IMBeR Scientific Steering Committee
Annual Report to SCOR 2023/2024
1 May 2023 – 1 August 2024

[Summary]
The reporting period was the ninth year of the IMBeR (2016-2025). Science research teams were quite productive, and their science highlights were significant. Individual group submissions are available at https://imber.info/imber-annual-reports-2024/. IMBeR suffered collectively from the prolonged absence of the SSC Chair and the scheduled closure of IPO-Canada (March 2024). The new SSC Chair came to the office in June 2024. The remaining International Project Office in Shanghai will stay until the end of IMBeR in August 2025. The coming year is the final year of the IMBeR (2016-2025). IMBeR plans to hold two workshops for wrapping up the 10-year IMBeR and developing a 10-year-long science plan starting in 2026.

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1. SCOR-Future Earth Scientific Steering Committee for IMBeR

The Scientific Steering Committee (SSC) oversees the progress of IMBeR Science by Regional Programmes/Working Groups, facilitates capacity developing activities, and reports regularly to its sponsors. The Chair represents IMBeR. The SSC consists of voting members appointed by SCOR and Future Earth and no-voting *ex-officio* members representing Regional Programs, Working Groups, the Interdisciplinary Marine Early Career Network (IMECaN), and the IPO host institution. After the Chair Diana Ruiz-Pino left in August 2023, the SSC was led by interim Co-Chairs (Alice Newton (- December 2023), Marion Gehlen, and Micaela Trimble) until 28 May 2024. Dongyan Liu (F, East China Normal University) started to lead the SSC on 29 May 2024. SSC consists of the Chair and 15 members, 12 Ex Officio Members (8 representatives of the Regional Programs, and Working groups, 3 Early Career Researchers (IMECaN), and one ex-interim Co-Chair) in July 2024 (Table 1).

Table 1. Scientific Steering Committee (June 2024)

Chair: Dongyan Liu, China		
Members		
Marion Gehlen, France	Marta Ballesteros, Spain	Thorsten Blenckner, Sweden
Micaela Trimble, Uruguay	Nina Bednaršek, USA	Wen-Chen Chou, Taiwan, China
Derek Armitage, Canada	Andrea Belgrano, Sweden	Narriman Jiddawi, Tanzania
Jess Melbourne-Thomas, Australia	Jingling Ren, China	Lynne Shannon, South Africa
Rowan Trebilco, Australia	Ron Vave, USA	Nireka Weeratunge Starkloff, Sri Lnaka

The SSC membership (Table 1) contains representatives from 11 countries with diverse expertise, including phytoplankton, marine carbon biogeochemistry, ecosystem modeling, fisheries, socio-ecological systems, governance, and anthropology.

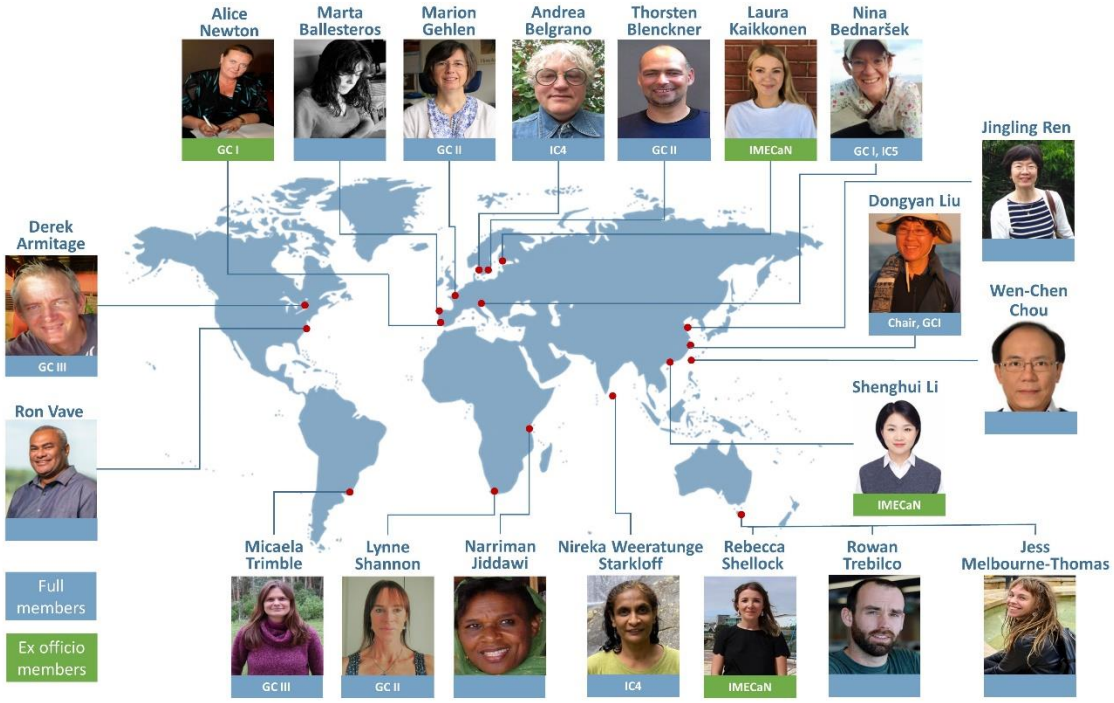

Figure 1. IMBeR SSC (June 2024). (Co-chairs of IMBeR Regional Programmes and Working Groups are also ex-officio members, but are not shown).

Activities in the last year

The yearend Scientific Steering Committee (SSC) meeting was held online on 27 November and 4 December 2023 with RP (ICED and CLIOTOP not ESSAS and SIBER), WG (CMWG and HDWG) and IMECaN representatives, and representatives from sponsors (SCOR and FE). The meeting updated planned meetings (IMBIZO7 and Future Ocean 3) and synthesis activities. The meeting decided to continue to explore any prospective leads for an IPO to succeed in the closing IPO-Canada in March 2024, albeit priority was given to developing a new MOU with the IPO-China host East China Normal University and inviting a Chair or Co-Chairs. At the same time, IPO-Canada and the meeting also decided to pursue using the hosting IMBeR Open Science Conference (Future Oceans 3) and Planning for IMBeR 3.0 as selling points for recruitment of SSC Chair(s) and IPO hosts for the next 6 months.

SCOR advised the meeting regarding a new post-IMBeR project. IMBeR could develop a new science plan with buy-in from others (non-IMBeR groups) and submit it to SCOR to consider for sponsorship, albeit acknowledging that the trajectory of IMBeR to become more inter- and transdisciplinary, SCOR is harder to fund because SCOR's focus is more on natural science.

Two institutions offered to host the Spring 2024 SSC meeting but the meeting did not occur until July 2024.

2. Progress on implementation of the project

IMBeR Science, IMBeR 2016-2025: Science Plan and Implementation Strategy, endeavors to address three Grand Challenges (GC) focusing on climate variability, global change, drivers, and stressors. The qualitative and quantitative understanding of the past and present ocean variability and change (GC I) is the basis for future scenarios, projections, and predictions (GC II). These are linked in Grand Challenge III to understand how humans are causing the variability and changes and how they, in turn, are impacted by these changes, including feedback between the human and ocean systems. Regional Programmes, Working Groups, Symposia, and Summer Schools are advancing the IMBeR Science agenda with the assistance of endorsed projects, a network of more than 10018 scientists from about 115 countries, and other competent scientific organizations. IMBeR Science further strengthens itself by creating new working groups, regional activities, ongoing, and new partnerships and collaboration with international and national scientific projects. This report covers the ninth year's activities of the IMBeR. IMBeR science activities contributes to provide scientific basis for fulfilling 17 UN Sustainable Development Goals.

Figure 2. Schematic overview of IMBeR's structure and operations during the reporting period.

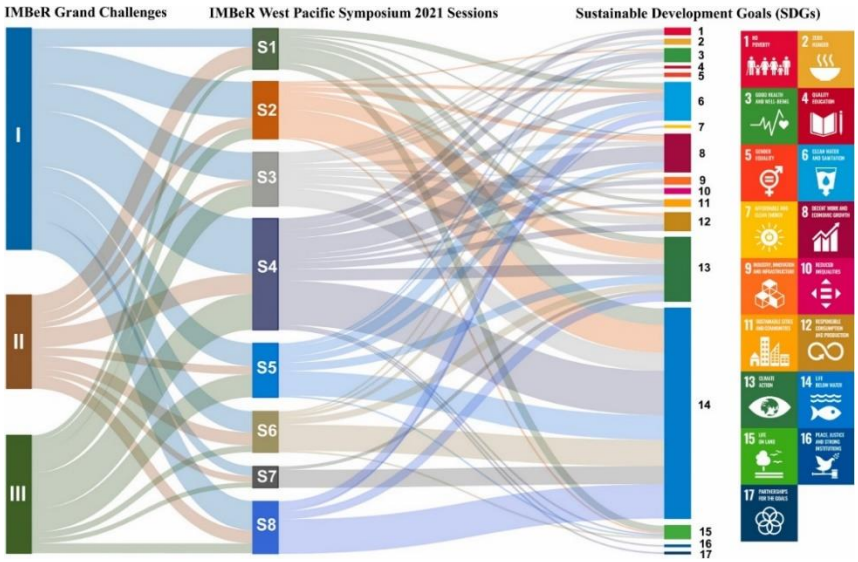

Figure 3. Sankey diagram showing the broader relationship among the IMBeR West Pacific Symposium presentations, 17 UN Sustainable Development Goals, and 3 overarching IMBeR science objectives (Grand Challenges). (Hong et al., 2024)

2.1. Status of IMBeR Regional Programmes (IMBeR funded)

2.1.1. Climate Impacts on Oceanic Top Predators (CLIOTOP) (Heidi Pethybridge and Anne Lorrain)

CLIOTOP is a regional programme of IMBeR, operating since 2005 and currently in its third phase (2016-2025). It aims to elucidate key processes involved in the interaction between climate variability and change and human uses of the ocean on the structure of the pelagic ecosystems and large marine species. While CLIOTOP did not focus specifically on Grand Challenges over the reporting period, several activities contributed to GCs and ICs.

