2. by evaporating sea water, lake water and brackish water.

Rock salt comes from fossil marine salt formed several million years ago. It occurs in deposits several metres below the ground. Present operations have very little environmental impact.

Sea salt production is widespread in the CCLME because of particularly favourable conditions. With 6 500 km of coastline, relatively high temperatures and frequent winds, the area offers particularly favourable production potential. The simplicity of the process and the low investment costs are contributing to the spread of sea salt production along the coast and on the banks of rivers and lakes. As a result, one finds farmers and unemployed people producing salt alongside companies that specialize in salt production.

Statistics on salt production in the area CCLME are little known. The largest producers are Morocco and Senegal, which produce about 400 000 tonnes each. Most of the production in Morocco is rock salt (85 percent on average), while Senegal focuses on sea salt.

2.5.3.7 Sand extraction

Since the invention of concrete in the 18th century, sand has been highly sought after as it is the main component of concrete (up to 80 percent). Since desert sands are unsuitable for construction, mining marine sand has become common in the world in general and, in particular, in the CCLME countries (Bayed, 1991). The sand is mainly used for the construction of buildings, as part of the trend towards urbanization of coastal areas in regions with strong economic growth and increasing populations. This is putting increasing pressure on the marine environment because it threatens the coastal strip which provides protection against the encroachment of the sea. Such encroachment endangers large areas of the CCLME region. A good example is provided by the Mauritanian capital Nouakchott, much of which is located below sea level. A thin strip of coastal dunes protects the city from the advancing ocean. This strip has, for three decades been heavily mined for

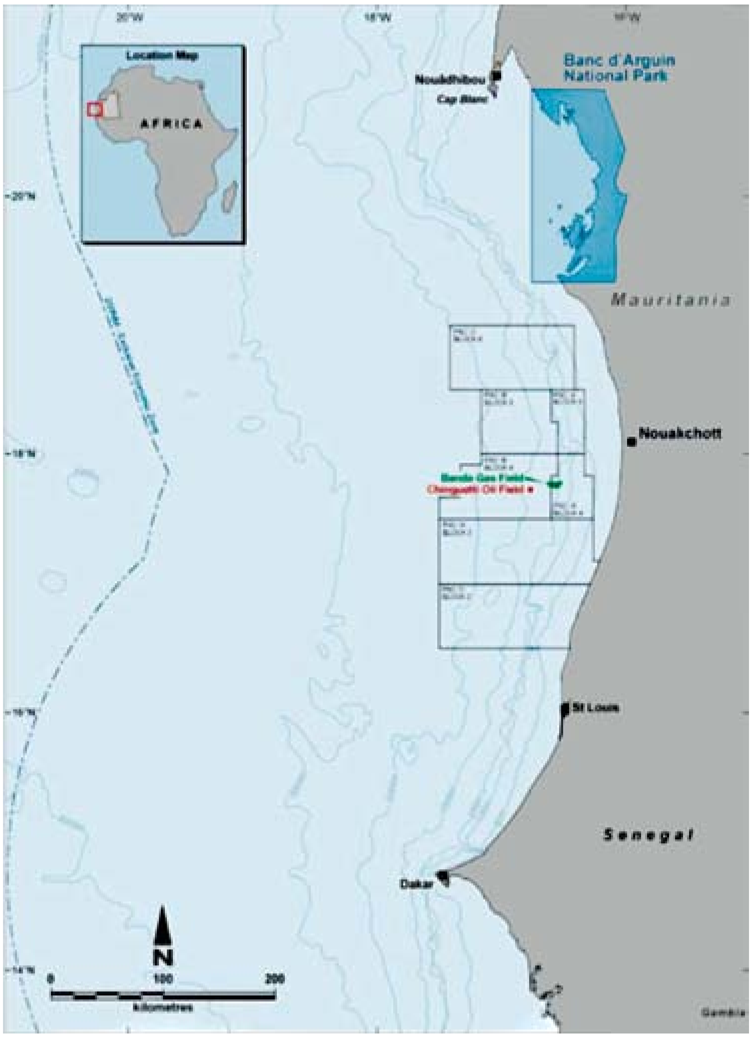

Figure 21: The location of oil exploration blocks and the Chinguetti and Banda oil and gas fields off the coast of Mauritania (Colman *et al.*, 2005)

sand for the purposes of the extension of the city (Coordination Unit of the Urban Development Programme, 2004). The steady degradation of the coastal dunes could pose a threat of severe flooding in parts of the city.

In Cape Verde, large quantities of sand have been extracted by the construction industry for many years, primarily on the islands that have higher degrees of civil construction, including Santiago, Sal, Maio and São Vicente.

2.3.5.8 Tourism

The countries with the largest tourism sectors include Morocco, Senegal, Cape Verde and the Gambia. Tourism in Morocco has grown steadily and this country receives about nine times more visitors than Senegal (Table 17). With 482 000 visitors in 2012, Cape Verde has shown a four-fold increase in visitors since 2000. Tourism activity in Cape Verde (*Îles de Salet de Boa Vista*) represented 7 percent of GDP in 2000 and 24.3 percent of GDP in 2012 (Gomes, 2013). The number of visitors to the Gambia has remained relatively stable at around 100 000 for the past 10 years, although earnings have increased as a result of government and private sector investment in ecotourism and the upscaling of tourism facilities. All other countries typically have less than 100 000 visitors per annum. The main tourist sites in the coastal zone of Guinea are Conakry, Boffa, Boke, Dubreka and Forecariah (Bah, 2008). Guinea-Bissau suffers from a lack of tourism infrastructure. Much of the tourism infrastructure is owned by foreigners, especially in the Bijagos archipelago, so that the tourism benefits for the country remain quite limited. The tourism sector in Guinea-Bissau is currently being reformed.

Political instability, civil unrest and perceived risks to tourists as a result of violence or terrorism, as well as limited capacity and infrastructure constraints, has meant that the tourism sector has not developed in all countries.

Table 17: Arrivals of non-resident tourists/visitors, departures and tourism expenditure in the CCLME countries (World Tourism Data, World Tourism Organization, from http://data.un.org/)

COUNTRY	Series	1995	2000	2005	2010	2011	2012
Morocco[a]							
Arrivals – Thousands	TF	2 602	4 278	5 843	9 288	9 342	..
Tourism expenditure in the country - US$ Mn	IMF	1 469	2 280	5 426	8 176	9 101	..
Travel - US$ Mn	IMF	1 296	2 039	4 610	6 702	7 321	..
Passenger transport - US$ Mn	IMF	173	241	816	1 474	1 780	..
Senegal[b]							
Arrivals – Thousands	TF (THS)	(280)	(389)	769 (387)	900	1 001	..
Tourism expenditure in the country - US$ Mn	IMF	168	152	334	464	..	..
Travel - US$ Mn	IMF	168	144	242	453	..	..
Passenger transport - US$ Mn	IMF	0,2	8	92	11	..	..
Mauritania[c]							
Arrivals – Thousands	TF	..	30	..	..	..	..
Tourism expenditure in the country - US$ Mn	..	..	..	..	..	..	..
Voyages (en millions d'EU)	FMI	11	28	..	..	..	..
Passenger transport - US$ Mn	..	..	..	..	..	..	..
Cape Verde[d]							
Arrivals – Thousands	TF	28	115	198	336	428	482
Tourism expenditure in the country - US$ Mn	IMF	29	64	177	387	438	470
Travel - US$ Mn	IMF	10	41	122	278	368	413
Passenger transport - US$ Mn	IMF	19	23	55	109	70	57
The Gambia[e]							
Arrivals – Thousands	TF	45	79	108	91	106	..
Tourism expenditure in the country - US$ Mn	IMF	..	..	59	38	102	..
Travel - US$ Mn	IMF	28	..	58	32	96	..
Passenger transport - US$ Mn	IMF	..	..	1	6	6	..

COUNTRY	Series	1995	2000	2005	2010	2011	2012
Guinea[f]							
Arrivals – Thousands	TF	..	33	45	..	..	..
Tourism expenditure in the country - US$ Mn	IMF	0,9	7,8	..	2,0	2,1	..
Travel - US$ Mn	IMF	0,9	2,0	..	2,0	2,1	..
Passenger transport - US$ Mn	IMF	0,01	5,8	5,6	0,04	0,02	..
Guinea-Bissau[g]							
Arrivals – Thousands	TF	..	8[h]	5	..	..	..
Tourism expenditure in the country - US$ Mn	IMF	..	..	..	13,6	..	..
Travel - US$ Mn	IMF	..	2,7[h]	1,6	13,3	..	..
Passenger transport - US$ Mn	IMF	..	..	..	0,3	..	..

[a] Including nationals residing abroad.
[b] 2008–2011: estimated data.
[c] (1999) Country data.
[d] (1995–1999) Arrivals by air. (2000–2012) Arrivals of non-resident tourists in hotels and similar establishments.
[e] Charter tourists only.
[f] (1996–2000, 2003, 2005–2007) Arrivals by air at Conakry airport.
[g] Arrivals by air.
[h] 2001.

2.5.3.9 Shipping and maritime transport

Globally, maritime transport is the backbone of international trade, a key engine driving globalization, and equally essential for the economic and social development of CCLME beneficiary countries. Ports can act as a catalyst for economic development and provide many levers for generating added value for enterprises and entrepreneurs. Fisheries activities are dependent on maritime transport systems to provide the infrastructure necessary to ensure longevity. The CCLME is the site of strategic shipping lanes that link Asia and Europe and the Americas, and existing waterways, ports and landside connections that allow the movement of people and freight and facilitate trade. Seagoing vessels off the coast of Northwest Africa consist mainly of bulk carriers and oil tankers. However, the maritime transport network in Northwest African countries would benefit from further investment.

UNCTAD Liner Shipping Connectivity Index (LSCI) reveals that there is a lack of economies of scale and competition in the shipping industry in many African countries, including those of the CCLME. The major nodes in terms of the global shipping networks in Africa, are Egypt, Morocco and South Africa and there are more companies that provide services between South Africa and Singapore, China and Malaysia than within Africa itself. This is partly due to the fact that most ports are unable to accommodate the largest or the latest container ships that offer the most competitive freight rates (UNCTAD, 2012). Exports from the CCLME countries mostly comprise bulk goods, which are transported by tankers and dry bulk carriers. There is thus an import surplus for containerized cargo, because vessels can often only be fully utilized in one direction. Low productivity, high charges and congestion in many African ports are some of the factors that limit the development of this sector. Vessel operators tend to pass these costs on to shippers when calculating their freight rates.

2.5.4 Evaluation of the goods and services of the ecosystem

From the above sections it can be seen that marine ecosystems, such as the CCLME, offer a wide range of goods and services that are used and/or consumed by humans. These services, called "ecosystem Services" (ES), or "ecosystem goods and services" include food provisioning (fish and other marine products) and coastal protection (through mangrove forests and coastal swamps), but also more indirect services, like landscapes that attracts visitors.

An evaluation of the CCLME ES was performed in the context of the CCLME Project, using the methodology prepared for the Guinea Current Large Marine Ecosystem (GCLME)[16]. The evaluation entailed three steps: (i) gathering information, in collaboration with CCLME national experts, on the existence and importance (quantity) of ES in the CCLME countries (e.g. yearly fish landings, costs of coastal protection infrastructure, and the range of mangrove forests); (ii) in the cases where national/regional data were missing, information was gathered from baseline assessments in other parts of the world and applied to the CCLME; and (iii) preparation of an approximation of the value of ES in the CCLME region.

The results of the preliminary analysis revealed economic values of ecosystem services in the CCLME region. Owing to significant gaps in data availability, a number of assumptions had to be made to close or bridge these gaps. Table 18 shows that the total annual value of the ES provided by the CCLME marine and coastal ecosystems is around US$11.7 billion. For example, one hectare of mangroves alone provides ES valued at US$2 235 per year, mostly credited to coastal protection (from storms and erosion), the provision of fish nurseries and climate regulation. Put differently, the destruction of one hectare of mangroves costs the region over US$2 000 per year (and this does not include the damages resulting from the emission of "blue carbon").

