PROPOSAL FOR IBDIOCC- SCOR WG

Submitted to: Dr. Edward Urban, Executive Secretary, Scientific Committee for Oceanic Research (SCOR)

Submitted by: Dr. Robert Y. George, President, George Institute for Biodiversity and Sustainability (GIBS), 1320 Vanagrif Ct., Wake Forest, North Carolina.

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IBDIOCC

<u>Interaction Between Drivers Impacting Ocean Carbonate Chemistry:</u> How can Deep-Sea Coral Ecosystems respond to ASH/CSH Shoaling in Seamounts that pose imminent threats from Ocean Acidification?

Summary/Abstract:

We propose a new SCOR Working Group IBDIOCC (2017 to 2019) that seeks to assess new impacts on seamount ecosystems from ocean acidification (OA), that essentially looks at the impact of shoaling of ASH and CSH on the biota that include communities/species associated with deep sea scleractinian corals e.g. *Lophelia pertusa* and *Solenosmilia variabilis*) The WG, with members from both southern and northern hemispheres, seeks to re-evaluate and augment the science priorities defined in 2012 by the Census of the Marine Life, but taking into account the new climate change threats and challenges from shifts in ocean carbonate chemistry. The WG will incorporate recommendations from 'Ocean In High Carbon World-Ocean Acidification international symposium which will be participated by Dr. George (chairman of WG) who will also present a paper on vulnerable deep sea ecosystems to ocean carbonate chemistry, especially seamounts southeast of Australia and New Zealand. The WG plans to develop a follow-on capacity building workshop in the ASLO annual meeting in Hawaii (2017) and in the AGU Ocean Sciences meeting in Portland, Oregon (2018). In 2017, the WG will meet for three days in 2017 at the ASLO annual meeting to generate two open-access publications; 1) the first global assessment of OA on seamount fauna, and 2) a peer-reviewed multi-authored paper to be submitted to *NATURE* CLIMATE. In 2018, the WG will meet for 3 days at Portland Oregon AGU Ocean Sciences meeting. IBDIOCC SCOR WG will focus on synergism between (1) temperature and carbonate saturation; (2) Deoxygenation processes in upwelling areas with seamounts and carbonate saturation; (3) multiple-stress impacts (temperature, deoxygenation and carbonate saturation).

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Scientific Background and Rationale

Deep-Sea Overview:

The biodiversity and ecosystem functioning can change quickly and significantly because of direct (e.g. bottom trawling, deep-water oil spills) and indirect (e.g. climate variation) human impacts (Smith et al, 2009). In addition, two new pressures have been recognized in recent years; 1) ocean acidification, including the effects of changing pH on shell-bearing planktonic and benthic organisms, and 2) In upwelling zones, there is some evidence that OA impact may couple with deoxygenation stress. How deep-sea ecosystems will respond to these new pressures is not clear. Deep-sea seamounts are considered to be especially vulnerable (Consalvey et al, 2010).

Reum et al (2016) succinctly addressed the complex synergism between carbonate chemistry changes and hypoxia in upwelling ecosystems and concluded: " With the continued collection of high-quality carbonate chemistry measurements and their archival on freely accessible databases, analyses like the one we present for the CCE may yield further insight into the relevance of carbonate chemistry variability to contemporary ecological processes as well as guide OA experimental design in other marine systems.

This proposal is timely owing to the increasing interest of "Oceans in the High Carbon World." The proposed work is truly global in scale encompassing Exclusive Economic Zones (EEZs), Extended Continental Shelves and the High Seas (Areas Beyond National Jurisdiction) in all world oceans. There are as many as 100,000 seamounts at least one kilometer in height. However, of these, less than 200 have been studied in any detail and their biodiversity is still poorly known. Depending on the height of the summit they may have particularly high productivity Seamounts are heterogeneous habitats, often spanning a great depth range (Pitcher et al., 2007; Consalvey et al., 2010; Clark et al., 2010). Deep-sea species of the seamount fauna generally has long generation times and therefore seamount communities are particularly sensitive to disturbance

It is only now with the greater availability of Remotely Operated Vehicles (ROVs) and the rapid development of genetic techniques that many issues relating to seamount ecosystems can be resolved. The lack of comprehensive data has led to generalizations about seamounts as a whole. Very often, however, the generalizations apply only to a subset of seamounts, depending also on the biogeographical province and depth band in which they occur (McCain, 2007; Kvile et al., 2013). A concerted effort on studying seamounts is needed, and possible.

