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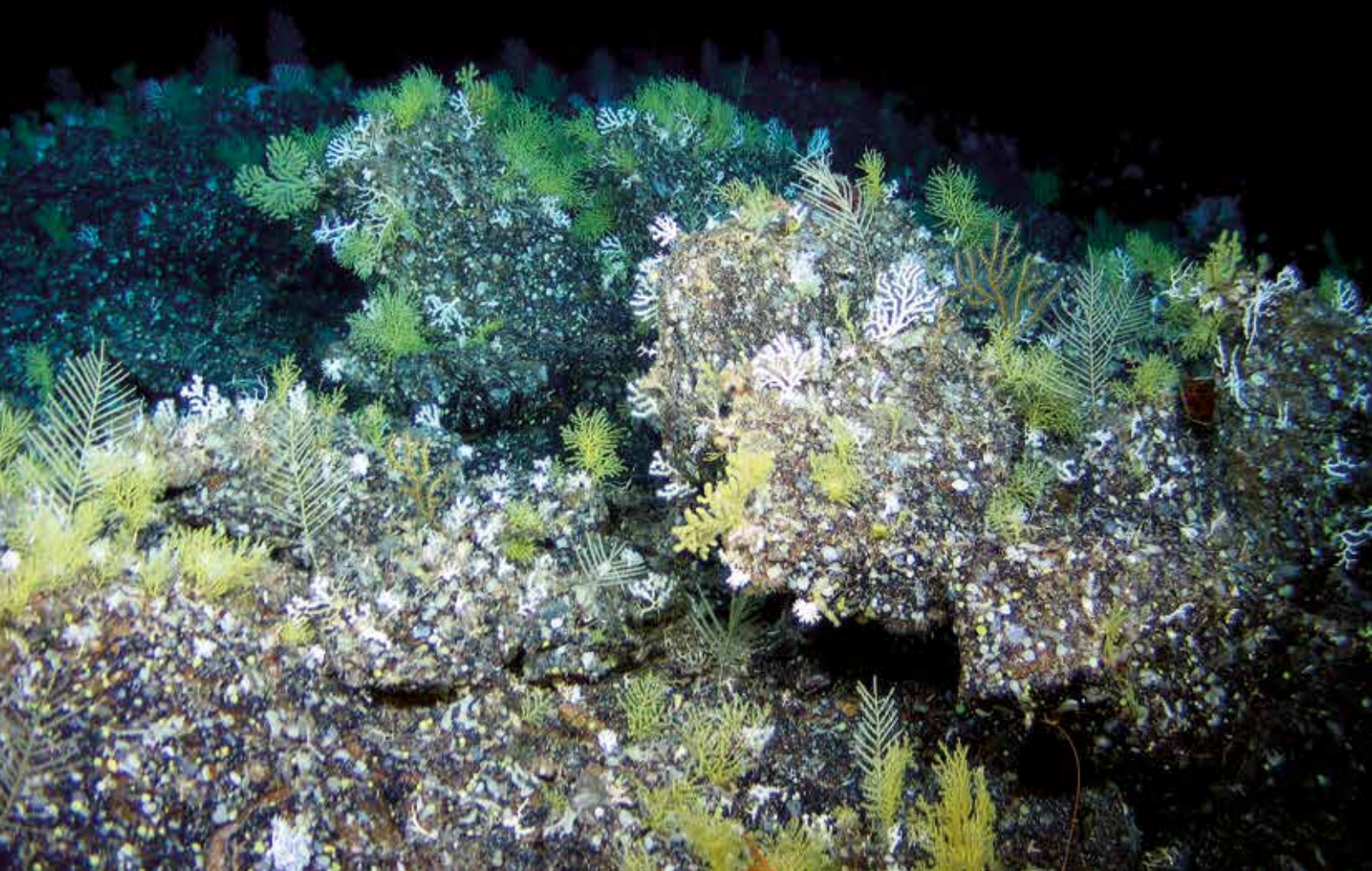
Seamounts Project

An Ecosystem Approach to Management of Seamounts in the Southern Indian Ocean



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The GEF unites 182 countries in partnership with international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives. Today the GEF is the largest public funder of projects to improve the global environment. An independently operating financial organization, the GEF provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. Since 1991, GEF has achieved a strong track record with developing countries and countries with economies in transition, providing $9.2 billion in grants and leveraging $40 billion in co-financing for over 2,700 projects in over 168 countries. www.thegef.org

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IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGO's, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,000 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world. www.iucn.org

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An Ecosystem Approach to Management of Seamounts in the Southern Indian Ocean

Published by: IUCN, Gland, Switzerland.

Citation:

Seamounts Project: An Ecosystem Approach to Management of Seamounts in the Southern Indian Ocean. Gland, Switzerland: IUCN. 60 pp.

Layout:
François-Xavier Bouillon,
F-06800 Cagnes-sur-Mer.

Printing: Solprint, Malaga, Spain.

ISBN: 978-2-8317-1635-0

Produced by: IUCN, Gland, Switzerland.

Available from:

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Fax +41 22 999 0002

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www.iucn.org/publications

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FOREWORD

The high seas, which represent 64% of the surface area of the world ocean, shelter a huge amount of biodiversity and provide humankind with essential goods and services such as fisheries and climate regulation.

With the improved technology and increasing needs of a growing global earth population, high seas deep-sea ecosystems are facing threats such as overexploitation and habitat destruction from deep-sea fisheries.

The Global Environment Facility (GEF) International Waters Focal area was established to help countries to manage collectively their trans-boundary surface water basins, groundwater basins, and coastal and marine systems in order to share the benefits from them. Recognizing the above threats to high seas biodiversity, the GEF has incorporated improving management of Marine Areas beyond National Jurisdiction (ABNJ) in its more recent programming strategies.

UNDP strengthens national capacities to sustainably manage the global environment while reducing poverty. Working with country and other partners, UNDP builds their capacity to integrate environment into development plans and strategies, mobilize resources, and implement low carbon, climate resilient, environmentally sustainable development pathways.

The IUCN Global Marine and Polar Programme (GMPP) is a team of staff committed to effectively addressing key global challenges in the marine and polar environment. GMPP cooperates with other IUCN thematic and regional programmes and with the IUCN Commissions to ensure that marine and polar ecosystems are maintained and restored in their biodiversity and productivity, and that any use of the resources is sustainable and equitable.

In 2009, UNDP-GEF and IUCN began collaborating on a pilot International Waters project designed to promote an ecosystem approach to management of seamounts in ABNJ. The project, "Applying an ecosystem-based approach to fisheries management: focus on seamounts of the southern Indian ocean", created a vital environmental status baseline from which to monitor future trends and impacts by conducting some of the first scientific assessments of these ecosystems. In parallel, an analysis of anthropogenic threats to seamount ecosystems in ABNJ highlighted the fact that, whereas fishing activities are widely recognized as the most significant threat, cumulative effects of the threats resulting from the complete range of human activities in these areas have to be taken into account. The project conducted a legal and institutional gap analysis and proposed options for improvement of the governance framework, such as encouraging flag States with vessels engaged in deep sea bottom fishing in the region to adopt measures consistent with UNGA Resolutions 61/105 and 64/72 and the 2009 FAO International Guidelines for Deep Sea Fishing, and, support negotiations in the UN to draft a multilateral agreement under the Convention on the Law of the Sea on conservation of biodiversity in ABNJ. Finally, the project proposed a road map process towards sustainable use and conservation of marine biodiversity via the development of an adaptive and collaborative management plan. By generating interest from major international press outlets around the scientific expeditions, the project raised awareness of policy makers and the general public around the world about deep sea biodiversity and the need to manage and protect the high seas.

UNDP-GEF and IUCN are pleased to present the results of the Indian Ocean Seamounts project in this report and hope the results can contribute to continued global efforts to establish effective governance regimes for sustainable management of high seas biodiversity.

Andrew Hudson

Principal Technical Advisor,
International Waters
UNDP-GEF

Carl Gustaf Lundin

Director,
IUCN Global Marine and Polar
Programme

ACKNOWLEDGMENTS

IUCN would like to recognize the many partners who have contributed to the project outlined in this publication, and the United Nation Development Programme (www.undp.org) and the Global Environment Facility (www.thegef.org) along with EAF Nansen, IMR, CenSeam and TOTAL Foundation for their support and financial contribution to this project.

We wish to express our gratitude to the financial contributors, the organisers and the participants of the two scientific expeditions conducted within the framework of this project. We would like to thank the authors of the technical reports and publications, as well as the co-organisers and hosting institutions of the technical workshops.

Finally, we would like to sincerely thank the legal, fisheries, and conservation experts who participated in the workshops and contributed to the development of the project's publications and outreach.

PARTICIPATING INSTITUTIONS

PROJECT PARTNERS

The African Coelacanth Ecosystem Programme is nested within the South African Institute for Aquatic Biodiversity (SAIAB). Its main goals are to generate new ecological knowledge about the marine environment of southern Africa, provide recommendations for conservation and management strategies, build capacity and promote public awareness. www.saiab.ac.za

The goal of the five-year Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project is to ensure the long-term sustainability of the living resources of the ASCLME region by introducing an ecosystem-based approach to management. The Project is funded by the Global Environment Facility (GEF) and implemented by the United Nations Development Programme (UNDP). www.asclme.org

The University of Reunion Marine Ecology Lab researches focus on the study of the structure and the functioning of marine ecosystems in order to sustainably manage marine biodiversity and better understand anthropogenic and climate change impacts on the marine environment.

The EAF-Nansen project is executed by the Fisheries and Aquaculture Department of FAO, in close collaboration with IMR, and funded by the Norwegian Agency for Development Cooperation (Norad).

The principal aim of the EAF-Nansen project is to strengthen the knowledge base for and implementing an ecosystem-approach to marine fisheries in developing countries, with a current emphasis on sub-Saharan Africa. www.eaf-nansen.org

The Institute of Marine Research (IMR) is Norway's largest centre of marine science. Its main task is to provide advice to Norwegian authorities on aquaculture and the ecosystems of Norway's adjacent seas and coast. IMR is also heavily engaged in development activities through the Centre for Development Cooperation in Fisheries. www.imr.no

The Natural Environment Research Council is the UK's main agency for funding and managing research, training and knowledge exchange in the environmental sciences. Its vision is to advance knowledge and understanding of the Earth and its environment to help secure a sustainable future for the planet and its people.

The Norwegian Agency for Development Cooperation (Norad) is a directorate under the Norwegian Ministry of Foreign Affairs (MFA).

The Southern Indian Ocean Deepsea Fishers Association is an Association of fishing companies established in 2006, whose primary goals are to maintain unsubsidized, profitable and environmentally sustainable fisheries and to set international best practice for responsible deep-sea fishery management. It is open to companies that have deepwater fishing operations in the high seas of the Indian Ocean and share the objectives of the Association.

The mission of the University of Oxford is to achieve and sustain excellence in every area of its teaching and research, maintaining and developing its historical position as a world-class university, and enriching the international, national and regional communities through the fruits of its research, the skills of its alumni and the publishing of academic and educational materials.

The Institute of Zoology (IOZ) is the research division of the Zoological Society of London (ZSL). It is a government-funded higher education and research establishment specialising in scientific issues relevant to the conservation of animal species and their habitats. IOZ research focuses on five thematic areas: evolutionary biology, genetics, ecology, reproductive biology and wildlife epidemiology. www.zsl.org/science

INTRODUCTION

The Global Marine and Polar Programme of IUCN coordinated a project on applying an ecosystem approach to management of seamounts in the Southern Indian Ocean between April 2009 and March 2013.

This project, supported by UNDP with GEF grant financing, aimed at addressing the three main barriers to marine biodiversity conservation: the lack of scientific knowledge about seamount ecosystems and their resources; the lack of comprehensive and effective governance frameworks for marine biodiversity in the high seas; the difficulty of managing human activities in the high seas, including monitoring, control and surveillance.

This report presents and highlights the main outcomes of the project in terms of:

— improved scientific understanding and capacity for monitoring, assessment and analysis of high seas biodiversity and fisheries;

— enhanced governance frameworks for high seas resource conservation and management;

— identifying options for conservation and management measures applicable to high seas areas in the Southern Indian Ocean;

— and learning, awareness raising and knowledge sharing.

Two research expeditions at sea were conducted within the framework of this project and provided an excellent opportunity to showcase these high seas ecosystems' value through media communications and daily expedition blogs addressed to the general public notably.

Some posts from the two expedition blogs and diary on the BBC Nature website are displayed alongside the pages of this report.

INFORMATION BOX

Scope:	Regional
Countries:	South Africa, Mozambique, Madagascar, Mauritius, Norway, UK
Medium-size project:	supported by UNDP with GEF grant financing
GEF Grant:	$0.950 million
Co-Finance:	$4.810 million
Project Cost:	$5.760 million

Project website:
http://www.iucn.org/about/work/programmes/marine/marine_our_work/marine_governance/seamounts/

I. THE PROJECT

The IUCN Seamounts project supported by UNDP with GEF grant financing focused on deep-sea habitats and associated biodiversity located in areas beyond national jurisdiction.

It aimed to improve conservation and management of marine resources in the high seas, with a focus on seamount ecosystems of the South West Indian Ridge.

This chapter describes the project background and introduces its main objectives.

PROJECT OBJECTIVE

The overall objective of the Seamounts project is to develop ecosystem approaches to fisheries management for biologically-globally significant and commercially-important areas beyond national jurisdiction (ABNJ), the high seas. By focusing on seamounts in the South-Western Indian Ocean, it aims to serve as an innovative demonstration for improving the conservation and management of unique biodiversity and ecological resources in the high seas. The project has been addressing the three main barriers to marine biodiversity conservation in the high seas:

1. Lack of scientific knowledge about seamount ecosystems and their resources.
2. Lack of comprehensive and effective governance frameworks for marine biodiversity in the high seas.
3. Difficulty of managing human activities in the high seas, including monitoring, control and surveillance.

BACKGROUND

The global depletion of inshore and continental shelf fisheries, coupled with improvements in fishing technology and growing demand for seafood, has led commercial operators to fish further out and deeper into the oceans. Some of these fisheries are in oceanic waters beyond national exclusive economic zones (EEZs), where they are subject to weak or sometimes no regulation.

Seamounts and other complex, raised seabed features in the open ocean are often hotspots of biological diversity and production. Some attract concentrations of commercially-important pelagic fish, such as tuna, and concentrations of animals such as cetaceans, seabirds, sharks and pinnipeds. Seamounts also host deep-water fish species, such as orange roughy or alfonsino, that are highly attractive to commercial operators. The limited knowledge of seamount-associated fauna to date indicates that many species grow and reproduce slowly and are therefore much more vulnerable to overexploitation.

Evidence has shown that deep-sea bottom fisheries can cause depletion of commercially-important fish stocks in just a few years and irreparable damage to slow-growing deep-seabed communities of cold water corals, sponges and other animals.

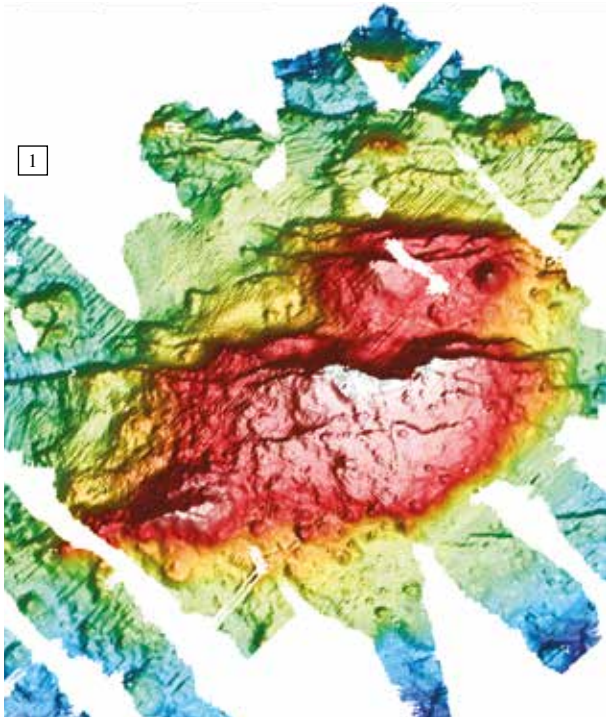
While seamounts in temperate regions around developed countries have been visited for research, those in more remote regions remain nearly unexplored. This is particularly true for the Southern Indian Ocean, for which the few biological data that exist come almost exclusively from the deep-sea fishing industry or from national fisheries research programs prospecting for exploitable fish stocks. Furthermore, these data are not available to the public for reasons of commercial confidentiality.

The Southern Indian Ocean remains the most significant gap in current knowledge of global seamount ecology and biodiversity. Thus, conservation and management of marine biodiversity based on precautionary and ecosystem approaches is hampered by a lack of fundamental scientific knowledge and understanding of seamount ecology and their relations to benthic and pelagic fish species of commercial interest.

SEAMOUNTS

Seamounts, underwater mountains rising from the ocean floor, are found in all oceans of the world and are abundant features of the seafloor. They are known to be hotspots of biological diversity and production, and are important for marine biodiversity and the status of marine food webs.

Migratory fish and cetaceans rely on seamounts as well for their food supply. Limited knowledge of seamount-associated fauna to date indicates that many species grow and reproduce slowly, thus are highly vulnerable to overexploitation.



1. Middle of What Seamount Multibeam Swath Bathymetry. © University of Oxford. Modified.
2. 2011-12-13_10-14-20_James Cook_JC066_8_22_ROV17. Gorgonians and ophiurians. © NERC.

