

REPORTING FORM 2024

SIBER

G. Cowie and R. Hood (co-chairs), with contributions from multiple SIBER SSC members

1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges

(Among other uses, information will be used to update the Grand Challenge Factsheets)

1.a. Grand Challenge I

Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:

Research Objective 1. *Evaluate and predict the cumulative effect of multiple stressors*

Research Objective 2. *Integration of climate change and climate variability*

Research Objective 3. *Impacts on society – preparation for a changed future*

This Challenge, and research objectives 1 and 2, remain the primary focus of SIBER activity. The activity is centred on the 2nd International Indian Ocean Expedition, (IIOE-2), in the main involving open-ocean processes and research cruises. SIBER members also are heavily involved in IIOE-2 through steering committees and working groups, and through chairing national IIOE-2 committees. Broader ongoing programmes relating to this Challenge include the IIOE-2's Eastern and Western Indian Ocean Upwelling Regime Initiatives (EIOURI and WIOURI).

The WIOURI programme is focused on 9 upwelling regions (Fig. 1), with emphasis on climate change and marine food security. The SOLSTICE-WIO programme (co-led by M. Roberts of SIBER; see 2022 SIBER report) is now complete but has been followed by projects focused on the Agulhas current upper reaches (CYCLOPS) and another focused on the Mozambique shelf (ReMoTURB; also led by M. Roberts).

Both are multi-disciplinary and address ocean productivity, fisheries and coastal communities. The last of 3 RESILIENCE cruises (part of CYCLOPS; *RV Marion Dufresne*) took place in 2022 with a focus on oceanic fronts (Mozambique channel), the Durban eddy, and coastal-offshore interactions around the Isimangaliso MPA. Nearshore fieldwork on the ReMoTURB project was complimented by a research cruise for linked studies offshore of the Bazaruto Archipelago in May-June 2023 with the *RV Fridtjof Nansen*.

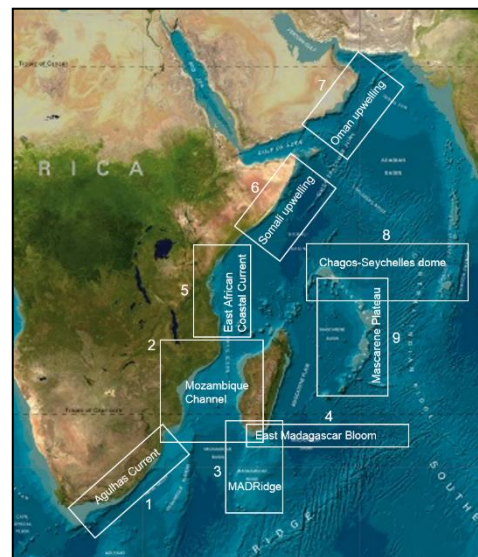


Figure 1. The 9 regions forming the centre of the WIOURI programme.

The Indian Ocean Mission of the Monaco Explorations took place in Oct-Nov 2022 (involving SIBER SC members F. Marsac and J-F TERNON). It is the first element of a project that was endorsed by the United Nations Decade of Ocean Sciences for Sustainable development and IIOE-2. The cruise (Fig. 2) went from Cape Town

Figure 2. Cruise track of the *RV Agulhas II* Monaco Explorations Indian Ocean Mission (Oct-Nov 2022).

(South Africa) to Mauritius, then Reunion, Seychelles (via Aldabra) and to Mauritius (via the Salha de Malha bank, where a multidisciplinary study of the ecosystem was conducted), then back to Cape Town. It involved over 150 participants of 20 different nationalities, including scientists, early-career researchers, and students at the onboard school, filmmakers and photographers, divers, artists, communicators, and the vessel crew. The expedition implemented a holistic approach based on a multidisciplinary programme including natural and social sciences.

The expedition's purpose was also to promote the contents, knowledge and resources resulting from the operations by encouraging the exchange and transmission of knowledge to as wide an audience as possible through a varied outreach programme, and extensive work continues. The various components were aimed at a broad public: schools, civil society, and decision-makers. Two documentary films were produced in 2023 for international distribution and other educational and artistic content. The offshore projects of the expedition included oceanographic stations (CTD and XBT), the deployment of 29 BioArgo floats, the deployment of drifters (19 of 3 months life expectancy, and 5 regular drifters with drogues from which 2 are still operational after 21 months at sea), and a full ecosystem study of the Salha de Malha Bank (physical and chemical oceanography, plankton and productivity, benthic biodiversity) on the bank and along its slopes. France has participated in the expedition with 45 scientists and 10 students. A special issue is underway in Deep Sea Research Part II. The issue will include 20 research papers, and is planned for release before June 2025. Three out of the four guest editors of the Special Issue are French scientists.

Other continuing French IO work follows the RESILIENCE cruises (2022), which focussed on physical/biogeochemical submesoscale interactions at two sites in the south-west IO: the front between a cyclonic and an anticyclonic mesoscale eddies in the central Mozambique Channel, and at the boundaries around a semi-permanent cyclonic eddy (the Durban eddy) moving southwestward between the large Agulhas Current (offshore) and the east coast of South Africa. High resolution sampling was done for currents, hydrology, phyto- and zooplankton, active acoustics, trace metals, CO₂, etc. The cruise involved about 40 scientists from France, Réunion, South-Africa and Mozambique, as well as a "floating university" (20 students, from these countries). Scientific papers are "in progress" – one (on high resolution distribution of phytoplankton at the eddies front) already submitted to the new IIOE-2 Special Issue in Deep Sea Research II.

Further cross-disciplinary IIOE-2 projects in the western and central IO that followed SIBER/IMBeR science themes included Bertarelli Foundation-funded projects investigating *i*) oceanographic drivers of ecosystem response at basin-to-atoll scales (P. Hosegood), and *ii*) cetacean ecology (C. Emling) and *iii*) manta ecology (J. Harris). Manta studies (Fig. 3) included a project focused on multiscale drivers of manta movement and behavior throughout the Maldives. Other studies focused on IO marine heatwaves and the impact of Indonesian Throughflow on IO circulation (Hosegood and SAEON/Uni. Cape Town).

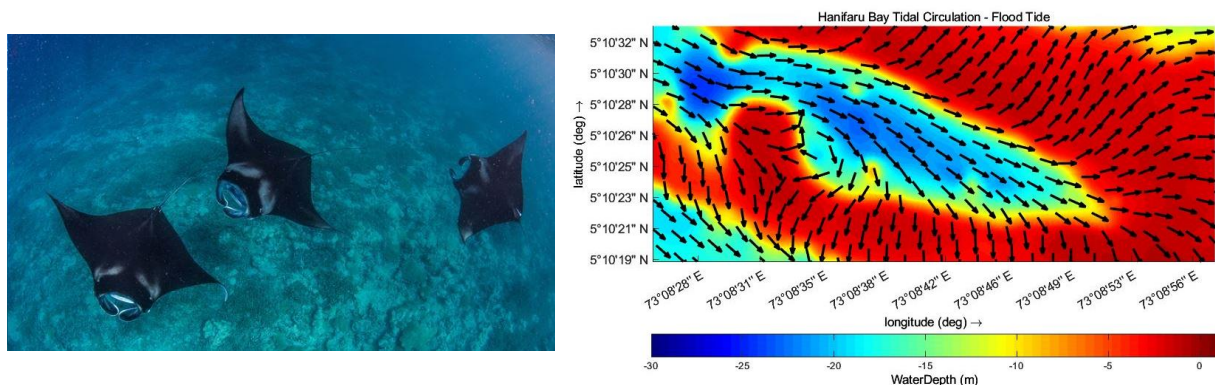


Figure 3. Oceanographic drivers of manta habitat use in the Maldives, through a combination of extensive in-situ observations (ADCPs and temperature sensors) and numerical modelling.