Apart from increasing spread of deoxygenation by creating hypoxic or anoxic zones in ocean areas off river deltas, ocean acidification (OA) threatens ocean health through effects on plankton (e.g. pteropods) and benthic shell-bearing animals (corals and mollusks) which in some cases are deep-water habitat engineers. Increasing CO_2 input is expected to decrease ocean pH by 0.3 to 0.5 by 2100, thus lowering the carbon ion concentration of surface waters. This rapid and dramatic scenario of ocean acidification has the potential to have serious effect on calcification of marine organisms. Since industrialization, there has been a substantial increase in CO_2 flux into the oceans from atmosphere. It is cautioned that by 2100, if this flux is not reduced

by shifting gear to renewable energy, irreversible damage may occur to our ecosystems and may diminish ecological services.

Volcanic CO_2 vents can provide useful proxies of future OA conditions allowing studies of species responses and ecosystem interactions across CO_2 gradients. Studies at suitable vents in the Mediterranean Sea and elsewhere show that benthic marine systems respond in consistent ways to locally increased CO_2. At the shelf-edge, the ongoing shoaling of carbonate-corrosive waters (with high CO_2 and low pH) threatens cold-water corals, in particular *Lophelia pertusa*, in the North East Atlantic Ocean.

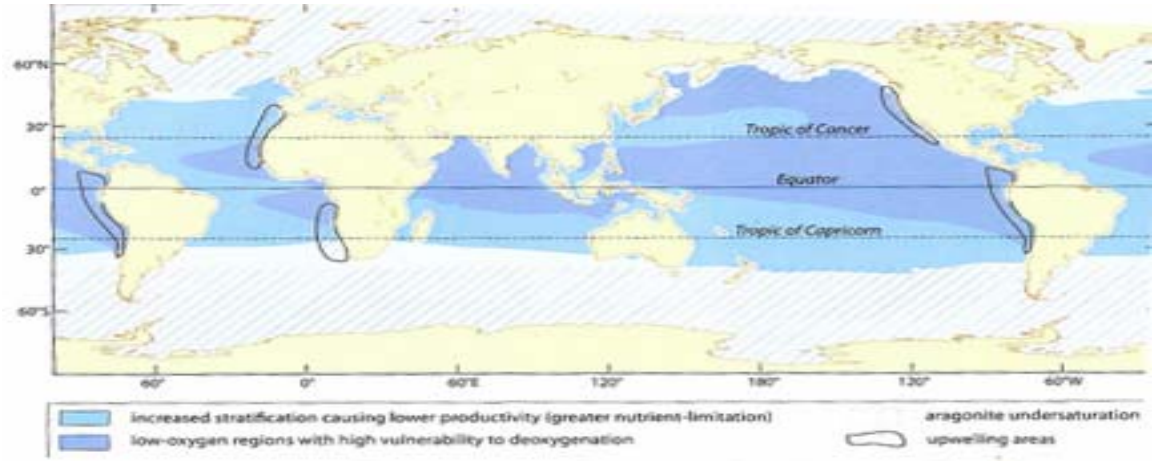
Ocean Acidification in relation to hard corals in the deep-sea

In upwelling areas of the Northeast Pacific Ocean, shoaling of the Aragonite Saturation Horizon (ASH) has reduced hard-coral ecosystems dominated by scleractinian corals. The ASH is located much deeper in the other regions of the deep sea. This led, in part, to Tittensor et al. (2010) postulating that OA threat is really confined to continental margins (continental slopes and plateaus) and that mid-ocean seamounts may not be impacted adversely by OA.

The first consequence of solution of CO2 in seawater is the formation of carbonic acid, but this immediately disassociates to form bicarbonates. To understand the impact on marine skeletal – forming animals, we must look not only at the changing (deceasing) pH, but also at the ambient levels of carbonate saturation of seawater from surface to deep depths. This scenario calls for the need for 'Ocean Observatory" at study-sites offshore, with sensors remotely monitoring and storing information in a database. Decreasing pH may erode skeletal material and calcite under saturation may constrain the rate of production of skeletal material that is aragonite in hard corals and calcite in soft corals

In a recent paper, (Hall-Spencer, 2015) outlined the imminent risks to marine life from ongoing ocean acidification. The increase in carbonate in surface seawater makes it corrosive for animals with aragonite or calcite skeletons such as clams and corals. Decrease in calcification process may make animals to become smaller and smaller, as Hall-Spencer calls it the "Lilliputian effect." In the upwelling zones of the Northeast Pacific ocean, the ASH reaching shallower has over the years reduced or eliminated *Lophelia pertusa et al 2006).* scleractinian *coral species. Guinotte et al, 2006).*

Recently, Gaylord et al., 2015) summarized succinctly ocean acidification through the lens of ecological theory. Likewise, Kroeker et al. (2011) earlier discussed ocean acidification threats with focus on divergent ecosystem responses within benthic marine community. Subsequently, Kroeker et al. (2013) reported that ocean acidification causes ecosystem shifts via altered competitive interactions. Undoubtedly, planetary changes due to ocean acidification have become imminent. The atmospheric methane concentration went up from 1250 to 1750 ppb and atmospheric carbon dioxide went up from 280 to > 400 ppm today and estimated to reach 700 ppm or more by 2100. George (2016) recommends selecting three regions where ocean acidification threats call for careful monitoring with OOI (Ocean Observation Initiatives) that US National Science has recently developed.