Table 18: Preliminary economic valuation of the ecosystem goods and services provided by the CCLME (Interwies and Görlitz, 2013)

Ecosystems	Ecosystem service	Total value (U$/a)	Area of ecosystem in CCLME	Value per hectare (U$/a)
Marine ecosystems	Fisheries (IUU activities and MSY considered)	2 909 300 000	1 123 887 km^2	25,9
	Biodiversity/cultural ES	2 584 940 100	1 123 887 km^2	23
TOTAL marine ecosystems	Fisheries and biodiversity/cultural ES	5 494 240 100	1 123 887 km^2	48,9
Mangroves	Timber forestry products	7 909 200	659 100 ha	12
	Non-timber forestry products	44 489 250	659 100 ha	67,5
	Extreme events and erosion control	883 589 460	659 100 ha	1 340,6
	Waste treatment	20 300 280	659 100 ha	30,8
	Climate regulation**	221 128 050	659 100 ha	335,5
	Fish nursery	280 516 084	659 100 ha	425,6
	Biodiversity/cultural ES	15 159 300	659 100 ha	23
Mangroves	*Overall TEV**	*313 072 500 to 1 103 992 500*	*659 100 ha*	*475 to 1 675*
Seagrass-beds and meadows	Fish nursery	42 783 916	100 525 ha	425,6
	Biodiversity/cultural ES	2 312 075	100 525 ha	23
Beaches/dunes	Biodiversity/cultural ES	no information	no information	23
All marine and coastal ecosystems	Opportunities for tourism and recreation	4 684 000 000	n. a.	1.1 million (per km of coastline)
TOTAL marine and coastal ecosystems	**ALL**	**11 696 427 720**	**n. a.**	**n. a.**

* According to several mangrove evaluation studies (this number is included in the table only for comparison; it is not calculated into the TOTAL VALUE).
** The underlying figure is valid for the present; according to DECC (2009), the value attached to carbon/the damage associated with CO_2 emissions, will increase sharply in the future.

[16] To be found at http://gclme.iwlearn.org

2.5.5 References

Ba, M. 2013. *National presentation on fisheries socio-economic and trade information in Gambia*. Presented during the CCLME socio-economic and trade working group, 16–18 September 2013, Dakar, Senegal.

Bah, M. 2008. *Rapport sur la mise en œuvre du programme sur la biodiversité marine et côtière. Troisième rapport national sur la diversité biologique, CDB. République de Guinée*. 57 p.

Bayed, A. 1991. *Étude écologique des écosystèmes de plages de sable fin de la côte atlantique marocaine. Modèle de zonation, biotypologie, dynamique des populations. Université Mohammed V*, Rabat, Morocco. 229 p.

CIA. 2013. *CIA World Factbook*. Available at: https://www.cia.gov/library/publications/the-world-factbook/. Accessed online 31st July 2013.

Colman, J.G., Gordon, D.M., Lane, A.P., Forde, M.J. & Fitzpatrick, J.F. 2005. Carbonate mounds off Mauritania, Northwest Africa: status of deep water corals and implications for management of fishing and oil exploration activities. *In* A. Freiwald & J.M. Roberts, eds. *Cold-water corals and ecosystems*. Berlin, Heidelberg, Springer, p. 417–441.

Coordination Unit of the Urban Development Programme. 2004. *Étude de l'environnement aux abords de Nouakchott: 1. Étude de l'environnement littoral; 2. Recherche de zones d'extraction de matériaux de construction. Rapport de Saint Martin paysage et IRC-Consultant*, 233 p.

Dia, A. 2013. *Rapport national de la Mauritanie présenté pendant la première réunion du groupe de travail socio-économie et commerce du CCLME, 16–18 septembre 2013*, Dakar, Senegal, 25 p.

Diallo, B. 2013. *Rapport national de la Guinée Conakry présenté pendant la première réunion du groupe de travail socio-économie et commerce du CCLME, 16–18 septembre 2013*, Dakar, Senegal, 16 p.

Deme, M. 2013. *Présentation du Sénégal relative aux informations socioéconomiques de pêcheries, présenté pendant première réunion du groupe de travail socio-économie et commerce du CCLME, 16 au 18 septembre 2013*, Dakar, Senegal.

Department of Energy and Climate Change, UK government. 2009. Carbon valuation in UK policy appraisal: a revised approach. Climate Change Economics, Department of Energy and Climate Change. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/245334/1_20090715105804_e_carbonvaluationinukpolicyappraisal.pdf

Diop, M. 2014. *État des lieux des mesures politiques et juridiques visant à protéger la biodiversité, l'habitat et la qualité de l'eau dans la zone CCLME: Bilan et perspectives. Document de consultation CCLME*.

FAO. 2012. 2010/. *FAO annuaire. Statistiques des pêches et de l'aquaculture. Service des statistiques et de l'information du Département des pêches et de l'aquaculture*. Rome, FAO. 78p.

FAO. 2013. *Annuaire des statistiques des pêches – Tableaux récapitulatifs: valeur totale du commerce international de sept groupes de produits de la pêche, par continents, par pays ou zones. Rome, FAO.* Available at: ftp://ftp.fao.org/FI/STAT/summary/a6ybc.pdf

Gomes, C.E. 2013. *Rapport national du Cap Vert présenté pendant la première réunion du groupe de travail socio-économie et commerce du CCLME, 16–18 septembre 2013*, Dakar, Senegal, 9 p.

Interwies, E. & Görlitz, S. 2013. Economic and social valuation of the CCLME ecosystem services. *Rapport au Groupe de travail socioéconomie et commerce du CCLME*. August 2013. 50 p.

Kamili, A. 2013. *Etat socio-économique du secteur de la pêche maritime au Maroc présenté pendant la première réunion du groupe de travail socio-économie et commerce du CCLME, 16–18 septembre 2013*, Dakar, Senegal, 35 p.

Mannar, V. M.G. & Dunn, J.T. 1995. *Iodation du sel pour l'élimination de la carence en iode. Conseil international pour la lutte contre les troubles de la carence en iode.* ISBN 90-70785-13-7. 144 p.

UNCTAD. 2012. *Review of maritime transport 2012*. UNCTAD/RMT/2012. United Nations publication. E.12.II.D.17.

UNDP. 2013. http://hDrundp.org/fr/content/l%E2%80%99indice-du-d%C3%A9veloppement-humain-idh

UNEP. 2002. Vital water graphics – an overview of the state of the world's fresh and marine waters. Nairobi, Kenya, UNEP. ISBN: 92-807-2236-0.

World Bank. 2013. World Databank. Available at: http://databank.worldbank.org/data/home.aspx

2.6 Governance

According to the definition of the United Nations Development Programme (UNDP), governance is "*The exercise of economic, political, and administrative authority to manage a country's affairs at all levels. It comprises mechanisms, processes, and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences.*" (UNDP, 1997, cited by UN, 2006). In broader terms, according to FAO, governance covers three main aspects: (i) the act of governing; (ii) individuals responsible for governing; and (iii) the system through which a society is governed. In fisheries, governance is defined as the sum of the legal, social, economic and policy arrangements used to manage fisheries at international, national and local levels. It includes legally binding rules, such as national laws and international treaties and customary social arrangements (FAO, 2005).

Governance of the Canary Current LME is very complex particularly because of the differences in colonial history between the countries and the different paths taken since independence. In modern times, the national authority vested primarily in ministries has infringed on traditional practices that developed long before today's national boundaries created separation. Today, the region is divided into seven national jurisdictions, each of which has a relatively short coastline (Figure 22). The presence of shared fisheries resources dissuades national level actions unless neighbouring countries adopt the same rules. Industrial distant water fleets fish across these boundaries for economic viability, yet there are limited resources within the region for enforcement and surveillance. These limitations increase the opportunities for IUU fishing. There are official national structures for fisheries management in some countries but not in others, likewise for coastal management. There are also several fisheries organizations in the region, as well as regional structures for the development and exchange of information (ICCAT, ATLAFCO, CECAF, SRFC and Abidjan Convention).

The need for greater coherence and effectiveness within national governance frameworks and improved cooperation and coordination at the regional level does not only concern fisheries, but also extends to other sectors. The CCLME region is important for maritime transport and both local port authorities and the IMO have influence over its governance. Oil exploration is increasing in the region and large hydrocarbon deposits were recently discovered. This is an area where national authorities issue licenses for exploitation, but any disasters would be regional in scope. Regional governance is still in its infancy although permanent cross-sectoral national bodies have been established in Senegal and Morocco.

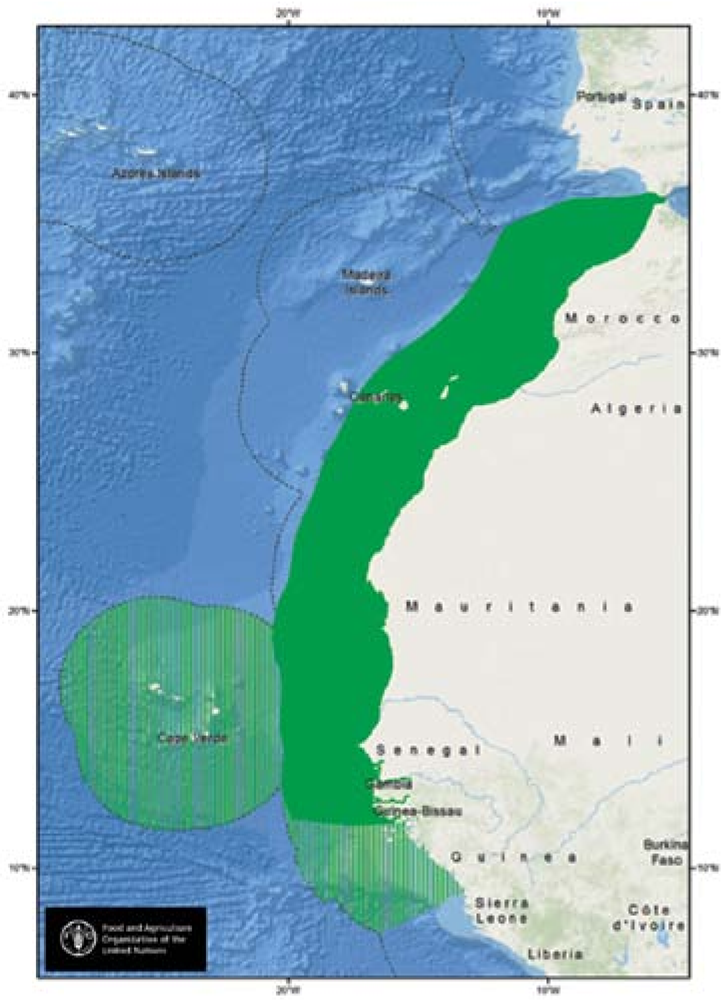

Figure 22: Illustration of the CCLME area according to NOAA (solid green) and the area of influence (green stripes) in relation to the arc of 200 nautical miles (dashed) (source: FAO, 2014 as cited in FAO, 2015). Illustration based on Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, Large Marine Ecosystem Programme NOAA-Fisheries Narragansett Laboratory, VLIZ MarBound database and other contributors.

To overcome these challenges, one of the key objectives of the CCLME Project is to strengthen governance within the CCLME through the establishment of a sustainable legal and institutional framework and the adoption of plans for regional cooperation to deal with the identified multisectoral and transboundary problems. This framework should take into account the mandates of existing organizations and cooperation mechanisms in the area to avoid duplication. It must also take into account international instruments regulating fisheries and environmental issues in order to identify possible modalities of cooperation in the CCLME, both between countries and between existing subregional bodies.

The CCLME Project has its own organization at the regional and national level. Project management is provided by the Regional Coordination Unit (RCU) and the National Coordination Units (Focal Point and Technical Coordinator). The Project Steering Committee is composed of National Focal Points and a representative of FAO, UNEP, the SRFC and the Secretariat of the Abidjan Convention. Countries are in the process of establishing their National Interministerial Committee by decree for the implementation of the project in each country.

2.6.1 International framework on fisheries and environment

Countries in the CCLME region have ratified the main international treaties on environmental protection: the Ramsar Convention on Wetlands of 1971, the Convention on International Trade in Endangered Species of Endangered Wild Fauna and Flora (CITES) of 1973 and the Convention on Biological Diversity (CBD) in 1992. In terms of fisheries, all the countries are members of the United Nations Convention on the Law of the Sea (UNCLOS) of 1982 and all CCLME countries except Guinea-Bissau are members of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) signed in 1973 and revised in 1978. The bodies of these international treaties provide an excellent framework for dialogue, each in its field, to manage the CCLME.

On the other hand, no CCLME country has ratified the FAO Agreement of 2009 on Port State Measures to Prevent, Deter and Eliminate IUU Fishing, which is not yet in force. The FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement) of 1993 was ratified by Cape Verde, Morocco and Senegal, while the UN Agreement for the application of the provisions of UNCLOS of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks of 1995 was ratified by Guinea, Morocco and Senegal.