There was also a continuation of mesophotic coral surveys through a Garfield Weston Foundation-funded project (2019-23). The deepest coral bleaching ever recorded (90 m) was found to be due to thermocline deepening caused by the IOD, with spatial variability attributed to internal waves (Diaz et al., 2023, *Nature Comms.*, Fig. 4). Surveys were recently completed (Jan/Feb. 2024) to establish the impacts of the 2023 IOD on deep bleaching.



Mesophotic coral bleaching associated with changes in thermocline depth

Received: 21 March 2023

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Figure 4. Mesophotic bleaching attributed to thermocline deepening.

ASCA Cruises: [PIs J. Hermes & T. Morris (SAEON), A. Johnson (DFFE); South Africa]

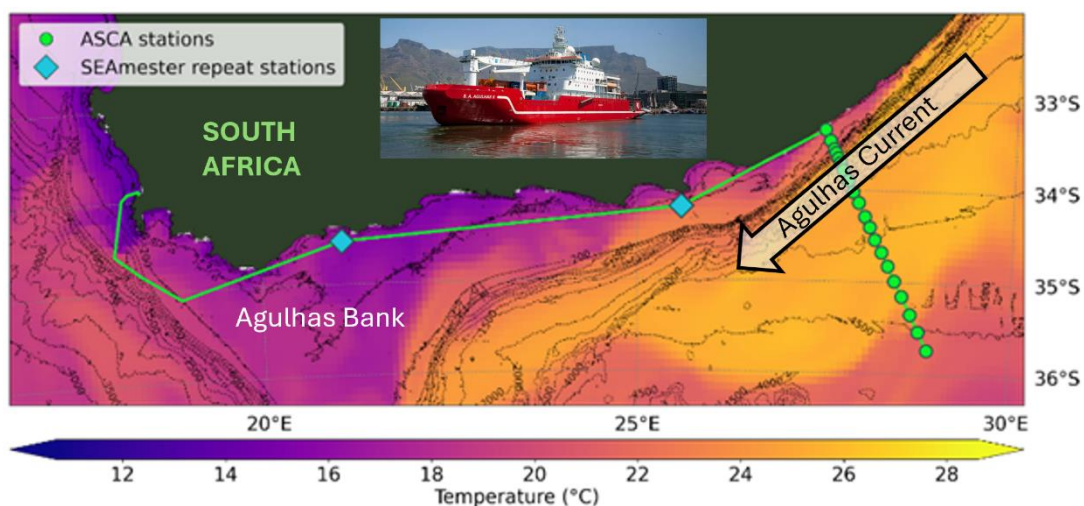


Figure 5: Map showing ASCA line stations crossing the Agulhas Current. Inset: SA Agulhas II.

Cruises are undertaken annually along the Agulhas System Climate Array (ASCA) transect, which extends 300 km offshore, to monitor variability in the Agulhas Current. The most recent cruises 9FIG 5) took place in July 2023 and July 2024 on the SA *Agulhas II*, with measurements and samples collected representing a full suite of physical, chemical and biological essential ocean variables, as well as for microplastics analysis. [Biological EOVs PI = J. Huggett, SIBER SC]

ACEP Project: The role of the Agulhas Current on the Coastal Environment [PI T. Morris; SAEON, SA]

A new 3-year project has been launched to investigate the role of the Agulhas Current, and in particular processes and anomalous physical events (such as meanders, trapped cyclonic eddies and upwelling), on the adjacent coastal region and downstream in Algoa Bay. Multidisciplinary sampling (physical, chemical and biological EOVs and microplastics) will be conducted every 2-3 months along a ca. 45 nm transect extending out of Algoa Bay into the Agulhas Current, on the 15 m-long RV *Observer*. The first cruise (Fig. 6) took place on 8th May 2024, with deployments including a Sailbuoy

and a Seatrec Argo float. This project falls within the African Coelacanth Ecosystem Programme (ACEP) and the GOOS Co-Design Program, for which the Agulhas Current is the Boundary Current exemplar.



Figure 6: Map showing ACEP sampling transect, the RV Observer, and the Sailbuoy deployed during the cruise on 8 May 2024.

US activities in the western IO have included Madagascar Basin projects (NSF x 2): Examining shallow and deep currents in the Madagascar Basin - Cruise completed in April 2023 on *RV Roger Revelle*, Deep Argo floats were deployed and more RAFOS floats will be deployed between May and November, 2024 on a chartered vessel. A BGC Argo project (NSF, \$53 million) in 2023/24 will see Agulhas current deployments from the *RV Agulhas II* to Marion Island, and the *RV Investigator* to Kerguelen/Cape Darnley, and off Madagascar from the *RV Agulhas II*. The US-India EKAMSAT (ONR/MOES/NOAA) focused on air-sea exchange in the Arabian Sea, involves multiple *RV Roger Revelle* and Indian vessel cruises in 2023-2025. The BIOSCAPE (NASA Applied Sciences Division) project focused on mapping biodiversity at the Southern tip of South Africa from ocean color data; fieldwork completed in 2023. An oxygen mooring is set for the Persian Gulf (NSF), with a target deployment date of Sep. 2024.

The US-Korea KUDOS program (Fig. 7; co-led by R. Hood, SIBER SC) on the physical, biogeochemical and ecological dynamics of the Seychelles-Chagos Thermocline Ridge also progressed, with *RV Isabu* cruises now scheduled into 2026, and to include servicing of RAMA moorings.

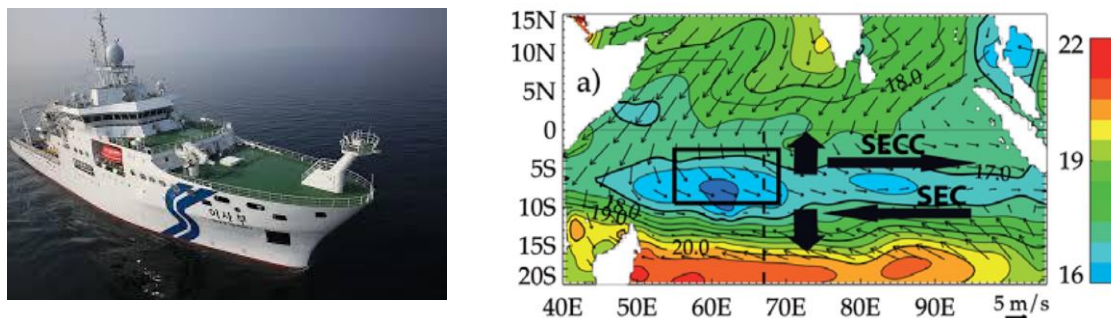


Figure 7; *RV Isabu* and KUDOS work area at the Seychelles-Chagos thermocline ridge.