Hall-Spencer's Identification of Upwelling Areas in the World Oceans (Circled)

Goals:

1. To determine ocean acidification impacts of pH change on deep-water coral reefs on continental margin and seamount communities above and below the Aragonite Saturation Horizon (ASH) and Calcite Saturation Horizon (CSH).

2. To explain the synergism between deoxygenation and carbonate saturation, synergism between temperature and carbonate saturation and multiple stressor impact involving carbonate saturation and deoxygenation and temperature.

Motivation behind the goals: We submitted a proposal to SCOR for establishing a WG for combing Ocean Acidification (OA) and Cobalt Mining (CM) impacts on seamount communities (deeps-ea corals). We are advised by the reviewers, as per letter from Prof. Peter Burhill (SCOR President), that in a resubmission we should (a) emphasize science *per se* rather than conservation and management of the seamounts and (b) focus on ocean acidification, rather than impacts of cobalt mining on seamount biota.

Work Plan – details of the Terms of Reference (1000 words)

ToR 1. Assess the current status of **threats from ASH shoaling to** *Solenosmilia variabilis* reef in Seamount A 1 off southeast Australia as well as *Lophelia pertusa* reefs on seamounts on both sides of the North Atlantic Ocean.

The WG will focus on knowledge hitherto revealed from published evidence of ASH shoaling on stony corals in seamounts off southeastern Australia, through the efforts of Dr. Ron Thresher of CSIRO, Australia (Thresher et al, 2015). Likewise, the WG will summarize the status of threats to seamount scleractinian corals on both sides of the North Atlantic Ocean.

ToR 2. Raise some questions pertaining to research into natural analogies for ocean change, based on Dr. Hall-Spencer's field experiments at the Mediterranean seep systems, in relation to UN Ocean Acidification officials at IAEA in Monaco and will initiate the first natural High CO2 analogue in the Atlantic.

This effort will test the hypothesis that Atlantic CO2 seeps create gradients in carbonate chemistry that have similar ecological shifts to those noted in the Mediterranean, despite lower alkalinity and a completely different set of species.

ToR. 3. Pool data from Dr. A. Morato's seamount coral data base with 500 seamounts already covered on biodiversity, coral species composition etc. into Dr. George's ongoing work with 'NSF South Big Data Spoke Project' in the Georgia Tech. for developing an interactive website.

Recently a proposal to NSF Directorate of Information and Computer Science is submitted for transferring databases from NSF Ocean Observatory Initiatives (OOI), Ocean Biogeographic Information System (OBIS) and WoRM data pools for various taxonomic groups on biodiversity into Encyclopedia of Life (EoL). The funding for this proposed activity is anticipated in from NSF in August 2016.

ToR 4. Mentor young investigators (postdocs and graduate students) from developing nations in the design process of laboratory and field experimentation to study ocean acidification impact at species to ecosystem levels, involving mesocosm studies.

We intend to develop a summer course in 2018 at the Friday Harbor Laboratories of the University of Washington where there is an ongoing Ocean Acidification Research Facility under the direction of Dr. Billie J. Swalla.

ToR. 5. Identify possible genetic connectivity between seamount fauna with focus on deep sea coral species of the octocoral genera *Narella, Paragorgia, Primnoa* and *Corralium*, based on available knowledge from the work of Dr. Amy Baco-Taylor and her collaborators.

This WG will assemble data from ongoing research in various labratories and numerous published papers on genetic connectivity between seamount fame-work-forming deep-sea corals.

ToR 6. Engage with policy makers (Dr. Mike Orbach) for 'Science-based Management' of Seamount Ecosystems creation of MPAs with potential High Seas seamounts**.**

Dr. George is currently serving as USA delegate to ICES (International Council for the Explorations of Seas) that is currently engaged in designating MPAs in High Seas and within EEZs of different nations in the North Atlantic. Dr. Orbach is associated with the Sargasso Sea Commission. This WG, based on, our efforts in 2017, will recommend vulnerable seamounts as candidates for new MPAs.