In early 2023, four CLIOTOP task teams, each focusing on different aspects of marine top predator and climate research, were selected for funds to run until the end of 2024. Summaries of these task teams are included on the CLIOTOP webpage. All task teams have been active, with most of their outlined task activities and milestones completed or on-track for completion. Here we step through the main activities and/or achievements of the four task teams.

Task team 2023-24/1 Global trophic linkages in the mesopelagic zone (Anai Médiu and Anela Choy): A global compilation (as of Nov 2023) includes 6,687 specimens with corresponding biochemical and trophic tracer data, covering 124 families of fishes, molluscs, crustaceans, and gelatinous taxa. This corresponds to 6,025 samples with $\delta^{13}C$ and $\delta^{15}N$ values, 1,528 with total mercury concentrations, and 952 with both stable isotope and mercury data. With the adoption of the Minamata Convention, Hg biomonitoring in seafood is needed to evaluate the effectiveness of political decisions and reduction efforts in relation to human health. Except for the northwestern Pacific, Hg concentrations in tunas are stable but year-to-year variability, which likely reflects natural biogeochemical and/or ecological processes. **Skipjack Hg concentrations near Asia increased significantly in the late 1990s**, reaching concentrations up to 4 times higher than those elsewhere in the global ocean. These temporal trends suggest that at the local scale along Asian coasts close to large Hg emissions hot spots, Hg concentrations in surface tuna may integrate the increased level of deposition from nearby anthropogenic Hg release over time. The authors suggest that only the maximum feasible reduction policy scenario would lead to a detectable decrease in surface ocean tuna Hg levels and achieve the objective of the Minamata Convention in the near future.

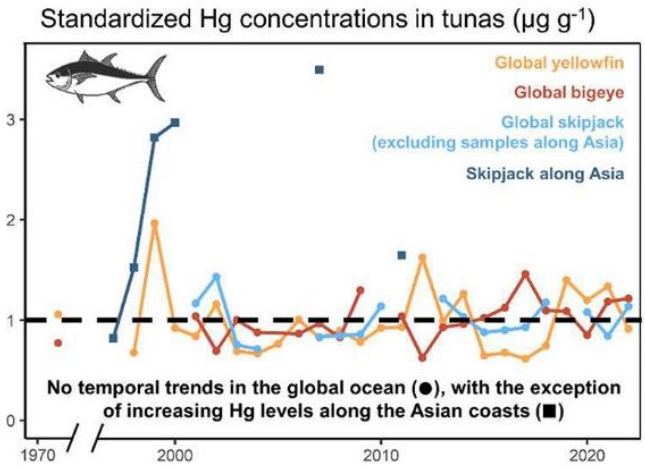

Figure 4. Stable Tuna Mercury Concentrations since 1971 Illustrate Marine Inertia and the Need for Strong Emission Reductions under the Minamata Convention (Médieu et al. 2024)

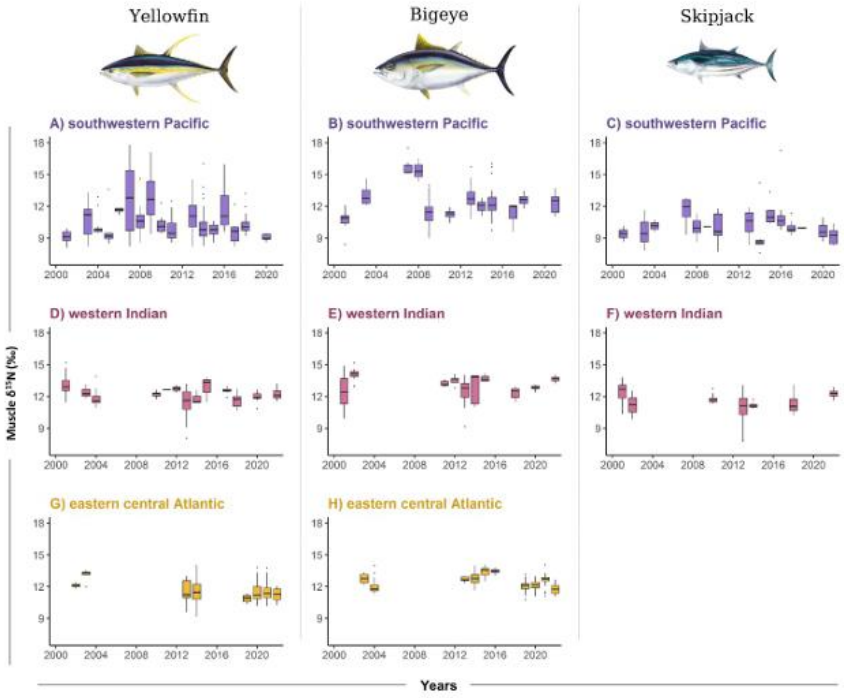

Figure 5. Our re-evaluation of tuna δ^{15}Nvalues with new data in the southwestern Pacific, western Indian, and eastern central Atlantic confirms stable trophic positions for the three tropical tunas over time (2001−2022), suggesting no changes in tuna foraging depth or diet that could have biased the tuna Hg time series in these three regions. Temporal variability of nitrogen isotope values in tunas. Boxplots of nitrogen isotope values (δ15N, ‰) measured in muscle samples of A) yellowfin, B) bigeye, and C) skipjack in the southwestern Pacific (2001 2021), D) yellowfin, E) bigeye, and F) skipjack in the western Indian (2001-2022), and G) yellowfin and H) bigeye in the eastern central Atlantic (2003-2022) (Médieu et al. 2024).

Task team 2023/2 The climate impacts of marine heatwaves on top predators in tropical oceans (Peng Lian and Barbara Muhling**)**: Two presentations have been given at academic conferences including at (i) the Third AI Oceanography Forum in China May 2024, and (ii) the 9th Youth Geoscience Forum in May 2024. Lian Peng was awarded the "Excellent Poster Award." The forum was co-organized by the AI Oceanography Committee of the Chinese Society for Oceanography, the Institute of Oceanology, Chinese Academy of Sciences, and Nanjing University of Information Science and Technology. Nearly 600 experts and scholars from over 100 universities, research institutions, and government enterprises participated. News here.

Task team 2023-24/3 Global analysis of white shark trophic role (Lauren Myers and Charlie Huveneers): In November 2023, 57 attendees from 7 countries attended the CLIOTOP Task Team *Global Analyses of White Shark Trophic Role* workshop at the Conference, White Shark Global 2023. Two scientific manuscripts were outlined during the workshop and continued to be worked on by Task Team members, including (i) Global trends and recommendations on methods used to research white sharks and (ii) Global analysis to look at ontogenetic and spatial (coastal vs pelagic) diet shifts.

Task team 2023-24/4 Exploring new horizons, barriers and bottlenecks in marine ecological forecasting for oceanic top predators (Kyle Scales and Stephanie Brodie): A manuscript is in preparation, entitled, *"A roadmap for ecological forecasting for the management of living marine resources*". This manuscript will (i) evaluate current practice regarding the development of ecological forecasts for applied management settings in the marine environment and, (ii) provide recommendations in the form of a "roadmap" for researchers and practitioners seeking to develop ecological forecasts for applied management, such as the mitigation of bycatch of oceanic top predators in tuna fisheries.

2.1.2. Ecosystem Studies of the Subarctic and Arctic Seas (ESSAS) (Franz Mueter)

While ESSAS did not focus specifically on Grand Challenges over the reporting period, several activities contributed to GCs and ICs such as through sessions of the ESSAS science meetings, such as "Natural disasters, multiple stressors, and cumulative impacts along sub-arctic and arctic coasts", "Cod and climate change at the coastal interface", "Using natural analogues to investigate the effects of climate change on northern ecosystems; moving from gradient to mosaic approaches", "Cooperative studies of coastal ecosystems engaging local communities in the sub-Arctic and Arctic", and "Blue Carbon, mariculture and climate change mitigation and adaptation in the Subarctic and Arctic".

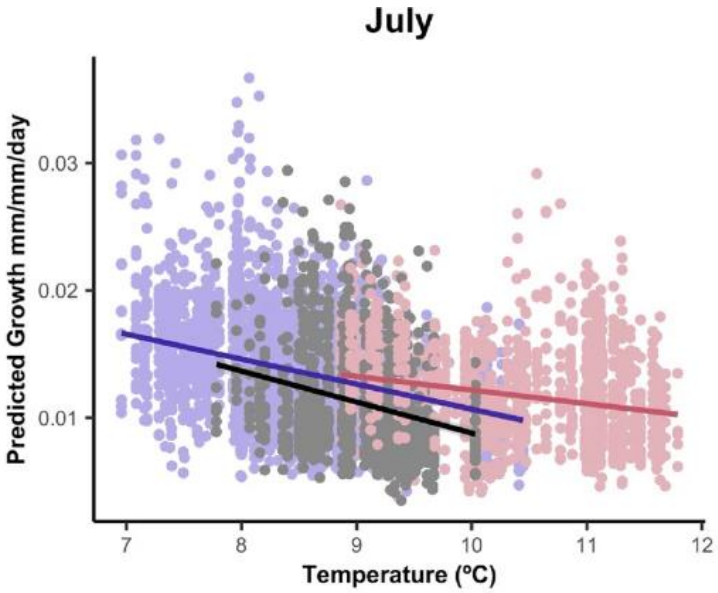

Figure 6. Predicted relative growth (mm/mm/day) for juvenile Pacific cod declined with temperature (Thalmann et al., 2024. Marine heatwaves alter the nursery function of coastal habitats for juvenile Gulf of Alaska Pacific cod. Scientific Reports 14, 14018).