The German research cruise *RV Sonne 303* was carried out as a collaborative project between the National Institute of Oceanography of Pakistan (Karachi) and several institutions in Germany led by the University of Hamburg (B. Gaye, SIBER SC, co-PI). The joint project was planned to investigate the oxygen minimum zone of the Arabian Sea on different time scales. Due to the unstable situation in the area, the project was rescheduled and sampling took place in the equatorial Indian Ocean in order to investigate the biogeochemistry of the equatorial region, and to characterize water masses and their exchange between the Arabian Sea and Bay of Bengal.

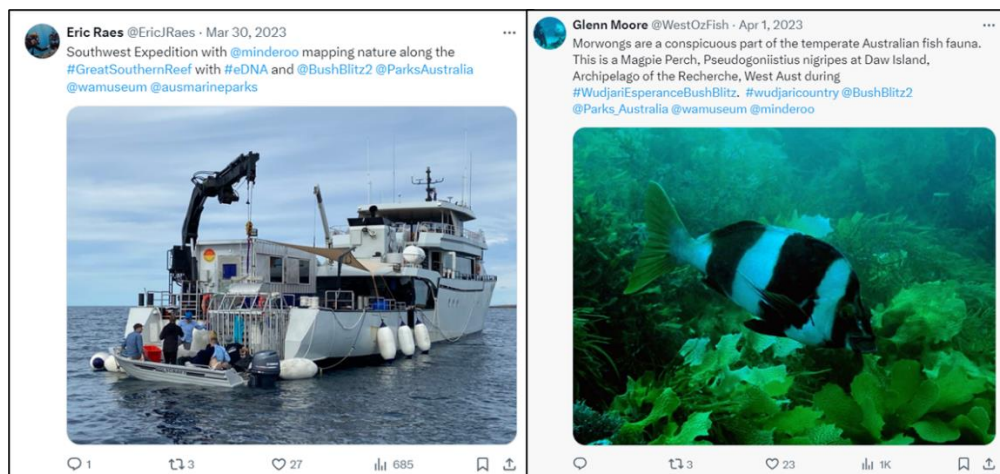
In Australia, the Munderoo Foundation's OceanOmics Program (E. Raes, SIBER SC) is committed to the advancement and deployment of marine genomics as a long-term, ocean-scale biomonitoring tool to characterise marine wildlife and monitor ecosystem health. This mission is anchored in the OceanOmics program's participation in the Ocean Decade Program of the [Ocean Biomolecular Observing Network](https://www.oceanbiomolecularobservingnetwork.org/).

Our strategy centres on harnessing cutting-edge genomic technologies and multidisciplinary expertise to generate high-quality, ocean-scale data. These data not only help us understand marine species distribution and range shifts but also serve as a critical resource for informing effective policies and management strategies. The latter aligns with Minderoo' partnership with Parks Australia under the [Ocean Discovery and Restoration](#) Program which is accelerating the use of genomic science and providing a 'proof of concept' that environmental DNA (eDNA) can be a cost-effective way to monitor biodiversity in Australia's large and remote marine parks, as compared to other marine sampling techniques. The ambition is to showcase how genomics tools can be integrated in the day-to-day operations of conservation and fisheries managers.

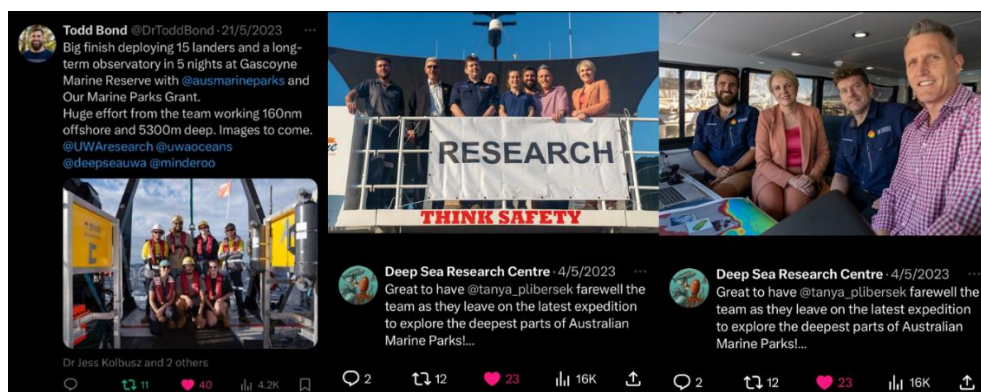
The partnership includes a series of oceanographic expeditions from the tropics (Cocos & Christmas Islands) all the way to the Southern Ocean (Tasmania) covering a latitudinal gradient spanning 35° of latitude (~3885 km; Figure 1). The expeditions have a focus to characterise the biodiversity and species distribution in the undersampled Indian Ocean, more specifically the north-west, south-west, and Indian Ocean Territory marine park networks. Although the expeditions have a specific attention to the eastern Indian Ocean, the technology can be applied to any marine ecosystem.

Expeditions in 2023:

- SW Australia in collaboration with the West Australian Museum. eDNA as a biomonitoring tool and collection of tissue samples for genome reference database 27/03- 16/04/2023



- Collaborative work with the Minderoo-UWA Deep-sea team. Deep-Sea: Diamantina Fracture Zone & Perth Canyon. 03/05/2023 – 21/05/2023



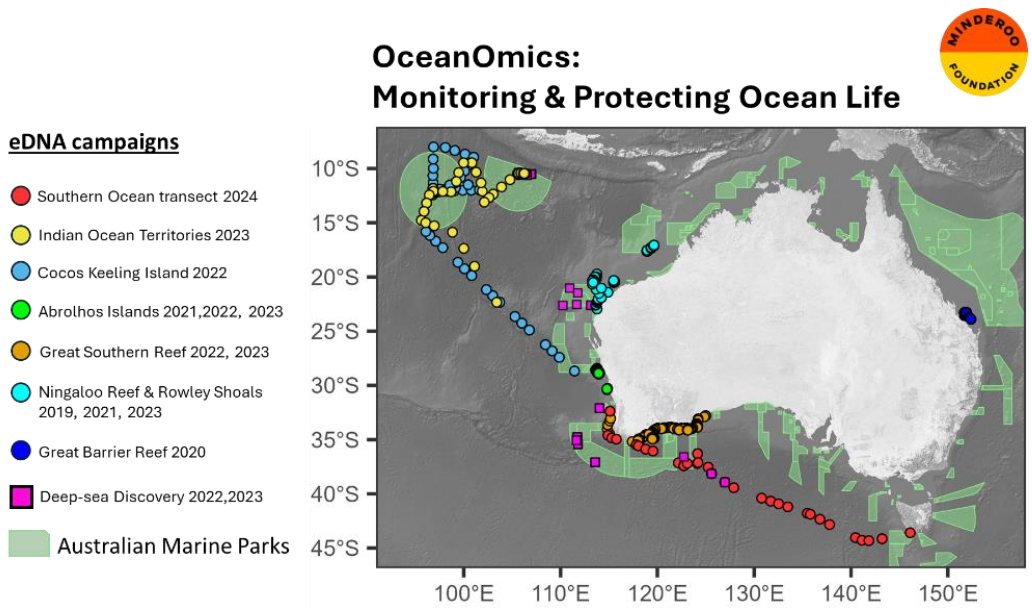
- Houtman Abrolhos Islands Expedition. Annual eDNA survey from 15/08/2023 – 26/08/2023 (12 days). Data to date from 2021,2022, 2023 and survey planned for August 2024.