ToR. 7. Assess our current knowledge on seamount ecosystems in the Indian Ocean, in the light of ongoing IIOE-2 and the expertise of Dr. Baban Ingole (WG member) and Dr. Banakar (WG Associate member), with specific focus on deep-sea corals and potential ASH (OA) impacts, related to climate change in the Indian Ocean.

This WG will explore the possibility of recommending young investigators to participate in the ongoing IIOE-s cruises to seamounts in the Indian Ocean and will also procure samples of deep

sea corals for DNA sequencing in selected genome laboratories where deep sea coral research is now in progress in Australia, New Zealand, Brazil, USA and Europe.

In 2014 the UN Convention on Biological Diversity (CBD), in collaboration with UNEP, updated the impacts of OA in a report on "A Updated Synthesis on the Impacts of Ocean Acidification Impacts on Marine Biodiversity" (Hennige, Roberts and Williamson (2014). Using the information from this paper, this WG will bring together the full members this workshop at the AGU Ocean Sciences conference in Portland, Oregon (2018), and will produce an open access publication on the conservation and management of deep-sea seamounts, including a forward-looking 10-year international research plan.

Deliverables

In addition to the 3 deliverables related to the ToR detailed above, IBDIOCC will prepare a multi-authored comprehensive science paper on potential impact of ocean acidification with emphasis on shell-bearing fauna in the seamounts such as scleractinian coral species. This paper will include the following research questions: (1) How ASH and CSH will behave in different geographic regions, upwelling zones on the eastern parts of world oceans vs. non-upwelling zones on western parts of the world oceans, and (2) Which deep-sea coral species have inherent genetic adaptability to be resilient in low pH conditions (and what shore-based OA study facilities are called for in order to conduct long-term experiments on chosen deep-sea corals.

Capacity Building Plan

Much of capacity building and training in marine science, conservation and management is focused on coastal systems. The marine training portal www.marinetraining.eu, as a measure of international opportunities, shows only a very limited number of courses targeting human impacts and deep-water systems. Searching the keyword "ocean acidification" provides only a negligible number of records. The importance and scale by which OA may impact biodiversity and ecosystem functioning in deep-water have not been reflected in training programs that have been organized to date. This is of concern as developing countries start to utilize offshore resources within their Exclusive Economic Zones (EEZs). Therefore, building knowledge and training capacity on OA in developed and developing countries (e.g. India, Uruguay, Brazil) will be of immense value, by the outcome of efforts from IBDIOCC.

We aim to inform and educate young scientists on the threats, research needs and management tools for the conservation of biodiversity on seamounts. We aim to conduct new capacity building activities related to IBDIOCC.

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This SCOR WG IBDIOCC will conduct a workshop in AGU Ocean Sciences meetings in Portland, Oregon in 2018 and will also participate in the summers of 2017 and 2018 in a graduate course at Friday Harbor Laboratories "Deep-Sea Ecosystems with focus on Seamount Ecology." This course will educate 20 students each year, on topics of direct importance to the student's country of origin.

In addition to these initiatives IBDIOCC, we will search for funding from agencies (e.g. NSF and private foundations (e.g. Packard) to provide scholarships for students from developing countries to attend targeted workshops. Already, Dr Bob George serves as senior scientist with Georgia Technical Institute's Dr. Ashok Goel with the NSF South Big Data Hub Spoke Project to pool data of deep-sea coral biodiversity and biogeography into Encyclopedia of Life (EoL). Dr. George will also get data from NSF OOI (Ocean Observatory Initiative) from different observatories.

Relationship to other SCOR WGs and International Programs:

IBDIOCC seeks to interact with the following ongoing efforts that emphasize the need to resolve OA threats to marine ecosystems and biodiversity. Apart from work on seafloor mapping and ocean observatories, SCOR has had little focus on benthic ecosystems in the world's oceans in the past. IBDIOCC builds on interests in SCOR on oceans in a high CO2 world and ocean acidification to fill a important gap in SCOR's past and present work.

International programs that will benefit directly from IBDIOCC and which have produced reports calling for research produced by CCCSOS are:

1. 2014 Recommendations from Convention for Biological Diversity (CBD) Report

2. SCOR WG will interact with Prof. Alex Rogers, Professor of Zoology at Oxford, UK and will use his consultant service on seamount ecosystem research.