In terms of pollution, only two of the seven countries have ratified the London Convention of the IMO of 1972 on the Prevention of Marine Pollution by Dumping of Waste (Cape Verde and Morocco). None has ratified the HNS Convention of the IMO of 1996 on the Carriage of Hazardous and Noxious Substances by Sea. Only Guinea and Senegal have ratified the Algiers Convention of 1968 (African Convention on the Conservation of Nature and Natural Resources), currently in force. None of the seven countries has ratified the Maputo Convention of 2003 (revised African Convention on the Conservation of Nature and Natural Resources), which is not yet in force.

2.6.2 National institutional framework

In the seven CCLME countries, fishing and the environment are managed by different institutions.

In Cape Verde, the mandated authorities include: the State Secretariat of Marine Resources (*Secretaría de Estado dos Recursos Marinhos*) and the Ministry of Environment, Housing and Territorial Development (*Ministério do Ambiente, Habitação e Ordenamento do Território*); in the Gambia, there is the Ministry of Fisheries and Water Resources and the National Environment Agency; in Guinea, the Ministry of Fisheries and Aquaculture (*ministère de la Pêche et de l'aquaculture*) and the Ministry of the Environment (*ministère de l'Environnement*); in Guinea-Bissau, the Ministry of Fisheries (*Ministério das Pescas*) and the Ministry of Natural Resources (*Ministério dos Recursos Naturais*); in Morocco, the Ministry of Agriculture and Maritime Fisheries (*ministère de l'Agriculture et de la pêche maritime*) and the Ministry delegate to the Minister of Energy, Mines and Environment (*Ministre de l'Energie, des Mines, de l'Eau et de l'Environnement chargé de l'environnement*); in Mauritania, the Ministry of Fisheries and Maritime Economy (*ministère des Pêches et de l'économie maritime*) and the Secretariat on the State of the Environment (*secrétariat d'Etat de l'Environnement*); in Senegal, the Ministry of Fisheries and Maritime Affairs (*ministère de la Pêche et des affaires maritimes*) and the Ministry of Environment and Nature Protection (*ministère de l'Environnement et de la protection de la nature*).

The participation of stakeholders in fisheries management is achieved through a number of advisory bodies in each country: the Fishery Advisory Committees in the Gambia, the Joint Committee for the Promotion of Sustainable Fishing in Guinea, the Chambers of Marine Fisheries and their federation in Morocco, the Advisory Board of Fisheries in Mauritania and the National Advisory Council of Marine Fisheries in Senegal. However, despite the growing institutionalization of participatory processes in the last decade there is a certain lack of maturity of participatory advisory bodies (Catanzano *et al*., 2009).

When it comes to the CCLME Project, the National Interministerial Committees (NICs) of the participating countries are established under the supervision of the fisheries administration, with participation of the environmental and finance administrations. Private sector participation is only provided by the NIC in the Gambia, Morocco and Senegal. In Cape Verde and Mauritania, NICs have not yet been formalized but draft decrees are in the process of adoption. With the exception of Morocco, where the Supreme Council for the Preservation and Exploitation of Fish Stocks, created in 2000 (hereinafter referred to as "Supreme Council for Fisheries") acts as NIC, the NICs in the CCLME countries all have similar mandates related to institutional coordination for the implementation of the CCLME Project and are established for a specific period, linked to the life-span of the project. However, in the case of the Gambia, there is no explicit mention of the duration of the NIC. Given its mandate as an overall advisory body for fisheries resources, the Moroccan Supreme Council for Fisheries is not established for a fixed term. It is further noted that the Senegalese NIC reports to the Interministerial Council on the Sea, a consultative body for maritime affairs.

2.6.2.1 National policies

National fisheries

In the CCLME, national policies and strategies have been adopted to promote the development and management of fisheries.

By way of example, Morocco has put in place a fisheries policy for the period 2010 to 2020 (BEAC, 2009), with fisheries management plans for small pelagics, hake, shrimp and large crustaceans, as part of the strategy to develop and improve the competitiveness of the fisheries sector, called "*Plan Stratégique Halieutis*" (2009). In Mauritania, the development of the sector is based on the Strategy for the Sustainable Development of the Fisheries Sector and Maritime Economy (2006 to 2008) and the Strategy for the Sustainable Management of the Fisheries and Aquaculture Sectors (2008 to 2012). In addition, a draft plan for the development of artisanal and coastal fisheries in Mauritania was elaborated in 2008. In Senegal, the Strategy for the Sustainable Development of Fisheries and Aquaculture was adopted in 2006 (BEAC, 2009) and the sectoral policy for fisheries and aquaculture in 2007. In 2013, Senegal adopted a management plan for a deep fishery for shrimps. The Gambia has had a fisheries policy since 2007. In Cape Verde, the sectoral fisheries policy is based on the Strategy for Growth and Poverty Reduction (2006–2011), but there is also a management plan for fisheries resources from 2003. In Guinea, the policy for fisheries and aquaculture development from 2009 stipulates that the fishery is governed by an annual management plan. Guinea-Bissau has a strategic plan for the sustainable development of artisanal fisheries from 2008 and a Fisheries Management Plan from 1997.

When it comes to national legislation, fishing activities in Senegal are governed by the Maritime Fishing Code of 1998. In Guinea, the legal framework for fisheries and aquaculture, which consists primarily of the Maritime Fishing Code from 1995 and the framework law on inland fisheries from 1996, is currently being revised. In Cape Verde, the main text on fisheries is the Decree on Fisheries from 2005. In the Gambia, the law on fisheries dates from 2007 and a joint management plan for the sole fishery was adopted in 2012. In Guinea-Bissau, the new General Law on Fisheries was adopted in 2011. In Morocco, the regulations on marine fisheries from 1973 are complemented by the Act on Illegal, Unreported and Unregulated Fishing from 2014. In Mauritania, the Fishing Code from 2000 was amended by an Ordinance in 2007.

In all countries, the laws are implemented by a number of statutory instruments. All countries in the CCLME region adopt fisheries management plans. The plans contain provisions regarding bycatch and discards, the minimum size of catches, protection of endangered species and highlight the prohibition of the introduction of species (Mika, 2014). The Fisheries Management Plan of Guinea has been updated every year since its development in 1995 and is the subject of a specific decree, which is published on 31 December each year. This includes conservation measures such as zoning with respect to the type of fishery or vessel and the prohibition of certain fishing methods.

Regarding the special provisions governing fishing activities, it should be noted that in Guinea, Morocco, Mauritania and Senegal trawling is prohibited within 20 nautical miles of the coast (measured from the low tide mark). In the Gambia and Guinea-Bissau, trawling is prohibited less than 12 nautical miles from the coast and in Cape Verde, less than 3 nautical miles offshore, where only artisanal fishing can be practised. Morocco prohibits the use of drag nets within 3 miles of the low tide mark, towed by one or more vessels (pair trawlers "*gangui*"), including fixed nets and floating nets that can be hung on the sea bed. For offshore vessels, trawling is prohibited in areas between 10 and 12 miles. The prohibitions are extended to other locations, such as dams and weirs. All countries prohibit techniques and practices that degrade the habitat and are applying zoning for certain fishing activities. Some countries, such as Cape Verde, the Gambia, Morocco, Mauritania and Senegal, have created closed areas for the biological recovery of certain species. Guinea-Bissau, Morocco and Mauritania practise temporary closure of certain fishing areas.

National environment policies

Regulatory legislation on the preservation and conservation of biodiversity and habitats, has been addressed in all countries by the establishment of environmental management policies.

In Cape Verde the National Policy Document for the Environment was adopted in 1993 and implemented in 1997 by legislative decree. The country has also had a legislative decree on protected areas since 2003. The Gambia has a National Water Policy of 2006 and an Environmental Action Plan for the periods 1999 to 2001 and 2009 to 2018. At the normative level, environmental issues are governed by the National Management Act of 1994 and by the Law on Wild Fauna and Flora and Biodiversity from 2003. Guinea-Bissau adopted a National Environmental Management Plan in 2004 and a Basic Law on the Environment in 2011. Mauritania adopted a Master Plan for Coastal Development in 2005. At the normative level, the main legislation includes the Framework Law on the Environment from 2000, complemented by the 2007 Ordinance on the Coast, and the Law regarding the Banc d'Arguin National Park, adopted in 2000. In Guinea, environmental issues are regulated by the 1987 Environmental Code and in Senegal by the Environmental Code from 2001. In Morocco, the main legislation is the 2003 Law on the Protection and Improvement of the Environment, but other laws are also important, such as Article 7 of the law of the National Charter for the Environment and Sustainable Development of 2014, the law concerning environmental impact studies (2003) and the law on waste management and disposal (2006). In 2010, Morocco also put in place a law on protected areas.

All countries have a national plan of adaptation to climate change, which stipulates the need to take climate change into consideration in the management of fisheries resources. Before implementing any project affecting natural resources, the laws of all countries concerned require that EIAs are conducted.

With the exception of Guinea-Bissau and the Gambia, all countries have laws to regulate the discharge of chemicals, pesticides, oil, sewage and ballast water.

Protected areas

All countries have adopted a policy for the creation of MPAs to better preserve vulnerable habitats. In general, countries are convinced of the need to establish marine and terrestrial ecologically and biologically significant areas. The CBD contributes significantly to the creation of such zones.

There are over 580 terrestrial and MPAs within the CCLME countries. With the exception of the Gambia, all countries in the CCLME have established MPAs and have succeeded in obtaining international recognition for one or more of these areas (Annex 1). There are 15 MPAs with international status, including two UNESCO World Heritage Sites (Banc D'Arguin National Park in Mauritania and Djoudj National Bird Sanctuary in Senegal), two UNESCO Man and Biosphere Reserves (Saloum Delta in Senegal and Bijagos Archipelago in Guinea-Bissau), and 13 RAMSAR wetlands of international importance (noting that some areas may be classified under several international status categories).

Senegal has designated the largest number of protected areas (19 covering an area of 2 062 km²). Guinea-Bissau has designated fewer MPAs (15), but has the largest area (20 874 km²), mainly owing to the large area covered by the Bijagos Archipelago Biosphere Reserve. Morocco recently created three MPAs for fishing purposes – one in the Mediterranean and two in the Atlantic (Complex Sidi Moussa, 10 000 ha; Dakhla Bay, 40 000 ha; and the wetland in Oued El Maleh, 1 200 ha).

2.6.3 Regional cooperation

Currently, there are no fisheries or environmental policies covering the whole of the CCLME Project area. However, as mentioned above, there is collaboration through many intergovernmental fisheries and environment agreements, as well as through bilateral agreements (BEAC, 2009). At the regional level, all countries apart from Morocco and Cape Verde are members of the Abidjan Convention from 1981[17]. in relation to the management, protection and improvement of the coastal and marine environment in western, central and southern Africa. The regulations of ICCAT are also applicable to the highly migratory species that pass the CCLME region. In this regard, it should be noted that the Gambia and Guinea-Bissau are not members of ICCAT. Morocco is also a member of the Commission on Fisheries Management in the Mediterranean.

[17] The Abidjan Convention was signed on 23 March 1981 and entered into force on 5 May 1984. The Abidjan Convention is a legal framework agreement with a regional scope which enables actions at national level and cooperation at the regional level for the protection and development of marine and coastal areas of the Africa western and central region (including South Africa).

The other mechanisms for cooperation in the areas of fisheries and the environment in the subregion are the Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (ATLAFCO); the Fishery Committee for the Eastern Central Atlantic (CECAF); the Sub-regional Fisheries Commission (SRFC); the Organization for the Development of the Senegal River (OMVS); the Organization for the Development of the Gambia River (OMVG); the Agency for Management and Cooperation between Senegal and Guinea-Bissau (AGC); and the Interim Commission of the GCLME. The presence of two regional economic communities (RECs) should also be noted, namely the Economic Community of West African States (ECOWAS) and the West African Economic and Monetary Union (WAEMU), as well as two Pan-African organizations, namely the African Development Bank (AfDB) and the African Union (AU).