- Expedition to the Indian Ocean Territories. 03/11– 05/12/2023. The focus of the work was to baseline the unique biodiversity in the IOT and to advance eDNA technologies to detect assemblage change across a gradient of fishing activity and other anthropogenic pressures.



Voyages to date:



US activities in the eastern IO include the MINTIE project (NSF), focused on the Indonesian throughflow (ITF), with voyages in 2024 and beyond on an Indonesian research vessel. The ongoing TRIUMPH (Throughflow Indonesian Seas, Upwelling & Mixing Physics) project (US-Indonesia-China; D. Susanto and O. Radjasa, SIBER SC), is multidisciplinary (physics, biology, biogeochemistry) and also focused on the ITF, and has further cruises in 2024 (*R/V Geomarin-3*) and beyond. The 2024 cruises will focus on recovery and redeployment of subsurface moorings in the Makassar, Lombok, Alas, Bali Straits. In addition, three more moorings will be added in the Sulawesi Sea and north Lombok Strait and an upwelling mooring will be recovered south of Java. TRIUMPH also involves a satellite remote sensing component focused on quantifying tidal mixing variability in the Indonesian Sea.

There has also been further development of the Indian MOSAIC coastal observing programme (led by A. Lotliker, SIBER SC;) towards establishment of six moorings, fitted with an array of physical and biogeochemical sensors (Fig. 9). Sensors have now been secured for the remaining moorings, which will be deployed in 2023 and 2024. The central objectives are to establish sustained coastal observatories to monitor and understand coastal processes, to assess the health of the coastal and estuarine waters, and for model validation, assimilation, and forecasting of water quality parameters. Stakeholders will include fishermen and fishery resource managers, the tourism industry, ecologists, environmentalists and the wider marine science research community.

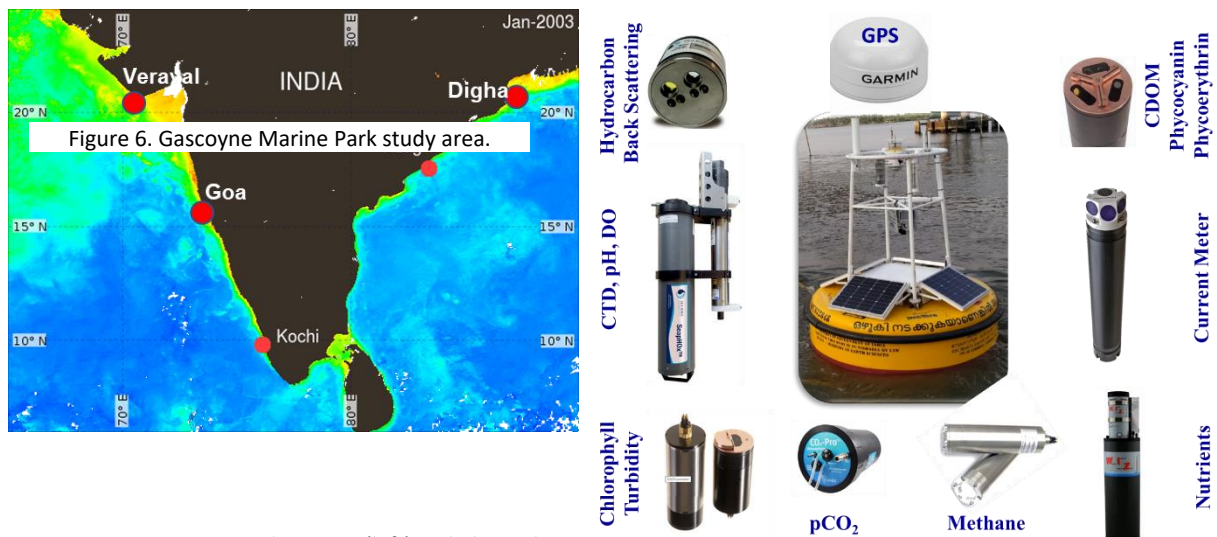


Figure 9. MOSAIC mooring locations (left) and planned physical and biogeochemical sensors (right).

1.b. Grand Challenge II

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:

Research Objective 4. *Development of integrated data systems and approaches for predictions and projections*

Research Objective 5. *Development of predictive models and projections for use at regional scales*

Research Objective 6. *Development of alternative scenarios to bridge the gap between physical climate sciences and humanities*

SIBER activities most relevant to this Challenge have been the deployment of observing/monitoring systems as part of the programmes outlined above (WIOURI, EIOURI and India's MOSAIC programmes) as well as the Australian observing programme (IMOS) and the ongoing multi-national INDOOS programme. Together, these programmes provide essential data for local to regional modelling efforts aimed at the impacts of climate change on processes, ecosystems and resources, and implications for coastal communities. In addition, a new IIOE-2 endorsed Indian Ocean multiscale numerical modelling

effort (P. Hosegood, UK, co-PI; 2022-25) aims to implement numerical models at local (atoll), regional (archipelago) and basin (Indian Ocean) scales and to explore how physical oceanography drives ecosystem response and species behaviour throughout the Indian Ocean. The US (NSF) has also funded a biogeochemical modeling program focused on oxygen minimum zones, physical drivers, biogeochemical feedbacks and coastal hypoxia.

1.c. Grand Challenge III

Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:

Research Objective 7. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation

Research Objective 8. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture

Research Objective 9. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas

Ocean governance aims at managing ocean resources to maintain them in a healthy state, for the benefit of current and future generations. It requires a holistic and multisectoral process, where natural/physical sciences and human sciences are considered in interaction. The role of oceanographers is to deliver the best available science on the ocean, assess the undergoing trends and produce indicators that can be understood by policy-makers and society to conduct adaptive policies and actions.

In 2022, the Nairobi Convention has launched a 2 year-consultation with a diversity of stakeholders (including scientists) to design a Regional Ocean Governance Strategy (ROGS). The work was structured into four thematic clusters: Marine security, Blue Economy, Environment and natural resources, Knowledge management and capacity building. France, as a member of the Nairobi Convention, has nominated two scientists (1 oceanographer, 1 law scientist) to participate in the many meetings (> 20, in-person and online) that were organised from 2022 to 2024. In February 2024, the French research Institute for sustainable development (IRD) organised a technical dialog on "Knowledge and capacity building on ocean sciences" which formed part of a series of Technical Dialogs organised across the four clusters.