GLOBAL GOVERNANCE FRAMEWORK FOR THE HIGH SEAS

The international legal regime for the high seas is made up of a number of global and regional legal instruments. It includes the United Nations Convention on the Law of the Sea (UNCLOS), an umbrella convention covering all ocean uses; and the Convention on Biological Diversity (CBD), which places obligations on nations to conserve and sustainably use marine biodiversity in areas beyond national jurisdiction.

With regards to fisheries, the only global framework calling for sustainable management of high seas fisheries, based on the precautionary and ecosystem approaches, is the United Nations Fish Stocks Agreement (UNFSA). However, the Agreement applies only to highly migratory and transboundary fish stocks and does not cover sedentary high or deep-sea fish populations.

There are some binding legal agreements at the regional level, such as those establishing Regional Fisheries Management Organizations (RFMOs). They do not, however, cover all high seas fisheries with respect to species or ocean areas.

Globally, the conservation and sustainable management of high seas biodiversity has gained momentum in recent years, and has become a priority at international fora and for specific institutions such as the United Nations General Assembly (UNGA), the CBD, and the Food and Agriculture Organization of the United Nations (FAO).

Since 2002, when the UNGA called on States to urgently consider ways of minimizing risks to seamounts and other underwater features, a number of milestone events and resolutions have been achieved. They have all urged States to take measures for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (ABNJ). In 2006, the UNGA adopted resolution 61/105 on sustainable fisheries which included a call for urgent action to protect deep-sea corals and other vulnerable ecosystems from the impacts of bottom fishing on the high seas. In specific, paragraph 80 of UNGA res. 61/105: "Calls upon States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain."

Paragraphs 83-85 of res. 61/105 detail the steps that States and RFMOs are to take to ensure the sustainability of deep sea fisheries and to prevent significant adverse impacts on vulnerable marine ecosystems. The FAO *Guidelines for the Management of Deep Sea Fisheries on the High Seas* elaborate on these elements.

GOVERNANCE FRAMEWORK FOR THE HIGH SEAS OF THE INDIAN OCEAN

The only regional fisheries agreement currently in force in the Indian Ocean, the Indian Ocean Tuna Commission (IOTC), applies specifically to the conservation and management of tuna and tuna-like species. The Southern Indian Ocean Fisheries Agreement (SIOFA), which focuses on all fishery resources of the Southern Indian Ocean, is not yet in force, and the interim measures called for by the UNGA resolution 61/105 have not yet been agreed on a regional basis for the Indian Ocean [the Agreement eventually entered in force in July

The combination of the lack of understanding of important oceanic features such as seamounts and their interactions with commercial fish species and the existing gap in the high seas marine biodiversity governance and regulatory system poses major threats to marine species and their habitat. These gaps can allow unregulated and unreported activities, overexploitation of marine resources and destruction of benthic habitats.

Trawler fishing in the project area. © Leighton Rolley.

2012 (Editor's note)]. Thus, unlike most high seas areas elsewhere, bottom fisheries in the Indian Ocean were not subject to multilaterally agreed conservation measures taken within the frame of a Regional Fisheries Management Organization (RFMO) until July 2012. They were subject to flag State regulation only, which can vary significantly from one country to the other. The only large-scale conservation initiative for bottom features such as seamounts in the Southern Indian Ocean came from within the industry. In 2006, the Southern Indian Ocean Deepsea Fishers Association (SIODFA) voluntarily set aside 11 Benthic Protected Areas (BPAs), thereby protecting over 300,000 km^2 of areas of the seafloor from the impact of fishing gear. SIODFA has also undertaken a number of complementary measures that contribute to conservation of deepwater fisheries in the region:

— Members have agreed not to expand fleet size or fishing capacity in the fishery in the absence of scientific assessments;

— Members have agreed that their operations should be free of subsidies to avoid incentives to overfish;

— SIODFA vessels are undertaking acoustic stock assessments of selected species to contribute to knowledge of the abundance of these species;

— All SIODFA vessels participate in data collection programs with an emphasis on bycatch, especially invertebrates and deepwater sharks; and

— SIODFA monitors all relevant conservation developments for potential adoption by their vessels, e.g. bird-strike mitigation measures.

While the initiative by SIODFA represents an important step forward, it emphasizes the need for effective governance and enforcement, within the framework of a transparent and open multilateral decision-making process. It also highlights the need for conservation measures to apply to other fishing and extractive companies, and for further identification of vulnerable marine ecosystems.

OBJECTIVES OF THE PROJECT

1- Improve scientific understanding and capacity for monitoring, assessment and analysis of high seas biodiversity and fisheries around seamounts

The project aims to enhance the knowledge base necessary to develop effective conservation and management options for high seas biodiversity.

Two research expeditions of 40 days each studied five selected seamounts in the Southern Indian Ocean. The first cruise focused on the pelagic ecosystem, fishery resources and oceanography, and the second one on benthic ecosystems. They have been helping answer key scientific questions, including:

— What is driving the seamount ecosystems and fisheries?

— How diverse are seamount fishes, crustaceans and other invertebrates?

— What are the benthic communities of the studied seamounts like?

— Are the predictions of coral diversity based on global modeling studies accurate?

— What are the impacts of past and current deep-sea fishing activities?

— Do the BPAs make a significant contribution to conservation of vulnerable seabed communities and do they benefit fishing?

The scientific expeditions, led at the end of 2009 and 2011 respectively, comprised a multidisciplinary team of international scientists, paired with experts from the region. This have provided opportunities for capacity building, as well as expanding the global network of scientists interested in oceanography and deep-sea applied research and conservation.

The major partners on this research cruise were IOZ/ZSL, FAO and its EAF-Nansen project, the UNDP-GEF ASCLME Project, ACEP, IMR and SIODFA. The work was funded by the Global Environment Facility, the Natural Environment Research Council, UK, and the FAO.

2- Enhance governance frameworks for high seas resources conservation and management

In order to support the enhancement of the governance and regulatory framework for the conservation and management of high seas marine biodiversity of the Southern Indian Ocean, the project has:

— Developed an institutional and legal gap analysis for the Indian Ocean.

— Developed a comprehensive list of possible options for the improvement and strengthening of the legal and institutional framework to achieve sustainable fisheries and biodiversity conservation.

— Closely followed developments at international and regional fora and feed project results into them.

— Liaised with key governments and international, regional and technical entities and networks to maximize cooperation and coordination.

The ASCLME Project, which also addresses high seas governance in areas that fall within the Large Marine Ecosystem boundaries but fall outside of national jurisdictions, is an important partner. Cooperation and liaison with relevant entities, such as FAO, the South West Indian Ocean Fisheries Commission (SWIOFC), the Indian Ocean Commission, IOTC, etc. have been actively sought as well as SIOFA since it came into existence.

3- Identify options for conservation and management measures applicable to high seas areas in the Southern Indian Ocean

The Seamounts project aimed at facilitating the identification and assessment of various options for conserving and sustainably managing deep-sea fishery resources and marine biodiversity. In particular, the project sought to:

— Identify conservation and management options based on precautionary and ecosystem approaches applicable to areas in the high seas of the Southern Indian Ocean.

— Identify options for managing deep-sea fisheries to prevent significant adverse impacts to vulnerable marine ecosystems and ecologically and biological significant areas.

— Identify appropriate monitoring, control and surveillance systems to ensure effective enforcement of, and compliance with, conservation and management plans.

— Develop a road map towards improved management framework for high seas areas in the Southern Indian Ocean.

— Identify threats from activities other than fisheries – such as maritime traffic or mining – that may negatively impact marine resources, and cumulate stress factors.

The project has worked in close collaboration with the fishing industry, to ensure feasibility and cost-effectiveness of measures, and encourage maximum buy-in and future compliance. It also seeks to provide a model that can be applied to other ocean areas, be expanded to a basin-wide scale, and include industries other than fishing.

4. Learning, awareness raising and knowledge sharing

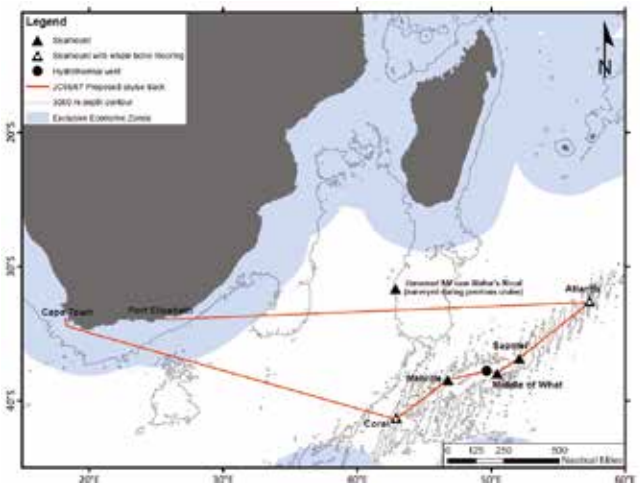
The project has contributed greatly to global knowledge of seamount ecosystems and has provided a concrete example of how remote oceanic ecosystems could be sustainably managed, in coordination with the fishing industry. To this end, the project has:

— Regularly exchanged findings and information of mutual interest with other projects and entities concerned with the Southern Indian Ocean and high seas resources, to ensure results and learning are shared as widely as possible and benefit from the experience of others.

— Widely publicized findings and results to raise awareness of the importance of deep-sea biodiversity and highlight new discoveries for the attention of decision-makers, the private sector, scientific institutions and the wider public.

— Disseminated project results at international, regional and technical fora and fed outcomes and developments of policy-making processes into the project implementation.

The project established cooperation and collaboration mechanisms with several entities and projects, including the ASCLME Project, ACEP and the Western Indian Ocean Marine Science Association (WIOMSA).



Map of the project area.
Route and stations of 2nd research expedition indicated.
Light blue shows Exclusive Economic Zones.
© University of Oxford.

http://seamountsexpedition.blogspot.com

Seamounts expedition:

Exploring underwater mountains on board the RRS James Cook from 7 November to 21 December 2011 (Cape Town - Port Elizabeth, South Africa).

TUESDAY, NOVEMBER 8, 2011

Departure from Cape Town!

The RRS James Cook left at 2pm yesterday. All participants and the crew were already on board for at least 24 hours and were busy unpacking, storing, securing every single item that will be used during the expedition.

Problem n°1: We had no internet connection until this morning and it is still very weak.

The weather was very nice yesterday and permitted the tricky operation of the calibration of the echosounders (downward looking instrument used to detect fish, plankton and even jellyfish). There are 5 echosounders on the James Cook and they are placed at different locations on the keel.

Clare, Philipp and the technicians put a small metal ball (calibration sphere) about 25 m under the ship, they turned on the echosounders and recorded the echoes from the ball.

During this operation, the ship was stopped a few miles away from Cape Town and many fur seals were hanging around.

Problem n°2: We guess that one of the seals played with the calibration sphere for a while - delaying the work for 2-3 hours!

at 12:26 PM

LINKS

IUCN webpage - Seamounts project
http://www.iucn.org/about/work/programmes/marine/marine_our_work/marine_governance/seamounts/

Previous expedition (2009 cruise): the blog
http://seamounts2009.blogspot.fr/

NERC - Natural Environment Research Council
http://www.nerc.ac.uk/index.asp?cookieConsent=A

IPSO - International Programme on the State of the Ocean
http://www.stateoftheocean.org/

BBC News - Science & environment - Second mission announced
http://www.bbc.co.uk/news/science-environment-15593602

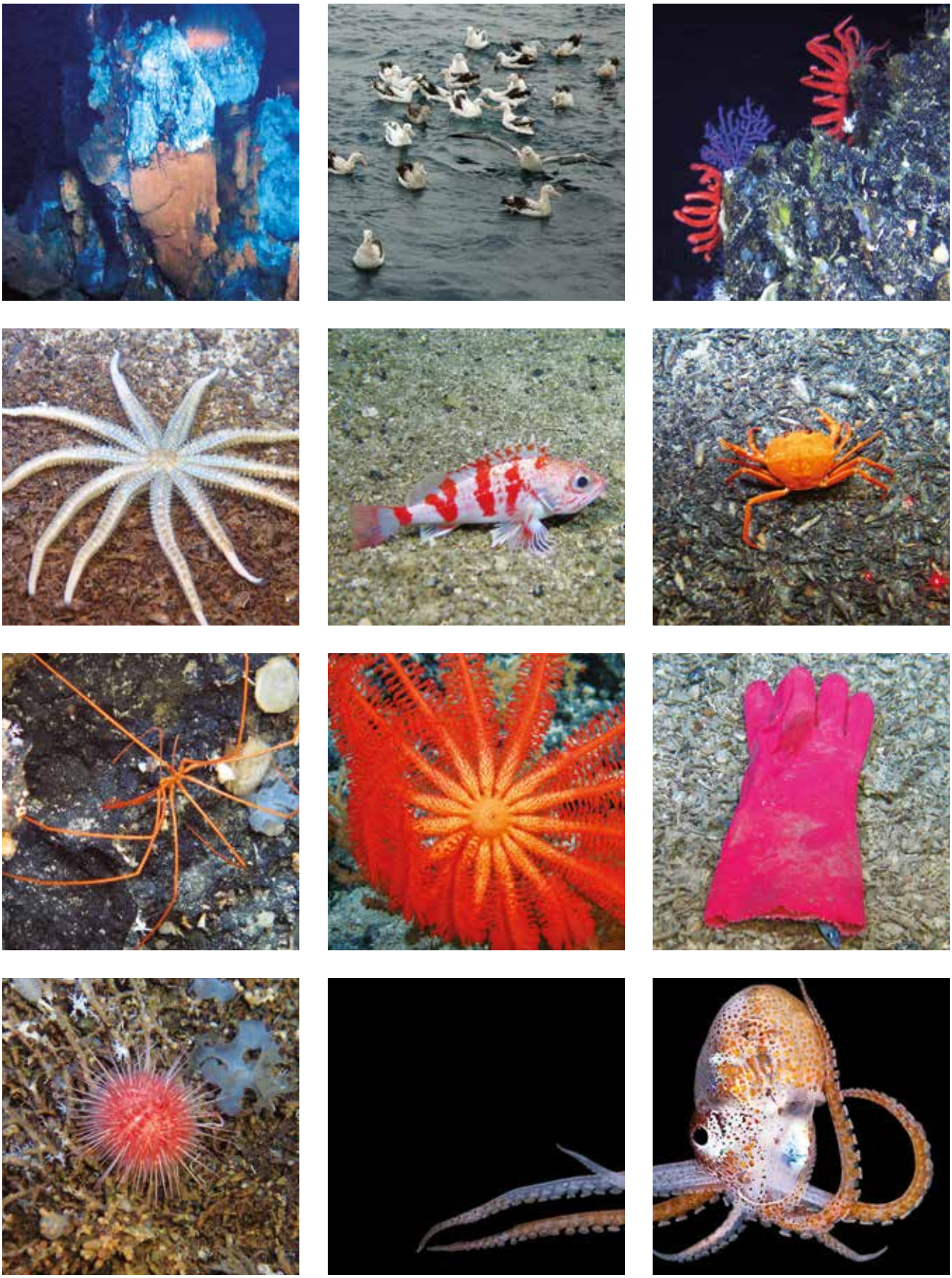
BBC Nature - A conservation diary from the deep - 18 Nov 2011
http://www.bbc.co.uk/nature/15772693

BBC Nature - A conservation diary from the deep - 25 Nov 2011
http://www.bbc.co.uk/nature/15872414

BBC Nature - A conservation diary from the deep - 2 Dec 2011
http://www.bbc.co.uk/nature/15991999

BBC Nature - A conservation diary from the deep - 9 Dec 2011
http://www.bbc.co.uk/nature/16076387

BBC Nature - A conservation diary from the deep - 16 Dec 2011
http://www.bbc.co.uk/nature/16197761



The assessments of seamount ecosystems led by the project are some of the first and provide a vital environmental status baseline. 200 species of fish and 74 species of squid have been identified and a 70-cm long new species of squid described. Sampling analyses are still ongoing. © NERC.

One of the main barriers to marine biodiversity conservation is the lack of scientific knowledge about seamount ecosystems and their resources.

Two research expeditions were conducted within this project framework, aiming to address this:

The first one, on board the RV Dr Fridtjof Nansen in 2009, focused on pelagic fauna, while the 2011 RRS James Cook campaign was devoted to the benthic realm.

II. SCIENTIFIC BACKGROUND AND INITIAL FINDINGS

Seamounts are known to be hotspots of biological activity, attracting large predators such as whales, seals, sharks and tuna. They are also known to host spectacular communities of life on the seabed, including cold-water coral reefs, coral gardens and sponge fields. However, why seamounts host such rich biological communities is poorly understood. Two contrasting theories have been put forward as an explanation: that seamounts enhance the generation of microscopic algae (phytoplankton) at the surface of the ocean because they cause upwelling of nutrient-rich deep water; or that seamounts trap layers of zooplankton and fish over their summits and flanks that migrate up to the ocean surface at night and dive into deeper waters during the day (trophic focusing).

Because of their rich fish resources seamounts have also been targeted by bottom trawlers both in national waters and on the high seas. Many of the species they target in these localities are long-lived deep-sea fish such as orange roughy, oreos, and cardinal fish. These fish stocks have been rapidly depleted on seamounts in many parts of the ocean. In addition, the corals, sponges and other life on the seabed, which are both fragile, and often also long-lived, have also been destroyed through the collateral impact of heavy fishing gear being dragged over them. Such ecosystems have a low ability to recover from such damage and to date no evidence of regrowth of such ecosystems has been documented.