All seven CCLME countries are members of CECAF and AfDB. Six out of seven CCLME countries are members of SRFC (not Morocco). Senegal is the only country participating in all listed subregional intergovernmental bodies (AGC, ADB, ECOWAS, ICCAT, ATLAFCO, CECAF, SRFC, OMVG, OMVS, AU and WAEMU). Guinea is also a member of all subregional organizations mentioned above, except WAEMU and AGC, which is a bilateral agreement between Senegal and Guinea-Bissau (only Guinea-Bissau and Senegal are members of WAEMU and AGC). Out of the seven countries, the Gambia and Mauritania are not members of ATLAFCO, Morocco and Mauritania are not members of ECOWAS and Morocco is not a member of the AU. Guinea and Guinea-Bissau are also part of the GCLME.

Table 19 below illustrates the membership of CCLME countries to these various intergovernmental organizations. Cooperation protocols exist between these organizations but these need further strengthening to ensure consistency and efficiency, particularly with regard to initiatives related to fisheries management and environmental protection. These organizations can also cooperate in the framework of the Regional Programme for West African Fisheries (PRAO) and the West African Regional Marine and Coastal Conservation programme (PRCM).

Table 19: CCLME country membership of the regional organizations related to fisheries and the environment (S= signatory, A = Associated, E = European Union)

	Cape Verde	Spain	The Gambia	Guinea	Guinea-Bissau	Morocco	Mauritania	Senegal
Guinea Current LME (GCLME and interim Guinea Current Commission)				●	●			
International Commission for the Conservation of Atlantic Tunas (ICCAT)	●	E		●		●	●	●
Sub-regional Fisheries Commission for West Africa (SRFC)	●		●	●	●	A	●	●
Ministerial Conference on Fisheries Cooperation among African States bordering the Atlantic Ocean (ATLAFCO)	●		S	●	●	●	S	●
Fishery Committee for the Eastern Central Atlantic (CECAF)	●	●	●	●	●	●	●	●
Organization for the Development of the Senegal River (OMVS)				●			●	●
Organization for the Development of the Gambia River (OMVG)			●	●	●			●
Management and Cooperation Agency between Senegal and Guinea-Bissau (AGC)					●			●
Abidjan Convention	S		●	●	●		●	●
African Union (AU)	●		●	●	●		●	●
Economic Community of West African States (ECOWAS)	●		●	●	●			●
West African Economic and Monetary Union (WAEMU)					●			●
African Development Bank (AfDB)	●	●	●	●	●	●	●	●

In the context of the SRFC, three major fisheries-related agreements have been ratified, namely the SRFC Convention on Cooperation in the Exercise of the Rights of Maritime Pursuit (1993), the SRFC Protocol for the Coordination of Surveillance Operations (1993) and the Convention on the Determination of the Minimum Conditions for Access and Exploitation of Marine Resources within the Maritime Areas under the jurisdiction of the SRFC (revised in 2012). The latter agreement provides important provisions for the implementation of national policies and plans for fisheries management, as well as the adoption of concerted management plans for the exploitation of shared stocks. In particular, for better conservation of the resource, the new Article 9 requires member states to consider the following measures:

- regulation of fishing areas and seasons, and if necessary the introduction of periods for biological recovery and/or MPAs;
- protection of endangered species and juveniles;
- limiting bycatch and minimizing discards;
- compliance with provisions relating to fishing gear, minimum sizes and weights used in the SRFC area;
- regulation of fishing effort;
- any other management measures or relevant information.

A Memorandum of Understanding was signed in 2012 between FAO and the SRFC in favour of cooperation in the CCLME region.

2.6.4 Governance of transboundary problems

The main transboundary problems identified in the Preliminary TDA adopted by CCLME countries in September 2006 were: **1)** decline of fisheries and ecosystem change; **2)** habitat degradation; and **3)** declining water quality. Ten general causes have been identified, four of which relate to governance, namely: (a) weak management systems and a lack of regulation and control; (b) lack of training and knowledge and limited participation of actors; (c) lack of data, monitoring and modeling of complex ecosystems; and (d) the lack of coordination between sectors.

In addition, for each of the three types of cross-border issues identified above, specific governance factors were specified (Table 20).

Table 20: Governance factors identified in the workshop on the Preliminary TDA and confirmed in the full project phase. (Adapted from Table 3, CCLME Project Document, Annex 6)

	Living marine resources	Habitat degradation	Water quality
Governance factors	(i) Insufficient access regulations regarding artisanal fishing (ii) Weak management systems (iii) Lack of regional management (iv) Under-estimation of technical advice (v) Badly negotiated access agreements (vi) Lack of coordination between the different sectors (vii) Inadequate application of regulations (viii) Low participation of actors	(i) Unregulated tourism activities (ii) Lack of political management of wetlands (iii) Lack of conservation policy (iv) Absence or weakness in monitoring, control and surveillance (MCS) (v) Inadequate regulation (vi) Inequitable fishing agreements	(i) Management of river basins not incorporating coastal issues (Ii) Lack of Integrated Coastal Zone Management (ICZM), land use planning and economic development planning (Iii) Non-compliance with international and regional conventions and protocols (iv) Lack of national regulations on pollution and environmental impact assessment (EIA)

In terms of solutions, five focus areas were identified: (a) assessment and monitoring of resources and ecosystems, and information management; (b) management and sustainable use of ecosystems; (c) implementation of agreements and regional and international action plans; (d) training of staff at institutions; and (e) awareness raising and stakeholder participation.

A PRAO study on governance in the fisheries sector in the SRFC (Catanzano *et al*., 2009) analysed the main weaknesses in four of the CCLME countries (the Gambia, Guinea, Mauritania and Senegal)[18]. The conclusions of this study are applicable to all the CCLME countries and, for good governance of the area, consider that the large fish production is one of the main assets of this Large Marine Ecosystem of global importance (FAO, 2009). The study states that good governance is based on seven principles: openness and transparency, participation, accountability, effectiveness, coherence, adaptability and responsiveness, and subsidiarity and proportionality. On this basis, the following conclusions are drawn:

1. **Openness and transparency:** transparency of decision-making is not always guaranteed because information about the fisheries sector is fragmented and not extensively shared, neither within institutions nor between different institutions.
2. **Participation:** the quality of stakeholder participation should be improved through better representation of stakeholders (e.g. fishers') organizations, improved knowledge of the issues and holding open fora for public dialogue.
3. **Responsibility:** the duties and responsibilities of concerned institutions are often not clearly defined and the mechanisms of intra- and inter-agency coordination, and human, material and financial resources are often insufficient for the work loads.
4. **Consistency:** an effort should be made to ensure consistency between sectoral objectives and macroeconomic policy, between the goals and the potential of the sector, and between fisheries objectives and the management objectives that are being implemented.
5. **Efficiency:** improved fish resource management measures should include enhancing the capacity of the countries to assess this effectiveness, through the definition of detailed objectives and a monitoring system with indicators to see if the progress leads to the desired goal.
6. **Adaptability and responsiveness:** the ability to respond to emergencies or unexpected situations should be improved by strengthening information systems and providing rapid response procedures in legislation and in fisheries management plans to anticipate these situations.
7. **Proportionality and subsidiarity:** before launching a regional initiative, it is important to verify that it's appropriate: (a) is a government intervention really necessary? (b) would regional level governance be more appropriate? (c) are the measures chosen appropriate to the objectives?

Strengthening fisheries and environmental governance in the CCLME countries would improve the management of the marine ecosystem, as well as the fishery resources, marine and coastal habitats and the water quality in the area. Large inequalities in fisheries governance and management exist between the CCLME countries. Therefore, strengthening of national institutions and human and material resources is essential in order to enable optimal and efficient regional cooperation between the countries. A better governance framework for the CCLME area could also provide countries with greater strength in the negotiation of the fisheries agreements that permit access to the waters of the subregion.

2.6.5 References

BEAC. 2009. *Étude des aspects juridiques et institutionnels de la gestion concertée des stocks partagés des petits pélagiques en Afrique Nord Ouest. Projet BBI 13286* – CSRP/Wageningen International.

Catanzano, J.; Greboval, D.; Sambe, B.; Tandstad, M. & Bodiguel, C. 2009. *Bonne gouvernance et gestion durable des pêches au sein de la Commission sous-régionale des pêches. Document FAO de consultation pour la Banque Mondiale (FAO/COPACE).*

Diop, H. 2012. *La contribution socio-économique et la bonne gouvernance dans les pêcheries des pays de la zone du projet Grand Ecosystème Marin du Courant des Canaries*. Dakar, Senegal, CSRP.

[18] Guinea-Bissau and Cape Verde will be treated as part of a special analysis in the final report (Catanzano *et al*., 2009). Morocco may be considered to have similar levels of governance, or superior levels to those of Mauritania (Diop, 2012).

FAO. 2005. Fisheries and aquaculture topics. What is governance? *In* S.M. Garcia. 2005. Topics fact sheets. FAO Fisheries and Aquaculture Department [online]. Rome, FAO. Available at: http://www.fao.org/fishery/topic/12271/en

FAO. 2009. Protection of the Canary Current Large Marine Ecosystem. FAO/GEF Project Document. Project GCP/INT/023/GFF.

FAO. 2015. *Document d'orientation sur la gouvernance du Grand écosystème marin du courant des Canaries (draft) par Ariella D'Andrea*. Rome, FAO. *29 avril 2015*.

Mika, D. 2014. *Etat des lieux des mesures politiques et juridiques visant à protéger la biodiversité, l'habitat, et la qualité de l'eau dans la zone CCLME. Document de consultation du projet CCLME*.

UN. 2006. Committee of experts on public administration – fifth session, New York, 27–31 March 2006. Agenda item 5. Compendium of basic terminology in governance and public administration, definition of basic concepts and terminologies in governance and public administration – note by the Secretariat. United Nations Economic and Social Council, New York, 5 January 2006 (E/C.16/2006/4).

UNDP. 1997. *Governance for sustainable human development*. UNDP policy document. New York, UNDP.

CANARY CURRENT LARGE MARINE ECOSYSTEM

CCLME

Section 3:
Major perceived transboundary problems in the CCLME

The CCLME is a shared, transboundary water body. Each country bordering the CCLME has its own set of experiences and perceptions of the problems affecting the marine ecosystem, but through a concerted regional process, it has been possible for the CCLME countries to identify *common concerns* which are *transboundary in nature* and which require cooperative action to address them effectively. These are termed the "*transboundary concerns*".

According to the results of the Preliminary Transboundary Diagnostic Analysis workshop (18 to 20th July 2006), which were adopted unanimously by country representatives at the final subregional consultation on 5 September 2006, the principal shared transboundary concerns of the CCLME countries are:

- **Declining marine living resources**
- **Degradation of habitats**
- **Declining water quality**

These broad concerns were divided into a total of 15 specific "transboundary issues": six relating to declining fisheries, three to degraded habitats and six to declining water quality. Following the commencement of the CCLME Project in 2010, these priority transboundary issues were refined through various consultation meetings (Annex 3) and two TDA working group meetings. The final set of priority transboundary issues is presented in Table 21.

Table 21: Priority transboundary issues for the CCLME identified by the Preliminary TDA and refined through subsequent consultations

Declining marine living resources	Habitat degradation	Declining water quality
• Decline and/or vulnerability of small pelagic resources; • Decline of demersal resources (finfish, cephalopods & crustaceans); • Threats to vulnerable species (sharks and rays, marine mammals, marine turtles); • Vulnerability of tuna resources.	• Destruction and disappearance of mangroves; • Degradation and modification of benthic habitats; • Degradation and modification of wetlands (Ramsar: coastal zones, coral reefs, estuaries).	• Modified transport of sands and sediments; • Exotic invasive species; • Salinity changes upstream of river mouths; • Increased levels of metals in fishery products notably cadmium; • Pollution (various types).

These problems are recurrent in CCLME countries and are sometimes of a transboundary nature. Although the acuity and extent of the problems may differ between the countries, solutions must be designed accordingly. A key aim of this section of the TDA is to summarize each issue, and analyse and identify their causes (direct causes, underlying causes or factors and root causes), their impacts on the marine and coastal ecosystem, their socio-economic consequences, the possible actions required to address them and their relative importance. It is important to appreciate that the precise classification of causes, as "direct", "underlying" or "root causes" is an approximate art. The primary purpose of the causal chain analysis is to help identify effective *solutions* to the causes that have been identified and whether the solutions are a sensible means of addressing those causes.

In 2006, there were insufficient data available to assess the relative importance of the issues. A further aim of the present document, supported by the first ever comprehensive economic evaluation of the goods and services of the CCLME, is to assess the *relative importance* of the issues in the CCLME, from environmental and socio-economic perspectives.