Two high level meetings that were organised in 2023 where France participated were in

- Zanzibar, 22-25 May, including both ROGS and Information Management Strategy. Over 70 participants.
- Seychelles, 30 July-4 Aug: regional workshop on ocean governance and the science-policy interface

The ROGS report was finalized in May 2024, and will be discussed in August 2024 at the 11th Conference of Parties of the Nairobi Convention. This process should lead to a better shared and more efficient governance in the ocean space in the Western Indian Ocean region.

The IIOE2-endorsed NEKTON Maldives programme (www.nektonmission.org/missions/maldives) continues (2022-24), and follows similar previous work in the Seychelles. The mission included extensive 0-1000m biological surveys and seafloor mapping, as well as diverse sampling and instrument deployments. Parallel to these field studies has been NEKTON involvement in development of the Western Indian Ocean Resilience & Prosperity Initiative (WIO-RPI), a new WIO-wide ocean policy and strategy. It has been developed in consultation with regional stakeholders (science, blue economy, governance, policy) and endorsed by all 10 WIO governments (Nairobi Convention COP10, Nov '21). The four main aims are to enhance marine science necessary to inform decisions on sustainable management of marine resources, to harness a sustainable blue economy, to

strengthen natural resilience and restoration, and to advance ocean governance.

1.d. Innovation Challenge 3

To advance understanding of ecological feedbacks in the Earth System

Many of the SIBER/IIOE-2 research activities and cruises outlined above have understanding of ecosystem response and ecological feedbacks at the core of linked cross-disciplinary projects.

1.e. Innovation Challenge 4

To advance and improve the use of social science data for ocean management, decision making and policy development

Collection and use of social science data are written into the IIOE-2 Science plan and implementation strategy, overseen through IIOE-2 Science Theme 1 (“Human Benefits and Impacts”) and Working Group 6 (“Translating Science for Society”) (<https://iioe-2.incois.gov.in/IIOE-2/index.jsp>).

1.f. Innovation Challenge 5

Interventions to change the course of climate impacts

1.g. Innovation Challenge 6

Sustainable management of Blue Carbon ecosystems

The SIBER and IIOE-2 science plans have carbon cycling and sequestration in the coastal and open Indian Ocean as core to many of the key science questions and themes. They are central to several of the ongoing SIBER/IIOE-2 activities outlined above and to projects/cruises scheduled for coming years (see below). SIBER (through G. Cowie) has been represented on the innovation challenge task team. The IIOE-2 Science Plan Addendum and request to SCOR (in preparation) to extend the program to 2030 includes specific emphasis on marine spatial planning.

2. Selected highlights

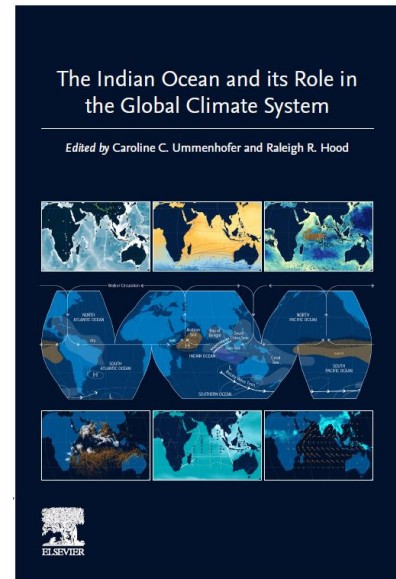
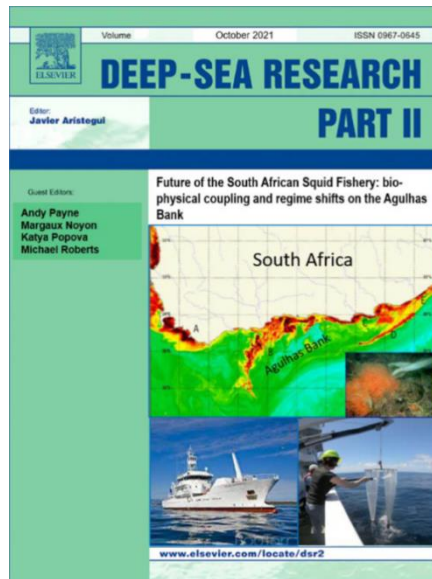
2.a. Selected scientific highlights since last report (1-5)

Last report was submitted to SSC meeting, August 2022

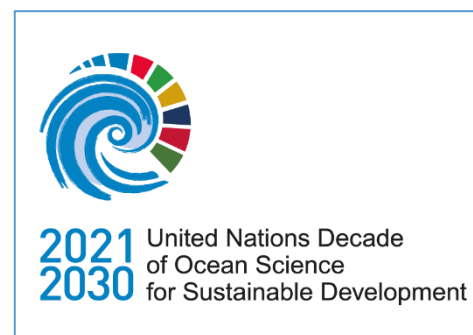
We view the major SIBER to be the following (details of each are provided in this report).

1. Contributions of SIBER SSC members to IIOE-2, both through governance (national committees and involvement in IIOE-2 working groups etc) and through motivating, leading and/or involvement in Indian Ocean research.
2. SIBER-led research cruises/projects, including SOLSTICE-WIO (Roberts), ReMoTurb (Roberts), CYCLOPS/RESILIENCE, TRIUMPH (EIOURI, Susanto and Radjasa), MOSAIC (Lotliker) etc.

- SIBER continues to lead publication of results of Indian Ocean research. This has included a series of SIBER-led IIOE-2 DSR II special volumes, with over 70 papers published and a seventh volume currently near completion. Also, a collection of synthesis papers on the Indian Ocean (Ummerhofer and Hood, SIBER SC, eds.) is being prepared as a 20-chapter book, and is nearing completion.



- A further SIBER highlight in 2023 and 2024 (ongoing) has been continued development of the Coastal Observation Lab in a Box (COLaB) initiative (a collaboration between SIBER and the CLIVAR Indian Ocean Resource Panel, co-led by G. Cowie and J. Hermes). The project involves development of portable packages of low-cost instrumentation, and protocols for standardised physical, biological and biogeochemical observations, to be applicable in diverse coastal settings (wetlands to shelf edge) and without need of major infrastructure (research vessel or formal laboratory). The instrument packages and methods will be accompanied by modelling and data management tools, and in-person and online training. Important progress has been made over the last year through involvement in and Ocean Best Practices task team and a series of in-person and hybrid workshops. COLaB also recently received endorsement by the UN Decade of Ocean, in association with the UN Decade *CoastPredict* program. Pilot COLaB activities are being carried out in Ghana and Kenya in July and September 2024 (respectively), with a full regional training camp in Mozambique scheduled for the first half of 2025. Other camps will follow, with locations in Ghana and Indonesia already identified and others in planning.



- Following agreement at the IIOE-2 SC meeting in Perth, Western Australia (Feb 6-10 2023) that the expedition should be extended beyond 2025, R. Hood and G. Cowie attended a workshop in Hyderabad, India (Nov-Dec 23). Decisions were reached as to proposed priorities for an extended IIOE-2, and R. Hood is currently leading preparation of a revised science plan and implementation strategy for the 2025-2030 period, with SIBER science themes at the core. Notably, coastal oceanography and marine science capacity building are set to become key priorities, and COLaB (and therefore SIBER) will be central to planned activities.