The unsustainable nature of deep-sea fisheries and their impacts on seabed life raised concerns amongst the international community impelling the United Nations General Assembly to call for management of bottom fisheries in the high seas to prevent unsustainable fishing and damage to vulnerable marine ecosystems. Implementation of such measures are technically extremely difficult because the lack of information on deep-sea ecosystems in many parts of the world. One approach, adopted by the deep-sea fishing industry in some regions was to voluntarily close areas of the deep sea to trawling where they suspected there were concentrations of vulnerable marine ecosystems as a result of high levels of by-catch of corals and other habitat-forming species. Another approach was to try and estimate the distribution of vulnerable marine ecosystems like cold-water coral reefs through habitat suitability modelling and then to feed this information in to spatial management of deep-sea fisheries to prevent impacts. This method takes the known occurrences of deep-sea corals

On left: Sea pen. © David Shale, 2011.

Below:

2011-11-26_09-58-00_James Cook_JC066_5_24_ROV10. Orange roughy.

2011-11-12_10-35-13_James Cook_JC066_4_2_ROV01, Gorgonocephalus with crinoid. © NERC.

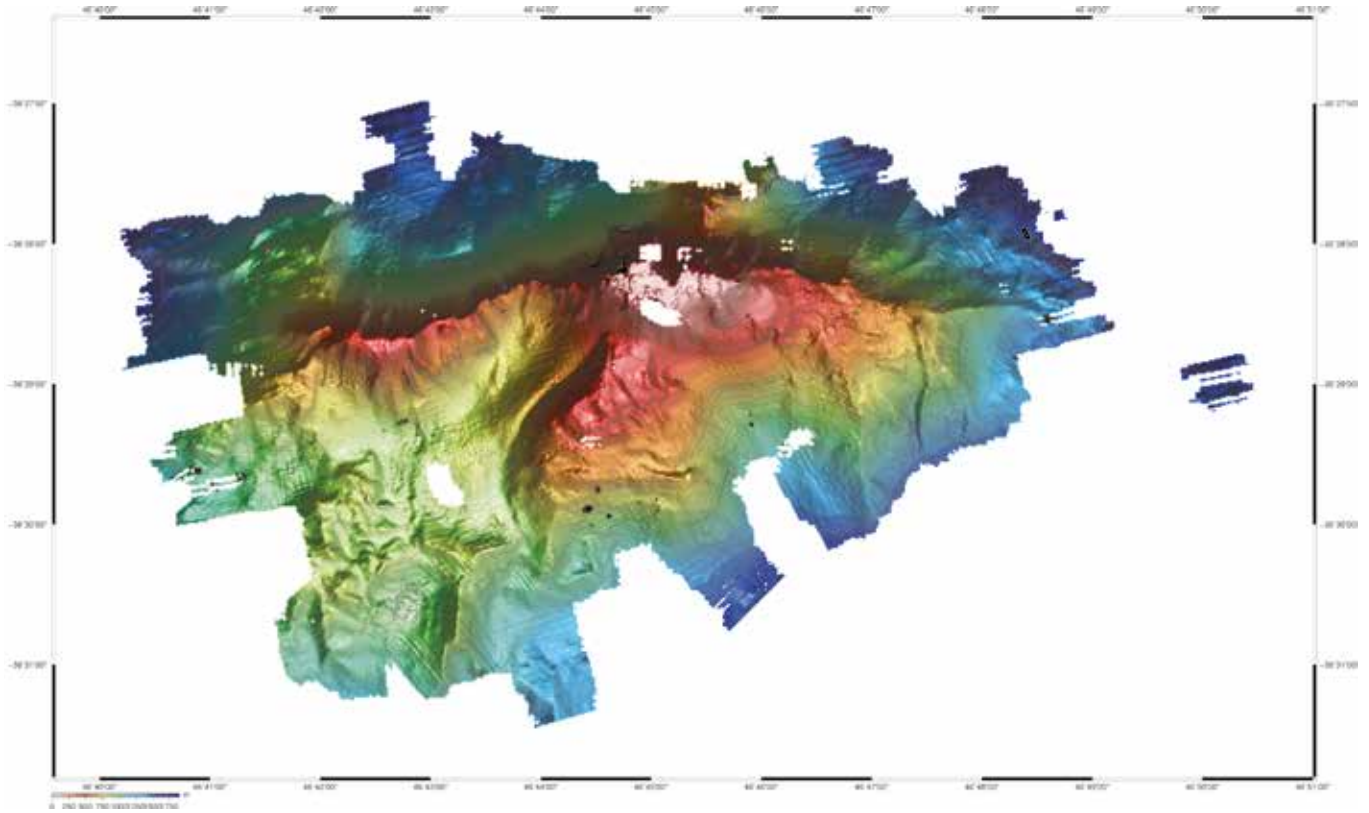
(or other species of interest) and correlates them with the environmental parameters known for the oceans at those localities. A model is then constructed that predicts the habitat suitability for deep-sea corals for the entire global deep sea. This approach has been adopted and refined by deep-sea biologists in an effort to supply the managers of deep-sea fisheries with information on the likely occurrence of cold-water coral reefs.

The Seamounts project was aimed at addressing several fundamental questions with regards to the ecology and management of deep-sea seamount ecosystems on the high seas. These included gathering evidence on what was driving the food webs around seamounts. Was there evidence of upwelling? Alternatively was trophic focusing the source of food for the mobile predators and sessile corals on seamounts? Another main aim of the Seamounts project was to validate the occurrence of cold-water corals in a region of the world that was currently unexplored but which habitat suitability modelling suggested hosted deep-sea reefs. The project also aimed to test the efficacy of the voluntary approach to protecting seamount ecosystems by industry or regional fisheries management bodies.

The ideal location to undertake this work was the high seas region of the South West Indian Ocean. In this region lies a range of seamounts called the South West Indian Ridge. This range of seamounts stretch from their junction with the Central Indian Ridge at ~25°S to a remote region of the Southern Ocean, just to the north west of Bouvet Island where it meets the Speiss Ridge in close proximity to the Mid Atlantic Ridge and American-Antarctic Ridge. These seamounts were subject to exploratory fishing by Soviet vessels from the 1960s but a commercial fishery began in the early 1990s, reaching a peak in 2000 and 2001 before crashing. The main target species over this latter period was orange roughy although other species such as alfonsino were also fished. Since this time bottom trawling for orange roughy and mid-water trawling for alfonsino have taken place at a lower level. Following concerns raised about deep-sea fishing, several seamounts in the Southern Indian Ocean were protected on a voluntary basis, including Coral Seamount and Atlantis Bank on the South West Indian Ridge. Habitat suitability modelling suggested the seamounts of the South West Indian Ridge should host stony corals capable of forming cold-water coral reefs. Furthermore, the deep-sea of the Indian Ocean was only first sampled in the 1960s and seamounts within the entire region are virtually unexplored. Being a spreading centre, the South West Indian ridge had also been discovered to host deep-sea hydrothermal vents meaning that there was the prospect that the region would be subject to deep-sea mining sometime in the future. A single region of the high seas encapsulated many of the issues scientists and IUCN wished to explore in the context of management of human activities in areas beyond national jurisdiction.

The first cruise was undertaken on the Dr Fridtjof Nansen, a Norwegian vessel funded by NORAD on the EAF Nansen programme and also supported on this occasion by the Algulhas and Somali Current Large Marine Ecosystems and UNDP-GEF. The cruise was aimed at understanding the pelagic ecosystems around the seamount of the South West Indian Ridge, to look for evidence of upwelling or trophic focusing on the seamounts, to record aquatic predators in the area and to map the seamounts of interest. Five seamounts were chosen which from north to south were Atlantis Bank, Sapmer Bank, Middle of What Seamount, Melville Bank and Coral Bank. Atlantis Bank and Coral Bank were Benthic Protected Areas (BPAs). The seamounts were located in a highly energetic boundary region between two main

2009, on board the Dr Fridtjof Nansen. © Sarah Gotheil.



Melville Seamount Multibeam Swath Bathymetry.

water masses of the Southern Ocean and sub-tropical gyre of the southern Indian Ocean with the addition of the Aghulas Retroflection also affecting the region. The cruise was undertaken jointly by scientists from Britain, South Africa, Reunion, Madagascar, Mauritius and Norway and included a strong element of training for those from countries within the region.

The cruise made many significant discoveries, many of which are still being worked up by scientists into papers for peer-reviewed journals. To summarise it was found that the organisms of the pelagic ecosystems changed completely across the area of the seamounts investigated with very distinct communities of animals associated with cold water mass of the Southern Ocean and the sub-tropical waters to the north. Evidence was gathered that indicated that trophic focusing was happening above the seamounts, that they were trapping vertically migrating animals that were being preyed on by seamount-associated predators, including some of the species targeted by commercial fisheries such as alfonsino. Many types of oceanic birds were observed during the cruise foraging along the South West Indian Ridge, again with different communities associated with the different water masses. These included a number of species at risk of extinction such as wandering albatross, white-chinned petrel and others. In a workshop in the South African Institute of Aquatic Biodiversity in Grahamstown funded by the Census of Marine Life scientists identified many of the collected samples. Remarkably it was found that a large proportion of the world's squid fauna including species new to science had been sampled and later even new species of fish were found. Overall it was clear that the seamounts exerted a strong influence on pelagic ecosystems.

The second cruise was funded mainly by NERC and was undertaken in the austral summer of 2011 on the RRS James Cook with the remotely operated vehicle Kiel 6000. This cruise aimed to investigate the seabed communities of the seamount and was instantly successful with the discovery of the first cold-water coral reef in the Indian Ocean. This coral reef was located on Coral Seamount, one of the BPAs and has now been proposed as an Ecologically and Biologically Sensitive Area (EBSA) to the Convention on Biological Diversity (CBD). The coral framework was associated with a high diversity of other animals. As we investigated the seamounts further we discovered other exciting communities, including coral gardens formed by octocorals, black corals, stony corals and hydrocorals (stylasterids). Many species of animals were also discovered associated with these habitat-forming corals, from tiny polychaete worms and crustaceans to larger echinoderms such as snake and medusa stars, brinsingids and crinoids. Perhaps the most startling association was that between a species of Venus's basket sponge (*Euplectella* sp.) and a species of shrimp which occurred as a paired male and female in each sponge colony. The beautiful sponges that were filmed on Atlantis Bank, another BPA site also proposed as an EBSA, later appeared on the BBC's Attenborough's Ark, as they are one of David Attenborough's favourite animals.

The RRS James Cook with the remotely operated vehicle Kiel 6000.
© IUCN/Aurélie Spadone.

The cruise also documented significant damage to seamount communities caused by fishing with evidence not only of trawling but also of other kinds of fishing not previously documented on the South West Indian Ridge. The cruise was also joint with another NERC funded cruise that investigated the Dragon hydrothermal vent field now within a seabed mineral claim by China. This also made startling discoveries some of which have implications for the future management of marine mining in the region.

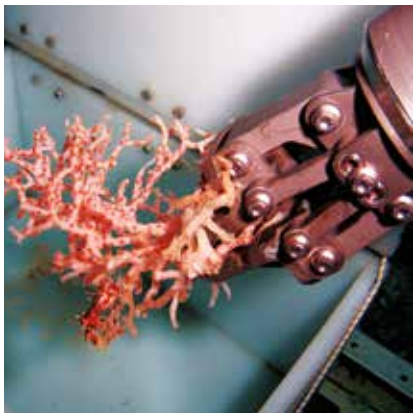
Overall these were two remarkable voyages of discovery that have provided new insights into seamount ecosystems, the life of the South West Indian Ridge and the human impacts that have already occurred. The habitat suitability modelling approach appears to also have been successful with great promise for future applications to poorly studied areas of the deep sea. All this information will be fed into the management of deep-sea fisheries within the high seas of the Southern Indian Ocean.

The 2011 cruise: team and works on board the RRS James Cook. © NERC.

III. AN ECOSYSTEM APPROACH TO MANAGEMENT OF SEAMOUNTS IN THE SOUTHERN INDIAN OCEAN

A series of four technical documents, entitled “An Ecosystem Approach to Management of Seamounts in the southern Indian Ocean”, has been developed within the framework of this project.

The first volume gives an **Overview of seamount ecosystems and biodiversity**. The second one explores the **Anthropogenic threats to seamount ecosystems** whereas the third one presents the **Legal and institutional gap analysis**. The fourth and last volume introduces **A road map towards sustainable use and conservation of biodiversity in the Southern Indian Ocean**.












The expeditions have mobilized many scientific and maritime skills. © IUCN/Aurélie Spadone.

III.1 - OVERVIEW OF SEAMOUNT ECOSYSTEMS AND BIODIVERSITY

This short summary refers to :
Alex D. Rogers. A*n Ecosystem Approach to Management of Seamounts in the Southern Ocean, vol. 1: Overview of Seamount Ecosystems and Biodiversity.* IUCN, 2012.

I. GENERAL: ABOUT SEAMOUNT ECOSYSTEMS

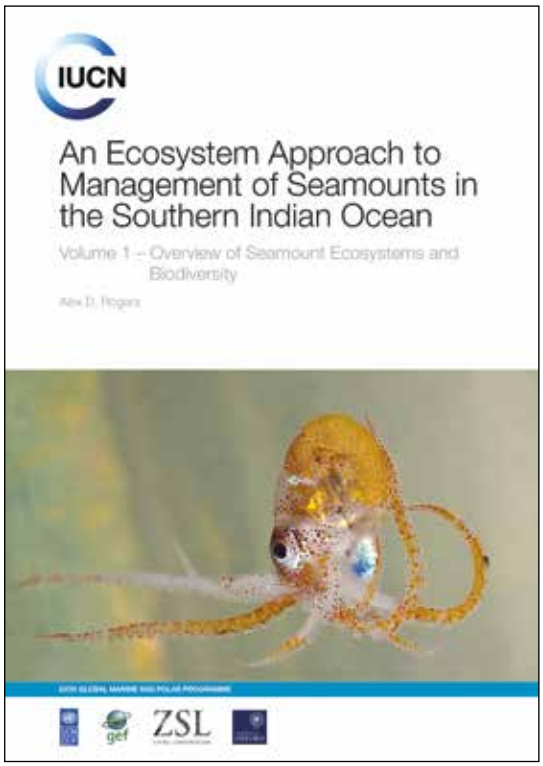
Seamounts are topographic rises of the seabed with a limited extent across the summit. Large seamounts usually originate as volcanoes, although some are formed by tectonic uplift, or even from serpentinite mud. Most large seamounts are associated with intraplate hotspots, mid-ocean ridges or island arcs. There may be up to 100,000-200,000 large seamounts in the oceans, with perhaps >25 million (with a range of error of 8-80 million) with an elevation ≥100 m. Most of them are located in the Pacific Ocean, with lower numbers in the Indian, Atlantic, Arctic and Southern Oceans. Overall this adds up to a globally significant area of habitat with an estimate of nearly 10 million km^2, comparable with tropical humid forest, temperate broad-leafed forest or all the world's wetlands

There is evidence that seamounts form hotspots of biological activity in the oceans. Over large geographic scales ocean predators appear to be associated with seamounts and other features. Tuna, billfish, sharks, cetaceans, pinnipeds, turtles and seabirds may all be associated with seamounts, and high biomass and abundance of such predators have been observed in the vicinity of seamounts. This is thought to be because of enhanced levels of prey or feeding opportunities for these species. Seamounts may also act as 'navigational waypoints' for oceanic migratory species and are important as spawning sites.

To date (July 2010), 798 species of fish have been listed as occurring at seamounts. Deep-sea fisheries target a relatively small fraction of these that aggregate around seamounts. Most of these species have been identified as forming a specific guild of robust bodied demersal fish species (strong swimming ability, high food consumption and energy expenditure, low rates of growth and productivity).

Why seamounts host abundant populations of fish and other pelagic and aquatic predators is still uncertain. Early observations suggested that chlorophyll concentrations may be higher above seamounts than in non-seamount locations. However, it has been argued more recently that evidence for enhancement of primary production, beyond sporadic and temporary blooms of phytoplankton, are lacking. Although such phenomena may enhance patchiness of phytoplankton downstream of seamounts, they are unlikely to significantly enhance the productivity of the seamounts themselves.

It is now recognized that several other physical processes associated with seamounts may enhance productivity or food supply in their vicinity. These include tidal rectification (generation of mean residual currents by tidal flow), flow acceleration and the formation of internal waves, and can enhance vertical mixing around a seamount, causing upwelling of nutrient-rich deep water and enhancement of primary production. The water above a seamount may become stabilized by high-density stratification, promoting productivity. Eddies have been observed to interact to different degrees with seamounts, sometimes moving around them, sometimes becoming trapped over them or being split by them. During such interactions eddies can be dissipated to different degrees and also significantly alter the physical structure of the waters above the summit and flanks of a seamount. At the largest scales, chains of seamounts can significantly alter or steer large ocean currents.



Anthomastus. © David Shale, 2011.

Another source of enhanced production at seamounts is the advection of phytoplankton, zooplankton, larger organisms, particulate organic material and nutrients from the far-field into the sphere of influence of a seamount. In such cases, enclosed or semi-enclosed circulation patterns over seamounts may retain material advected into the vicinity of a seamount or produced over it. Asymetric flow acceleration over a seamount flank or summit may also enhance horizontal fluxes of organic material.

Several studies indicate that seamounts may also trap the diurnally migrating layers of plankton and micronekton. These layers, known as the deep-scattering layer (DSL) because it is seen as a layer of acoustic reflectivity in echosounders, undergo migrations towards the surface at dusk and then back down into deeper waters at dawn. During the night the DSL may be advected over a seamount and at dawn, when the organisms descend, their passage is obstructed by the raised topography and they are preyed on by fish and other planktivores living on the seamount. The DSL may be enhanced by organisms that are associated with the seabed on the seamount but which undertake migrations into the water column to feed at night. Evidence that the DSL is an important food source for seamount-resident or visiting species of predators has been observed through analyses of stomach contents for demersal and pelagic species. Acoustic surveys have also shown seamount associated fish 'intercepting' the DSL as it moves downwards at dawn.