2.1.3. ICED

The report was not submitted on time due to a field trip or medical leave. Please review the late submission reports here once they have been uploaded.

2.1.4. SIBER

The report was not submitted on time due to a field trip or medical leave. Please review the late submission reports here once they have been uploaded.

2.2. Status of IMBeR Working Groups (IMBeR funded)

2.2.1. Continental Margins Working Group (CMWG) (Sumei Liu)

The CMWG Chinese Marginal Seas Case Study investigated sedimentary biogenic silica dynamics in the continental margins adjacent to China to advance the scientific understanding of marine biogeochemistry of silicon (GC I) and assess the impact of atmospheric emission measures on the water quality (nutrient level) in the coastal oceans (GC III) using the long-term observations of essential ocean variables.

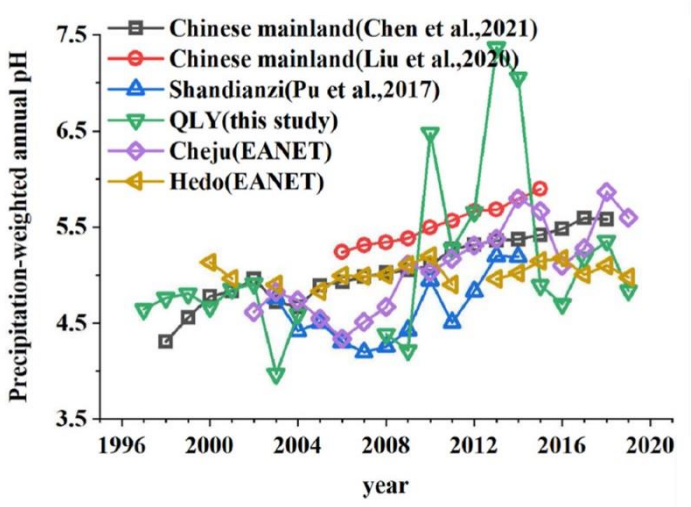

Figure 7. China expanded the regional sulfur dioxide and acid rain control zone control measures in 1998 to the National SO_2 and Acid Rain Pollution Prevention Plan in 2006. The pH of precipitation started to increase, consequently, gradually over the Yellow and the northern East China Sea (Zhang et al., 2024).

The group met on 23-24 November 2023, Qingdao, China as an on and off hybrid meeting: Part I (WEBINAR - Tour of the Asian Marginal Seas representing the Chinese marginal seas, the Seto Inland Sea, the Persian Gulf, and the Gulf of Thailand) and Part II having 12 presentations on various disciplines of marine science and thoroughly discussion about how to draft a scientific synthesis of the Chinese marginal sea ecosystems studies over the last several decades. The group participated in the Marine Ecology and Blue Carbon Sink during the Global Ocean Summit 2023 in Qingdao, China and the Circulation Research in East Asian Marginal Seas (CREAMS)/PICES Program in East Asian marginal Seas (AP-CREAMS) in June, 2023. The group plans to convene the 2024 annual meeting in October 2024.

2.2.2. Human Dimensions Working Group (HDWG) (Samiya Selim, Annette Breckwoldt)

The group has a plan to conduct a workshop at the aborted IMBIZO7 in September 2024 and no activity to report for the reporting period.

2.2.3. IMBeR Integrated Ocean Carbon Research (IOC-R) (Nina Bednarše)

Bednaršek attended the UNESCO IOC-R meeting in Brussels (May 2023). She was involved in two work groups (Theme 2 and 4) and was a rapporteur on Theme 4. The content of the two themes addressed for IMBeR: "What is the (changing) role of biology in the ocean carbon cycle?" and "How are humans altering the ocean carbon cycle and what is the resulting feedback?" Bednaršek led the writing of the section on the updated IOC-R report of UNESCO on the new process studies and experiments and co-wrote the chapter related to the Future changes in the carbon cycle from deliberate ocean-based climate interventions, as well as the role of biology in the ocean carbon cycle.

2.2.4. IMBeR SOLAS-IMBeR Ocean Acidification (SIOA)

No activities were reported.

2.3. Endorsed Projects

IPO-China reviewed the progress of the endorsed projects in June 2023.at IMBeR IPO - China Newsletter June 2023 No.35 - Endorsed Projects Updates (constantcontact.com).

2.3.1. Atlantic Meridional Transect (AMT) (Andy Rees, Gavin Tilstone, Glen Tarran, Tim Smyth)

The AMT has collected samples for microbial molecular characterization by research cruises on a passage between the UK and destinations in the South Atlantic since 1995. The extensive AMT data set has enabled scientists in 34 countries to improve our understanding of the biodiversity and biogeochemical processes for the basin scale Atlantic Ocean (GC I), sophisticate the existing scenario models for better understanding future ocean-human systems at multiple scales (GC II), and provide scientific basis, such as water quality, for industry and deliver policy directives to national and international government regimes (GC III). Funding for the continuation of AMT (2024-2029) was approved under the UK Natural Environment Research Council (NERC). A detailed AMT annual report can be found here.

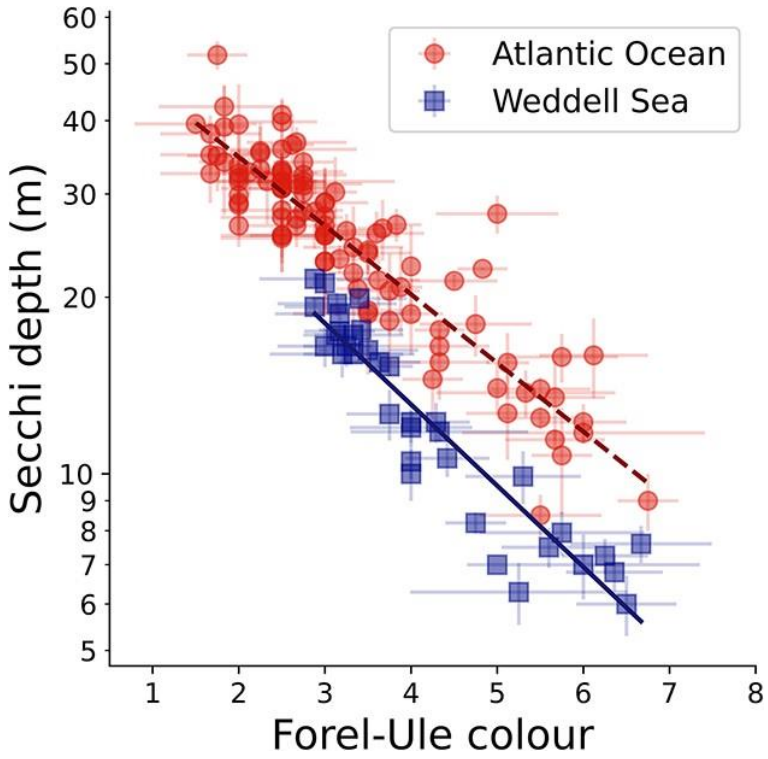

Figure 8. The relationship between Secchi depth (using a 30 cm white disk) and Forel-Ule colour (Novoa *et al.*, 2014) of water above the Secchi disk at half the Secchi depth in the Atlantic Ocean (circles, $N = 102$) and the Weddell Sea (squares, $N = 36$) using the same methods (Brewin *et al.*, 2023). Low values of Forel-Ule colour refer to bluer water, higher values greener water. Bars represent standard deviations for multiple samples at a station, from different participants. Regression lines (computed using IDL function LOBUST_LINEFIT.pro) are $ZSD=10A\times FU+B$ (ZSD is the Secchi depth and FU the Forel-Ule colour) for the Atlantic Ocean dashed line, $A=-0.117$ (±0.005), $B=1.774$ (±0.011); (Brewin *et al.*, 2023) and the Weddell Sea (solid line, $A=-0.138$ (±0.009), $B=1.672$ (±0.020)) and should not be extrapolated outside the range of data used in the fits. (Brewin and Dall'Olmo, 2024)

2.3.2. Collaborative Research and Education Project in Southeast Asia for Sustainable Use of Marine Ecosystems (CREPSUM) (Hiroaki Saito)

CREPSUM carried out six subprojects directly contributing to the GC 1 (cumulative effect of multiple stressors- temperature) for coral, Raphidophyte, dinoflagellate, Platycephalidae and Soleidae, emperor fishes, and sea cucumbers in the tropical Northwest Pacific. It conducted a global survey in Australia, France, Japan, and the USA on "the Ocean We Want" to elaborate on the relationship between personal beliefs and environmental norms using the Value-Belief-Norm framework. Scientists at Universiti Sains Malaysia (USM) and colleagues were tasked by the Penang State Government to undertake studies and prepare the groundwork for the gazettement of the Middle Bank area as a marine sanctuary to be named the Middle Bank Marine Sanctuary (MBMS). Studies revealed crucial ecosystems, such as seagrass meadows, important feeding grounds, and nursery areas for marine animals and are a part of the Penang Green Agenda 2030.