2.b. Publications since last report

Please add all publications since last report to the table below (see notes for details on “Class” and “Activity” fields).

NOTE: The following is not a comprehensive list; it is those publications received from a subset of SIBER SC members.

Publication with DOI	Class 1, 2, 3	Activity*
Mishra, P. K., Jehangir, A., Yousuf, A. R., Prasad, S., Anoop, A. & Gaye, B. (2024). Testing and refinement of elemental proxies in tropical lakes from the Indian subcontinent. <i>Earth Surface Processes and Landforms</i> , 49(5), 1575-1589. doi: https://doi.org/10.1002/esp.5787 .	2	Publication resulting from SIBER-led cruise/project
Burdanowitz, N., Schmiedl, G., Gaye, B. , Munz, P. M. & Schulz, H. (2024). Distinct oxygenation modes of the Gulf of Oman over the past 43,000 years – a multi-proxy approach. <i>Biogeosciences</i> , 21(6), 1477-1499. doi:10.5194/bg-21-1477-2024.	2	Publication resulting from SIBER-led cruise/project
Dugenne M, Corrales-Ugalde M, Luo JY, Kiko R, O’Brien T, Irisson J-O, Lombard F, Stemmann L, Stock C, Anderson CR, Babin M, Bhairy N, Bonnet S, Carlotti F, Cornils A, Crockford ET, Daniel P, Desnos C, Drago L, Elineau A, Fischer A, Grandrémy N, Grondin P-L, Guidi L, Guieu C, Hauss H, Hayashi K, Huggett JA , Jalabert L, Karp-Boss L, Kenitz KM, Kudela RM, Lescot M, Marec C, McDonnell A, Mériguet Z, Niehoff B, Noyon M, Panaïotis T, Peacock E, Picheral M, Riquier E, Roesler C, Romagnan J-B, Sosik HM, Spencer G, Taucher J, Tilliette C, Vilain M (2024) First release of the Pelagic Size Structure database: Global datasets of marine size spectra obtained from individual imaging devices. <i>Earth Syst. Sci. Data</i> , 16, 2971–2999, 2024. https://doi.org/10.5194/essd-16-2971-2024	2	Publication resulting from SIBER-led cruise/project
Malauene BS, Lett C, Marsac F , Penven P, Abdula S, Moloney CL, et al. (2024) Influence of Mozambique Channel eddies on larval loss of two shallow-water commercial shrimp species. <i>PLOS Clim</i> 3(6): e0000414. https://doi.org/10.1371/journal.pclm.0000414	2	Publication resulting from SIBER-led cruise/project
Hood RR , Coles VC, Huggett JA , Landry M , Levy M, Moffett J, Rixen T (2024) Chapter 13 - Nutrient, phytoplankton, and zooplankton variability in the Indian Ocean. In: Ummenhofer C & Hood RR (eds) <i>The Indian Ocean and its Role in the Global Climate System</i> , p. 293-397. Elsevier, 410 p. https://doi.org/10.1016/B978-0-12-822698-8.00020-2	2	Research led by/involving SIBER SC member
Govender A, Willows-Munro S, Singh SP, Groeneveld JC (2024) Net type, tow duration and day/night sampling effects on the composition of marine zooplankton derived from metabarcoding. <i>Metabarcoding and Metagenomics</i> 8: e119614. https://doi.org/10.3897/mbmg.8.119614	3	SIBER/IMBeR relevant research
Bond, T., Niyazi, Y., Kolbucz, J.L., Jamieson, A.J., 2023. Habitat and benthic fauna of the Wally-Cuvier escarpment, SE Indian Ocean. <i>Deep-Sea Research II</i> , 210, 105299.	3	SIBER/IMBeR relevant research

Brock, M.L., Larkin, A.A., Raes, E.J. , Martiny, A.C., 2023. Bacterial biogeography of the Indian Ocean. <i>Limnology and Oceanography</i> 9999, 2023, 1-14.	2	Research led by/involving SIBER SC member
Chowdhury, S., Raes, E. , Horstmann, C., Ahmed, A., Ridame, C., Metzl, N., Bhavya, P.S., Sato, T., Shiozaki, T., Bonnet, S., Löscher, C.R., Singh, A., Benavides, M., 2023. <i>Limnology and Oceanography Letters</i> , 82023, 707-722.	2	Research led by/involving SIBER SC member
Evans-Powell, R.T., Hesp, S.A., Denham, A., Beckley, L.E. 2024. Implications of big, old, fat, fecund, female fish (BOFFFFs) for the reproductive potential of a demersal teleost stock. <i>Fisheries Research</i> , 272, 106934. https://doi.org/10.1016/j.fishres.2023.106934 Kolbucz, J.L., Zika, J., Pattiaratchi, C., Jamieson, A.J., 2024.	2	Research led by/involving SIBER SC member
Water properties and bottom water patterns in hadal trench environments. <i>EGU Ocean Science</i> 20, 123-140. Thompson, P.A., Carstensen, J., 2023. Global observing for phytoplankton? A perspective. <i>Journal of Plankton Research</i> 45 (1): 221-234.	3	SIBER/IMBeR relevant research
Mohamed A, et al (2023) The Nekton Maldives taxonomic workshop: Exploring the biodiversity of shallow, mesophotic and deep-sea communities in Maldives, Research Ideas and Outcomes 9:e114370	3	SIBER/IMBeR relevant research
Pinheiro HT, et al (2023) Plastic pollution on the world's coral reefs, <i>Nature</i> 619: 311-316	3	SIBER/IMBeR relevant research
Stefanoudis PV, et al (2023) Trait-based approaches reveal that deep reef ecosystems in the Western Indian Ocean are functionally distinct, <i>Science of the Total Environment</i> 872: 162111	3	SIBER/IMBeR relevant research
Swanborn DJB, Huvenne VAI, Malpas T, Pittman SJ, Rogers AD, Taylor ML, Woodall LC (2023) Seamount seascape composition and configuration shape Southwest Indian Ridge fish assemblages, <i>Deep-Sea Research Pt 1</i> , 191: 103921	3	SIBER/IMBeR relevant research
Van der Mheen M., Wernberg, T., Pattiaratchi, C., Pessarrodona, A., Jenkovic, I., Simpkins, T., Hovey, R., Filbee-Dexter, K. 2024. Substantial kelp detritus exported beyond the continental shelf by dense shelf water transport. <i>Scientific Reports</i> , 14: 839	3	SIBER/IMBeR relevant research
Kehinde, O., M, Bourassa, S. Kranz, M.R. Landry , T. Kelly and M.R. Stukel. (2023). Lateral advection of particulate organic matter in the eastern Indian Ocean. <i>J. Geophys. Res., Oceans</i> . 128, e2023JC019723. https://doi.org/10.1029/2023JC019723 .	2	Research led by/involving SIBER SC member
Quintanilla, J.M., R. Borrego-Santos, E. Malca, R. Swalethorp, M.R., Landry , T. Gerard, J. Lamkin, A. García and R. Laiz-Carrión. (2024) Maternal effects and trophodynamics drive interannual larval growth variability of Atlantic Bluefin Tuna (<i>Thunnus thynnus</i>) from the Gulf of Mexico. <i>Animals</i> , 14, 1319. https://doi.org/10.3390/ani14091319 .	2	Research led by/involving SIBER SC member