3. Dr. Maria Baker of National Oceanography Center and the University of Southampton UK has consented help as liaison between the SCOR WG and INDEEP and DOSI (Deep-Ocean Stewardship Initiatives) that have made significant progress under the leadership of Prof. Lisa Levin of Scripps Institution of Oceanography and Prof. Elva Escobar of UNAM, Mexico to assemble concerned deep-ocean scientists to address issues such as:

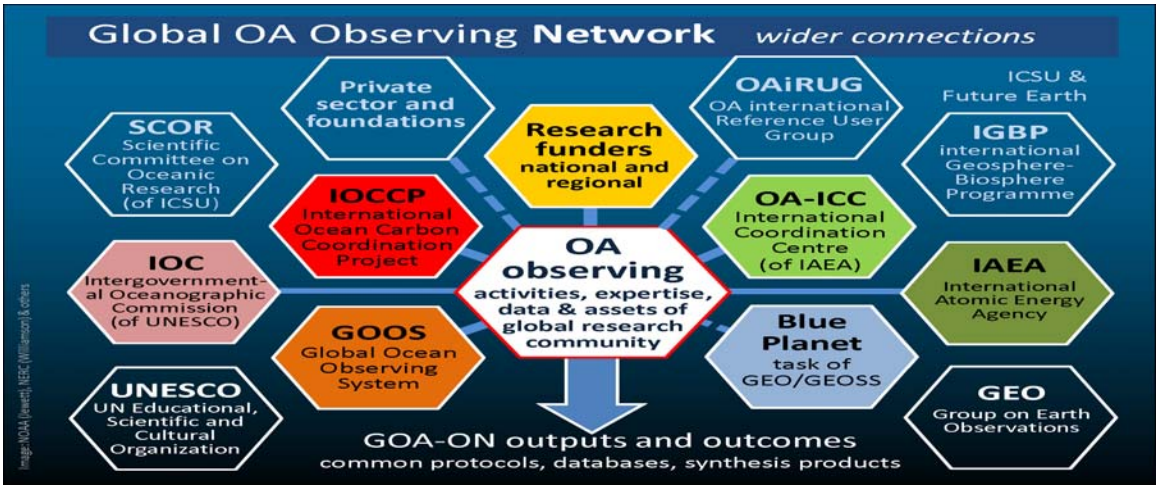
    (A) Global Ocean Assessment (Dr. Tony Koslow, Scripps Institution of Oceanography)
    (B) Ocean Conservation (Dr. Jeff Ardron, Commonwealth Secretariat, London)
    (C) Collaborations with Developing Nations (Dr. Christian Neumann)
    (D) High Sea and Sargasso Sea Commission (Dr. Kristina, Gjerde, IUCN)
    (E) Networking (Dr. Maria Baker, NOC, University of Southampton, UK)
    (F) Deep-Sea Fisheries (Dr. Les Watling, University of Hawaii)

4. The SCOR WG will also interact with Dr. Tim Shank who will host the 2016 Deep-Sea Coral Symposium. Note: the first International deep-sea coral symposium in USA was coordinated by Prof.. Robert Y. George (GIBS) and Dr. Robert Brock (NOAA) at the University of Miami in 2005). Dr. George co-edited this symposium proceedings with Dr. Stephen Cairns of Smithsonian Institution in two volumes, one entitled:"Conservation and Adaptive Management of Deep-Sea coral and seamount ecosystems."

5. The WG will bring together the outcome of the two workshops, one in ASLO meeting in 2017 and the other in AGU Ocean Sciences meeting in Portland, Oregon and will produce an open access publication that entails forward-looking 10-year international seamount research and conservation plan

6. Global Ocean Acidification Network (GOAN)

   We are also aware of the existing "Global Ocean Acidification Network", with a vast number of scientists and managers from many nations, actively involved in OA research and monitoring efforts in the world ocean with Dr. Libby Jewett of NOAA as a coordinator of this activity, as illustrated below. The Scientific Committee for Oceanic Research (SCOR) is one of many participants in this ongoing network



Collaboration with GOA-ON, NOAA AND OA science experts

Dr. Sam Dupont at the Department of Biological and Environmental Sciences of Gothenburg University and Sven Loven Center for Marine Sciences, Kristineberg, Sweden (Vice-Chair of this SCOR IBDIOCC WG) will serve as a liaison with 2016 SCOR WG # 149 that looks multistress impact in marine ecosystems. Dr. Dupont is a member of Executive Council of Global Observatory Network for Ocean Acidification (GOA-ON) and he is leader of the Biology WG of GOA-ON).

Dr. Bob George will also hold IBDIOCC planning meeting in Hobart on May 5 with Dr. Richard A, Feely (NOAA) Dr. Libby Jewett (NOAA), Dr. Phil Boyd in the Institute of Marine and Antarctic Studies Australia (who chair the SCOR WG # 149 that addresses the multiple-stressors and also Dr. Jean-Pierre Gattuso (University of Pierre-et-Marie Curie) who chairs the 'Ocean in the High Carbon World' symposium in Hobart (May 3-6, 2016) and will explore potential avenues for collaborations.