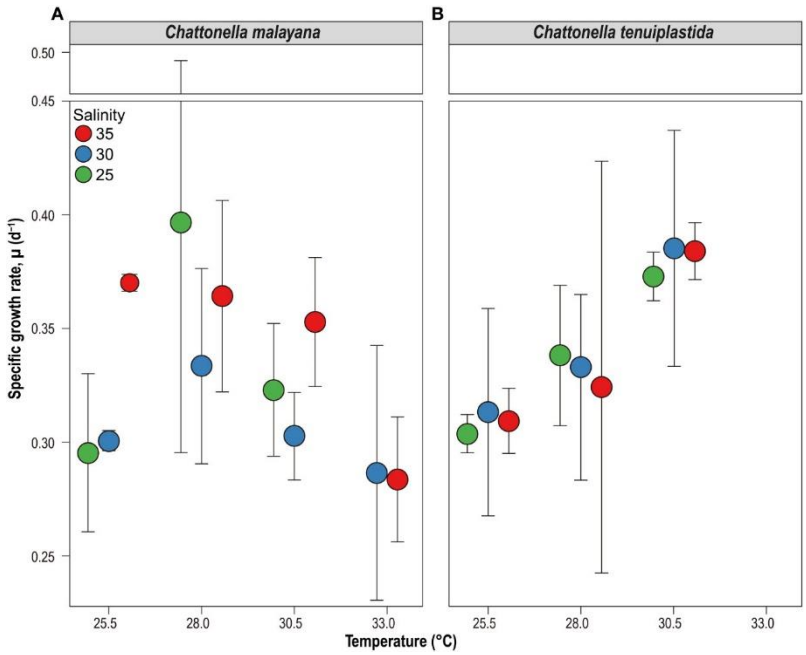

Figure 9. Specific growth rate, μ (d-1) of *Chattonella malayana* (A) and *C. tenuiplastida* (B) and in the cross-factorial experiments of temperatures (x-axis) and salinity (colored circles). (Lum et al. 2023. Comparative effects of temperature and salinity on growth of four harmful *Chattonella* spp. (Raphiophycease) from tropical Asian waters).

The project also assisted in formulating Indonesian policy and research toward a 70% reduction of marine plastic pollution by 2025. The project held the CRPSUM Seminar on Biodiversity of Marine Benthic Invertebrates in January 2024 at the National Museum of Nature and Science, Tsukuba, Japan.

2.3.3. Gulf of Trieste – Time-series (GoTTS) (Bruno Cataletto)

OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) observes and samples for biological studies monthly. The project reported Time series multivariate analyses on 16S rRNA amplicon sequencing data, setting common methods for assessment of eutrophication in the Eastern Mediterranean, molecular insight into the invasive ctenophore, and functions of the mycobiome of coastal waters.

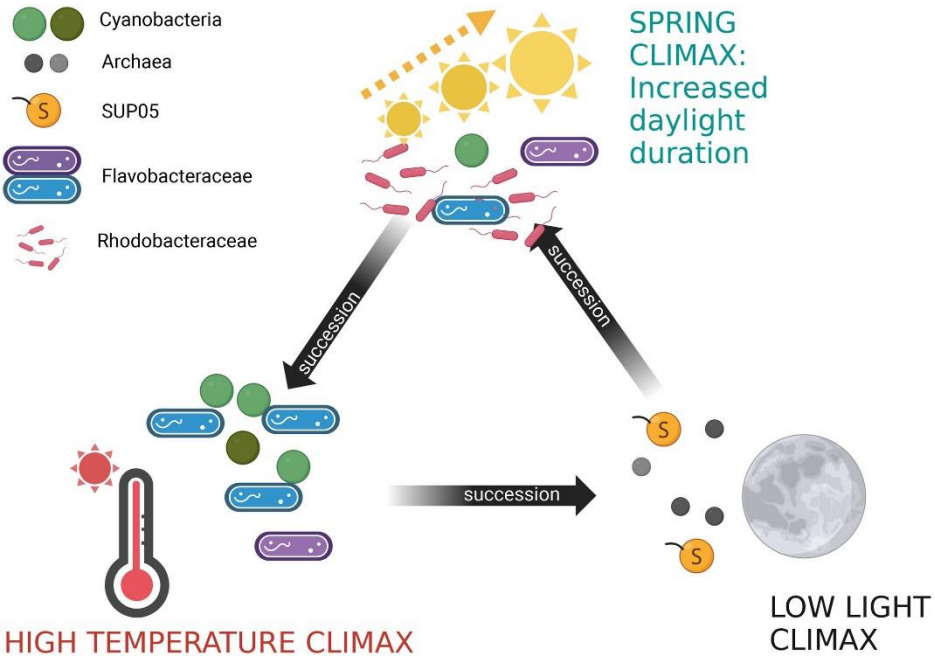

Figure 10. Recurrent environmental patterns structure temperate Mediterranean coastal microbial communities in climax assemblages. Springtime climax communities recruit copiotrophic taxa associated with phytoplankton-derived organic matter degradation (e.g., Flavobacteraceae—NS4 and NS5 Marine Groups, and Rhodobacteraceae), as well as photoautotrophic prokaryotes (i.e., *Synechococcus*) whose rhythmicity is linked to the increase in photoperiod length. (Celussi et al. 2024)

2.3.4. Marine Ecosystem-based Management Progress Evaluation Group: tracking the global progress (MEBM-PEG) (Mark Dickey-Collas)

MEBM-PEG and an international group of ecosystem-based management (EBM) experts developed a poll consisting of 23 multiple-choice and open-ended questions to assess the global progress on EBM (Haugen et al., 2024). The preliminary poll results were used to guide discussions at an online workshop convened in late 2022. The workshop included over 40 invited EBM experts representing different countries and various ocean-use sectors. The results represent a culmination of the poll, workshop discussions, and author expertise, supported by substantial literature where applicable. Based on this, the authors identified the global status of EBM, the top six challenges to EBM implementation, the solutions to overcome them (Figure 11), and the probable direction of marine EBM in the coming years.

Figure 11. The global challenges, solutions, and progress for implementation of Ecosystem-Based Management (EBM) identified by the pre-workshop poll results and workshop results (Haugen et al., 2024).

2.3.5. Importance of Physico-Chemical cycling of nutrients and carbon in Marine Transitional Zones (NUTS&BOLTS) (Peter Croot)

NUTS&BOLTS focused on unraveling the impact of multiple environmental stressors on ecosystems in Irish marine transitional zones (MTZs) and is strongly aligned with several of IMBeR's stated goals connected to Grand Challenge I. NUTS&BOLTS was a 4-year project (2019-2023) funded by the EPA and Marine Institute Ireland which focused on the biogeochemical cycling of nutrients and elements in Irish MTZs and fluxes of bio-relevant elements from Irish surface and groundwaters to the MTZ and continental shelf. In 2023 NUTS&BOLTS received a 1-year no-cost extension to complete work disrupted by the COVID-19 pandemic. The project hosted a workshop on "Sustainability of Marine Transitional Zones in Ireland" on 19 January 2024 in the Aula Maxima. The themes of the workshop were the estimation of the fluxes of bio-relevant elements from the Irish surface and groundwaters to the MTZ and continental shelf, quantification of the impact of picoplankton growth rate under different combinations of environmental stressors, determination of the bio-optical properties in the mixing zone in Irish MTZs, and quantification of the sources and sinks of climate-relevant gases in Irish MTZs. The workshop was well attended by thirty-five Irish scientists.

2.4. SSC Science Groups

Grand Challenges

2.4.1. Grand Challenge I (GC I): Understanding and quantifying the state and variability of marine ecosystems (Wen-Chen Chou, Alice Newton)

Chou reported his contribution to Research Objective 2 based on his research activity. The structure of the plankton food web and carbon and energy flow in the euphotic zone; (2) the study of carbon fluxes throughout the water column; and (3) the study of coastal blue carbon were highlighted. His team found that forests, sediments, and oceans account for approximately 21.5, 42.1, and 96.8 Mt-CO_2 per year, respectively, of Taiwan island, which falls short of the total greenhouse gas emission from the island (280 Mt-CO_2 yr^{-1}). A review on the multi-stressors of eutrophication (Nina Bednaršek and Alice Newton) and drafting 10 Facts about the Oceans (Nina Bednaršek and Alice Newton) are underway.

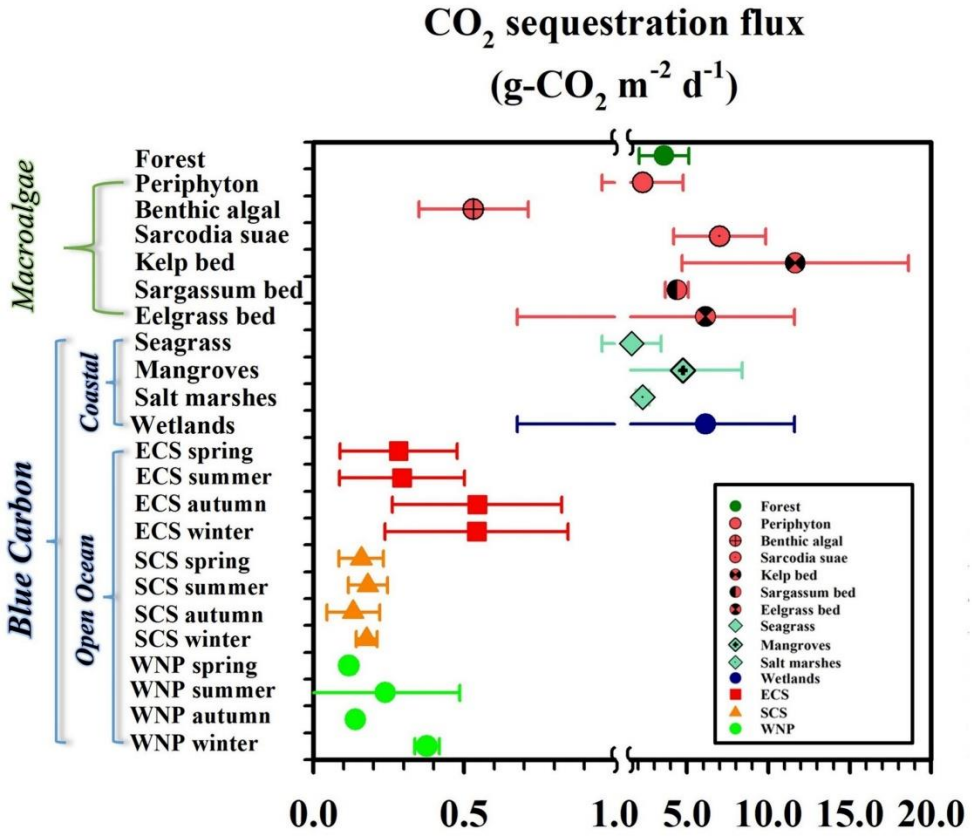

Figure 12. A comparison of the levels of CO_2 sequestration rate (g-CO_2 m^{-2} d^{-1}) presented in forests, marcroalages, coastal and ocean (East China Sea (ECS), South China Sea (SCS) and Western North Pacific (WNP) blue carbons from Weerakkody et al. (2023) and Hung et al. (2024).