Seamounts differ in their size, shape, elevation, summit depth, and oceanographic and climatic setting, the latter varying with latitude. They are often exposed to strong water flow because of the interactions of impinging currents and tides with elevated topography, and as a result of this and the steep and irregular profiles they may present, hard substrata are more common than on continental slopes and abyssal plains. However, sediment-covered environments also occur on seamounts, especially on the flat summits of guyots and banks. As a result of strong current flow, the predominant benthic communities on seamounts are suspension feeding. On hard substrata, frequently observed epilithic organisms include corals, actiniarians, hydroids, sponges, ascidians and crinoids.

These organisms may structure the ecosystems by forming reefs or dense gardens associated with other species of sessile and mobile organisms such as molluscs, crustaceans and echinoderms. In some cases these biogenic habitats, such as cold-water coral reefs, can be extensive and are occupied by a distinctive and diverse fauna. Observations indicate that soft substrata may be inhabited by both epibenthic megafauna, such as sea pens, hexactinellid sponges and xenophyophores. Presence of epibenthic megafauna on soft substrata can also influence the diversity of other species. A variety of animals have been found living in or on the tests of xenophyophores and they can also enhance the diversity and abundance of species living in the sediment beneath.

2011-12-09_09-30-20_James Cook_JC066_8_3_ROV15: *On hard substrata, frequently observed epilithic organisms include corals, actiniarians, hydroids, sponges, ascidians and crinoids*. © NERC.

For both hard and soft substrata, exposure to current is important in determination of the local distribution of fauna. Epilithic species favour locations with a higher exposure to current at a variety of spatial scales. Thus the abundance of suspension feeders on hard substrata may be higher on seamount peaks and along the rims of summits, on terraces or basalt dykes, whilst at smaller spatial scales, abundance is higher on pinnacles and knobs of rock or on vertical rock walls. Areas with a greater exposure to current probably also receive greater supplies of suspended food particles and perhaps larvae, whilst substrata are less likely to become inundated with sediment. For soft substrata, current directly influences the grain-size of sediments, and infaunal densities have been observed to be inversely proportional to coarseness of sediment.

Depth is also a major determinant of community composition on seamounts. Shallow seamounts, where the summit lies within the euphotic zone, may host communities of macroalgae including kelps and coralline encrusting algae or, in the tropics, reef-forming corals. Analyses of the composition of communities beneath the euphotic zone show that the taxa present and community composition vary significantly with depth. This is a result of changes in environmental parameters such as temperature, pressure, oxygen concentration and food supply with increasing depth.

Seamount communities tend to reflect the local species pool and can display normal patterns of latitudinal species turnover from the tropics to sub-polar regions as other marine ecosystems. Although there have been claims of high levels of endemism in seamount fauna from some regions of the world, these are difficult to evaluate because of the lack of sampling of non-seamount deep-sea habitats within regions. Contradictory evidence to high levels of endemism include studies that have identified that seamounts represent a 'sub-sample' of regional fauna (see above), and evidence of widespread haplotypes in organisms such as corals and fish have been cited as supporting long-distance dispersal of species that live on or around seamounts. However, genetic studies have only been undertaken on a limited subset of seamounts and taxa; interpretation of genetic data can be complicated by historical influences on populations; and there are studies that provide evidence of genetic differentiation between populations located between seamounts, and between seamounts and islands or the continental margin. Sampling of seamounts at larger geographic scales is extremely uneven, making attempts to estimate the geographic range of seamount associated species difficult to ascertain. Regardless of levels of endemism, it is clear that seamount communities are different in composition to those of nearby slopes of continents and oceanic islands. Taxa that are rarely observed or which occur as scattered individuals may be abundant on seamounts, raising the possibility that seamounts may act as source populations for some taxa within regions. Such findings not only complicate the relationship between sampling effort on seamount and non-seamount

Yellow octocoral. © David Shale, 2011.

localities and estimates of levels of seamount endemism, but also make interpretation of the conservation value of seamounts markedly different to one based solely on the presence of endemic species.

II. SPECIFIC: THE SOUTHERN INDIAN OCEAN AND ITS SEAMOUNTS

The Indian Ocean is the world's third largest ocean, stretching 9,600 km from the Bay of Bengal to Antarctica and 7,600 km from Africa to Australia. It is a globally important region for marine capture fisheries, representing more than 10% of global catches according to the latest FAO figures (as of July 2010). Within this region, the western Indian Ocean is notable for recent increases in fish catches. However, it is also the region of the world where the highest proportions of exploited fish stocks are of unknown or uncertain status, reflecting problems of fisheries management and ocean governance in the region. Artisanal fisheries in the Indian Ocean are critical for the livelihoods and food security of the populations of coastal States in the region, particularly island nations such as the Seychelles. The offshore fisheries of the western Indian Ocean are rich but countries within the region have been unable to develop the infrastructure to exploit these fisheries. As a result they have allowed the distant-water fishing fleets of developed countries to access fish resources through multilateral or bilateral agreements. This situation is promoted by the subsidies received by foreign distant-water fleets which give them a competitive advantage over local fishing fleets.

Unlike other oceans of the world, the Indian Ocean was explored relatively little during the 'heroic age' of deep-sea exploration. It was only during the Indian Ocean Expedition of 1962-1965 that deep-sea areas were extensively sampled. Since that time deep-sea research in the Indian Ocean has largely focused on the Arabian Sea, and in general the deep-sea ecosystems of the rest of the region remain poorly explored. Although the geology of seamounts in the Indian Ocean has been explored extensively, the seamount fauna inhabiting the region is poorly known. There is an urgent requirement to explore these ecosystems to complete the picture of the biodiversity and productivity associated with the Indian Ocean. Until now the main source of information on the biology of these seamounts have been scientific/fisheries reports of past Soviet expeditions related to exploratory fishing which are focused on fish populating the ridges of the Indian Ocean. Here, current knowledge on seamounts in the Indian Ocean is summarized with respect to geology and particular ecology.

The Indian Ocean hosts fewer seamounts than the Atlantic and Pacific Oceans. Many seamounts are associated with ridges or originate at ridges (spreading centres) even though they are located within the ocean basins of the Indian Ocean. Several ridges form significant ranges of seamounts. Several of them are aseismic and may be associated with hot-spots and several are extremely long. Uplifted areas of

Arcturid. © David Shale, 2011.

the seafloor are a special feature of the Indian Ocean and include areas such as the Aghulas Plateau and the Mascarene Plateau. Most seamounts in the Indian Ocean are deep (>3,000m) and most are located north of 55˚S and west of 80˚E.

Whilst little is known about the biology associated with seamounts in the Indian Ocean, studies have indicated that they exert an important influence on water circulation in the region. This also holds true for deeper circulation as well. At smaller scales, ridges within the Indian Ocean are associated with internal wave formation, and possibly the formation of eddies and localized upwelling. However, studies on mesoscale to microscale oceanography associated with seamounts in the Indian Ocean remain few.

A. Biology of seamounts in the Indian Ocean

Data on the diversity of biological communities of the Southern Indian Ocean are sparse. More studies have been undertaken on Walter's Shoal than other seamounts, probably because the region is closer to land than other areas and because of interests in commercial fisheries in the region. The shoal was sampled during the Indian Ocean expedition in 1964 by the R/V Anton Bruun and subsequently by the Vityaz. These collections included a new endemic sub-species of crinoid prevalent in the shallow waters of the shoal, and several crustaceans including an endemic species of alpheid shrimp and an endemic isopod. Recently, an endemic species of rock lobster has been described from the shoals following the landing of the species from commercial fishing vessels. Authors described the fish fauna from ~400 m depth to the surface on the shoal (summit depth approx. 15 m) and identified 20 species of which several were potentially endemic, undescribed species; several were widespread temperate or sub-tropical species and several were Indo-Pacific reef-associated species. Biogeographic affinities of elements of the shallow fish fauna with Gough Island, Tristan da Cunha and St Pauls and Amsterdam Islands (West Wind Drift Islands) were identified. Others are found in Australia and New Zealand. Several other species from Walter's Shoal also occur on the South West Indian Ocean Ridge. The implication here is that the Sub-Tropical Anticyclonic Gyre and Antarctic Circumpolar Current and/or other westerly flowing currents have assisted in transoceanic dispersal of these species, with islands and seamounts acting as stepping stones. Russian exploration of the Madagascar Ridge in the search of fisheries resources identified several species of fish.

Several investigations on the macroplankton occurring on slopes and seamounts in the Indian Ocean have been summarized and list a large number of taxa as occurring on Walter's Shoal. These animals fall into two distinct groups: species that were associated mainly with the water column and decrease in numbers towards the seabed; and those that are associated with the seabed. The latter group falls into several categories, including: animals that are found near the seabed at night

http://seamountsexpedition.blogspot.com

MONDAY, DECEMBER 12, 2011

Trapped on a mountain

By Philipp Boersch-Supan, University of St Andrews and University of Oxford

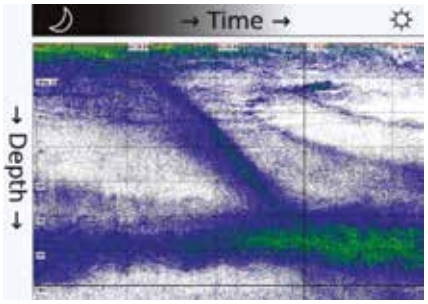
Around seamounts large fishes appear to be more abundant than elsewhere – one reason why fisheries tend to focus on these features. Currently it is poorly understood what mechanisms provide the food to these seamount-residents as the open ocean is a comparably food-poor environment.

Phytoplankton are tiny plant-like creatures that dwell in sunlit surface waters across the world's oceans; small jellies and crustaceans graze on them and are in turn eaten by slightly bigger animals, for example inch-long hatchetfish or small squid. In fact, the risk of predation is so large near the surface that many midwater animals hide in the twilight zone many hundreds of meters below the waves during the day, and only come up to feed at night under the cover of darkness. As soon as the sun comes up they disappear into the inky deep again. This daily vertical migration is one of the defining characteristics of midwater life, and might be the largest animal migration on earth both in numbers and in terms of biomass.

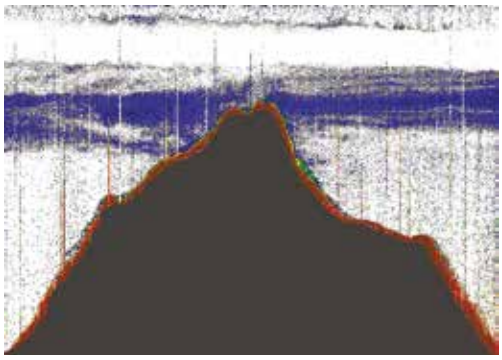
Hiding in the deep darkness might seem a good idea when predators lurk at the surface. Around seamounts, however, the downward migration comes with added danger. Having drifted over the summit of a seamount, the midwater animals become trapped on the mountain top when they descend around sunrise. Seamount resident predators like rockfish or alfonsino are only too happy to turn these trapped animals into breakfast.

Exactly how much biomass is transferred from the midwater into the stomachs of seamount fish is unknown, and in my PhD research I am trying to gain a better understanding of this process. Earlier in the blog you heard about how Lily is using sound to map the seafloor (Nov. 16th), and essentially I am using the same principle to map the distribution of midwater animals around seamounts. The difference is that the echoes from fish and invertebrates are very faint and thus much more difficult to detect. Also, inferring the type and size of animal from the echo trace is not always possible, as not all animals are equally good reflectors of sound. For example, the gas-filled swimbladder of a small fish might return a much stronger echo than the watery body of a large squid or even a jellyfish (see Clare's blog on Nov. 14th). Nonetheless, even without knowing exactly which species I am observing, I have already learned a lot about the interactions between midwater animals and seamounts.

These hatchetfish are about 2 cm long and migrate around 600m vertically every evening and every morning.
On a human scale this is like walking roughly 50 km to get food, and then 50 km back to get home (photo: Oddgeir Alvheim).



As the sun comes up, midwater animals migrate into deep water.
Green indicates dense aggregations of animals,
white indicates their absence.



Echogram of an unnamed seamount (brown/grey) protruding into a layer of midwater animals (blue).

Stoloniferous coral. © David Shale, 2011.

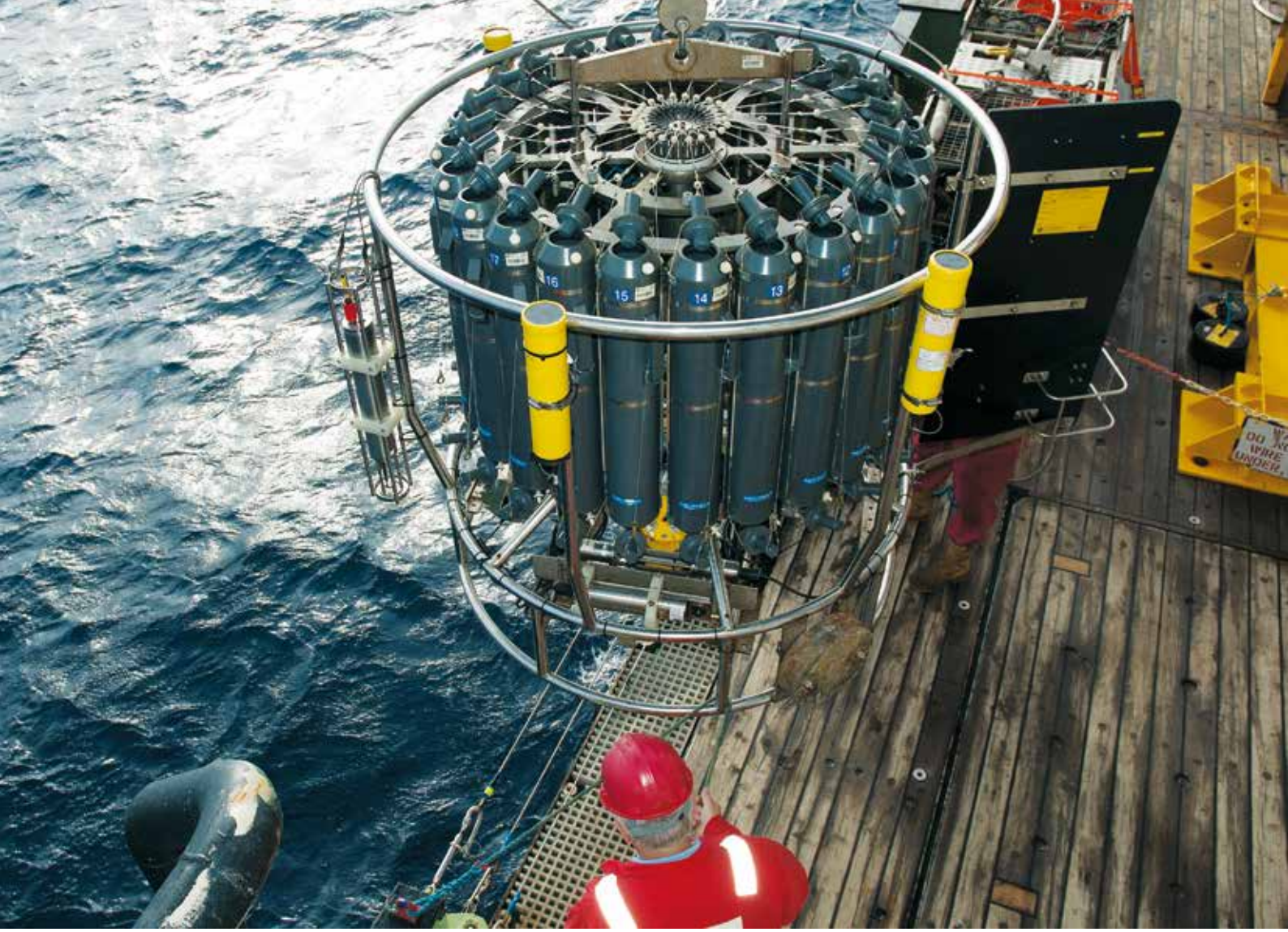
but disappear by day, presumably because they migrate to benthic habitats during daylight hours; animals found well above the seabed by day and which descend to the seabed by day; and larval animals which are found mainly over areas of seabed inhabited by adults.

Investigations of high-seas areas of the Indian Ocean for fish resources were undertaken by Soviet research vessels and exploratory fishing vessels from the 1960s to 1998. Whilst detailed information is not available data on the fish species present on the South West Indian Ocean Ridge have been published. It was noted that seamounts on the South West Indian Ocean Ridge showed a marked variation in the fish present. Some of the species listed are exclusively Antarctic/ Sub-Antarctic and so probably occur further south than the seamounts sampled on the present expedition.

As with invertebrates and fish, knowledge of the distribution of aquatic predators, including cetaceans and birds in the region, is sparse. There have been sightings of concentrations of humpback whales in the vicinity of Walter's Shoal, suggesting that it may be an important migratory area between high-latitude feeding grounds and low-latitude breeding grounds off Madagascar. There are reports of pilot whales, humpback whales and sperm whales in the areas of deep-water fishing in the Southern Indian Ocean, although it is not clear where these were.

Sightings of birds are rare in the areas of fishing and these were rarely seen north of 35˚S. White-chinned petrels had been reported as occurring in areas of deep-water fishing, and cape pigeons and sooty shearwaters were reported as being observed from fishing vessels. Bird observations taken from a cruise between La Réunion, Crozet, Kerguelen, St. Paul, Amsterdam Islands, and Perth, Western Australia identified 51 species of birds from over 15,000 sightings. During this cruise the density of birds increased significantly across the sub-tropical convergence, from 2.4 birds/km^2 in sub-tropical waters to 23.8 birds/km^2 in sub-Antarctic waters. The taxonomic composition of birds also differed markedly in the three areas, with prions accounting for 57% of all sub-Antarctic birds, wedge-tailed shearwater accounting for 46% of all subtropical birds, and Indian Ocean yellow-nosed albatross accounting for 32% of all birds in the sub-tropical convergence zone. Given that this cruise transited part of the South West Indian Ocean Ridge, it would seem likely that significant numbers of seabirds are present in the vicinity of the seamounts, particularly in the more southerly areas.