SCOR WG IBDIOCC (Seamounts & Ocean Acidification)

Full Members (no more than 10, please identify chair(s))

Name	Gender	Place of work	Expertise relevant to proposal
1 Prof.Robert Y. George (CHAIR)	Male	GIBS, Raleigh, North Carolina	Deep-Sea Ecology. Ocean Acidification
2 Dr. Sam Dupont (VICE_CHAIR)	Male	Kristineberg, Sweden	Ocean Acidification
3 Dr. Mark Eakin	Male	NOAA, USA	NOAA OA WG
4 Dr. Baban Ingole	Male	NIO, Goa, India	Seamounts Ecology
5 Dr. Marcelo Kitahara	Male	Sao Paulo, Brazil	Deep-Sea Corals
6 Dr. Jason Hall-Spencer	Male	University of Plymouth, UK	High Carbon Oceans
7 Dr. Amy Baco-Taylor	Female	Florida State University	Seamount and deep-sea Corals
8 Dr. Di Tracey	Female	National Institute for Water and Atmospheric Research, New Zealand	Deep-Sea Hard Corals
9 Prof. Alvar Carranza	Male	University of Ghent Belgium	Deep-Sea seeps and nematode biodiversity
10 Dr. Sarma V.B. Yellepeddi	Male	ARAMCO, Saudi Arabia	Deep Sea Explorations and Physical oceanography

Associate Members (no more than 10)

Name	Gender	Place of work	Expertise relevant to proposal
1 Dr. David Billet	Male	NOC, Southampton, UK	Deep-Sea Ecology
2 Dr. Thomas Hourigan	Male	NOAA, USA	Deep-Sea Corals
3 Michael Orbach	Male	Duke University	Marine Policy/Conservation
4 Dr. Telmo Morato	Male	Univ. of Portugal-Azores	Seamount Ecosystems
5 Dr. Debora Pires	Female	National Museum, Rio de Janeiro, Brazil	Deep-Sea Corals
6 Dr. David Eggleston	Male	CMST, NCSU Raleigh, NC	Coastal & Marine Ecology/Food-chain/Ecosystems
7 Dr. Ann Vanreusel	Female	University of Brussels	Capacity Building
8 Dr. Ron Thresher	Male	CSIRO, Hobart, Australia	Seamount Ecology
9 Dr. V. K. Banakar	Male	NIO, GOA, India	Indian Ocean-Seamounts
10 Dr. Karen Stocks	Female	University of California San Diego	Seamount Fisheries

BIODATA OF MEMBERS AND SELECTED PUBLICATIONS

1. **Dr. Robert Y. George (GIBS) – Chair**

Dr. Robert Y. George was Professor of Biological Oceanography for 30 years (1972-2002) at UNC-Wilmington, North Carolina, USA and he taught a graduate course on deep-sea biology. Dr. George conducted original deep-sea research for 40 years off North Carolina Coast, Puerto Rico Trench, Blake Plateau Coral Ecosystems, Sargasso Sea (Beaufort – Bermuda Transect), Arctic and Antarctic deep-sea. Since 2002, Dr. George has been the President and CEO of the George Institute for Biodiversity and Sustainability, a Non-Profit 501-C-3 organization in North Carolina. Dr. George now serves as NOAA delegate to ICES (International Council for Exploration of Seas) Deep-Sea Working Group, since 2005, and also organized with NOAA the 3rd international deep-sea coral symposium at the University of Miami.

2. **Dr. Sam Dupont, Kristineberg Sweden. –Vice-Chair**

Sam Dupont is a Researcher and an Associate Professor in Marine Ecophysiologist at the University of Gothenburg and an Honorary Assistant Professor at the School of Biological Sciences, Hong Kong University. He has published more than 130 publications in journals including Nature, PNAS and TREE. His work aims at revealing the mechanisms behind species and ecosystem responses to environmental changes and at developing the needed unifying theory for large-scale projections. He is in direct contacts with various stakeholders, both at local and global level. He is a member of the Advisory Board of the Ocean Acidification International Coordination Center (OA-ICC), the Executive Council of the Global Ocean Acidification Observing Network (GOA-ON) and the Steering committee of the EuroMarine consortium.

3. **Dr. Mark Eakin (Vice-Chair), NOAA Ocean Acidification Workgroup**

Dr. C. Mark Eakin has worked for the National Oceanic and Atmospheric Administration for over 20 years and directs Coral Reef Watch, a program that monitors coral reef ecosystems through satellite and in water observations. Dr. Eakin holds a Ph.D. from the University of Miami and publishes on coral reef ecology, especially the impact of climate change on coral reefs, coral bleaching, ocean acidification, oil spills, coral paleoclimatology, and the behavior of marine organisms. He co-chaired the US Coral Reef Task Force's Climate Change Working Group, has testified before the US Congress on the impacts of climate change, and was a contributing author on the 2014 Intergovernmental Panel on Climate Change Assessment Report.