2.4.2. Grand Challenge II (GC II): Improving scenarios, predictions and projections of future ocean-human systems at multiple scales (Thorsten Blenckner, Marion Gehlen, Lynne Shannon)

The group organized the IMBIZO workshop (aborted), provided case studies and input to Innovation Challenge 4's "best practices in integrating social and natural sciences in marine research" work, liaised with the Human Dimension Working Group to evaluate existing data for socio-ecological modeling, contributed to a review paper on ecological feedback, and was involved in the Ocean Action Plan.

2.4.3. Grand Challenge III (GC III): Improving and achieving sustainable ocean governance (Derk Armitage, David VandderZwaag)

GC III group completed a special issue on best practices for multilevel governance approaches to ocean climate adaptation and mitigation (https://ecologyandsociety.org/feature/128/). The group prepared for the September IMBIZO workshop initiative in Morocco (workshop focal activities and questions; potential outcomes and planning facilitation).

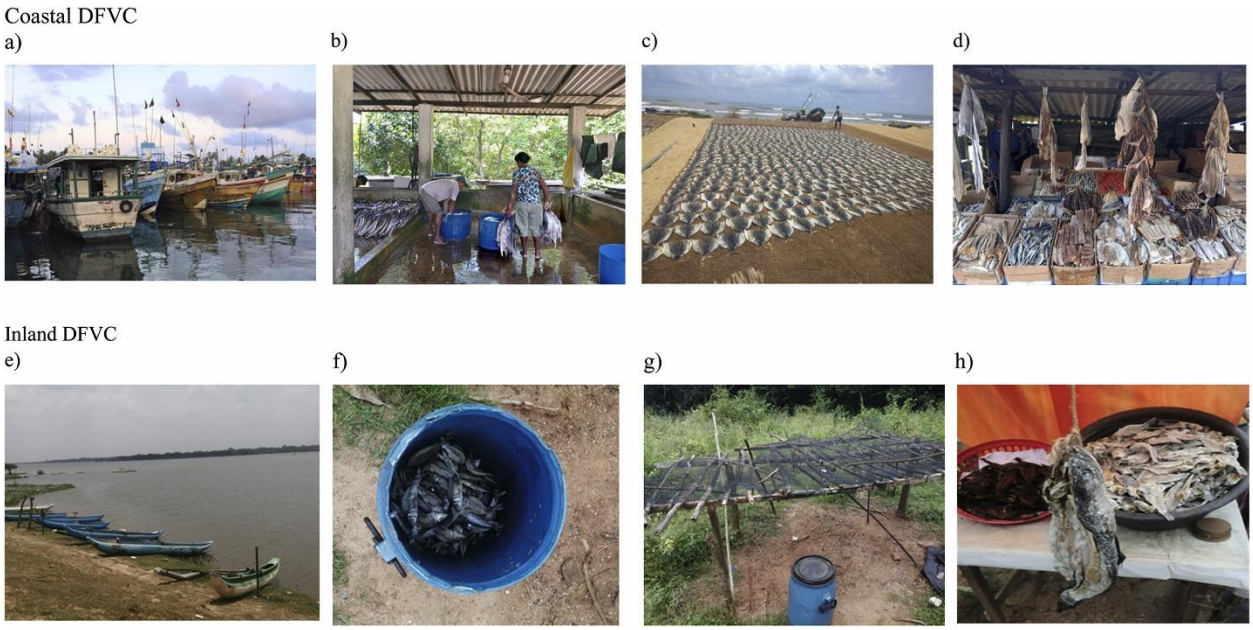

Figure 13. The dried fish value chains are of disproportionate importance to the wellbeing of marginalized people in fishing communities, particularly women, Sri Lanka (Gendered dimensions of social wellbeing within dried fish value chains: insights from Sri Lanka (Galappaththi M, Weeratunge N, Armitage D, Collins AM, 2023).

GC III Group collected also several manuscripts emerging primarily from the IMBeR IMBIZO6 Workshop 3 in 2021 under the title of "Ocean Governance and Climate Adaptation: Comparing Responses, Charting Future Courses" in a special issue of the journal "Frontiers in Marine Science" to showcase the work in progress with a multi-scales and transdisciplinary approach. Four current and former SSC members served as co-editors (Andrea Belgrano, Swedish University of Agricultural Sciences; David Lee VandderZwaag, Dalhousie University; Karen Evans, Commonwealth Scientific and Industrial Research Organization; Samiya Ahmed Selim; Leibniz Center for Tropical Marine Research).

Bai and Li (2023) reviewed China's governance policies related to the adaptation of marine and coastal ecosystems to climate change after ratification of the United Nations Framework Convention on Climate Change 1992. Governance systems evolved from the collection of isolated environmental protection policies in 1992-1992 to incorporate biodiversity in 2000-2007, convergence among environment, climate, marine, and biodiversity in 2008-2015, to synergistic integration of environment, climate, marine, and biodiversity in 2016-2023. The authors view that (i) ecosystem-based management is vital equipment for climate change adaptation. (ii) the support system of such policies ensures the implementation of such policies, (iii), the evaluation tool to check the performance of such policies, such as a framework of quantitative assessment of the impact of marine protected areas on marine biodiversity are needed in the coming years. This paper is a product of **Continental Margins Working Group**.

VanderZwaag et al. (2023) reviewed Canadian government policy about climate change adaptation initiatives in Canada at the ocean-climate nexus. The policy was shaped through Climate Adaptation Platform 2012, National Adaptation Strategy/Adaptation Action Plan 2022 along with marine protected areas (MPAs) and other area-based conservation measures, such as CLIMAtlantic and indigenous-led climate engagement and adaptation initiatives (e.g., National Inuit Climate Change Strategy). The authors suggested that the adoption of climate adaptation strategies for governmental departments and agencies with ocean and coastal responsibilities should be a priority and incorporate climate change adaptation responsibilities through legislative and regulatory changes.

Innovation Challenges

2.4.4. Innovation Challenge 3 (IC3): To advance understanding of ecological feedback in the Earth System (Eugene Murphy)

Eugene Murphy, Emma Cavan and Jess Williams have completed drafting a perspective paper titled "Ecological Feedbacks in the Earth System" to be submitted soon. The paper has developed to encompass both marine and terrestrial ecosystems. The authorship includes several IMBeR community scientists, and specialists in aspects of terrestrial and freshwater ecosystem science, modeling, and climate change impacts. The current abstract reads "Ecological feedbacks are fundamental features of the Earth system, affecting physical processes and biogeochemical cycles. Our understanding of the interactions between ecological, physical, and chemical processes at different spatial and temporal scales and the extent to which feedback can affect Earth system functioning remains limited. The effects of accelerated anthropogenically-driven climate change are already negatively affecting ecological processes in marine, freshwater, and terrestrial ecosystems. These will most likely be amplified in the coming decades under our current warming pathway. The impacts on ecological feedback have the potential to cause rapid perturbations to the Earth system, and combined with other human-driven stressors (e.g., deforestation, pollution), may significantly impact the structure and functioning of ecosystems. However, the role of our planet's diverse ecological feedbacks in Earth system processes and the impacts of perturbations are major knowledge gaps. Here, we first examine what is known about ecological feedback in ecosystems and how they affect physical and chemical processes. Second, we consider the implications of ecological feedback for analyses of anthropogenically-

driven change, development of scientific understanding and models, and provision of scientific advice for policy-makers. Third, we highlight major knowledge gaps and research needs for the rapid assessment and integration of ecological feedback in Earth system science. Finally, the group proposed to develop a systematic approach to improve the understanding of ecological feedback at different spatial and temporal scales. This perspective piece is an urgent call to the scientific community for the rapid development of integrated ecosystem – Earth system research."

2.4.5. Innovation Challenge 4 (IC4): To advance and improve the use of social science data for ocean management, decision making and policy development (Nireka Weeratunge and Andrea Belgrano)

The IC4 team held two sets of Zoom meetings (27 April and 4 May 2023, as well as 24 October 2023 to cover the different time zones) with representatives from 9 collaborating institutions across the globe. The IC4 group initiated to identify best practices in integrating social and natural science data in upscaling from local to global application, based on around 10 case studies across the globe, and to aim to develop a network of collaborating partners, leading to a peer-reviewed journal paper. The group developed a questionnaire on "Best practices in integrating social and natural sciences in marine research: Case studies". The questionnaire covers the themes of context and history of the case studies, what has worked in integrating natural and social sciences in marine research so far within the selected case study context, challenges in integrating natural and social sciences in marine research, experience in the use of integrated knowledge in ocean governance/management, including local/traditional/indigenous/community knowledge, and suggestions on how to better integrate social and natural science knowledge in marine research. The questionnaire was sent out to collaborators at the end of January 2024. The IC4 group aims to produce a peer-reviewed journal paper by the end of the year.

2.4.6. Innovation Challenge 5 (IC5): Interventions to change the course of climate impacts (Nina Bednaršek and Rowan Trebilco after Spring 2024)

Bednaršek presented at the ECCWO-5 International Symposium on the Effects of Climate Change on the World Oceans (April 2023, Bergen, Norway), where she discussed her paper on the "Predictable patterns within the kelp forest can indirectly create temporary spatial refugia for ocean acidification". She also presented her paper on the "Natural ocean acidification analogues in the subpolar and polar Northern regions: a synthesis study" at the ESSAS (Ecosystem Studies of Subarctic and Arctic Seas conference) in May 2023 in Bergen, Norway, by invitation and in collaboration with IC5 member, Sam Rastrick.