3.1 Living marine resources

The decline of living marine resources (which includes fish and fisheries resources as well as marine species of conservation concern) was identified unanimously by all countries as the most important concern affecting the CCLME. The importance of the other key concerns – habitat degradation and declining water quality – are primarily drivers of the first concern. This is unsurprising if one considers the regional importance of fisheries for the economies and as a source of food for western Africa and beyond. The countries have divided marine living resources into fisheries resources (small pelagic fisheries, demersal fisheries, sharks and rays and oceanic tuna) and species of conservation concern (marine turtles and cetaceans).

3.1.1 Decline and/or vulnerability of small pelagic resources

Small pelagic fishes constitute by far the largest single fishery in terms of capture tonnage and biomass within the CCLME and stocks are shared as a result of their migration within the region. The importance of this marine resource may be less obvious to coastal residents than it is to the international industrial fishing fleets that exploit these offshore stocks under licence to the CCLME states through the European Union, bilateral agreements or IUU fishing, and the international organizations and development partners concerned with their sustainable management (e.g. regional fisheries committees [CECAF], commissions [SRFC], FAO and the European Union).

Until recently, the state of small pelagic stocks gave no cause for concern. Driven by the primary production in the ocean's surface waters, these stocks were considered to be relatively resilient to fishing pressure as compared with other inshore fisheries which depend on fragile seabed or estuarine habitats to feed and reproduce. While a number of pelagic stocks were being fished close to the limit of their MSY or beyond, some species were considered to be underexploited. However, the latest evaluations show signs of decline in the central stock of sardines and in the stock of sardinella (especially the round sardinella). Recognizing that these resources are vulnerable to increasing industrial fishing effort, IUU fishing and the combined effects of climate change on their distribution or reproductive success, the transboundary concern is described as "decline and/or vulnerability of small pelagic resources".

Owing to the ecological, economic and social importance of these small pelagic stocks, it is imperative that strong measures are taken within the region to address this transboundary concern. Although several pelagic stocks are regularly evaluated, scientific gaps still remain. There is growing interest in fisheries for anchovy and bonga shad in certain areas, yet there are real gaps in the scientific information necessary for sustainable management of these resources. Given the anticipated impacts of climate change there is also a general need to improve understanding of the environmental factors currently influencing fluctuations in abundance, recruitment, geographic distribution, migration patterns and stock identity.

A particular feature of pelagic fisheries is that they are dominated by a small number of "wasp waist" species responsible for the majority of energy transfer between trophic levels of the ecosystem. Significant declines of these resources can result in a temporary breakdown of energy transfer up the food chain, resulting in a proliferation of species at lower trophic levels (such as jellyfish) and the collapse of higher trophic level species (such as tuna or sharks) that are dependent on the "wasp waist" species as prey. Thus, maintenance of healthy stocks of the wasp waist species can be critical for maintaining overall ecosystem integrity and their ecological and economic importance may greatly exceed the economic value of the stocks themselves.

The *direct causes* of declines of pelagic fish stocks identified by the CCLME countries include overcapacity within both the industrial and artisanal fisheries. This is exacerbated by IUU fishing, excessive fishing in breeding areas and bycatch of fisheries targeting other species. In addition, climatic fluctuations can have a direct impact on pelagic stocks, either through range displacement or massive mortality owing to interruptions in surface water primary productivity, such as when winds driving the deepwater upwellings drop abnormally.

The types of *underlying causes* of declines in pelagic fish stocks are heterogeneous and include indirect physical causes, capacity-related causes, economic drivers, governance factors and climate variation. Indirect physical causes include the transfer of fishing capacity to foreign fleets and insufficient control and surveillance. Causes related to capacity include insufficient scientific knowledge of the resources, such as species life cycles. Economic drivers include the emergence of new markets (e.g. for fish meal) and poorly negotiated fisheries agreements. Governance related issues include the lack of national management and co-management and subregional collaboration on management, or the inappropriate management of the larger river basins, which may affect fish reproduction. Offshore oil and gas exploitation may also have an effect on pelagic stocks. Finally, climate change factors affecting pelagic resources include short- or medium-term variations in the intensity of upwelling systems and long-term effects of climate change, including rising sea water temperatures.

The *root causes* or drivers of decline and vulnerability of small pelagic resources include the overexploitation of demersal resources (causing fishers to turn to the still abundant small pelagic stocks) and the development of new market demands (especially for the industrial production of fish meal using small pelagic fishes).

The main *environmental impacts* of the decline of small pelagic stocks include changes in the structure and function of the ecosystem (especially where "wasp-waist" species are affected) resulting in regime shifts. The *socio-economic consequences* of the decline of small pelagic resources include the loss of market options and opportunities, the wasteful use of resources and food insecurity.

The *main solutions* identified for resolving the small pelagics decline issue include:

- Improved monitoring and information management
  - Assessment and monitoring of resources
  - Improved monitoring for the identification of spawning grounds
  - Strengthened regional surveys and extended coverage
  - Improved collection of biological and ecological data
  - Continued monitoring and evaluation of stocks with reinforced regional surveys
  - Development of a regional strategy for data management and access
  - Development of better modelling of the upwelling and river discharges (presumed source of variability)
  - Improvement in the understanding of fish-climate interactions, through joint campaigns and information sharing, using teledetection and modelling.
- Improved management
  - Improved mechanisms for MCS
  - Specific effort regulations in spawning grounds
  - Harmonized national management
  - Harmonized subregional policies
  - Establishment of a regional co-management mechanism.

The focus of the proposed solutions is primarily on information gathering and management, protection and surveillance measures and the design of regional co-management mechanisms, to promote sustainable management. Priority for the suggested solutions is in most cases high, with highest priority being accorded to resource monitoring, identification of spawning areas, putting in place concerted management systems, improved data collection, improved MCS, joint research surveys and harmonization of regional policies.

3.1.2 Decline of demersal resources (finfish, cephalopods, crustaceans)

In terms of their importance to regional food supplies and accessibility by artisanal fisheries, the demersal fishery resources of the CCLME are of exceptional socio-economic importance, but are in an extremely degraded state. The majority of demersal stocks studied, targeted both by artisanal and industrial fishing are overexploited (13 stocks). Reductions in fishing effort have been recommended in order to restore the CCLME's declining demersal fisheries (FAO, 2012).

The transboundary concerns with regard to demersal fish stocks, as expressed by fisheries managers, scientists and other concerned individuals and institutions are: depletion of coastal demersal fish stocks, unsustainable fishing practices, IUU fishing, degradation and alteration of habitats including the seabed, spawning and nursery grounds, disruption of food webs and threats to biodiversity.

There are various transboundary issues of concern with respect to shrimp and lobster resources. Bycatch and discard rates are high in the shrimp fisheries and reported to be as high as 70 to 80 percent in some cases. The bycatch is often composed of small fishes that are discarded at sea, hence introducing an element of fishing mortality which is not accounted for. Lobster resources both in Cape Verde and Mauritania show signs of overexploitation. The impacts of climate change on coastal habitats and estuaries, which are important shrimp spawning and nursery habitats, will also impact upon shrimp resources. Underpinning these concerns is the lack of adequate information on key resources, including basic data such as catch and effort and bycatch statistics. Mechanisms that allow monitoring and verification of data between different sources are not always available.

The transboundary concerns related to cephalopod populations within the CCLME relate mainly to the variability in stocks and the lack of knowledge. The variability of the cephalopod populations, notably the octopus resource, creates difficulties for fisheries management. The exact cause of these changes in abundance are not always clear, but are normally attributed to changes in exploitation patterns, species compositions and environmental influences. The influence of the environment on larval survival and recruitment is particularly important.

While the numbers of studies have increased in recent years (mostly concentrated on octopus), there is still a need to improve knowledge about the basic biology and ecology of these species to better inform sustainable management. The study of cephalopod populations also currently lacks the means to define all populations adequately and to resolve basic systematic confusions. Quantitative data on the resources required for assessments are also not always available. There is, for example, little information on the bycatch of cephalopods by fleets that do not target them. In a situation where studies are still underway to improve the basic availability of information, the use of the "precautionary principle" in management is especially important. Adaptive management allows for adjusting management measures rapidly if new information arises supporting the rationale for such changes.

The *direct causes* of the collapse of demersal fishery resources are overfishing, the use of non-selective gears, destructive fishing practices, bycatch of juveniles, degradation and habitat change, changing environmental factors, IUU fishing and poor management of river basins and rivers.

As is the case with pelagic resources, the *underlying causes* of demersal stock collapse have been split into indirect physical causes, causes linked to capacity, economic factors and institutional and governance factors, with the latter being the most frequently cited. The main indirect physical cause identified is fisheries overcapacity – too many vessels and gears are chasing limited resources; this includes IUU fishing. Capacity factors include poor access to information about resources and their habitats, inadequate data on stocks and their dynamics in estuaries and inadequate capacity to predict the influence of environmental factors. The main economic factor identified is the constant migration of fishers to areas where the stocks are still abundant. Institutional and governance factors include inadequate control of effort (access to resources), insufficient collaborative management, absence of a harmonized strategy related to markets, poor governance, insufficient scientific information, weak application of scientific advice, weak participation of stakeholders, weak MCS and non-compliance with regulations, poorly negotiated fisheries agreements and poor coastal management.

The *root cause* of demersal resource decline is identified simply as the intense demand for the resources. *Ecosystem impacts* of the decline include negative impacts on productivity, changes in ecosystem structure and function, species substitution and loss of biodiversity. *Socio-economic consequences* include loss of options and economic opportunities, non-optimal use of resources and food insecurity.

The main *solutions* to address the problem of declining demersal resources include:

- Improved monitoring and information management
  - Coordinated regional surveys of stocks
  - Studies on identities of shared stocks
  - Regional assessment of shared stocks
  - Improved biological and ecological data collection systems.
- Improved management
  - Promotion of more selective fishing gear
  - Development of management plans for demersal fisheries
  - Reinforcing capacity for negotiation of fisheries licence agreements
  - Improved stakeholder participation
  - Piloting fisheries management through MPAs
  - Use of market forces to promote more efficient resource use
  - Harmonized re-purchase schemes
  - Harmonized subregional policies
  - Strengthen forums between scientists and fisheries managers
  - Develop alternative livelihoods
  - Public awareness raising.

The large number of solutions and the preponderance of short-term (i.e. urgent) solutions related to fisheries management reflect the crisis in demersal fisheries. The highest priority is accorded to introducing selective gears, establishing management plans (including addressing IUU fishing), better negotiation of fishery agreements, piloting the use of MPAs in fisheries management, evaluation of regional stocks and developing alternative livelihoods.

3.1.3 Threats to vulnerable species (elasmobranchs, marine turtles, marine mammals)

Certain species targeted by fisheries are vulnerable to extinction. These species are usually large, high value and easily targeted with low reproductive rates. In the CCLME, as in many seas of the world, the vulnerable species include elasmobranchs (sharks and rays), marine turtles and marine mammals (whales, dolphins, seals and manatees). These species merit special attention because the introduction of conventional resource management systems will not be enough to save them from the threat of extinction, and protective management is therefore necessary. Nonetheless, the vulnerable species are heterogeneous and the issues and management solutions are different in each case.

One of the major contributory transboundary issues is the high discard rate in the tuna and tuna-like fisheries. The tuna longliners have an average discard rate of 28 percent, which is amongst the highest, while tuna purse seiners have a rate of 5 percent (FAO, 2006a). The species most commonly discarded by longliners is the blue shark. Other sharks and marine mammals are also caught accidentally and discarded. Marine turtles and seabirds also constitute the bycatch of longliners operating on the high seas. In the case of tuna purse seiners, the discarded species include bonito, dolphins and sharks. Hence, marine mammals, sea turtles and seabirds, which have low abundance and are often protected, are threatened with extinction because they are regularly caught as bycatch in the tuna fishery.

3.1.3.1 Elasmobranches

The elasmobranchs (sharks and rays) are large cartilaginous fishes with low rates of reproduction (many give birth to live young). Elasmobranchs are targeted both for their fins (used for soup in Asia) and meat (driven by local demand for protein). They are large and easy to catch. Local stocks are rapidly depleted, after which fishers migrate to new grounds to exploit new stocks. To date, fisheries management authorities have not kept pace with the expansion of these fisheries or their transboundary nature.