. 4. **Dr. Baban Ingole (NIO. Goa, India)**

Dr. Ingole is Professor & Chief Scientist at Goa based National Institute of Oceanography since 1981 and presently leading a research programs on coastal and deep-sea biodiversity & Resource Management. He also participated in Census of Marine Life-CoML, SEATOS- Discovery Channel's International Tsunami Expedition; *INDEEP* international research programs such as: - International Network for Scientific Investigations of Deep-sea Ecosystems; International Seabed Authority's impact of deep sea mining; SCOR special group on Seafloor Ecosystem

Functions and their Role in Global Processes; SCOR visiting scholar.

5. Dr. Marcelo Kitahara (University of Sao Paulo, Brazil)

Dr Kitahara is a deep-sea coral molecular biologist at the University of Sao Paulo, Brazil, using molecular approaches in addition to morphology (micro architecture, and macro and microstructure of the skeleton), fossil data, and bioinformatics to study the evolutionary history of scleractinian corals and related groups, such Corallimorpharia. This research is showing how scleractinians have survived climate change and OA events in the past and shedding light on how corals of ecological and economic importance will cope with increasing modern anthropogenic pressures.

6. Dr. Jason Hall-Spencer (Professor, University of Plymouth, UK)

Jason Hall-Spencer is Professor of Marine Biology at Plymouth University in a city home to >500 marine scientists at the Marine Institute, the Marine Biological Association of the UK, the Sir Alistair Hardy Foundation for Ocean Science and Plymouth Marine Laboratory. He now leads a group of 9 PhD students who conduct applied research to provide policy makers with the scientific information needed to best manage the marine environment, ranging from deep-sea benthos, fisheries, aquaculture, marine protected areas, biogenic reefs and seamounts. His research has attracted grant income from various EU projects (COST IMPACT, MARINEXUS, FP7 KNOWSEAS, FP7 MEDSEA, 3 EU MARES PhD studentships) and from NERC. He has >100 publications.

7. Dr. Amy Baco-Taylor, Florida State University

Baco-Taylor has been studying deep-sea corals on seamounts since 1998 using submersibles, ROVs and AUVs. She has studied these communities throughout the Hawaiian Archipelago and into the broader Pacific including Alaska, Necker Ridge, and New Zealand. Her research on deep-sea corals has included exploration for deep-sea coral and sponge communities, examining the distributions of deep-sea coral species on seamounts, coral reproductive biology, developing and screening microsatellite markers for several species of precious corals and delineating precious coral stock structure through population genetics. She has also been involved in a number of international meta-analyses efforts to determine habitat suitability models for deep-sea corals, and to compare the communities of cobalt-rich vs. non-cobalt rich seamounts. She has current NSF funding to study the recovery of seamount coral communities from trawling impacts.

8. **Dr. Di Tracey (NIWA, NEW ZEALAND**)

Di Tracey is a deep-sea scientist at NIWA in Wellington. She has had a 35-year career researching the biology of deep-sea fishes and invertebrates in specific deep-sea habitats such as seamounts. Her recent work has been on the taxonomy, distribution, and age and growth of protected deep-sea corals. She co-convened the 4th International Symposium on Deep Sea Corals, is a on the 6th International Deep-Sea Coral Symposium Science Steering Committee,

and leads the New Zealand- United States Joint Commission Meeting (JCM) on Science and Technology Cooperation Ocean and Marine Theme Project.

9. Dr. Alvar Carranza (Uruguay)

Dr. Carranza serves as full tenured Professor at the Univeridad de la Uruguay. She is also chair of the university's Environmental Science and Management Program. Dr. Carranza is active in outer continental and slope fisheries program of Uruguay.

10 Dr. Sarma V. B. Yellepeddi, (YVB Sarma) King Abdullah University of Science and Technology, Red Sea Research Center, Saudi Arabia