2.4.7. Innovation Challenge 6 (IC6): Sustainable management of Blue Carbon ecosystems (BCWG) (Tiziana Luisetti, A'an Wahyudi)

IC6 group solicited ECRs to join and is in the process of finalizing 3-5 individuals. Tiziana Luisetti (CEFAS) gave a talk on the blue carbon training (providing training on the economics of blue carbon accounting) at The Global Dialogue on Sustainable Ocean Development (oceanaccounts.org) and A'an Wahyudi's review paper on approaches for retaining carbon. The group noted the lack of group activities.

Bednaršek discussed with several members of IC5 the potential of connecting the blue carbon management topics with the climate change interventions, effectively connecting the activities of the Innovation Challenge 5 and 6 at the ECCWO-5 International Symposium's on the Effects of Climate Change on the World's Ocean (April 2023, Bergen, Norway). Bednaršek has led and designed the survey to collect the status quo, gaps, and recommendations from governments and academia from the Mediterranean region as her role in the scientific steering committee for the Ocean Acidification (OA) Mediterranean Hub. She has analyzed the survey results to draft a manuscript to be submitted and plans to use the result to formulate the IMBeR synthesis on understanding and enhancing intervention governance frameworks.

2.4.8. Action Plan for the Ocean (Eugene Murphy, Carol Robinson and Alistair Hobday launched in 2022)

The group held two IMBeR SSC/IMECaN online workshops during 2023 to discuss the development of the Action Plan and clarify the goal and steps required. The group aimed to develop a diverse team of representatives from 100 countries (or more) –the "OCEAN 100 Team" and to develop the assessment and ranking of risks of the changing ocean by devising the risk ranking process. The IMBeR Action Plan Team presented the **Developing an Action Plan for the Ocean at** AGU Ocean Sciences, in February 2024 and the ICES Annual Science Meeting in September 2024. The refined goal is "to progress the development of a risk-based action plan for responding to observed and predicted ocean change, including building capacity for applying such a plan at multiple scales."

2.5. Synthesis Activities

About 50 potential Synthesis Activities resulted from the April 2023 SSC meeting and suggestions submitted by the IMBeR working groups and regional programmes. The list was reduced to those deemed feasible and where individuals have stepped up to lead the synthesis.

2.5.1. Advances in oceanic top predator research through international collaboration and global data sets (CLIOPTOP): Eleven CLIOTOP SSC and task team members participated in a two-day CLIOTOP synthesis paper writing workshop between 14-15th November 2023 at the Pacific Community (SPC) in New Caledonia.

2.5.2. A synthesis of the past IMBIZO workshop: Building an international research community: The IMBeR IMBIZO approach (Alistair Hobday) is under preparation.

3. Capacity-Developing Activities

3.1. IMBeR ECR Network (Interdisciplinary Marine Early Career Network - IMECaN)

[Organization]
Since last April, IMECaN has welcomed several new members to the IMECaN steering committee. In 2023 Kat Maltby, a postdoc at the Gulf of Maine Research Institute in Maine, US, and Juliano Palacios Abrantes, a postdoc at the Institute for the Oceans and Fisheries of the University of British Columbia, joined the committee. In 2024, the committee welcomed Alex Smith, the Project Coordinator at the Ocean Frontier Institute in Halifax, Canada; Priyatma Singh, a lecturer and researcher at the University of Fiji; Mia Strand, a marine social scientist at Nelson Mandela University in South Africa and Gabriella Akpah Yeboah, a PhD student at the University of Ghana. The chairs have also changed, with Samiya Selim stepping down in December 2022, and Laura Kaikkonen, Shenghui Li, and Rebecca Shellock taking the lead in January 2023. In July of 2024, Laura and Rebecca stepping down and the leadership will fall upon Shenghui Li and Juliano Palacios Abrantes. During the same time, Carl Peters and Shan Jiang stepped down from the steering committee. To date, the IMECaN steering committee comprises 12 members, including two chairs.

Figure 14. Current and past members of the IMECaN organising committee at the *5th International Symposium on Effects of Climate Change on the World's Oceans*, 17-21 April 2023, Bergen, Norway. From left to right: Kat Maltby, Kelly Ortega-Cisneros, Stephanie Brodie, Sara Garcia-Morales Hurtado, Juliano Palacios Abrantes, and Samiya Selim.

Figure 15. Current members of the IMECaN organising committee at the 2024 UN Ocean Decade Conference,10-12 April 2024, Barcelona, Spain.
From left to right: Shenghui Li and Sara GarciaMorales Hurtado.

[Activities]
IMECaN convened an online workshop on fostering Diversity, Equity, and Inclusion in interdisciplinary marine sciences. The workshop outcomes were used as a basis of a collaborative perspective paper led by the IMECaN organising committee and co-authored by all workshop participants. The manuscript has been under review by *npj Ocean Sustainability* since 29 February 2024.

IMECaN convened two online workshops in January-February 2024 for representatives of marine and polar science early career networks to develop guidelines for how to better engage early career researchers in scientific collaborations and processes. A manuscript to accompany the guidelines is currently being developed with the co-author group (n=27).

Attended at

(1) 5th International Symposium on Effects of Climate Change on the World's Oceans, 17-21 April 2023, Bergen, Norway, with the participation of several IMECaN members, Kat Maltby, Kelly Ortega-Cisneros, Stephanie Brodie, Sara Garcia-Morales Hurtado, Juliano Palacios Abrantes, and Samiya Selim.
(2) 2024 UN Ocean Decade Conference, 10-12 April 2024, Barcelona, Spain, with the participation of several IMECaN members, Shenghui Li, Sara Garcia-Morales Hurtado and Samiya Selim.
(3) 2nd UN Ocean Decade Regional Conference & 11th WESTPAC International Marine Science Conference "Accelerating Ocean Science Solutions for Sustainable Development", 22-25 April 2024, Bangkok, Thailand, Shenghui Li, oral presentation in and expert dialogue in Scientific Sessions and Ocean Action Workshops.
(4) ICES Annual Science Conference, 11-14 September 2023, Bilbao, Spain. IMECaN work on "Fostering Diversity, Equity, and Inclusion in Interdisciplinary Marine Science" was presented by co-chair Laura Kaikkonen.

IMECaN collates a newsletter for its members every 3 months, highlighting content from their members, interesting reads, job opportunities, and upcoming events. In addition, IMECaN has a strong online presence on X (formerly Twitter) (@IMECaN4), where they share events, papers, and opportunities and communicate with both their network's members and other ECR initiatives and associated projects. As per IMECaN's terms of reference, IMECaN activities are focused on capacity development for marine ECRs. To improve their activities, IMECaN conducted an online survey and a series of X (formerly Twitter) polls to its members to learn more about what IMECaN members hope to see from IMECaN in the future.

IMECaN monthly webinar on science communication in partnership with the Ocean Frontier Institute, led by Ariel Smith, April 24, 2024.

[Planned Activities]

(1) IMECaN plans to continue to support IMBeR events in delivering activities, content, and outreach to early-career marine researchers. The focus area for the upcoming year is furthering IMECaN's work on diversity, equity and inclusion, as well as capacity building for ECRs to work on interdisciplinary projects. In addition, they are increasing their focus on career development, a topic that has been highly demanded by their members based on their membership surveys.
(2) IMECaN co-chair (Shenghui Li) and ECOP-China coordinators (Yuntao Wang and Chunhua Jiang) will co-convene ECOP Engagement Workshop entitled "Advancing Ocean Sustainability: The Role of Early Career Ocean Professionals in Capacity Building, Ocean Literacy and Collaborative Leadership" in 2025 Xiamen Symposium on Marine Environmental Sciences, January 14-17, 2025, Xiamen, China.
(3) More on-site and online activities (such as monthly webinars) will be organised to achieve three key goals of IMECaN: to develop collaborations, to provide training, and to provide leadership opportunities.

3.2. Summer School (8th IMBeR's ClimEco8)

The 8th IMBeR's ClimEco8 summer school: *Sustaining the ocean we need for the future we want* was held in Koper, Slovenia on 19-24 June 2023. The programme was designed to progress all the IMBeR Grand Challenges (GCs) and Priority Research Objectives. It was endorsed as a UN Decade activity. The ClimEco8 Summer School aimed to foster excellence in interdisciplinary ocean science. The natural, social, and economic sciences lecturers and participants developed a strong theoretical and applied understanding of interdisciplinary ocean science. To complement the theoretical content, participants also gained practical skills through various interactive workshops. The workshop covered interdisciplinary ocean science for sustainable development, climate change, and the world's oceans, modeling, managing marine resources, and how to write successful research grants and a scientific paper.