Landry, M.R. , M. Décima, M.R. Stukel, and A. Gutiérrez-Rodríguez. (In Review) The microzooplankton trophic link: does conventional understanding of food web structure satisfy mesozooplankton carbon requirements in the oceans? ICES J. Mar. Syst.	2	Research led by/involving SIBER SC member
Hood, R. R. , T. Rixen, M. Levy, D. A. Hansell, V. J. Coles and Zouhair Lachkar (2024) Oxygen, Carbon and pH Variability in the Indian Ocean. In: The Indian Ocean and its Role in the Global Climate System, C. Ummenhofer and R. R. Hood (eds.), Elsevier, Amsterdam.	2	Research led by/involving SIBER SC member
Hood, R. R. , T. Rixen, M. Levy, D. A. Hansell, V. J. Coles and Zouhair Lachkar (2024) Oxygen, Carbon and pH Variability in the Indian Ocean. In: The Indian Ocean and its Role in the Global Climate System, C. Ummenhofer and R. R. Hood (eds.), Elsevier, Amsterdam.	2	Research led by/involving SIBER SC member
Hood, R. R. , C. C. Ummenhofer, H. Phillips, and J. Sprintall (2024) Introduction to the Indian Ocean. In: The Indian Ocean and its Role in the Global Climate System, C. Ummenhofer and R. R. Hood (eds.), Elsevier, Amsterdam.	2	Research led by/involving SIBER SC member
Amri, K., Priatna, A., Ma'mun, A., Setyadji, B., Suman, A., Susanto, R. D. , Gaol, J. L., Nababan, B., Pranowo, W. S., and Efizon, D., 2023, Evidence of spawning migration of protandrous longtail shad (<i>Tenualosa macrura</i>) in the Siak River estuarine, Indonesia: Ocean & Coastal Management, v. 231, p. 106384.	2	Research led by/involving SIBER SC member
Manullang, C. Y., Patria, M. P., Haryono, A., Anuar, S. T., Fadli, M., Susanto, R. D. , and Wei, Z., 2024, Vertical distribution of microplastic along the main gate of Indonesian Throughflow pathways: Marine Pollution Bulletin, v. 199, p. 115954.	2	Research led by/involving SIBER SC member
Munandar, B., Wirasatriya, A., Sugianto, D. N., Susanto, R. D. , and Purwandana, A., 2023, Distinct mechanisms of chlorophyll-a blooms occur in the Northern Maluku Sea and Sulu Sill revealed by satellite data: Dynamics of Atmospheres and Oceans, v. 102, p. 101360.	2	Research led by/involving SIBER SC member
Nie, Y., Li, S., Wei, Z., Xu, T., Pan, H., Nie, X., Zhu, Y., Susanto, R. D. , Agustiadi, T., and Trenggono, M., 2023, Amplitude modulations of seasonal variability in the Karimata Strait throughflow: Frontiers in Marine Science, v. 10, p. 1085032.	2	Research led by/involving SIBER SC member
SIALLAGAN, Z. L., KRISTIANTI, T., DWIVANY, F., NUGRAHAPRAJA, H., DE FRETES, C. E., FADLI, M., TRINUGROHO, J. P., RADJASA, O. K., and SUSANTO, R. , 2023, Vertical profile of culturable bacteria from the Makassar Strait, Indonesia: Biodiversitas: Journal of Biological Diversity, v. 24, no. 3.	2	Research led by/involving SIBER SC member
Wirasatriya, A., Susanto, R. D. , Setiawan, J. D., Agustiadi, T., Iskandar, I., Ismanto, A., Nugraha, A. L., Kunarso, A. D. P., Purwandana, A., and Ramdani, F., 2023, Extreme Upwelling Events in the Seas of the Alor Kecil, Alor Island, Indonesia: Oceanography, v. 36, no. 1, p. 28-37.	2	Research led by/involving SIBER SC member

Bold Font: SIBER SC members

All publications resulting from IIOE-2 projects and from SIBER SC members or their cruises/projects are facilitated by IMBeR.

2.c. Events, Meetings, and Workshops

List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Regional Programme / Working Group committee meetings and workshops.

11th Indo-Pacific Fish Conference, Auckland, 20-24 November 2023.

L.E. Beckley was chair of the International Steering Committee of the IPFC 2017-2023

L.E. Beckley co-convened a special session "Larval fishes - solving phylogenetic, life-cycle and ecological questions" at this conference

Enabling eDNA for Management in Australian Marine Parks. 13 - 15 September 2023. Perth. Multi-level stakeholder discussions focused on the future efforts to scale the deployment of environmental DNA (eDNA) and advance genomics research to make more informed conservation decisions so we can better protect our natural ecosystems. Stakeholders ranged from industry, NGOs, national science agencies, traditional owner and community groups, philanthropy. Minderoo & CSIRO organised the workshop.

EGU General Assembly, April 23-28, 2023, in Vienna, Austria

- Session ID: OS1.7/BG4/CL2: "Understanding the Indian Ocean's past, present, and future",
Conveners: Caroline Ummenhofer, Alejandra Sanchez-Franks, Peter Sheehan, Yan Du, Muhammad Adnan Abid

Annual Indian Ocean Sessions at Japan Geoscience Union and Ocean Science Japan meetings (M. Honda co-convenor).

COLaB presentations at multiple training, capacity building and low-cost oceanography workshops (Mozambique, Ghana, India, France) (G. Cowie).

3. International collaboration and links

In addition to fostering wide international collaboration through directly leading multidisciplinary and multinational research projects and cruises, and generally through active engagement in IIOE-2, SIBER has been involved in bringing to life two important new collaborative programmes, in the form of the US-India EKAMSAT joint project (multidisciplinary process studies, focused on the Arabian Sea) and the UK-KUDOS joint project (focused on the Seychelles-Chagos Thermocline Ridge). Both programmes are IIOE2-endorsed, have biogeochemistry and ecosystem research at their cores and will involve frequent cruises from this year forward (with both US and Indian vessels in the case of EKAMSAT, and with *RV Isabu* in the case of KUDOS).

4. Input to management, policy and SOCIETY* over the last year

Add anything that is not covered under "1.c. Grand Challenge III"

**As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

Add text...

5. Education, Outreach and Capacity Development

As outlined above and in previous reports, multiple SIBER projects (e.g. Monaco Indian Ocean expedition, SOLSTICE-WIO, TRIUMPH etc) have involved education and training through inclusion of students in research cruises etc.