Hydrothermal vents have been located on ridges in the Indian Ocean. The first were observed on the Central Indian Ocean Ridge in 2000. This site comprised a fauna with affinities to western Pacific hydrothermal vent fields but with the addition of shrimps. Vent plumes were first identified along the South West Indian Ocean Ridge in 1997 but the first vent has only just been discovered using an autonomous underwater vehicle. The site has not been sampled but comprises black smokers, sulphide edifices and a fauna comprising stalked barnacles, anemones and gastropods. Hydrothermal vents are of current interest for mineral extraction and it is likely that possibilities for mining these sites will be explored in the future (see below).



Deployement of the CTD (Conductivity, Temperature, Depth recorder). The CTD is an oceanographic instrument commonly used to record salinity (by measuring conductivity), temperature, and depth (by measuring pressure). © IUCN/Aurélie Spadone.

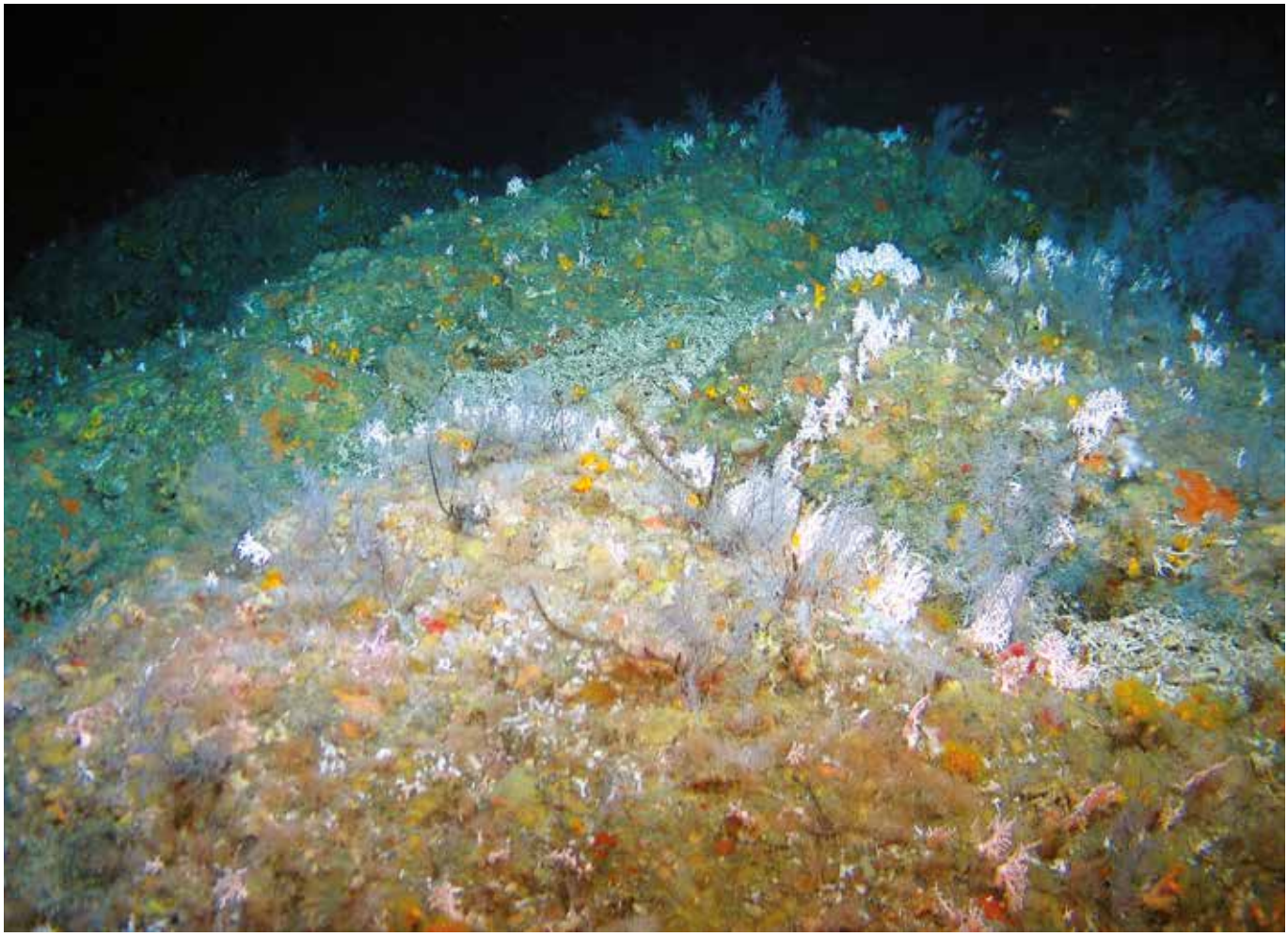
B. Deep-sea fisheries on seamounts in the Indian Ocean

The development of deep-sea fisheries in the high-seas regions of the Indian Ocean was undertaken by distant-water fleets of developed countries, particularly the USSR, whose distantwater fishing fleet in the early 1970s was the largest in the world. Exploratory fishing on the South West Indian Ocean Ridge, the Mozambique Ridge and the Madagascar Ridge began in the 1970s by the Soviet fleet, and associated research institutions, with commercial trawling beginning in the early 1980s. These fisheries targeted redbait and rubyfish with catches peaking in about 1980 and then decreasing in the mid- 1980s. Fishing then switched to alfonsino in the 1990s as new seamounts were exploited. Some exploratory trawling was also carried out on the Madagascar Ridge and South West Indian Ocean Ridge by French vessels in the 1970s and 1980s, targeting in particular Walter's Shoals and Sapmer Bank.

In the late 1990s, a new fishery developed on the South West Indian Ocean Ridge, with trawlers targeting deep-water species such as orange roughy, black cardinal fish, southern boarfish, oreo and alfonsino. This fishery rapidly expanded, with estimated catches of orange roughy being in the region of 10,000 tonnes, but the fishery rapidly collapsed. Fishing then shifted to the Madagascar Plateau, Mozambique Ridge and Mid-Indian Ocean Ridge, targeting alfonsino and rubyfish.

Fishing continues along the South West Indian Ocean Ridge, mainly targeting orange roughy and alfonsino. Recent fishing has also taken place on the Broken Ridge (eastern Indian Ocean), 90 East Ridge, possibly the Central Indian Ridge, the Mozambique Ridge and Plateau and Walter's Shoal (western Indian Ocean), where a deepwater fishery for lobster has developed. The banks around Mauritius within the Exclusive Economic Zone (EEZ) and high-seas portions of the Saya da Malha Bank have been targeted by fisheries for snappers and lethrinid fish. There are also reports of unregulated fishing using gillnets (which target sharks) in areas of the Southern Indian Ocean such as Walter's Shoal. The Southern Indian Ocean Fishers' Association (SIODFA) report that their vessels undertake approximately 2,000 deepwater trawl tows per year in the entire Indian Ocean. By-catch of fish from SIODFA fishing operations in the region are reported to be small, especially when fishing below 500 m depth. As with New Zealand vessels operating in the southern Pacific Ocean, tow times have been reported to be typically short in the region, with a duration of 10-15 minutes, reflecting the highly targeted nature of roughy and alfonsino fisheries on seamounts.

Currently (as of July 2010), there is little or no information available for the assessment of the impacts of deep-sea fishing in high-seas areas of the Indian Ocean on populations of target or bycatch species. Reporting of data is complicated by issues of commercial confiden-



2011-11-24_15-04-15_James Cook_JC066_5_14_ROV08. © NERC.

tiality in fisheries where individual stocks may be located across a wide area (e.g., the South West Indian Ocean Ridge). At present, new fisheries are developing in the region with no apparent assessment of resource size or appropriate exploitation levels to ensure sustainability of fisheries.

C. Management of deep-water fisheries on the high seas of the Indian Ocean

At present there are two main agreements that exist for the Southern Indian Ocean, the Southwest Indian Ocean Fisheries Commission (SWIOFC), which was opened in 2004 to promote sustainable utilization of marine living resources. This agreement was signed by Comoros, France, Kenya, Madagascar, Mauritius, Mozambique, the Seychelles, Somalia and Tanzania. SWIOFC is focused on shallow-water fisheries but some States are investigating new fisheries for deepwater species within their EEZs. In 2006, the South Indian Ocean Fisheries Agreement (SIOFA) was opened and signatories so far include Australia, the Comoros, France, Kenya, Madagascar, Mozambique, Mauritius, New Zealand, Seychelles and the European Community. However, the latter agreement, which forms the basis of a regional fisheries management organization (RFMO), entered into force in June 2012 only. This delay in the implementation of the SIOFA agreement, and the concern it raised amongst several of the deep-water fishing companies in the area, brought about the formation, in 2006, of SIODFA. The association's objectives are to promote technical, research and conservation activities that will furnish a future RFMO with the necessary data required for management of deep-water fisheries in the region.

At present the only initiative protecting vulnerable marine ecosystems in the high-seas region of the Indian Ocean is the unilateral declaration by SIODFA of Benthic Protected Areas (BPAs). The companies that belong to SIODFA have voluntarily closed these areas to bottom-fishing or mid-water trawling. The BPAs were selected on the basis of a number of criteria, including:

— representivity of seabed type (e.g., seamount, slope edge);

— fishing history;

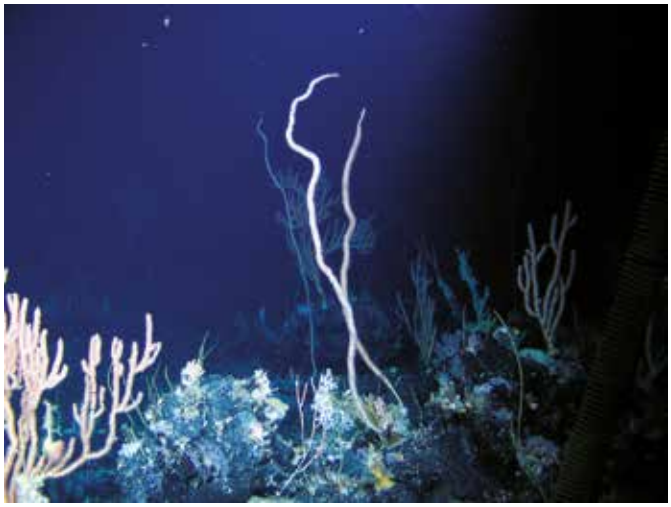
— level of pre-existing knowledge on an area of geology, bathymetry and biology;

— protection of benthic communities; and

— protection of areas of special scientific interest (e.g., geological features of Atlantis Bank).

Using these criteria, ten areas were protected in the Indian Ocean on the basis of the knowledge gathered from various sources by the

Narella. © David Shale, 2011.



2011-12-02_07-48-58_James Cook_JC066_6_7_ROV13. © NERC.

members of the association, as well as the research and data gathered during fishing operations by vessel masters. These sites include a number of seamount, knoll, ridge and other topographic features that in some cases are known or suspected to host Vulnerable Marine Ecosystems (VMEs), as well as populations of commercial and non-commercial fish species.

At present little is understood about the representivity of the BPAs or whether they offer protection from bottom-fishing, as non-members of SIODFA are under no legal obligation to avoid fishing these areas.

III. KNOWLEDGE GAPS

In general terms many aspects of our understanding of seamounts remain poor. The seafloor of the oceans is not mapped to a sufficient resolution to determine the position, size and shape of the majority of seamounts, particularly those <1,000 m in elevation. Knowledge on interactions between seamounts and the ocean is based on a few observational 'case studies' and modeling of idealized seamount and flow configurations. Likewise, studies of pelagic and benthic communities on seamounts remain limited, with only a few hundred seamounts having been sampled at all and only few of these having been sampled extensively. With such a lack of observations, generalization about any aspect of the biology of seamounts is extremely difficult.

As well as very limited sampling effort, seamount studies are also subject to significant bias in a number of aspects. For example, few low-latitude seamounts have been studied as most research has concentrated on mid-latitude seamounts close to the coastlines of developed States (e.g., NE Atlantic or SW Pacific). Knowledge of seamounts is particularly poor for some regions, especially the Indian Ocean, parts of the Pacific and the Southern Ocean. Studies on seamount fauna have focused on large organisms obtained in dredges or bottom trawls, or those easily viewed from towed cameras or submersibles.

Despite these limitations, a general picture of the potential interactions of seamounts with the ocean, and there importance to marine ecosystems, has developed, especially over the last 20 years. To further this understanding, particularly in the context of management

HYBIS towed camera and grab system being recovered on board the RRS James Cook. © Philipp Boersch-Supan.

of seamount ecosystems, the following areas require further research effort at the present time:

— Meter – 100 km scale current-seamount interactions, particularly in relation to tidally-driven effects;
— Linkages between current-seamount interactions and seamount food webs;
— Resolution of the importance of upwelling, vertical mixing, retention and resuspension on primary production;
— The basis of seamount food webs, particularly bentho-pelagic coupling;
— Factors influencing the seamount-scale distribution of benthic organisms;
— The importance of seamount ecosystems to the surrounding ocean, especially to visitors such as aquatic predators;
— Connectivity of seamount populations, and distributional geographic ranges of seamount species;
— The differences (and similarities) of seamount and non-seamount communities, including consideration of ecosystem structure and endemism;
— Life histories of seamount species;
— The nature of the association between commercially targeted species and the seamount ecosystem;
— Recovery of seamount ecosystems following human-induced impacts; and
— Long-term implications of climate change to seamount communities.

Screen Shot 2011-12-06 at 22.35.09. © NERC.

III.2 - ANTHROPOGENIC THREATS TO SEAMOUNT ECOSYSTEMS AND BIODIVERSITY

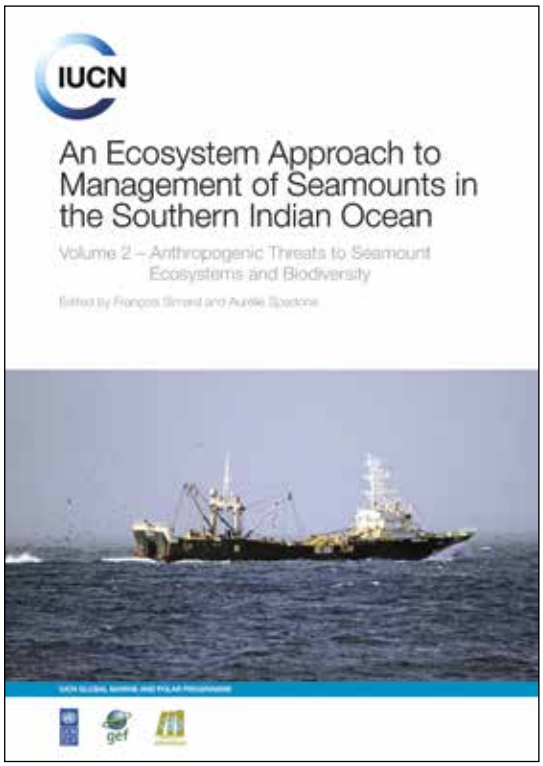
This paper is the executive summary of :
A*n Ecosystem Approach to Management of Seamounts in the Southern Ocean, vol. 2: Anthropogenic Threats to Seamount Ecosystems and Biodiversity*. Simard F. & A. Spadone (ed.), IUCN, 2012.

The individual and cumulative threats to and effects of the full range of human activities on marine ecosystems and biodiversity in general, and seamounts in particular, in areas beyond national jurisdiction (ABNJ) are still largely unknown. These threats and their effects must be taken into account in order to be able to develop a robust, holistic ecosystem-based management scheme. This paper compiles and examines existing and potential future threats to seamount ecosystems and biodiversity located in ABNJ of the Indian Ocean. It is also intended to serve as a template for anthropogenic threat analyses of other seamount ecosystems elsewhere. Hence the scope of the present study includes actual and imminent threats to these areas as well. An institutional and legal gap analysis complements this paper. The reader is referred to this companion paper as appropriate.

Ecosystems and biodiversity must not be conflated. They play interactive but distinct roles in the marine environment. Biodiversity is the fundamental component of ecosystems, and a variety of ecosystems is included in the concept of biodiversity. Biodiversity provides options for organisms to respond to environmental challenges – such as those posed by the activities addressed in this paper – by maintaining their variability. To function best, biodiversity requires healthy ecosystems and vice-versa. Maintenance of biodiversity is essential to ecosystem stability. Loss of biodiversity can temporarily or permanently move an ecosystem into a different set of biogeochemical conditions, and lead to – at best – changes and – at worst – disruption of or reduction in the ecosystem's effective operation.

Many different mechanisms and ecosystems are responsible for the origin and maintenance of different aspects of biodiversity. They are all important to one or more species at one or more points in their life cycle. Marine ecosystems are numerous and varied, they operate on several temporal and spatial scales, and they are all crucial to marine biodiversity.

The activities posing actual or potential threats to seamount biodiversity and ecosystems are grouped into three categories. All activities physically conducted here will involve ships. Activities common to the use of all ships (category 1) are distinguished from activities for which the ship serves primarily as a platform (category 2). Category 3 covers activities that do not involve ships but that actually or potentially affect seamount biodiversity and ecosystems, including land-based activities.