The situation regarding shark exploitation in the subregion appears to be of concern to all member states. This is not surprising given the complexity of shark exploitation in the subregion and the different nationalities of the fishers (mainly Senegalese and Ghanaian), the processors for salted meat (Senegalese and Ghanain) and the processors for smoked shark (Guinean and Burkinabe). The fin trade is dominated by the Guineans, while salted fish is under the control of the Ghanaians. This explains why this issue deserves to be examined from a LME perspective.

The high price of fins poses a real threat of overexploitation of these scarce species, for which there are no appropriate protection measures in many countries. The high earnings derived from elasmobranch fishing enable operators to protect themselves. Therefore, urgent action is required to improve knowledge of the stocks available to ensure better management. It is now well recognized that each country working individually cannot alone ensure the sustainable management of these shared resources. The LME framework is the most appropriate mechanism for cooperation and coordination to improve knowledge of sharks and rays and to ensure their sustainable use.

This particular transboundary issue is defined by CCLME countries as "threats to, and vulnerability of, elasmobranch resources". The *direct causes* of their decline include overfishing (essentially fishing to local extinction), which affects mainly coastal species, and substantial bycatch of elasmobranchs in industrial fisheries (affecting offshore species). *Underlying causes* include the rapid growth of specialized elasmobranch fisheries, wasteful exploitation methods (fishers often cut off the fins and throw the shark back into the water in a practice called "finning") and the slow reproductive rates of elasmobranch species. The main *root cause* identified is market demand (particularly from Asia), but the powerful status of fishery owners and political lobbying are also blocking the required policy responses.

The complexity of the governance and institutional factors involved in these fisheries has resulted in a primarily open access, unregulated situation with uncontrolled growth. These factors create real difficulties for effective monitoring control and enforcement. No one entity is sufficient to establish effective management. Efforts by ICCAT (with large pelagic fisheries) can be undermined by coastal state fisheries and vice versa. One coastal country alone cannot ensure effective management. LME management is necessary, but needs to be supported by management in adjacent LMEs and on the high seas. As management is implemented the improvement of scientific knowledge will be required for adaptive management to enable sustainability.

The decline of elasmobranch species not only affects the species themselves, but is a loss of valuable biodiversity that also impacts marine ecosystems As these important species (mostly predators) are removed, there are changes in the trophic structure of the ecosystem. The main socio-economic consequence is a loss of options and opportunities for future generations as species become locally extinct.

Solutions for the decline in elasmobranch resources have been identified as:

- Improved monitoring and information management
  - Ensure monitoring and evaluation actions
  - Improved knowledge of the fisheries and main resources.
- Improved management
  - Reinforce existing conservation measures and implement new measures, including addressing IUU fishing
  - Promote alternative livelihood activities
  - Ban finning and require fisheries to land the entire shark
  - Support development of a sensitization programme for all fishery stakeholders
  - Develop and implement a LME management policy.

The above solutions are rated as "medium" or "high" priority, with the highest priorities being accorded to conservation action, data collection and raising awareness.

3.1.3.2 Cetaceans

Cetaceans (whales and dolphins) are also subject to declines. While the industrial-scale hunting of whales in the region ceased in 1971, coastal dolphins and small whales are still subject to artisanal hunting and all cetaceans are indirectly threatened by interaction with fisheries, by the loss of prey species (due to commercial fisheries) and by the disorientating effects of marine noise from shipping and bathymetric and seismic surveys carried out by the oil and gas industry. The problem is defined by the CCLME countries simply as the "vulnerability of cetacean resources".

The *direct causes* of vulnerability include fisheries interactions, sonar from bathymetric surveys, seismic campaigns by the oil and gas industry, various unexplained illnesses and collisions with vessels. The main *underlying cause* identified is the lack of data on their status and biology. No root cause has been identified. Impacts on the ecosystem include the loss of biodiversity and destabilization of the ecosystem. No socio-economic consequences were identified.

Solutions identified were:

- Improved monitoring and information management
  - Monitoring of cetacean-fishery interactions
  - Improved knowledge about cetaceans and their place in the ecosystem.

Priority for these solutions is rated as "medium", reflecting the relative lack of socio-economic impact and the lack of information indicating any severe ecosystem impact.

3.1.3.3 Marine turtles

Marine turtles (five species frequent the coastal seas of the CCLME) are subject to population declines. Turtles are threatened by direct hunting, bycatch, nest raiding and loss of beach habitat suitable for nesting. The problem is defined by CCLME countries simply as "threats to marine turtles".

The *direct causes* include hunting, bycatch (in both industrial and artisanal fisheries), pollution (particularly from plastic bags, which can be ingested, and abandoned fishing gear, which can entangle the animals), the extraction of beach sand and beach construction (which degrade nesting habitat), nest raiding and the destruction of nests, climate change and changes in marine currents.

The *underlying causes* include increased beach construction, tourism development, lack of scientific information, beliefs and traditions, poverty, the lack of alternatives and a lack of enforcement of regulations.

The *root causes* are identified as coastal development (owing to population growth), construction related to tourism and coastal erosion. Impacts on the ecosystem include loss of biodiversity and destabilizing effects owing to their decline. Socio-economic consequences include cultural impoverishment and loss of tourism revenues.

Solutions identified are:

- Development of ecotourism projects to promote turtle conservation
- Information and awareness raising
- Integrated coastal management
- Promoting selective fishing methods (working with fishers)

- Capacity reinforcement in application of conventions and regional agreements
- Promoting local management
- Developing alternatives to sand extraction
- Improve knowledge of turtle migration routes.

3.1.4 Vulnerability of tuna resources

The term "tunas" includes small and large tunas, "false tunas" (false tuna is a term originating in Ivory Coast to refer to small sized tunas sold on local markets) and the bill fishes (marlin, sailfish, swordfish). They are offshore pelagic fishes of high commercial value exploited by a specialized multinational industry. Awareness of the state of tuna resources is quite limited at the level of CCLME coastal states, which in the Preliminary TDA defined the problem as "uncertainty about the status of tuna resources", reflecting a sense of non-participation in their exploitation or management. In the present TDA, the problem is defined as the "vulnerability of tuna resources".

The *direct causes* of vulnerability of tunas are the increasing levels of deep-sea fishing and the high levels of IUU fishing or piracy which impact stocks.

The *underlying causes* have been split into indirect physical causes and causes linked to capacity and economic factors. The indirect physical causes include the return of vessels to West African waters from other fishing grounds in the Indian Ocean, climate change (including impacts on the oxygenated layer) and reduced availability of prey (owing to small pelagic fishing). Capacity factors include a lack of data (particularly on "false tunas") and insufficient participation of CCLME states in ICCAT. The main economic factor identified is increased international market pressure.

The main *root causes* identified are piracy in Somalia (driving tuna vessels back to West Africa) and increased international trade pressure. Ecosystem impacts of tuna vulnerability include destabilizing effects owing to the removal of large tuna biomass, bycatch of elasmobranchs, sea turtles and cetaceans associated with the tuna industry and loss of biodiversity. Socio-economic consequences include limited access to markets by CCLME states and conflicts between offshore and coastal and artisanal fishing fleets.

The main *solutions* to address the problems include:

- Improved participation of CCLME states in ICCAT
- Harmonized strategy for access to markets.

Priority for these solutions is rated as "high", reflecting the high economic importance of tuna fisheries.

3.2 Biodiversity and habitats

The modification of natural habitat was identified as the second major transboundary impact for CCLME countries, whose main elements are: (1) disappearance and destruction of mangroves; (2) degradation and modification of seabed habitats and seamounts; and (3) degradation and modification of wetlands (Ramsar: coastal zones, coral reefs, estuaries). This characterization of habitat issues has not changed since the Preliminary TDA, indicating that the identification of issues is robust and enjoys general consensus.

3.2.1 Disappearance and destruction of mangroves

Mangroves are key ecosystems in many respects. At the interface between land and sea, mangroves provide many valuable ecosystem goods and services, including functioning as nurseries for fish species, sources of food, wood and other useful products. They also provide coastal protection.

The *direct causes* of mangrove disappearance and destruction are non-sustainable logging, increased salinity (usually owing to artificial changes in the hydrological regime as caused by major dams) and heavy sedimentation due to deposits of sand and pollution. The *underlying* causes include indirect physical causes (construction of dams, climate change impacts and upstream deforestation), capacity-related causes (mariculture and inadequate shellfish harvesting methods), economic factors (absence of alternative energy sources and demographic pressure) and institutional and governance factors (insufficient application of conservation policies and poor energy policy). The single *root cause* identified for mangrove loss is poverty.

The *ecosystem impacts* of mangrove loss are coastal erosion, sedimentation, loss of fish breeding areas, loss of biodiversity, disturbance to the food web, modification of the hydrological regime and changes to local microclimate. *Socio-economic consequences* include the loss of revenue sources (food, tourism), loss of amenity value, increased poverty, difficulties in navigation and food insecurity.

The *solutions* to address the problem identified include:

- Short-term solutions:
  - Mangrove restoration and reforestation
  - Awareness raising for communities and decision-makers
  - Sustainable revenue generation from mangroves
  - Reinforce capacity of managing institutions
  - Implement the action plans of the mangrove charter
  - Promote the establishment of oyster production.
- Long-term solutions:
  - Promotion of alternative wood sources
  - Transboundary protected areas.

The priority assigned to the above actions was high to low, with the highest priority being assigned to restoration, sustainable revenue generation, implementing the mangrove action charter and promoting alternative sources of energy.

3.2.2 Degradation and modification of seabed habitats and seamounts

Seabed habitats are critical to the reproduction of many species, including those important for fisheries. The degradation of seabed habitats by destructive fishing methods has long been recognized as one of the causes of declining fisheries. The CCLME TDA identifies this and other sources of impact and includes consideration of the habitat of seamounts, increasingly the object of destructive industrial trawling. The CCLME countries identified the issue as "degradation and modification of seabed habitats and seamounts".

The *direct causes* of degradation and modification of seabed habitats and seamounts include destructive fishing methods, inadequate coastal management (causing sedimentation), pollution, oil and gas exploration and exploitation and coastal erosion. Indirect physical causes include deforestation inland, climate change and excessive resource exploitation. Causes related to capacity include poor or absent urban waste collection; economic causes identified include the increase in industrial fishing effort, including IUU fishing. Governance and institutional factors include inadequate policies on climate change and MCS and inadequate regulatory frameworks. The single root cause identified is the intensification of industrial fishing.

Impacts on ecosystems include the regression of seagrass beds, the loss of breeding areas, loss of biodiversity and disturbance to the food web. Socio-economic consequences include reduction of fishery resources, loss of revenues from fisheries, food insecurity, human migration and increased poverty.

Solutions to address the problems include:

- Short-term solutions:
  - Reduction of fisheries effort and implementation of national plans against IUU fishing
  - Reinforcement of regional and national MCS
  - Putting integrated management tools in place
  - Implementation of threatened species conservation action plans
  - Promotion of less destructive fishing gears
  - Promotion of national plans against marine pollution.

- Long-term solutions:
  - Reinforcement and harmonization of legislation
  - Establishment of a regional protocol on biodiversity conservation
  - Promote climate adaptation measures
  - Planning and implementation of waste water treatment systems for major urban centres.

The above solutions were prioritized as high to low, with the highest priorities being assigned to reducing fishing effort, promoting plans to reduce IUU fishing, promoting less destructive fishing methods and promoting national plans to reduce marine pollution.

3.2.3 Degradation and modification of wetlands

In addition to mangroves, the degradation of wetlands in the wider sense of the Ramsar convention (including shallow coastal waters, coral reefs and estuaries) was identified by the CCLME countries as a transboundary concern. Of particular importance in this category are the major estuaries of the CCLME, which serve as breeding and feeding areas for many commercial fish species.

Direct causes of degradation of wetland systems include destructive fishing methods, illegal fishing, inadequate coastal management, pollution, climate change, extraction of sand, coral, salt and clay, sedimentation, aquaculture and agricultural activities. Indirect physical causes include erosion, coastal works and overexploitation of resources. Causes related to capacity include insufficient training and poor or absent urban waste collection, while economic causes include demographic pressure, uncontrolled tourism, urban development and poverty. The main governance and institutional factors included were the lack of national policy and legislation on wetlands. The *single root* cause identified was human development of the coastal zone.

Impacts on wetland ecosystems include: declining function of ecosystems, degradation of the aquatic *milieu*, loss of biodiversity, disturbance of the food web, modification of biotopes and appearance of invasive species. Socio-economic consequences include diminution of fishery resources, loss of revenue sources, food insecurity, human migration and the loss of landscape, cultural and amenity values.