3.3. IMBeR Eutrophication Study Group

The group convened its eighth meeting and conducted its inaugural in-person and online training session (22-23 September 2023, Weihai, Shandong province, China) with a resounding success. The occasion was one of the four sub-sessions of the Conference for the Northeast Asia Region on Green, Low-Carbon and High-Quality Marine Development. This marked the first in-person meeting for some group members since its formation in 2022. More than 60 participants attended in person, representing diverse sectors including academic institutions, government departments, environmental monitoring agencies, and industry. All presentations were scheduled in the afternoon to accommodate online attendees in different time zones.
Under the overarching theme of Ecological Protection and High-Quality Development of Coastal Areas, nine ESG members and experts delivered keynote presentations and lectures:

(1) Peter Thompson (ESG Co-Chair), CSIRO – The use of physical and biogeochemical models to manage eutrophication: Two case studies

(2) Jacob Carstensen, Aarhus University – Managing eutrophication in a world of climate change: 50 years of experience from Denmark
(3) Haifeng Gu, Third Institute of Oceanography, Ministry of Natural Resources, PRC – Mechanisms behind toxic red tide outbreaks in coastal Fujian Province
(4) Kun Lei, Chinese Research Academy of Environmental Sciences – Assessment method of coastal eutrophication based on ecological zoning and nutrient criteria
(5) Dongyan Liu (ESG Co-Chair), SKLEC, East China Normal University – Eutrophication process and phytoplankton response
(6) Keqiang Li, Ocean University of China – The process of eco-environment change, effects of regulation on nutrients, and control method in the Bohai Sea
(7) GiHoon Hong and Kai Qin, IMBeR IPO-China – Marine plankton in novel eyes: unlocking low-cost monitoring and nature-based solutions for carbon removal
(8) Huichao Jiang, Shandong Marine Resource and Environment Research Institute – Long-term evolution of plankton community in Laizhou Bay under nutrient reduction

Figure 16. Dongyan Liu (ESG Co-Chair), SKLEC, East China Normal University presented “Eutrophication process and phytoplankton response”.

Figure 17. Jacob Carstensen, Aarhus University presented “Managing eutrophication in a world of climate change: 50 years of experience from Denmark”.

Figure 18. Peter Thompson (ESG Co-Chair), CSIRO presented “The use of physical and biogeochemical models to manage eutrophication: Two case studies”.

Figure 19. Kai Qin, IMBeR IPO-China demonstrated the low-cost Portable Plankton Flow Imaging Device.

In addition, a half-day field trip to Sanggou Bay was organized in tandem with the training session. Participants had the opportunity to learn about Integrated Multi-Trophic Aquaculture and eelgrass breeding treatments. IMBeR Eutrophication Study Group received a letter of appreciation from the Shandong Ocean Bureau for its pivotal role in shaping this event. This event also contributes to the priority research objectives of IMBeR Grand Challenge I. To watch the news video, please follow this link to access the news coverage: https://www.ecnu.edu.cn/info/1426/64559.htm

3.4. IMBeR Ocean Color-based Plant species identification and Carbon flux in the Indo-Pacific oceans (OC-PC) study group

The IMBeR Ocean Color-based Plant Species Identification and Carbon Flux in the Indo-Pacific Oceans (OC-PC) study group was formed to address marine plant species identification and carbon flux estimate using space borne sensors in 2023. The group won funding via the ESA-Future Earth Joint Program to support a uniquely successful mentoring and training project to upskill early career researchers in the region.

Figure 20. Novel Mentoring Project Equips the Next Generation of Marine Monitoring Scientists | Future Earth

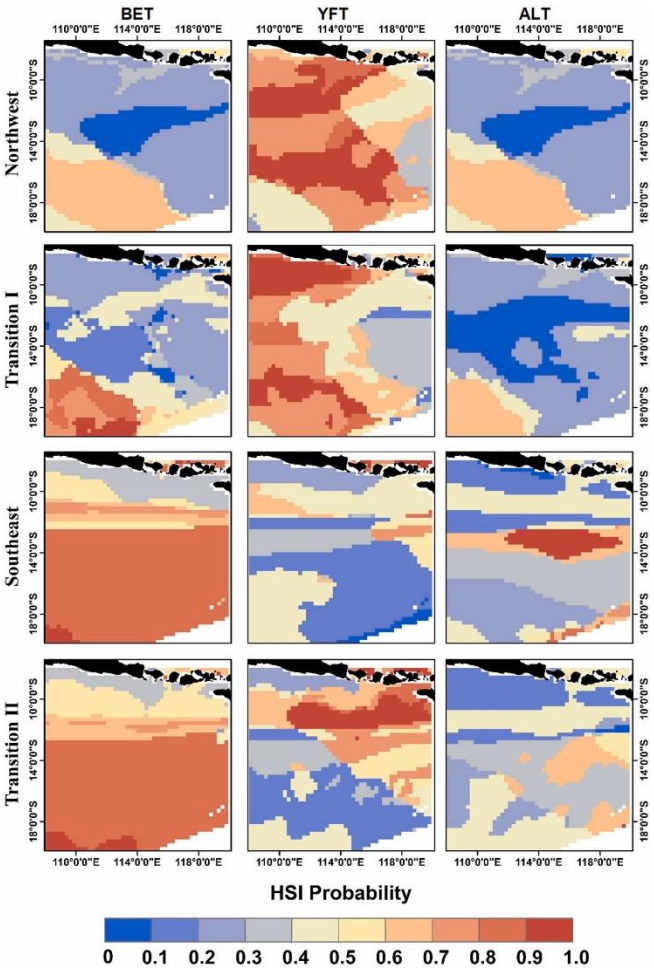

Figure 21. Expanding EO data usage to address climatic changes in the marine biosphere of the northwest Pacific and the Indo-Pacific regional seas (EO-WPI) funded by the joint European Space Agency and Future Earth awarded to the SKLEC and IMBeR IPO-China. One of the outputs is to identify habitat preference of commercial tuna species in the tropical Eastern Indian Ocean off Java-Bali (Setiawati et al., 2024). The authors were able to generate Habitat Suitability Index for yellowfin, albacore, and bigeye tuna species. Authors noted that sea surface temperature (SST), sea surface Chlorophyll a (Chl a), sea surface height (SSH), dissolved oxygen at 100 m depth (DO100), seawater temperature at 100 m depth (temp100) extracted from global EO dataset archived by NOAA, Copernicus Marine Environmental Monitoring Service (CMEMS) and Global Ocean Satellite Observations, and tuna landing statistics archived by the Indonesian agencies, All those ocean variables significantly correlate with the fish abundance, however, all stocks aviod an water warmer than 29^{o}C.

3.5. Indo-Pacific Region: marine biogeochemistry, biodiversity, sustainability study group (IMBeR IPR) (Shan Jiang)

IOCAS (China) and BRIN (Indonesia) conducted a joint oceanographic research cruise to collect essential ocean physical, chemical, and biological ocean variables from several sea basins of the central Indo-Pacific region in late 2023. BRIN scientists visited several institutions and universities in and around Shanghai, China.

3.6. Developing low-cost instruments and observation methods for the under-resourced community (Greg Cowie, SIBER)

Developing low-cost instruments and observation methods for the under-resourced community was proposed to allow broader participation and reduce barriers to entry in the international scientific project of IMBeR. Coastal Observing Lab in a Box (COLaB), a part of CoastPredict – Observing and Predicting the Global Coastal Ocean was introduced by Greg Cowie (SIBER) in April 2024 at the SSC meeting. COLaB is also associated with an Ocean Best Practices System (OBPS) task team, which aims to identify a

methodology that has repeatedly produced superior results with the same objective and widely adopted. The relevance to IMBeR is that the COLaB package supports ongoing training of scientists and technicians and knowledge transfer by providing accessible tools and techniques. The follow-up activities were not done over the year.

3.7. Other Capacity-Developing Activities done by IPO-China

IPO-China keeps archives for the earlier newsletters, abstracts, presentation videos, and Editor Picks (IMBeR-related interesting new publications) in its portal for reference.

Mentoring Workshop Recap Videos:
Expanding EO data usage to address climatic changes in the marine biosphere of the northwest Pacific and Indo-Pacific regional seas (EO-WPI) project, November 2023 in Indonesia.
The ESA-Future Earth jointly funded EO-WPI project concluded successfully in March 2024. This project stems from the ongoing IMBeR study group activities of the Ocean Color-based Plant species identification and Carbon flux in the Indo-Pacific oceans (OC-PC). The project established one-to-one Mentor-Mentee relationships between remote sensing experts and Southeast Asian participants. The IMBeR International Project Office (IPO) helped organize the workshop in Indonesia to assist participants without remote sensing backgrounds in generating collaborative datasets and conducting scientific research for their respective research areas and topics. The three-episode interview videos of the workshop are released to show untold behind-the-scenes stories from the perspective of the workshop organizers, OC-PC members, and participants. Watch the videos on YouTube and Youku. The project also collated selected papers to print as a Special Issue of the Journal of Sea Research: Changes in the marine biosphere of the Northwest Pacific and the Central Indo-Pacific observed via Earth Observation data.
European Space Agency and Future Earth also recognized EO-WPI activities on their web pages. More information can be found on the EO-WPI website.

3.7.1. IMBeR Coffee Reception

Over the past year, the IMBeR Coffee Reception convened five times, bringing together international early career researchers to share their findings and experiences across diverse regions, such as arid, tropical, and cold temperate coastal waters. Each session highlighted pressing ecological concerns and underscored the importance of rigorous scientific inquiry and collaboration among all stakeholders.

Figure 22. Event posters for IMBeR Coffee Reception.

Dr. Maryam Ghaemi shared her insightful views on environmental challenges facing the Persian Gulf, such as extreme aridity, highly concentrated petroleum exploitation, and maritime transport activities, and cooperative strategies to address the scientific aspects of those challenges. Dr. Pavel Yu. Semkin highlighted two natural forces driving coastal eutrophication in the Russian Far East. One is that the seasonal salmon carcasses discharged from rivers induce eutrophication in one of the seaside bays of the Okhotsk Sea. The other is that intermittent volcanic ash falls trigger enriched nutrient concentrations in the rivers and estuaries off the Kamchatka Peninsula. More than two dozen volcanoes are active on the Kamchatka Peninsula. Volcanic ash is rich in iron and other minerals, which keeps both soil and ocean very fertile.

Figure 23. Maryam Ghaemi presented "The Persian Gulf: A Semi-enclosed Marginal Sea of the Indian Ocean" at the 3rd Coffee Reception.

Figure 24. Pavel Yu. Semkin presented "Diverse nature of the coastal eutrophication and ecosystem responses: the Peter the Great Bay with hypoxia and unique areas of the Sea of Okhotsk and Eastern Kamchatka with whales" at the 4th Coffee Reception.