From an ecosystem-based standpoint, categories 1 and 3 represent an underlying chronic set of threats, superimposed on which are acute, and potentially chronic, threats from category 2. None of the activities operate in an otherwise unstressed (threat- and effect-free) environment. Anthropogenic threats and their effects can and often do interact, with cumulative and synergistic adverse consequences for seamount biodiversity and ecosystems. Therefore none of the activities should be considered in isolation in assessing its implications for seamount biodiversity and ecosystem health.

The threats to seamount biodiversity and ecosystems fall into one or more of the following four overarching categories:

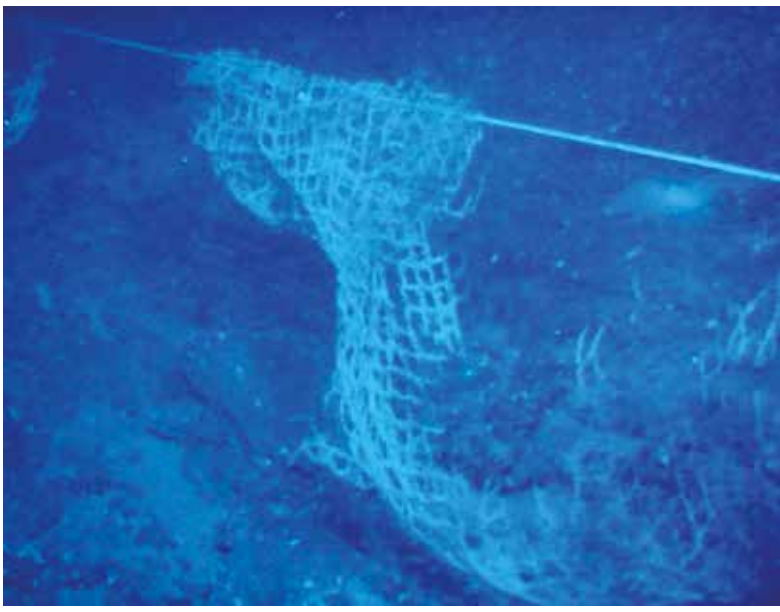
1. Pollution
2. Habitat destruction, degradation and fragmentation
3. Overexploitation
4. Invasive alien species (IAS).

Feather star on coral. © David Shale, 2011.

Although the detailed interaction – feedback loops – among this quartet of fundamental threats is poorly understood, they also usually overlap in and exacerbate their individual deleterious effects on seamount ecosystems and biodiversity. It is highly likely that their detrimental effects are also synergistic and cumulative. The ultimate results of pollution, overexploitation and IAS are to degrade, fragment and eventually destroy seamount habitats, and thus their biodiversity and ecosystems on an oceanic, i.e., basin-wide, scale.

Ecosystem change in response to threats is often neither linear nor gradual. It tends to occur abruptly or accelerates once a threshold is crossed. This threshold is called the tipping point. After the tipping point has occurred, recovery or rehabilitation of the ecosystem is virtually impossible. Even if it were possible, it would be prohibitively expensive. The occurrence of tipping points in the marine environment is at present unpredictable.

Seamount ecosystems are particularly fragile and vulnerable to anthropogenic threats. Any additional or new activity, or the intensification of an ongoing activity, could become the tipping point for the collapse of a seamount ecosystem. At present an objective comparator of the threats and effects associated with the activities in this regard is lacking. This fundamental knowledge gap would be filled by a mechanism to improve the predictability of the tipping point trigger(s) and to improve the quantification of the risks thereof for seamount ecosystems.



Lost net found by the RRS James Cook ROV on the seabed. Abandoned or lost nets may continue to "ghost fish" for a long period of time. © NERC.

III.3 - LEGAL AND INSTITUTIONAL GAP ANALYSIS

This paper is the executive summary of :
Robin Warner, Philomène Verlaan and Gail Lugten. A*n Ecosystem Approach to Management of Seamounts in the Southern Ocean, vol. 3: Legal and Institutional Gap Analysis*. IUCN, 2012.

The International Union for Conservation of Nature (IUCN) is committed to achieving effective protection, restoration and sustainable use of biological diversity and ecosystem processes on the high seas. IUCN Resolution 4.031 (2008), "Achieving conservation of marine biodiversity in areas beyond national jurisdiction", called, inter alia, for the promotion of arrangements, processes and agreements that ensure the consistent, coordinated and coherent application of the best conservation and governance principles and approaches, including integrated ecosystem-based management and the precautionary approach.

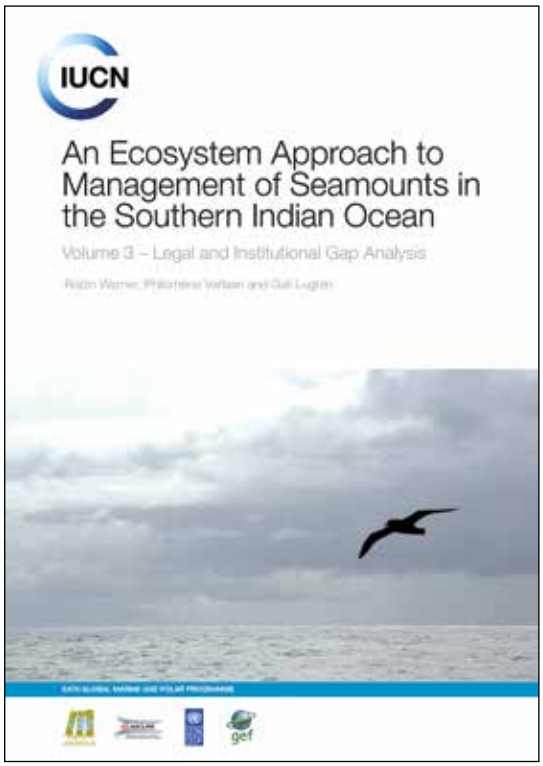
To implement this mandate, IUCN and the United Nations Development Program (UNDP) developed a project entitled "Applying an ecosystem-based approach to fisheries management: focus on seamounts in the southern Indian Ocean", which was approved by the Global Environment Facility (GEF) in December 2008. The overarching project objective is to help improve marine resources conservation and management in the high seas. A biodiversity-rich area beyond national jurisdiction (ABNJ) centred on seamounts of the southern Indian Ocean (SIO) will serve as a test case.

Trending NE across approximately 10 degrees of latitude (~41-31 degrees S) in the SIO, the project area covers five seamount regions, two of which are inside proposed Benthic Protected Areas (BPAs), Atlantis Bank and Coral Seamount, and three outside BPAs. The following States are nearest to the project area: France (via Crozet Island, La Réunion), Madagascar, Mauritius, Mozambique and South Africa.

The four main components of the project are:

1. Improve scientific understanding of seamounts in the SIO (2 research expeditions, one each in 2009 and 2011);
2. Improve the governance framework for the project area;
3. Develop a model ecosystem-based management framework for the project area; Communications and outreach.

This report[1] commences the implementation of the second component. It presents a so-called legal and institutional gap analysis of the



project area and proposes improvements to the legal and institutional framework. This type of analysis identifies global and regional legal instruments and institutional arrangements which apply to the project area and assesses any legal and governance gaps related to the conservation of biodiversity in the project area.

A number of legally binding and not legally binding global instruments address the protection and preservation of the marine environment and its living resources. The study focuses on the legally binding instruments applicable to the project area. Annex 2 briefly reviews the principal related instruments that are not legally binding. They provide guidance for the implementation of the existing legally binding obligations and form the basis for their further development.

The 1982 Law of the Sea Convention (LOSC) is the overarching primary legally binding global instrument of international law governing the oceans. Analyzed in Part III, it sets out detailed obligations on

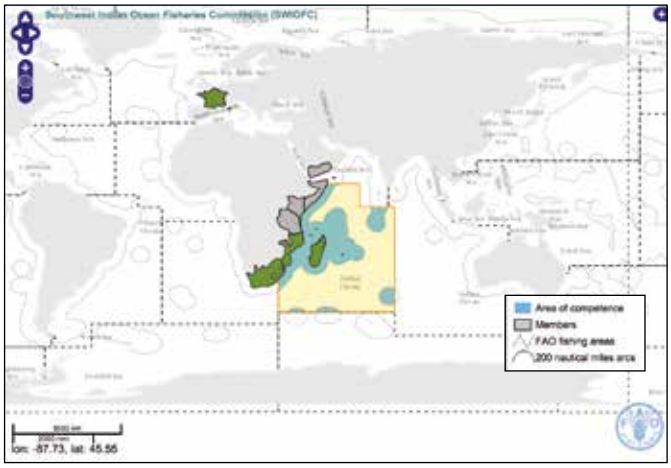
[1] Robin Warner, Philomène Verlaan and Gail Lugten. *An Ecosystem Approach to Management of Seamounts in the Southern Ocean, vol. 3: Legal and Institutional Gap Analysis*. IUCN, 2012. http://data.iucn.org/dbtw-wpd/edocs/2012-078-3.pdf

Feather star on coral. © David Shale, 2011.

States for marine environmental and living resource protection, conservation and management throughout the ocean, including ABNJ, and hence also to the project area. States must cooperate on a global and, as appropriate, regional basis for marine environmental and living resource protection, conservation and management and to formulate and elaborate international rules and standards and recommended practices and procedures for the protection and preservation of the marine environment and conservation of living resources.

Even on the high seas, i.e., in ABNJ and thus in the project area, States are circumscribed in what they may do. The exercise of so-called high seas freedoms is subject to the conditions laid down by the LOSC, which include the provisions on marine environmental and living resource protection, conservation and management LOSC Part XII on the marine environment, and by other rules of international law. These freedoms must be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas. The 'due regard' obligation was interpreted by the International Court of Justice to require cooperation between States for conservation of living resources even on the high seas, when "the needs of conservation for the benefit of all" are involved. The parties were also required "to take full account... of any fishery conservation measures the necessity of which is shown to exist in those waters." Hence these obligations are applicable to the project area.

The LOSC does not depend on its implementation through development of annexes and protocols. It is wholly applicable to its [162 as of 12/2011] States Parties. Those parts of the LOSC that reflect or



Southwest Indian Ocean Fisheries Commission (SWIOFC) area of competence.

In green, France (via Crozet Island and La Réunion), Madagascar, Mauritius, Mozambique and South Africa are the nearest to the project area.

http://www.fao.org/figis/geoserver/factsheets/rfbs.html, modified.

2011-11-25_13-20-22_James Cook_JC066_5_20_ROV09. © NERC.

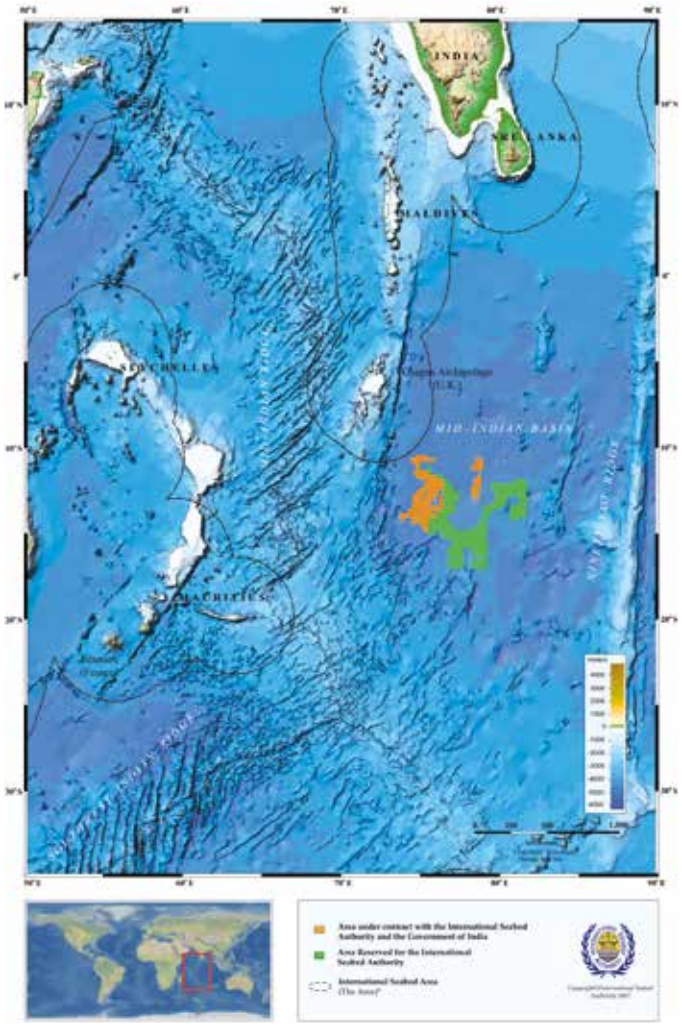
have become customary international law are generally considered to apply to non-parties. Signatories that have not yet ratified the LOSC are obliged under international law not to take any actions that would defeat the object and purpose of the LOSC.

Recognizing the need for ecosystem-based management of the oceans, the LOSC requires States to take measures to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life. This obligation applies throughout the oceans and thus also to the project area. In this regard the global Convention on Biological Diversity (CBD), with its addition of the concept of biological diversity to the lexicon of international law, complements the LOSC. In relation to the marine environment, the CBD requires that it be implemented consistently with the rights and obligations of States under the LOSC. This provision reinforces the CBD, as parties to both instruments must comply with the far stronger obligations imposed by the LOSC on States to protect and preserve the marine environment under Part XII, including in ABNJ, and hence in the project area. As further described in Part III, the CBD also assists in the implementation of the LOSC's marine environmental protection requirements through its provision of details on the definition of biological diversity and its conservation.

The LOSC sets out specific obligations governing environmental effects of maritime traffic, including dumping at sea of wastes and other matter. These obligations are further defined in a suite of global conventions dealing with pollution by oil, noxious liquid substances in bulk, harmful substances carried by sea in packaged form, sewage, garbage, air pollution, ballast water, dumping, and emergency responses to spills, usually promulgated under the auspices of the International Maritime Organization, and addressed in Part III.

With regard to fisheries, the LOSC, the UN Fish Stocks Agreement and the Food and Agriculture Organization (FAO) High Seas Compliance Agreement are the principal global legally binding instruments applicable to ABNJ and hence also to the project area. The so-called high seas freedom of fishing, already limited by the marine environmental provisions of the LOSC, and arguably by the biodiversity provisions of the CBD, is further circumscribed by these instruments.

Additional protection to the project area is afforded by specific species-focused global legally binding instruments, in particular those related to cetaceans and migratory species, and to trade in endangered species generally, all also addressed in Part III, as is the underwater cultural heritage of the project area, which is also protected by a dedicated convention.



Polymetallic nodules exploration in the Indian Ocean.
© International Seabed Authority, 2007.

The seabed of the project area is part of the so-called Area and is under the jurisdiction of the International Seabed Authority (ISA), an intergovernmental body set up and governed by the LOSC and its Part XI Implementing Agreement. The ISA is responsible for adopting appropriate rules, regulations and procedures for the prevention of pollution and other hazards to the marine environment caused by activities in the Area and for the protection and conservation of the natural resources of the Area. States have a complementary obligation under the LOSC to adopt laws and regulations, no less effective than those adopted by the ISA, to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by their flag vessels, installations, structures and other devices. In the Indian Ocean, as of 12/2011, the ISA has issued one exploration license for polymetallic nodules in the Central Indian Ocean Basin to the Government of India. The ISA has issued 2 sets of regulations, for polymetallic nodules and for sulphides, respectively, that impose stringent and comprehensive environmental protection obligations on the States and State-sponsored entities involved in the prospecting and exploration phases for these deposits.

The Regulations and ISA's Environmental Guidelines for Polymetallic Nodules provide useful examples of Environmental Impact Assessment (EIA) for activities that could affect benthic habitats.

Although a number of unresolved sovereignty disputes exist in the western Indian Ocean, none affect the project area. The five States nearest the project area have each proclaimed a 200-nautical-mile Exclusive Economic Zone (EEZ) and each benefits from a 200-nautical-mile 'legal' continental shelf. Future challenges for the Indian Ocean will include the settling of extended continental shelf claims. States can claim a continental shelf beyond 200 nautical miles, up to a total of 350 nautical miles, where certain physical criteria are met. Claims must be lodged with the Commission on the Limits of the Continental Shelf; the deadline for doing so having passed for the five States nearest the project area on 30 May 2009.

Particularly since the adoption of the LOSC, international law has recognised the importance of regional cooperation as an important tool in the conservation and management of marine biodiversity. With regard to the project area, no ready-made regional institutional mechanism for the management of the project area currently exists in the region. However, four potentially relevant regional mechanisms are present, two with a marine environmental focus and two with a fisheries focus. These are briefly summarized below.

— The Eastern African Regional Sea Programme, whose members include the five States nearest the project area. Developed under the auspices of UNEP and headquartered in the Seychelles, it is governed by the legally binding Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) and two Protocols (on Protected Areas and Wild Fauna and Flora, and on Co-operation in Combating Marine Pollution in Cases of Emergency), which provide a mechanism for regional cooperation to address marine and coastal environmental issues.

— The UNDP-GEF Agulhas and Somali Current Large Marine Ecosystem Project (ASCLME), a regional International Waters project, whose objectives are to gather information on all aspects of the LME, to document environmental threats facing the LME, to develop an action plan for dealing with transboundary threats, and to introduce an ecosystem approach to managing the marine resources of the western Indian Ocean. The five States nearest the project area are participants.

— The Indian Ocean Tuna Commission (IOTC), set up by an Agreement under FAO auspices for the purpose of conserving and managing tuna and tuna-like species that migrate into or out of the Indian Ocean, including the project area, and encouraging sustainable development of fisheries based on such stocks. The lack of an ecosystem approach to fisheries management, the absence of the precautionary approach, and no application of area-based management tools were deficiencies noted in a 2008 performance review. Of the five States immediately adjacent to the project area, only Mozambique is not a member of the IOTC.