The *solutions* identified to the above problems are:

- Short-term solutions:
  - Reduction in fishing effort
  - Promotion of national plans to combat IUU fishing
  - Reinforcement of national and regional MCS
  - Implementation of tools of ICZM
  - Supporting a regional protected areas network (RAMPAO)
  - Establishing threatened species conservation plans (potentially undertaken as part of fisheries resources management)
  - Promotion of less destructive fishing methods
  - Promotion of national marine pollution plans.
- Long-term solutions:
  - Promotion of measures to mitigate or adapt to climate change impacts
  - Reinforce harmonization of legislation
  - Establish a regional protocol for the conservation of biodiversity
  - Establish the **ecosystem approach to management**.

The above solutions are prioritized as high to low, with the highest priority being accorded to reducing fishing effort, promoting national plans to combat IUU, reinforcing national and regional MCS, supporting MPAs, promoting less destructive fishing methods and climate change adaptation and mitigation measures.

3.3 Water quality

Declining water quality was identified as the third major transboundary concern for CCLME countries, whose main elements are: 1) modified transport of sands and sediments; 2) invasive alien species; 3) salinity changes upstream of river mouths; 4) increased levels of heavy metals in fishery products; and 5) pollution (various types).

3.3.1 Modified transport of sands and sediments

The region is characterized by desertification, overgrazing of fragile ecosystems, cultivation of crops on steep slopes (Cape Verde), and soil erosion. These anthropogenic activities lead to run-off and increases in turbidity in the major rivers and lakes in the region. Data on suspended solids for the Gambia and Senegal rivers illustrate that the Senegal River has a fairly high concentration of suspended solids (196 mg/l) compared to other major African rivers (Martins and Probst, 1991).

The *direct causes* of modified transport of sands and sediments include coastal protection works, dam construction, blockage of sediment supply from run-off, construction of irrigation dykes, illegal beach sand mining and dredging activities. The *underlying causes* include indirect physical causes (drought), capacity-related causes (unplanned coastal urban development) and institutional and governance factors (poor regional consultation and planning). The *root causes* identified are high energy demand and tourism development.

The ecosystem impacts of modified transport of sands and sediment are destruction of critical habitats, high mortality of mangroves, accelerated coastal erosion, decreased fish spawning grounds and loss of species. Socio-economic consequences include loss of employment, displacement of coastal inhabitants, loss of revenue and loss of aesthetic value.

The *solutions* to address the problems identified include:

- Requirement for a study of abiotic factors
- Requirement for an inventory of major natural waterways blocked by infrastructure developments
- Use of GIS for monitoring purposes
- Institutionalize mandatory EIAs for all dam projects
- Work to improve integrated watershed management
- Enforce an effective set-back zone for development in the coastal zone.

The above solutions are prioritized as high to low, with the highest priority being accorded to conducting an inventory of blocked waterways, a study of abiotic factors and the use of GIS for monitoring.

3.3.2 Alien invasive species

Alien invasive species are those species that were introduced either accidentally or intentionally and which then colonize or invade their new environment, threatening biological diversity, ecosystems and habitats, and human well-being. Africa is home to hundreds of alien invasive species – both plants and animals, which threaten a number of important ecosystems In many countries. Freshwater ecosystems are particularly at risk.

Various alien and invasive species have been reported from the countries of the CCLME (Chenje and Mohamed-Katerere, 2006). The water hyacinth (*Eichhornia crassipes*) from South America, for example, originally imported into Africa as an ornamental plant, has exploded into large infestations causing serious disruption of waterways across West Africa. The water fern (*Salvinia molesta*) has invaded the Senegal River and its tributaries, and the National Park Bird Sanctuary. In Mauritania and Senegal, one of the main invasive species causing problems is the reed (*Typha australis*). Thousands of hectares of the lower valley of the Senegal river, including fishing grounds have been invaded by a large continuous mat of the reed which can extend over several tens or hundreds of kilometres. In other countries such as the Gambia the two most invasive alien species are neem (*Azadirachta indica*) and lantana (*Lantana camara*). The neem tree spreads rapidly and threatens several habitat types, ranging from coastal woodlands to scrub riparian forests and freshwater river passages in the Gambia.

Marine alien invasive species are a growing problem in coastal waters, estuaries and lagoons. Many of these introductions are related to shipping and aquaculture. For example, *Hypnea musciformis* is a red alga, originally from Italy, which is now found throughout the world including the coastal waters of Morocco, Guinea-Bissau, the Gambia, north Senegal, the Cape Verde Islands and Mauritania (Chenje and Mohamed-Katerere, 2006). Very little is, however, known about the invasive marine exotic species in the CCLME region or their impact on marine habitats and the other species present there.

Direct causes of the introduction of alien invasive species include discharge of ballast water, escape of aquaculture species into open water systems and large-scale changes in oceanographic systems. The *underlying causes* include capacity-related causes (lack of available treatment of ballast water, lack of awareness and lack of enforcement) and institutional and governance factors (lack of enforcement of international conventions). The *root causes* identified are climate change, poorly controlled aquaculture, an increase in shipping traffic and dam construction.

The ecosystem impacts of alien invasive species are alteration of species composition in the ecosystem, disappearance of economically important species, loss of habitats and invasion of water bodies. Socio-economic consequences include economic losses and costs of removal of obstructive species.

The *solutions* to address the problems identified include:

- Strict enforcement of existing national regulations
- Development of national protocols for aquaculture ventures
- Ratification and region-wide enforcement of international conventions
- Development of a regionally harmonized approach to policies on aquaculture development
- Improvement of predictive capacities for impact evaluation.

Priority for these solutions is rated as "medium", reflecting the lack of knowledge about the environmental impact of exotic invasive species.

3.3.3 Salinity changes upstream of river mouths

Many river systems in the CCLME, particularly those in the north of the region flow through semi-arid and desert environments, where evaporation rates are high. Modification of these river systems through human activities such as damming, water extraction and agricultural development, has resulted in chronic salinization, which threatens coastal habitats such as mangroves.

Direct causes of salinity changes upstream of river mouths were identified as morphological modification of estuaries and deltas, dams causing water retention upstream and reduced water flow downstream of the dam, dominance of marine dynamics and coastal structures. The *underlying causes* include indirect physical causes (droughts and water extraction), capacity-related causes (no regulation of small hydro-agricultural dam projects), economic causes (negative downstream impacts not fully taken into consideration) and institutional and governance factors (failure of EIAs to take the marine environment into account). No root causes were identified.

The ecosystem impacts of salinity changes upstream of river mouths are morphological modifications of estuaries and deltas, a change in the composition and abundance of species, loss or degradation of critical habitats, degradation of soils and wetlands, substitution of freshwater vegetation with salt-tolerant vegetation and changes in terrestrial and submarine landscapes. Socio-economic consequences include a decline in agricultural activities, changes in the activities of coastal communities, reduced livelihoods of communities living in estuarine and coastal zones and social and institutional conflict over the operation of dams.

The *solutions* to address the problems identified include:

- Short-term solutions:
  - Desalination with renewable energy
  - Improved operation of large dams
  - Impact assessments of existing dams, water extraction and coastal works
  - Regulation of water extraction
  - Regulation of small dam projects.
- Long-term solutions:
  - Development of national policies for wetland management
  - Integrated river basin management
  - Installation of monitoring stations on the coast
  - Long-term monitoring of the impacts of dams and coastal works.

The above solutions are prioritized as high to low, with the highest priority being accorded to the long-term solutions.

3.3.4 Increased levels of microcontaminants in fishery products

Metals occur naturally in low concentrations in aquatic environments, but recently the occurrence of metal contaminants, especially heavy metals, has become a problem of increasing concern. This situation has arisen as a result of the rapid growth of population, increased urbanization, expansion of industrial activities, exploration and exploitation of natural resources, extension of irrigation and other modern agricultural practices as well as a lack of environmental regulations (Calamari and Naeve, 1994).

Cadmium is found in plastics and paints as well as electronic equipment and batteries. It enters the marine environment from both natural sources such as weathering of rocks and anthropogenic sources such as industrial and domestic waste and agricultural run-off. Cadmium is a persistent pollutant and accumulates in the tissues of aquatic organisms such as shellfish, crustaceans and fish and in the liver and kidneys of mammals (UNEP, 2010). Humans are then exposed to the heavy metals through the consumption of contaminated fishery products.

Direct causes of environmental enrichment with heavy metals were identified as mining, treatment and recovery of phosphates and upwelling of cold nutrient-rich waters. The *underlying causes* are variability of the upwelling system and scientific uncertainty about the issue. The single *root cause* identified was market demand.

No ecosystem impacts were identified. Socio-economic consequences include loss of revenue from fishing, loss of jobs and human health risks.

The *solutions* to address the problems identified include:

- Understand and model the transport of cadmium from the main source areas
- Evaluate the transfer of cadmium and risks to ecosystems and fisheries
- Estimate the effect of cadmium on fisheries and the fishing industry
- Categorize the potential vulnerabilities caused by cadmium enrichment.

The above solutions are prioritized as high and medium, with the highest priority being accorded to the actions to better understand the transfer of cadmium and its effect on fisheries.

3.3.5 Pollution

Pollution along and in Atlantic waters is a transboundary problem and affects all the countries in the CCLME region. Various types of pollution have been identified including solid wastes, hydrocarbons and land-based pollution (domestic and industrial wastewater and agricultural run-off). Household and industrial solid wastes are discharged directly into rivers and the ocean which in turn results in the deterioration of water quality. Owing to the lack of household waste collection, most domestic wastes remain in the streets, open canals or illicit dumpsites throughout the cities. The problem also affects the coastal beaches, giving rise to public concern about recreational use. Eutrophication has been identified as a problem, particularly in the southern part of the CCLME. Eutrophication occurs as a result of artificially enhanced primary productivity caused by increased nutrient supply. Chemical pollution was also ranked as a major problem in the Canary Current region. There is no regular monitoring of chemical pollutants, but the intensive use of pesticides and fertilizers in the agricultural and irrigated areas (Morocco and Senegal River valley, for example), is a well-known fact (UNEP, 2005).

Direct causes of pollution were identified as discharge of solid waste (marine litter), discharge of ballast water offshore and oil spills from platforms, pipelines and ships (hydrocarbons), domestic and industrial wastewater, agricultural run-off and excessive nutrient input (land-based pollution), agricultural activities and industrial waste from fertilizer factories (toxicity from pesticides). Localized impacts are obvious from land-based sources of pollution, but transboundary implications are not well documented.The exception is hydrocarbon pollution from ship and offshore drilling accidents. Offshore currents may cause catastrophic transboundary events.

The *underlying causes* of hydrocarbon pollution include indirect physical causes (equipment failure and human error and lack of ballast water and other wastewater treatment facilities), capacity-related causes (lack of public awareness of reporting procedures) and institutional and governance factors (non-compliance with maritime conventions and protocols and lack of appropriate contingency plans). A number of different underlying causes of land-based pollution were identified: (1) nutrient-rich agricultural run-off through river discharges (indirect physical cause), excessive use of fertilizers (capacity-related cause) and optimization of agricultural output (economic factor); (2) urban sewage run-off (indirect physical cause), inadequate wastewater treatment and sewerage infrastructure (capacity-related cause) and prioritization of urban planning issues under limiting conditions (economic factor); (3) airborne dust of terrestrial origin (indirect physical cause) and lack of information and knowledge about the phenomenon (capacity-related cause); and (4) aquaculture operations (indirect physical cause), insufficient planning and impact analysis, a lack of understanding and experience (capacity-related causes), the need to diversify the economy and reduce pressure on wild capture fisheries (economic factors) and a lack of a regulatory framework, lack of understanding of potential issues and a reluctance to regulate, monitor and control responsible expansion of the sector (institutional and governance factors). The underlying causes of toxicity from pesticides were identified as externalization of costs for better competitiveness (economic factors) and a lack of EIAs (institutional and governance factors). The single *root cause* of pollution was identified as externalization of costs.

The ecosystem impacts of hydrocarbon pollution include degradation of marine and coastal habitats, mortality of coastal flora and fauna and aesthetic environmental impacts. Socio-economic consequences include loss of recreational value, loss of tourism and fisheries income, loss of employment and clean up and rehabilitation costs. The ecosystem impacts of land-based pollution include excessive primary production, toxic algal blooms, eutrophication of coastal waters, high biological oxygen demand and anoxic waters, loss of coastal habitats and reduced secondary production. Socio-economic consequences include reduced recreational value, potential impacts on the tourism industry, reduced productivity of degraded habitats and impacts on fisheries production and catch levels. The ecosystem impacts of toxicity from pesticides include impacts on fish reproduction. Socio-economic consequences include direct impacts on human health and loss of access to regulated markets (e.g. the European Union).