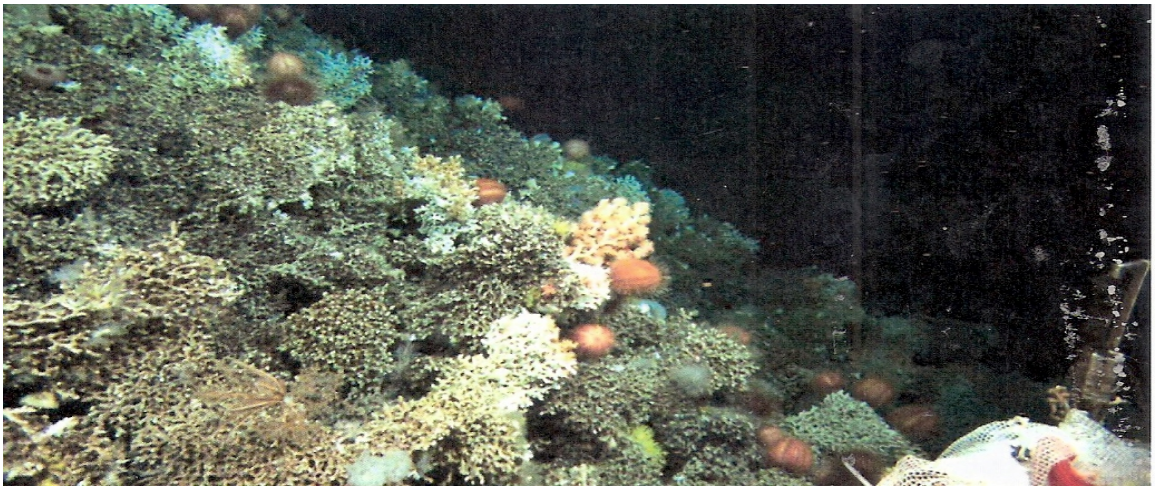
Dr. Sarma is a research scientist working on biophysical and ecological aspects of the Red Sea at King Abdullah University of Science and Technology (KAUST), Saudi Arabia. Earlier he worked as professor at Sultan Qaboos University, Oman. Sarma's work in the recent years is related to changes in thermal characteristics of seas around Oman. Presently establishing ocean observing and prediction system at KAUST that includes, conventional ocean expeditions (for hydrography and ecological studies), automated underwater vehicles (Sea gliders and Webb gliders), Coastal HF radars (CODAR), Towed under water vehicles (Scanfish) and numerical modeling. The acidification is an important factor to investigate in this region as a large coastal fishery depends on the sea for local food security.

Proposed Budget

Total Funds Requested From SCOR: $ 45,000*

*This budget will cover travel cost and hotel/per-diem expenses for (1) WG chair and Vice-chair to hold a Town-Hall meeting on SCOR IBDIOCC goals at the 6th International Deep-Sea Coral Symposium in Boston (Sept. 12-16, 2016): (2) All ten full members of the WG to participate in the workshop at the 2017 ASLO Meeting in Honolulu, Hawaii and 2018 AGU Ocean Sciences meeting in Portland, Oregon (2018). (3) In addition, the budget includes travel cost and per-diem plus hotel expenses for Dr. Robert George, Dr. Mike Orbach, Dr. Sam Dupont, and Dr. Amy Baco-Taylor in Raleigh, North Carolina in 2018 for the preparatory planning meeting for the annual assembly of WG members at Portland Oregon AGU meeting and science paper preparation.

Typical scene of Threatened Deep-Sea Corals From Seamount A off Southeast Australia (See Below):
(Photo Taken at *Solenosimmilia variabilis* Reef at 1300 m (3900 ft) in Seamount system off Southeast Australia By ROV Jason2)



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Biodata of Dr. Michael Orbach, POLICY ADVISOR (Associate Member)

Mike Orbach is Professor Emeritus of Marine Affairs and Policy in the Nicholas School of the Environment at Duke University. Mike has performed research and has been involved in coastal and marine policy on all coasts and oceans of the U.S. and in Mexico, Central and Latin America, the Caribbean, Southeast Asia, Europe, Alaska and the Pacific, and has published widely on social science and policy in coastal and marine environments. He was a formal advisor to both the U.S. Commission on Ocean Policy and the Pew Ocean Commission, and has served on the Ocean Studies Board -- and is a National Associate -- of the National Research Council. He is also a Research Professor in the Institute for Marine Sciences at the University of California at Santa Cruz and an Affiliated Researcher with the Center for Ocean Solutions at Stanford University.

Selected Publication.

Amber Himes-Cornell, Mike Orbach, Lead Authors, Section 4: *Impacts of Climate Change on Human Uses of the Ocean, in* Griffis, R. and Howard, J., Eds., 2013. Oceans and Marine Resources in a Changing Climate: A Technical Input to the 2013 National Climate Assessment. Washington, DC: Island Press.

Dr. Thomas Hourigan (NOAA - Science Consultant-Associate Member)

Dr. Hourigan is the Chief Scientist for the National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research and Technology Program, a congressionally-mandated program that provides sound scientific information needed to conserve and manage deep-sea coral ecosystems. Tom also led the team that developed NOAA's *Strategic Plan for Sea Coral and Sponge Ecosystems* and the first report on the *State of Deep Coral Ecosystems of the United States*.

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