— The Southern Indian Ocean Fisheries Agreement (SIOFA), signed but not ratified by four of the States (South Africa is not a signatory) nearest the project area, and not yet in force[2]. The EU is a party in its own right, but France is not. Its objective is to ensure the long-term conservation and sustainable use of the fishery resources in the SIOFA area through cooperation among the Contracting Parties. It covers the project area and excludes all waters under national jurisdiction. Although the waters of SIOFA and the IOTC overlap, the two agreements are responsible for different species

[2] Eventually, the SIOFA Agreement entered into force on 21 June 2012.

of fish. Whereas the IOTC has a mandate for tuna and tuna-like highly migratory fish, the SIOFA is concerned with other fish species, especially demersals (such as orange roughy) which have attracted substantial fishing effort. The SIOFA incorporates more modern principles of environmental and fisheries management, including the duty of States to cooperate, implementation of an ecosystem approach to fisheries management, application of the precautionary approach, protection of biodiversity in the marine environment and a requirement that fishing practices shall take due account of the need to minimize the harmful impact that fishing activities may have on the marine environment.

Two other bodies with a fisheries focus were examined but not found to be relevant, at least not currently, as potential appropriate institutional mechanisms for the management of the project area. These are the South West Indian Ocean Fisheries Commission (SWIOFC) and the Asia-Pacific Fishery Commission (APFIC).

A potentially valuable partner could be found in a private industrial fisheries grouping, the Southern Indian Ocean Deepsea Fishers' Association (SIODFA), which unites the fishing companies that conduct most of the deepwater fishing in the southern Indian Ocean. Its primary goals are to set self-imposed restrictions to maintain unsubsidised, profitable and environmentally sustainable fisheries and to set international best practice for responsible deep-sea fishery management. SIODFA voluntarily closed more than 300,000 square kilometres to trawling, by creating 11 BPAs, which include part of the project area.

There is ample international and, to a certain extent, regional law available to provide a solid legal basis to justify setting aside the project area for marine environmental, biodiversity and living resources protection purposes. Lacking is a specific regulatory and implementation mechanism for the project area and a body to administer and enforce it. The regulatory mechanism will need to address the fisheries and non-fisheries threats to the project area – essentially implementing the international and regional laws and regulations already in place to address these threats – and identify species of common concern and priorities for protection in the project area, including the creation of a representative network of marine protected areas (MPAs) in the project area. The Nairobi Convention and its Protocols and the UNDP-GEF ASCLME project each provide a platform for regional cooperation and possibly a home for the administrative body, although this ideally should be located in one of the five States nearest to the project area. There certainly are common species of concern here. The valuable industry contribution by SIODFA to the preservation and management of ABNJ in the SIO in general and the project area in particular should be recognized, encouraged and if possible reinforced with supportive legislation. Thus the absence of an immediately appropriate regional mechanism is not an insuperable obstacle. The principal problem – or gap – with regard to protection and preservation of the marine environment and its living resources and biodiversity lies in obtaining effective compliance with and enforcement of the law. The primary responsibility for this lies with flag States, especially in ABNJ, including the project area. Because some flag States' execution of this responsibility is inadequate, port and coastal States are increasingly assuming compliance and enforcement functions. Although they increasingly apply LOSC and IMO standards to all noncompliant ships in their ports, regardless of what the flag State may – or may not – require or be party to, port and coastal States have few legal options and even fewer resources for dealing

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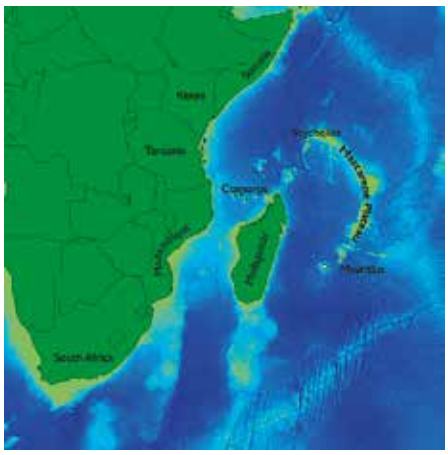

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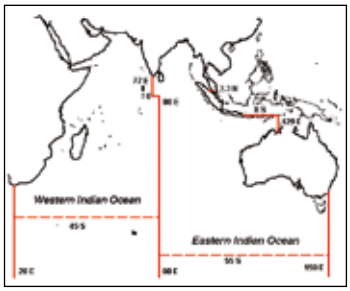

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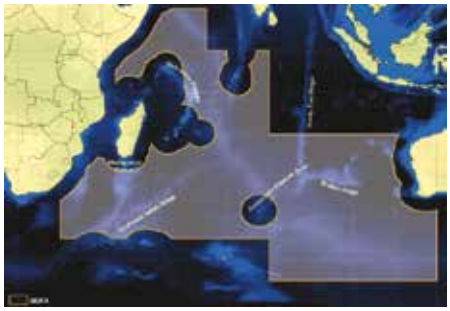


The Eastern African Regional Sea Programme (1), ASCLME (2), IOTC (3) and SIOFA (4) areas.

2011-11-25_12-03-03_James Cook_JC066_5_20_ROV09. © NERC.

with violations occurring at sea in ABNJ. This is especially the case in the project area, where the nearest coastal States are all, with one exception (France), still developing countries.

Recommendations for improvement in legal and regulatory governance of the project area are summarized below.

1. Change the focus of the IUCN GEF-UNDP Seamounts project from the existing sectoral orientation to a broader ecosystem management approach for the region, noting that fisheries is an important component.

2. A primary aim of this project should be to enhance cooperation between existing bodies and organisations rather than creating a new body.

3. Use the ASCLME project and its existing and evolving partnerships to explore the development of an alliance as a working arrangement to demonstrate effective management and governance mechanisms for ABNJ in the Indian Ocean.

4. This alliance concept should include the initiation of joint programs, plans of action, and MOUs to promote cooperation amongst the coastal States of the South West Indian Ocean, the signatories and parties to SIOFA, and the secretariats or administrative units of all relevant public and private bodies (such as the IOTC, SWIOFC, the Nairobi Convention, the ASCLME and SWIOF projects, Indian Ocean Commission, ISA, FAO, the Port State Control Memorandum of Understanding and SIODFA).

5. The initial composition of the alliance should not exclude consideration being given to including additional States and parties who are stakeholders in the sustainable development, management and use of the resources of the ABNJ in the Indian Ocean.

Southern Indian Ocean Deepsea Fishers Association
SIODFA

The SIODFA fishery in the Southern Indian Ocean consists of two major fisheries:

— A (austral) winter spawn fishery for orange roughy and

— A year-round fishery for alfonsino.

In addition to the two major targeted fishery, a range of bycatch species are sold, some of which are of relatively high value, e.g. armourhead. Retained bycatch species include:

— Oreos (Black Oreo [*Allocyttus niger*], Smooth Oreo [*Pseudocyttus maculates*] and Spiky Oreo [*Neocyttus rhomboidalis*])

— (Black) Cardinal fish (*Epigonus telescopes*)

— Bluenose warehou (Also called Antarctic butterfish) (*Hyperoglyphe antarctica*)

— Blue Eye Trevalla; Indian Ocean Trevalla (*Schedophilius labrynthica*)

— Oilfish (*Ruvettus pretiosus*)

— Pelagic armourhead (Boarfish) (*Pseudopentaceros richardsoni*).

— Rubyfish (*Plagiogeneion rubiginosus*)

— Ribaldo (*Mora moro*)

— Wreckfish, Groper (*Oxyprion* spp.)

— Ray's bream (*Brama brama*: Bramidae)

— Black gemfish/black scabbardfish (*Nesiarchus nasutus*)

Effective fishery management requires certain actions no matter size of the fishery:

— Data must be collected on the amount of catch, fishing effort, locations of catch and biological information (fish sizes, sex, status of gonads, age, etc.): this date must be analyzed and reported in a competent and timely manner.

— Resource status must be assessed: what is the biomass – at a minimum is it stable, being depleted or increasing?

— What is the status of the spawning biomass of the stocks being examined? This provides one of the determinants of subsequent potential recruitment success.

— How much fish should be harvested or at least, what level of effort should be permitted in the fishery?

— Are particular conservation measures required, e.g. closed seasons, closed areas, minimum fish sizes, protection of associated or dependent species or discarded bycatch species?

This process usually proceeds on an annual basis and for international fisheries requires the cooperation of the various flag States that are involved and the funding of working groups to undertake the required analyses in an appropriate environment of trust and confidentiality.

In the case of orange roughy, much work has been done on the population biology of this species in Australia and New Zealand, and to a lesser extent elsewhere. In the SIO a first challenge is to determine what biomass of orange roughy exists and its population structure. Also important, but really a challenge of 'forensic' fisheries science is trying to determine the unfished stock sizes of the various populations prior to the start of fishing. This would give an idea of the potential long-term productivity of the stocks in question. However, data are not available for most of the vessels that participated in the fishery during its Klondike days of 2000 – 2002 and funding needs to be found to support indirect methods as well as interviewing past participants in the fishery. Related to this will be the cost-benefits of this activity, given that a wide range of research activities remain to be addressed.

For the retained bycatch species, many make relatively minor contributions the fishery, but should still remain of interest to the assessment biologist. Both armourhead and bluenose warehou are at times important and valuable components of the catch – when they are encountered. Other bycatch species may be taken incidentally, e.g. certain oreos, by skippers less skilled in identifying them on their echo sounders and so enabling the vessel to avoid catching them in the trawl.

SIODFA vessels have collected an enormous amount of biological information on the population biology of commercial species they catch consisting of length and weight frequencies, sex and gonad condition data and otoliths for aging purposes.

SIODFA operators believe that because of the small scale, 'boutique', nature of the fisheries, traditional methods that are dependent on fishery-independent surveys and research will never be cost-effective for the SIO and thus will never be undertaken. Rather, SIODFA believes that the industry must play the leading role in the collection of data and perhaps even its initial, if not complete, analysis. One particular example of industry-lead research is that of aggregation-based commercial-vessel acoustic fish-stock assessment surveys. Considerable effort has been directed in this activity and certain SIODFA members can be considered leaders in this developing and applying this technique. All SIODFA vessels are equipped with SIMRAD ES60 acoustic systems capable of undertaking scientifically-calibrated acoustic surveys. Indeed, two SIODFA associates participated in the December 2009 FAO workshop that produced the "Report of the Workshop on Fishing Vessel Execution of Acoustic Surveys of Deep-sea Species: Main Issues and Way Forward",FAO Fisheries and Aquaculture Circular No.1059.

The vulnerability of orange roughy to overfishing is (now) well known, and SIODFA operators are aware that their fishing effort should not result in a fishing mortality that exceeds this species very low natural mortality. This emphasizes the extremely important issue of ensuring that the fleet fishing capacity targeting this species does not exceed that required to take the sustainable yield. For this reason, SIODFA operators have committed themselves to capping their fishing effort at the existing level, which is four vessels.

It is stressed that as an industry association, SIODFA has no enforcement powers over non-member operators and in the case of its own members, compliance with Association agreements is based solely on a shared vision of what is required to ensure responsible fisheries management and a sustainable fishery.

All SIODFA members have experience in operating in countries where the fisheries management regimes use strong forms of property rights that promote effective management of their fisheries. This long exposure to this evidently successful method of fisheries governance provides a solid basis for their support for such rights-based fisheries management of high seas stocks, It is the view of SIODFA that in the case of the Southern Indian Ocean deep-sea fisheries, endowing the operators with secure fishing entitlements would be the most effective way to provide the incentives to ensure effective fisheries management: it would remove existing perverse incentives and follow the examples set in the most successful fisehries management regimes existing today.

On a tactical level, working groups need to be established and funded to address management of (a) orange roughy, which has the advantage that much scientific work has been undertaken in Australian and New Zealand that should provide much guidance in the case of the Southern Indian Ocean, (b) alfonsino, which though a nearly-global high seas fishery its management requirements remain yet to be addressed (c) the more important retained bycatch species such as armourhead, bluenose warehou and other Centrolophidae and (d) all other bycatch species. In terms of discarded bycatch species, funding is required to establish a working group to address the issue of deepwater sharks. Finally, not so much for its relative unimportance in the SIO, but because of the perception of the importance with which it is held because of advocates' lobbying activities, are the cold-water corals and other benthos, particularly sponges. Ideally, these working groups will function in some manner within the context of the Southern Indian Ocean Fisheries Agreement after 21 June 2012 when it enters into force.

http://www.siodfa.org/programmes/fisheries-management/

Squat lobster on black coral. © David Shale, 2011.

6. Within the region, it is in particular recommended to:

- **Encourage implementation of existing relevant instruments, including applicable UN Resolutions.**
- **Encourage flag States with vessels engaged in deep-sea bottom fishing in the region to adopt measures consistent with UNGA Resolutions 61/105 and 64/72 and the 2009 FAO International Guidelines for Deep Sea Fishing.**
- **Encourage Parties and signatories of SIOFA to bring the agreement into force and to update the 2006 interim measures bringing them into line with the 2009 FAO International Guidelines for Deep Sea Fishing Collaborate with the CBD Secretariat and FAO to convene a sub-regional workshop or workshops with relevant States, authorities, experts and stakeholders to identify ecologically and biologically significant areas (EBSAs) and vulnerable marine ecosystems (VMEs) in the Indian Ocean ABNJ Remove market inefficiencies such as subsidies from industrial-level fishing operations in ABNJ.**
- **Encourage relevant regional bodies such as the Nairobi Convention and the IOTC to explore the feasibility and appropriateness of expanding their existing mandates so as to address ecosystem management in the ABNJ more effectively.**
- **Encourage effective management of all other activities that represent risks to biodiversity and ecosystem functions in ABNJ in the Indian Ocean.**

7. Support negotiations in the UN to draft a multilateral agreement under the LOSC on conservation of biodiversity in marine ABNJ that would create a framework for all currently unregulated activities, ensure that best conservation principles are incorporated and applied in all activities and sectors in marine ABNJ, improve communications among State and non-State actors in marine ABNJ, and improve compliance and enforcement mechanisms.

Sponge and glass shrimps & a primnoid coral with polychaetes (right). © David Shale, 2011.

DEEP SEA PHOTOGRAPHY

David Shale specialises in deep sea photography. He accompanied the James Cook scientific team in the 2011 cruise:

My aim for this cruise, as in recent expeditions, has been to provide a link between the HD video captured on the seafloor and the preserved and archived specimens.

This is important as the video does provide a detailed in vivo record of the species collected and the other nearby and associated fauna. Once the specimens have been collected the main priority is to preserve and barcode the material before it deteriorates. This is the key, because whenever samples are preserved for later examination, whatever the method of preservation, they all change; transparent animals become opaque, soft tissue becomes hard, colours change and animals contract.

I have been given first access to all material and I consider this a privilege, but it is also important from a specimen point of view. As soon as samples are in the cold room I select those I consider most vulnerable or important and transfer them to cold-water aquaria for photography. My tanks are small so I can photograph material up to a maximum size of 20cm in length; more than that it has to be a part-animal. But my interest is in macro-photography, so minimum size is not a problem.

I hope my photographs provide a permanent record and a valuable and additional resource to the other data collected on this cruise.

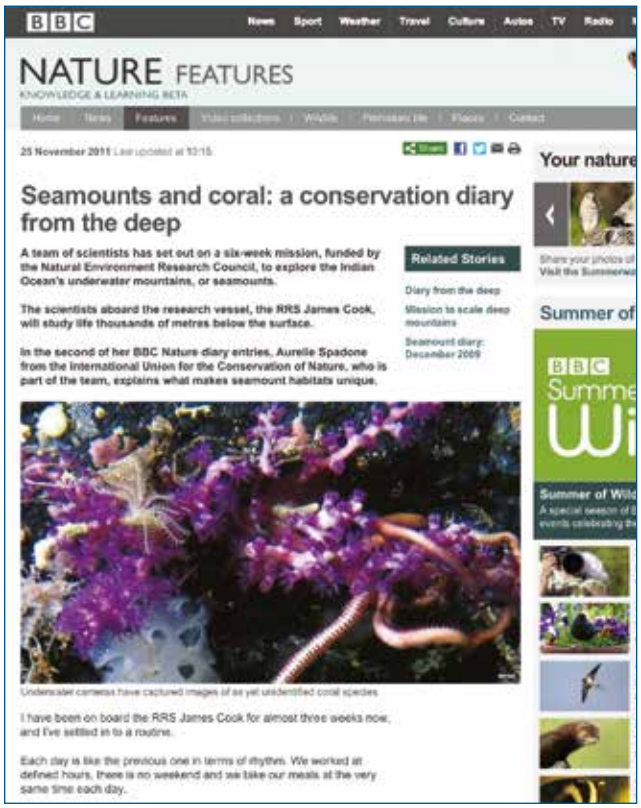
I have been intrigued by how much "associated fauna" there has been, particularly with the corals. Once I have specimens in my tanks I have the ability to scan and magnify my subjects and have been amazed by the variety of commensal fauna and how cryptic much of it is.