The *solutions* to address the problem identified include:

- Hydrocarbon pollution:
  - Development of a regional contingency plan
  - Regulation and surveillance of petroleum-related industries.
- Land-based pollution:
  - Identification of areas with transboundary impact
  - Promotion of national plans to counter land-based pollution
  - Information campaign directed at agricultural sectors proposing alternative solutions to chemical fertilizers
  - Planning and implementation of large-scale wastewater treatment plants for major coastal urban centres
  - Development of appropriate regulatory frameworks for aquaculture and training staff to manage the responsible expansion of the aquaculture sector.
- Toxicity from pesticides:
  - Raise awareness within the industrial sector
  - Regulate the use of chemical products
  - Develop a common regional policy for management of major river basins.

The above solutions are prioritized as high to low, with the highest priority being accorded to the actions to address hydrocarbon pollution, development of national plans to counter land-based pollution and an information campaign to reduce chemical fertilizer usage.

3.4 References

Calamari, D. & Naeve, H., eds. 1994. Review of pollution in the African aquatic environment. CIFAA Technical Paper No. 25. Rome, FAO. 118 pp.

Chenje, M. & Mohamed-Katerere, J. 2006. Chapter 10: invasive alien Species. In *Africa environmental outlook 2: our environment, our wealth*. Nairobi, DEWA/UNEP, p. 331–349.

FAO. 2012. *Rapport du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe Nord. Agadir, Maroc, 8–17 février 2010. COPACE/PACE Series. Rome, à paraître*.

Martins, O. & Probst, J.L. 1991. Biogeochemistry of major african rivers: carbon and mineral transport (part 6). *In* E.T. Degens, S. Kempe & J. Richey, eds. *Biochemistry of major world rivers*. Scientific Committee on Problems of the Environment. Wiley UK.

UNEP. 2005. *Canary Current, GIWA regional assessment 41*. *In* M. Tayaa, A. Saine, G. Ndiaye & M. Deme, eds. Global international waters assessment. University of Kalmar, Kalmar, Sweden. 76 pp. + appendices

UNEP. 2010. *Final review of scientific information on cadmium*. Nairobi, UNEP Chemicals Branch, DTIE. 201 pp. + appendices.


CANARY CURRENT LARGE MARINE ECOSYSTEM
CCLME

Annex 1. **Marine Protected Areas in the CCLME region**

Marine Protected Areas in the CCLME, as listed in the World Database on Protected Areas (WDPA) (www.wdpa.org), including those that are listed as terrestrial but include areas of mangrove. Area coverage is as listed in the WDPA and includes the official area reported and the area calculated by WDPA using GIS. All areas are in km². Areas in [square brackets] indicate duplication (e.g. if an MPA is listed twice as different types of protected area) and not included in the total areas.

Name	Type	Designation	Status	Year	Marine area (reported)	Marine area (GIS)	Total area (Reported)	Total area (GIS)	Marine space	Mangroves
Morocco										
Al Hoceima	National	National Park	Designated	2004	190,0	0,0	484,6	466,1	✓	
Khenifiss	National	National Park	Designated	2006	209,0	0,0	1 850,0	1 661,4	✓	✓
Merja Zerga	National	Biological Reserve	Designated	1978	45,0	0,0	70,0	41,5	✓	
Sous Massa	National	National Park	Designated	1991	373,1	0,0	711,1	469,0	✓	
Total Area (National Status)					**817,1**	**0,0**	**3 115,7**	**2 638,0**		
Al-Hoceima National Park	International	Specially Protected Area of Marine Importance (Barcelona Convention)	Adopted	2009	196,0	204,1	484,6	466,1	✓	
Merja Sidi Boughaba	International	Ramsar Site, Wetland of International Importance	Designated	1980	0,0	0,0	6,5	10,2	✓	
Merja Zerga	International	Ramsar Site, Wetland of International Importance	Designated	1980	45,0	0,0	73,0	58,8	✓	✓
Total Area (International Status)					**241,0**	**204,1**	**564,1**	**535,2**		
Mauritania										
Banc d'Arguin	National	National Park	Designated	1978	6 245,0	0,0	12 075,0	11 925,7	✓	
Total Area (National Status)					**6 245,0**	**0,0**	**12 075,0**	**11 925,7**		
Banc d'Arguin	International	Ramsar Site, Wetland of International Importance	Designated	1982	6 000,0	0,0	12 000,0	11 916,4	✓	
Banc d'Arguin National Park	International	World Heritage Site	Inscribed	1989	[600]	6 459,7	[12 000,0]	[11 916,4]	✓	
Diawling National Park	International	Ramsar Site, Wetland of International Importance	Designated	1994	0,0	0,0	156,0	663,6	✓	✓
Total Area (International Status)					**6 000,0**	**6 459,7**	**12 156,0**	**12 580,0**		
Senegal										
Abéné	National	Marine Protected Area	Designated	2004	0,0	0,0	118,4	116,7	✓	✓
Basse-Casamance	National	National Park	Designated	1970	0,0	0,0	50,0	42,7	✓	✓
Delta du Saloum	National	National Park	Designated	1976	540,9	0,0	599,3	724,5	✓	✓
Joal	National	Marine Protected Area	Designated	2004	0,0	0,0	173,6	154,6	✓	✓
Kayar	National	Marine Protected Area	Designated	2004	0,0	0,0	170,3	161,4	✓	
Langue de Barbarie	National	National Park	Designated	1976	0,0	0,0	20,0	9,2	✓	
Saint-Louis	National	Marine Protected Area	Designated	2004	0,0	0,0	495,6	463,7	✓	

Name	Type	Designation	Status	Year	Marine area (reported)	Marine area (GIS)	Total area (Reported)	Total area (GIS)	Marine space	Mangroves
Foret de Diantene	National	Forest Reserve	Designated		0,0	0,0	2,9	2,9		✓
Foret de Djibelor	National	Forest Reserve	Designated		0,0	0,0	1,8	1,8		✓
Foret de Djipakoum	National	Forest Reserve	Designated		0,0	0,0	26,1	26,1		✓
Foret de Fathala	National	Forest Reserve	Designated		0,0	0,0	72,6	72,6		✓
Foret de Kalounayes	National	Forest Reserve	Designated		0,0	0,0	166,4	166,4		✓
Foret de Leybar	National	Forest Reserve	Designated		0,0	0,0	2,7	2,7		✓
Foret de Mangaroungou	National	Forest Reserve	Designated		0,0	0,0	10,0	10,0		✓
Foret de Patako	National	Forest Reserve	Designated		0,0	0,0	43,2	43,2		✓
Foret de Saboya	National	Forest Reserve	Designated		0,0	0,0	20,7	20,7		✓
Foret de Sangako	National	Forest Reserve	Designated		0,0	0,0	24,9	24,9		✓
Foret de Sokone	National	Forest Reserve	Designated		0,0	0,0	5,4	5,4		✓
Foret des Bayot	National	Forest Reserve	Designated		0,0	0,0	13,0	13,0		✓
Total Area (National Status)					**540,9**	**0,0**	**2 017,0**	**2 062,5**		
Delta du Saloum	International	UNESCO-MAB Biosphere Reserve	Designated	1980	0,0	0,0	1 800,0	3 205,8	✓	✓
Delta du Saloum	International	Ramsar Site, Wetland of International Importance	Designated	1984	0,0	0,0	[730,0]	[3 205,8]	✓	✓
Gueumbeul	International	Ramsar Site, Wetland of International Importance	Designated	1986	0,0	0,0	7,2	7,5	✓	✓
Total (International Status)					**0,0**	**0,0**	**1 807,2**	**3 213,2**		
The Gambia										
Baobolong	National	Wetland Reserve	Designated	1996	0,0	0,0	220,0	204,6		✓
Gunjur (Bolong Fenyo)	National	Community Wildlife Reserve	Designated	2008	0,0	0,0	3,2	1,2		✓
Kiang West	National	National Park	Designated	1987	6,6	0,0	115,3	114,4	✓	✓
Niumi	National	National Park	Designated	1986	0,0	0,0	49,4	49,1		✓
Tanbi	National	National Park	Designated	2001	0,0	0,0	60,3	67,2		✓
Tanji/Karenti	National	Bird Reserve	Designated	1993	0,0	0,0	6,1	8,2		✓
Total National					**6,6**	**0,0**	**454,3**	**444,7**		
Guinea										
Dixinn	National	Classified Forest	Designated	1944	0,0	0,0	39,0	34,4		✓
Kaloum	National	Classified Forest	Designated	1955	0,0	0,0	6,7	3,2		✓
Khabitaye	National	Classified Forest	Designated	1944	0,0	0,0	49,0	50,0		✓
Total Area (National Status)					**0,0**	**0,0**	**94,7**	**87,7**		
Ile Alcatraz	International	Ramsar Site, Wetland of International Importance	Designated	1992	0,0	0,0	0,0	0,7	✓	
Ile Blanche	International	Ramsar Site, Wetland of International Importance	Designated	1993	0,0	0,0	0,1	1,7	✓	
Iles Tristao	International	Ramsar Site, Wetland of International Importance	Designated	1992	0,0	0,0	850,0	820,0	✓	✓
Konkouré	International	Ramsar Site, Wetland of International Importance	Designated	1992	0,0	0,0	900,0	299,7	✓	✓

Name	Type	Designation	Status	Year	Marine area (reported)	Marine area (GIS)	Total area (Reported)	Total area (GIS)	Marine space	Mangroves
Rio Kapatchez	International	Ramsar Site, Wetland of International Importance	Designated	1992	0,0	0,0	200,0	300,3	✓	✓
Rio Pongo	International	Ramsar Site, Wetland of International Importance	Designated	1992	0,0	0,0	300,0	262,1	✓	✓
Total Area (International Status)					**0,0**	**0,0**	**2 250,1**	**1 684,6**		
Guinea-Bissau										
Bijagos Archipelago Biosphere Reserve	National	Biosphere Reserve	Designated	1996	0,0	0,0	10 279,0	10 343,0	✓	✓
Canjambari	National	Faunal Reserve	Proposed		0,0	0,0	142,0	142,9		✓
Cantanhez Forest	National	Hunting Reserve	Designated	1980	0,0	0,0	680,0	1 217,4	✓	✓
Cantanhez Forest	National	National Park	Proposed	2007	0,0	0,0	1 057,7	1 217,4		✓
Cufada	National	National Park	Proposed		0,0	0,0	890,0	728,5		✓
Dulombi	National	National Park	Proposed	1991	0,0	0,0	1 770,0	1 208,4		✓
Ilhas Formosa, Nago and Tchediã (Urok)	National	Marine Community Protected Area	Designated		0,0	0,0	618,9	622,7	✓	✓
João Vieira and Poilão Marine National Park	National	Marine National Park	Designated	2000	479,4	0,0	495,0	492,9	✓	✓
Lagoas de Cufada	National	National Park	Designated	2000	0,0	0,0	890,0	728,5	✓	✓
Mansoa	National	Forest Reserve	Proposed		0,0	0,0	91,3	91,8		✓
Orango	National	National Park	Designated	2000	942,4	0,0	1 582,4	1 568,5	✓	✓
Pelundo	National	Faunal Reserve	Proposed		0,0	0,0	375,5	377,8		✓
Rio Cacheu Mangroves	National	National Park	Designated	2000	0,0	0,0	886,2	892,0	✓	✓
Rio Grande de Buba	National	Protected Area	Proposed		0,0	0,0	1 108,5	1 156,1		✓
Varela	National	National Park	Proposed		0,0	0,0	86,0	86,6		✓
Total Area (National Status)					**1 421,8**	**0,0**	**20 952,4**	**20 874,5**		
Bolama - Bijagos	International	UNESCO-MAB Biosphere Reserve	Designated	1996	0,0	0,0	1 012,3	10 652,6	✓	✓
Lagoas de Cufada	International	Ramsar Site, Wetland of International Importance	Designated	1990	0,0	0,0	391,0	227,7	✓	✓
Total Area (International Status)					**0,0**	**0,0**	**1 403,3**	**10 880,4**		

Transboundary Diagnostic Analysis (TDA)