SIBER members have also been involved in various training activities, including COLaB presentations (Cowie) at online and in-person (France, UK, Ghana) workshops. A pilot study for the COLaB project, in Ghana (July 2024), was conducted with scientists from the University of Ghana, and focused on testing affordable open-source oceanographic instruments and assessing mercury and sediment contamination in the Pra river/estuary system, resulting from upstream illegal gold mining. A further pilot study is planned for Kenya in September 2024, before a full COLaB regional training camp in Mozambique in 2025. Further COLaB work in Ghana, on the Pra and Ankobra rivers, will continue from 2025.



eDNA survey to the Abrolhos Islands in September 2023

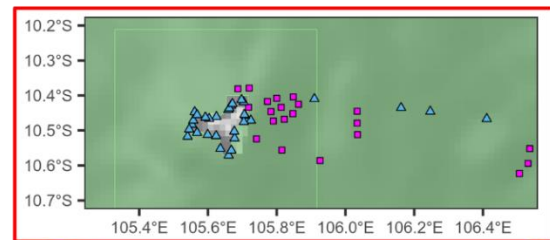
During the planning phase of our scientific research, we communicated with the Yamatji Southern Regional Corporation to inform them about our intended study in their region. We provided them with an overview of our OceanOmics program (accessible [here](#)), including maps of our intended sampling sites and offering background information on our initiative and science goals. Two junior Sea Rangers from the Yamatji Southern Regional Corporation joined us on our expedition in August 2023. During these discussions, we have been scoping collaborative opportunities that can mutually benefit the ranger program of the Yamatji Southern Regional Corporation and OceanOmics. Specifically, we aim to identify initiatives that contribute to the conservation of Sea Country, ensuring that our efforts align with the preservation and protection of the marine environment in the region.

Marine outreach summary on Christmas Islands (November 2023):

We conducted an onshore eDNA survey in the vicinity of Christmas Island, accompanied by fish tissue collection for reference genome analysis in November 2023. Wayne Walters, Marine Education Manager at Minderoo Foundation, joined the OceanOmics team on the first leg of this research expedition. He delivered a variety of outreach activities for students and cadets at Christmas Island District High School. The outreach activities engaged over 120 students and 36 cadets in hands-on marine biodiversity and eDNA experiences. They also provided opportunities for 5 marine scientists to work with local students and share inspiring career stories.

Christmas Island

Eric Raes @EricJRaes · Nov 21, 2023
We engaged with 122 students and 36 cadets in marine biodiversity 🐟 and environmental DNA 🧬 outreach activities on Christmas Island @Minderoo @ausmarineparks @Parks_Australia #education #ProtectOurOceans #oceanconservation #IndianOcean #locUnesco



6. Planned activities

A key SIBER activity over the next year will be involvement in planning for the extension of IIOE-2 beyond 2025, where coastal observations, marine science capacity building, and COLaB, and therefore SBER, will form major parts.

Numerous IIOE-2 research cruises led by or involving SIBER members or addressing SIBER science themes are now scheduled or planned for 2024 and coming years, extending beyond 2025. These include multiple Arabian Sea cruises with Indian and US vessels as part of the EKAMSAT joint project and annual cruises with the Korean research vessel *RV Isabu* as part of the KUDOS joint project.

Other upcoming/planned US IIOE-2 projects include:

MINTIE (NSF): ITF Study, Recently Deployed 5 Riser floats in the Banda Sea, Working on research clearance for MINTIE mooring voyage in 2024 on Indonesian Vessel.

TRIUMPH (LIPI/NSF): ITF Study, Cruise in 2022 completed in the upwelling season on Indonesian vessel, More cruises in 2024 and beyond likely with NSF support.

MADAGASCAR BASIN (NSF x 2): Examining shallow and deep currents in the Madagascar Basin, Cruise in April 2023 on *RV Roger Revelle*, RAFOS floats to be deployed. Further cruise in 2024/2025.

BIOSCAPE (NASA Applied Sciences Division): Mapping Biodiversity at Southern tip of South Africa, from ocean color data.

Multiple proposals submitted/pending: for example, Mullholland et al. (NSF), cruise from Madagascar to SW Australia to look at primary production, nitrogen fixation and Fe limitation in the southern Subtropical Gyre of the India Ocean.

Germany has a number of SIBER-led or relevant cruises with *RV Sonne* (e.g. BIOCAT and BIOCAN projects in the Arabian Sea and Bay of Bengal, see 2022 report) now rescheduled for 2024. Other projects and cruises are also pending.

Japanese EIOURI cruises (involving M. Honda, SIBER SSC member) that were cancelled due to COVID have now also been rescheduled, and further projects and cruises are in planning.

Similarly, multiple other Australian, Indian, Indonesian and French SIBER/IIOE-2 projects and cruises are either scheduled or in planning, to extend beyond 2025.

There are multiple plans for COLaB marine science capacity building in the IO in coming years, to firstly include a regional training camp in Mozambique in 2025, followed by another in Indonesia (at BRIN Lombok). Others, in the Andaman islands and Seychelles/Mauritius, are in planning.

6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

Add text...

6.b. Upcoming papers (Community-Position-Review-etc)

Add text...

7. Funding

7.a. Funding from external sources

Funds from an Experiment.com crowdfunding project (\$5600), combined with a POGO grant (\$10000) enabled completion of prototype open-source COLaB instruments and the pilot field study in Ghana in July 2024.

7.b. Funding proposals in progress or planned

Other funding sources are being pursued to cover costs of future COLaB training and capacity building activities.

7.c. Funding requested from IMBeR for 2023-2024

The usual funds are requested to cover attendance of SIBER SC members at the annual joint SIBER/IIOE-2/IORP/IOGOOS meetings in 2025 (tentatively set for Mauritius). The meetings will be particularly important because the proposed extension of IIOE-2 beyond 2025 will be finalised, and SIBER SC members have contributed to planning and writing the revised science plan and implementation strategy. Coastal observations and marine science capacity building are set to become priority focus areas, and COLaB (a SIBER-IORP collaboration) will play a central role.

8. Changes to Organisational Structure (e.g. SSC) of RP / WG / IMECaN

The SIBER executive and scientific steering committees have recently undergone significant change. Jenny Huggett, a long-time SSC member has stepped up to the EC and we have recently added Ocky Radjasa (BRIN, Indonesia) and Eric Raes (Minderoo Foundation and UWA Ocean Institute, Australia) to the SSC (in place of Somkiat Khokiattiwong, Jerry Wiggert and Zainal Arifin, who have rotated off). We are seeking another ECS (in addition to Eric Raes) to join the SSC in the near future.

9. Images / Figures

****It is always good to have some recent photos / figures / infographics to create more exposure for the Regional Programmes, Working Groups, etc. These can range from those suitable for a very scientific audience, to those that would engage the general public. IMBeR would use these, on the website (e.g. <http://www.imber.info/> and <http://www.imber.info/en/news>), in tweets (@imber_ipo), in presentations, etc. In addition, Future Earth (one of our sponsors) regularly asks us to provide high quality images for their glossy reports. These can highlight the activities of IMBeR and their other Global Research Projects (see pdfs of past Future Earth reports here <https://futureearth.org/publications/annual-reports/>)*

*So, please provide any images that you might think are useful. These can be pasted in this document or emailed as an attachment to imber@dal.ca.****

10. Update on Action Items from 2022 SSC meeting

Please update the [table of Action Items](#)

Add text...

11. Anything not covered above

Add text...

12. How to improve this form

Please give suggestions on how to improve this form and make it better next time.

Add text...

13. Appendices

Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)

Add text...