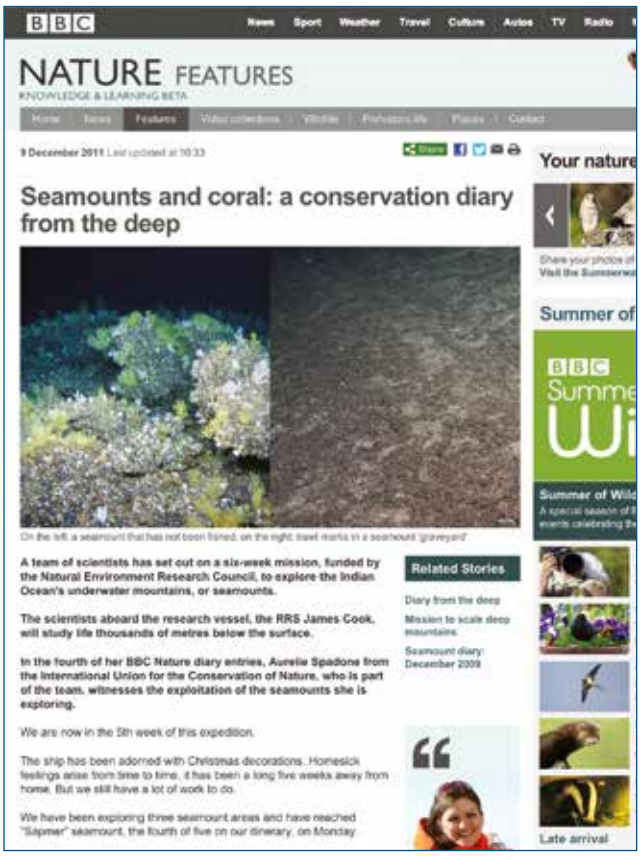
This specimen intrigued me (right page); it is of a primnoid coral with polychaetes which have aligned themselves to the rachis and have wrapped the coral scales around themselves. They are almost invisible and certainly protected.

But, I have to admit, that the animals which elicited the most interest were the glass sponges. Having reluctantly requested the collection of a small specimen during the dive because I know that size can be deceptive underwater and often those that arrive in the 'bio-boxes' are just too large to photograph. We collected 4, of which two were damaged but two were intact. The amazing part was that they contained "imprisoned" glass shrimps. Each sponge had a male and a female shrimp and the females were carrying eggs. How do they get inside? How are only one of each sex selected? What do they feed on? What is the relationship with the sponge and what benefit if anything is there to the sponge?

http://deepseaimages.co.uk/

http://www.bbc.co.uk/nature/16197761





16 DECEMBER 2011

By Aurélie Spadone

We are reaching the end of this expedition and time is flying by now. On Wednesday, we will reach our final destination, Port Elizabeth, South Africa. Seeing land again is going to be a strange feeling for sure, not to mention walking on an immobile surface. Writing this text feels like travelling back in time. Our departure from Cape Town seems an age ago. We have seen so many things; beauties of the deep and scenes of desolation.

The first seamount of the expedition – Coral seamount – was certainly the most preserved and richest in life. Melville and Middle of What were seamounts that showed us two faces of these marine ecosystems: one very rich, beautiful and with a diverse fauna; the other quite devastated, with trawl marks and fishing gear on the bare seabed. Sapmer was the seamount where we saw the fishing boat actively trawling. Most of the seabed has been damaged by trawling there, and we saw a lot of evidence of human activity on the seafloor, but inaccessible areas of the seamount still supported abundant life. On Atlantis we saw lots of urchins, but also giant coral trees. Some parts have been fished, but the rocky seabed makes it more difficult for trawlers to work some areas.

Some species only live at a single seamount. We saw patches of extremely rich fauna on rocks just next to areas covered with debris and coral rubble. The top of the seamount, which is very flat, was mostly barren.

These five seamounts are very different in terms of their shape and size, their fauna and their diversity and abundance of marine life.

We have seen cliffs with elegant glass sponges, coral gardens, coral reefs, sandy areas with curly urchin tracks on them. We have seen different fish species, sharks (from the slow-moving six gilled to another unidentified very angular species), urchins of different colours, sculptured shellfish, bright red shrimps and other delicate crustaceans. We have seen beautiful sea spiders, three-metre-high bamboo corals and tiny solitary species. A good number of these were present only on one seamount and some only occupied a single slope of one seamount.

It has been a very enriching experience to be part of this expedition. I sincerely hope that the outreach of this cruise and the scientific results obtained will have significant impacts on the protection of seamounts in this and other parts of the world's oceans. And I hope that the evidence of human impact on the seabed that we have gathered will help to ensure that measures are taken to manage the way we exploit seamounts, especially in view of the imminent threat of deep-sea mining.

With the UN General Assembly's new resolution on the deep-seas, countries have now the chance to regulate against exploitation and protect these unique habitats.

It is our planet, our oceans and their future in the balance.

III.4 - A ROAD MAP TOWARDS SUSTAINABLE USE AND CONSERVATION OF BIODIVERSITY IN THE SOUTHERN INDIAN OCEAN

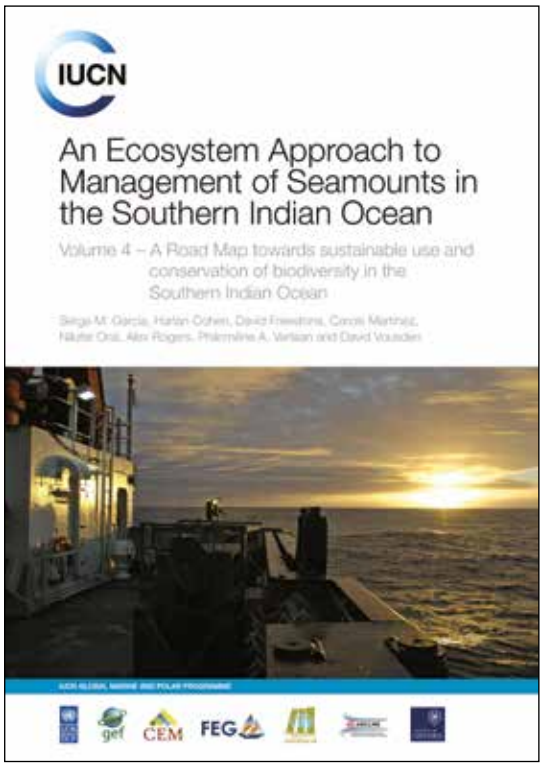
This paper is the executive summary of:
Serge M. Garcia, Harlan Cohen, David Freestone, Carole Martinez, Nilufer Oral, Alex Rogers, Philomene A. Verlaan and David Vousden.
An Ecosystem Approach to Management of Seamounts in the Southern Ocean, vol. 4:
A road map towards sustainable use and conservation of biodiversity in the Southern Indian Ocean. IUCN, 2013.

Marine features such as seamounts are important geomorphological structures sustaining marine benthic and pelagic ecosystems. They are fragile and remain poorly known. They cover close to 17 million km^2 of the ocean and sea area, while tropical forests cover 10 million km^2 of the entire Earth surface. They are important for seabirds, marine mammals and numerous pelagic and benthic, resident and migratory species, and are hotspots of biological activity. There is increasing scientific evidence of and concern about the significant adverse impacts on seamounts from fisheries and other extractive human activities both at present (e.g. precious coral exploitation) and in the future (e.g. cobalt-rich ferromanganese crusts and polymetallic sulphide mining, oil and gas extraction).

IUCN and its Members have a long-standing commitment to achieving effective protection, restoration and sustainable use of biological diversity and ecosystem processes on the high seas. This commitment was reiterated at the 2008 IUCN World Conservation Congress and again at the 2012 World Conservation Congress, which called on States, acting individually or though multilateral organizations, to promote consistent, coordinated and coherent application of the best conservation and governance principles and approaches.

Within the framework of an IUCN/GEF/UNDP Southern Indian Ocean (SIO) Project, IUCN organized in Rome, on 16–17 July 2012, a Management Workshop on conservation and management measures applicable to high seas areas in the SIO. The objectives were to: (i) define the different elements of a governance plan for the region (specific objectives, actors, actions required for its implementation); and (ii) discuss ways towards achieving an operational management plan for the SIO (develop considerations for an ecosystem approach, identify options for monitoring, control and surveillance, etc.).

This document briefly presents the proposals from the Management Workshop regarding: (i) a Biodiversity Initiative; (ii) the principles, objectives and process included in the draft Road Map developed in support of the Initiative; (iii) the concept, advantages and potential members of the Alliance proposed to further develop the Initiative; and (iv) the Collaborative Arrangement needed to formalize the Alliance, and the key elements of the adaptive and collaborative Management Plan that the Alliance will adopt and implement.



THE SIO BIODIVERSITY INITIATIVE

The SIO Biodiversity Initiative is informal and voluntary. It intends to promote integrated management of biodiversity in the SIO and to mobilize existing and potential interested parties for that endeavour. It serves as a reference point and holds together the first partners at this early stage of the process, while no other formal mechanism is yet established.

The Initiative will operate under the following principles:

— Duty to cooperate
— Openness
— Duty to promote sustainable and equitable use
— Focus on biodiversity and the activities impacting upon it
— Good governance

— Consensus decision-making

— Realism

— Broad participation.

Its goals will include: promotion of integrated management and sustainable use; identification of partners for an Alliance in that endeavour; and facilitation of the Road Map and Management Planning processes (see below).

THE ROAD MAP

The Road Map is the document, informally agreed among the partners, that underpins the process of participative development, adoption and implementation of the Management Plan. It indicates the objectives, the expected outputs, the partners and their respective roles, the means available, and the calendar for the activities. The expected outcomes include: (i) a voluntary alliance of partners (the SIO Alliance); a Collaborative Arrangement between these partners (the SIO Arrangement); and an SIO Management Plan formally adopted by the Alliance, under the SIO Arrangement. The process will be facilitated by IUCN. Following an inception meeting at which the SIO Alliance will be established, the Road Map partners will agree on the aims and objectives of their process, and will elaborate a Management Plan.

THE SIO ALLIANCE

The governance and management of biodiversity in the SIO can now more efficiently move forward through a voluntary association of existing institutions from interested States and other interested parties (e.g. from among the private sector and civil society) in the form of an Alliance, following the examples of the Sargasso Sea Alliance (SSA) and the Western Indian Ocean Sustainable Ecosystem Alliance (WIOSEA). The Alliance is conceived as open and flexible, implying a light administrative burden on members. Recognizing the existing mandates of the different partners, it will offer a platform for synergy, with a strong shared focus: the Management Plan. Potential members include a wide range of States, multilateral organizations and other stakeholders drawn from civil society.

THE COLLABORATIVE ARRANGEMENT

This is a non-legally binding agreement signed by all members of the Alliance to implement together the Biodiversity Management Plan. It morally engages only its signatories. A draft structure for the Management Plan, as referred to below, could be part of the Arrangement. Because of its objective, the Collaborative Arrangement is intended to be a long-lasting institution, requiring constancy and coherence in the commitment and action of its signatories. Additional members might be added as time goes by.

THE BIODIVERSITY MANAGEMENT PLAN

The Management Plan contains the details of the agreement among Alliance members and defines their joint action. Its structure will be determined by the Alliance. The Management Plan is a long-term commitment among the partners aiming at conservation and sustainable use of biodiversity in the designated area. The Plan's general objective is to elaborate implementable action for the protection, conservation and sustainable use of seamount-related biodiversity in

http://seamounts2009.blogspot.fr/

MONDAY, DECEMBER 7, 2009

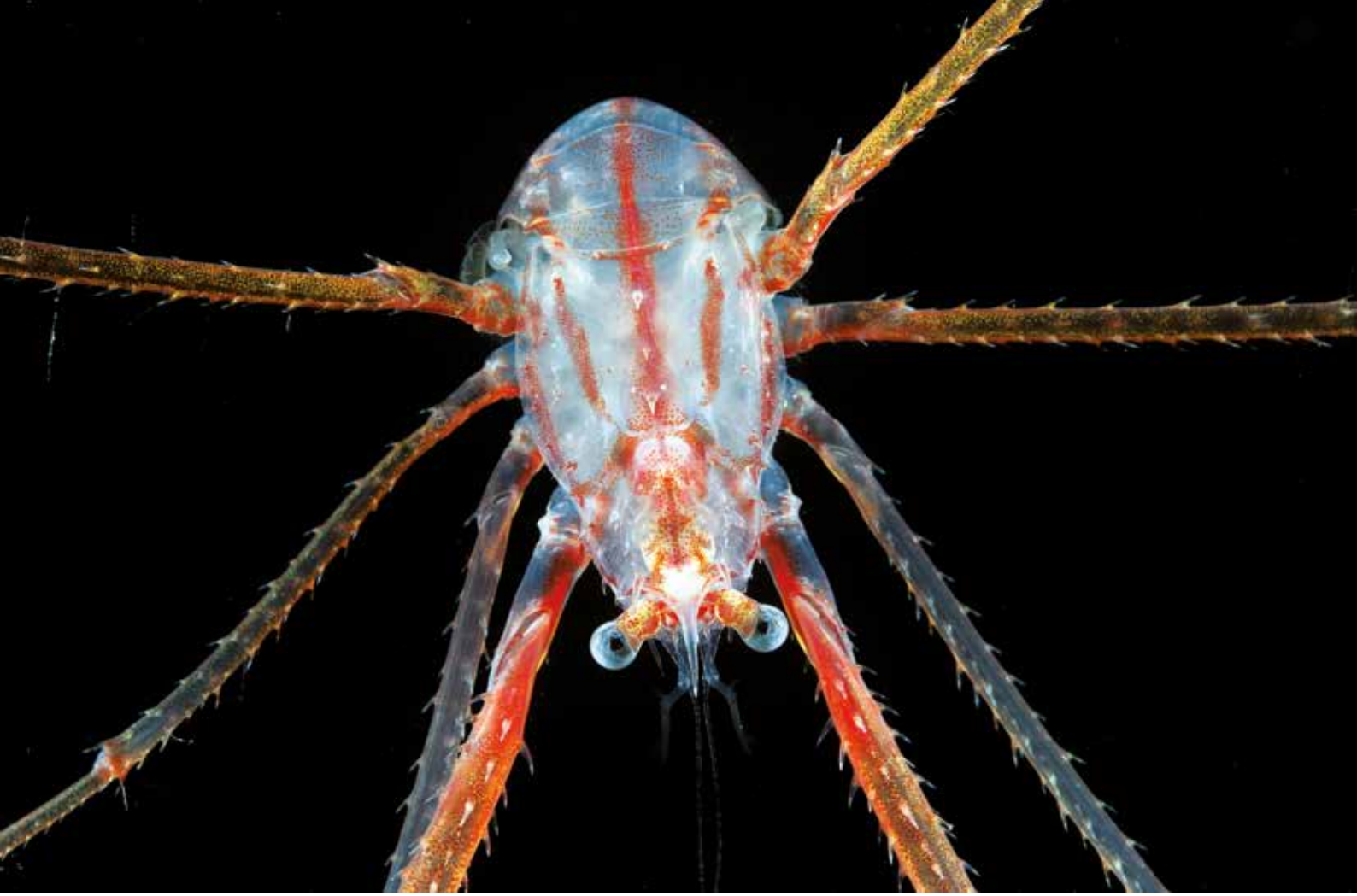
Unforgettable day / Jour inoubliable

The kids from the school Baies roses have a great memory of the visit of the Nansen. We invited them for a tour on the vessel while it was at port, in Reunion, on November 10. They're telling their memories in the December edition of their school journal, accompanied with great drawings! (in French only)


Les salles pour se détendre

Les salles de prélèvements et d'analyses

Le laboratoire



Squat lobster. © David Shale, 2011.

the area to be defined within the Plan. This, in turn, implies a number of sub-objectives and milestones to be agreed by Alliance members. The content of the Plan and the boundaries of the area to be managed have been succinctly outlined but will be decided by Alliance members. The legal frameworks and relevant institutions from the region include: UNCLOS, UNFSA, CCAMLR, SIOFA, SWIOFC, IOTC and CBD. The Management Plan will describe the management area and biodiversity targets, the actual and potential economic activities impacting upon biodiversity, and will define objectives in this regard and identify means and financing sources.

FINAL CONSIDERATIONS

The Road Map needs to be kept simple and practical. It should be locally driven (e.g. by the interested parties from the region or those operating in it). Its development and implementation will follow a step-by-step approach and will identify short-term, mediumterm and long-term action. The adaptive Management Plan might be tested first in pilot projects before being scaled up. Effective international cooperation is essential and while the full process may take some time, it is important to begin and show that implementation is feasible. The role of IUCN in starting and facilitating the project is essential. The Alliance will pool the competencies available in the region. Participation of the sector and existing international institution is essential. Last but not least, the Initiative cannot begin to make progress without the appropriate funding. Therefore one of the most important tasks for IUCN, assisted by its Members, will be to raise the funding necessary to conclude the Road Map and start implementing the Management Plan, which should also identify long-term funding sources.

CONCLUSION

The project proposed some options to improve the governance framework, notably:

— Enhancing cooperation between existing bodies and organisations rather than creating a new body.

— Exploring the development of an alliance as a working arrangement to demonstrate effective management and governance mechanisms for areas beyond national jurisdiction (ABNJ) in the Indian Ocean, including using the ASCLME project outcomes and its existing and evolving partnerships.

Within the region, it is in particular recommended to:

— Encourage implementation of existing relevant instruments, including applicable UN Resolutions.

— Encourage flag States with vessels engaged in deep-sea bottom fishing in the region to adopt measures consistent with UNGA Resolutions 61/105 and 64/72 and the 2009 FAO International Guidelines for Deep Sea Fisheries.

— Encourage Parties and signatories of SIOFA to update the 2006 interim measures bringing them into line with the 2009 FAO International Guidelines for Deep Sea Fisheries.

— Collaborate with the CBD Secretariat and FAO to identify ecologically and biologically significant areas (EBSAs) and vulnerable marine ecosystems (VMEs) in the Indian Ocean ABNJ.

— Remove market inefficiencies such as subsidies from industrial level fishing operations in ABNJ.

— Encourage relevant regional bodies such as the Nairobi Convention and the IOTC to explore the feasibility and appropriateness of expanding their existing mandates so as to address ecosystem management in the ABNJ more effectively.

— Encourage effective management of all other activities, including mining exploration, that represent risks to biodiversity and ecosystem functions in ABNJ in the Indian Ocean.

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