Dr. Idha Yulia Ikhsani explored iron biogeochemistry in the Eastern Indian Ocean, revealing that there are more than one hundred active volcanoes in Indonesia. Dr. Juma Rajabu Selemani examined fisheries and their potential contributions to the Tanzanian blue economy. Graduate students Wulantari and Milki Debi shared their field sampling experiences and transboundary shipments of scientific samples in Indonesia, Bangladesh, and China. Wulantari further reported her insights into the genetic makeup of fiddler crabs in Indonesia. Milki Debi offered practical insights into the role of the intertidal beach tidal flat in material balance using natural and artificial radionuclides. Milki also drew attention to the iconic Panowa (Cox's Bazar) beach (~120 km long), the longest uninterrupted sandy beach in the world.

Figure 25. Idha Yulia Ikhsani presented "Thinking Beyond the Dissertation: Iron Biogeochemistry in the Eastern Indian Ocean" at the 5th Coffee Reception

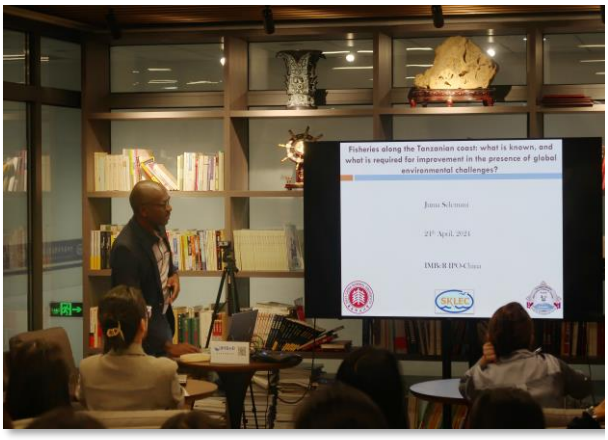

Figure 26. Juma Rajabu Selemani presented "Fisheries along the Tanzanian coast: What is known, and what is required for improvement in the presence of global environmental challenges?" at the 6th Coffee Reception

Figure 27. Wulantari presented "Journey of Field Sampling in Indonesia" at the 7th Coffee Reception

Figure 28. Milki Debi presented "Journey of Field Sampling on the Coast of Bangladesh and China" at the 7th Coffee Reception

The IMBeR Coffee Reception continues to offer diverse scientific problems outlined in the IMBeR Science Plan and Implementation Strategy (SPIS 2016-2025), challenges in scientific sampling, international scientific research collaboration, sharing scientifically significant natural settings, local knowledge, and local cultures with offline and online participants.

The recordings are available for multiple viewings on the website.

3.7.2. IMBeR Young Scholar Program

2024 Applications Open

Who can apply: Senior, post-graduate students or early career researchers in Asia-African countries who perceive a deficiency in research resources in their networks.

How to apply: Any interested individual should submit a one-page application to the IMBeR IPO (imber@ecnu.edu.cn).

Process time: The IMBeR IPO evaluates the application and returns comments to the applicant within 14 working days. If the application is deemed meritorious, the IMBeR IPO seeks a suitable advanced laboratory to provide a mentoring service to the applicant. Submit the IMBeR Young Scholar Program Application Form now!

3.7.3. Tour of Asian Marginal Seas

The IMBeR IPO administrated the Chinese Marginal Seas Case Study 2024 Annual Meeting in November 2023, Qingdao, China. Part I featured a webinar titled "Tour of the Asian Marginal Seas," covering the Chinese marginal seas, the Seto Inland Sea, the Persian Gulf, and the Gulf of Thailand. Part II included 12 presentations across various disciplines of marine science. Watch the recording.

3.7.4. IMBeR IPO 2023-2024 Internship Program

Interns' Feedback

We are excited to announce that our outstanding student interns from East China Normal University have gained practical work experience at the IMBeR IPO. We congratulate them on a fruitful internship journey and wish them all the best in their future endeavors! Let's take a closer look at their accomplishments and key takeaways. Details are found at IMBeR IPO Newsletter June 2024 No.42 - Capacity Development Update (constantcontact.com).

3.7.5. Outreach

Citizen Science Survey

IMBeR launched a multilingual survey: Friends of Marine Biosphere, available in English, Chinese, and Arabic.

Celebrating World Book Day

The IMBeR IPO shared seven ocean-related books to celebrate the 29th World Book Day, by interpreting these books through the voices and perspectives of the younger generation (lovely IMBeR IPO interns).

News here

Figure 29. Ocean-related books sharing.

Celebrating World Oceans Day

The IMBeR IPO orchestrated a scientific popularization event, including a scientific poster session entitled "Exploring Ocean Wonders: Plankton," showcasing the Portable Plankton Flow Imaging Device, and hosting a creative plankton coloring activity for children.

News here.

Figure 30. Snapshot of the scientific popularization event.

3.8. Communications

Website

Regular updates on news and information, with the IMBeR logo, brochure, and activity flyers available for download. IMBeR Website and IMBeR IPO Website.

Newsletter

Since the last SCOR report, 5278 contacts within the IMBeR network have received various newsletters, including: 20 issues of IMBeR e-News, 10 bilingual IMBeR IPO newsletters, and 5 quarterly IMECaN newsletters. These newsletters feature diverse content, such as announcements from IMBeR and its

sponsors, editor picks of publications, information on events, webinars, conferences, job listings, career development opportunities, and spotlights on early career researchers (ECRs). Special features include the IMBeR West Pacific Symposium special issue introduction and IMBeR Capacity Development updates. Past issues can be viewed on X (formerly Twitter) (@imber_ipo), the IMBeR-IPO Website, and the IMECaN Website. The video links appeared in the newsletter are served through IMBeR Vimeo Channel.

X (formerly Twitter) Official Account

@imber_ipo: Regular posts (currently 1644) with 2185 followers.
@IMECaN4: Regular posts (currently 1027) with 1019 followers.

Wechat Official Account

Releases news and announcements to 641 subscribers, distributing 171 posts, and being forwarded by other influential official accounts. Wechat Official account

Video Platforms

The IMBeR YouTube channel has 206 subscribers and features 264 videos, including recordings of past events, symposiums, conferences, and interviews.
The IMBeR Youku channel provides the same content to accommodate audiences who have difficulty accessing YouTube.

4. Budget

IMBeR consists of Science Groups (Regional Programmes, Working Groups, and Endorsed Projects), SSC, National Contacts, and IPO. SCOR-Future Earth funds are consumed by the SSC members, Science Groups' travel, and IMBeR workshops and conferences. Scientific Projects of the science groups are sponsored by national science funding agencies. IMBeR national contacts are supported by their host institutions. IPO is fully financed by its host State Key Laboratory and East China Normal University. The SCOR-Future Earth funds are only reported here.

Incomes, expenses and budget for January 2024 until 2 August 2024:

Calendar Year		**2024**
All values USD	**Credit**	
INCOMES		
NSF fund via SCOR remaining until 31 August 2024	(No record for Dec 2023)	
NSF fund via SCOR remaining until 31 August 2025	47,000	
Future Earth block grant leftover from previous year	19,192	
Future Earth block grant 2024	6,368	
Total Income	N/A	

EXPENSES recorded by IPO	Budgeted	Debit[1] till 2 August
ICED	7,500	0
ESSAS	7,500	7,530
CLIOTOP	7,500	3,540
SIBER	7,500	6,366
CMWG	5,000	0
HDWG	7,500	0
IMBeR SIOA	7,500	0
IMBeR IOC-R	2,000	0
IMECaN	3,000	0
"30K' Support Fund – CLIOTOP (7500 for 2023-2024)	4,625	0
"30K' Support Fund - Action Plan for the Ocean	7,500	0
Total Expenses	**67,125**	**17,436**
Balance[2]		
NSF fund via SCOR remaining until 31 August 2024		**39,729[3]**
NSF fund via SCOR remaining until 31 August 2025		**47,000[3]**
Future Earth		**25,560[3]**

[1] Debit records the expenses from the reimbursement requests submitted or informed by subgroups to the IPO. Actual expenses to IMBeR include currency conversion and banking fees that may occur.
[2] SCOR, the treasurer of IMBeR, provided update on balance on 2 August 2024.
[3] Meetings and workshops are being planned for the last year of IMBeR at the time of reporting.

5. Plans for the coming year

The coming year is the final year of the IMBeR (2016-2025). Two workshops are planned for wrapping up the 10-year IMBeR and developing a 10-year-long science plan starting in 2026.

6. National Contacts

IMBeR has national contacts in 37 countries: Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Egypt, Finland, France, Germany, Greece, India, Indonesia, Ireland, Italy, Japan, Mexico, Morocco, Namibia, New Zealand, Nigeria, Norway, Oman, Peru, Russia, South Africa, South Korea, Spain, Sri Lanka, Sweden, Switzerland, The Netherlands, Turkey, UK, USA, Uruguay.

Figure 31. IMBeR national contacts 2024.

7. IMBeR International Project Office

The IMBeR International Project Office (IPO) is based at the State Key Laboratory of Estuarine and Coastal Research (SKLEC), East China Normal University (ECNU), Shanghai, China. The IPO is staffed by Fang Zuo (Executive Officer), Kai Qin and Suhui Qian (Project Officer), and GiHoon Hong (Strategy Director). The IPO is fully supported by its host ECNU.

The IPO is responsible for assisting the Scientific Steering Committee (SSC), interacting with national contacts and other related international bodies, assisting financial transactions of IMBeR funds and administrative services to Regional Programmes, Working Groups, Endorsed Projects, and IMECaN if required, managing IMBeR finances, maintaining the IMBeR websites, updating the IMBeR mailing lists, and updating the IMBeR publication database. The IPO-China activities are listed in the capacity-developing section of this report.

In this reporting period, the IPO arrangement underwent a notable change. It is worthwhile to recap the history of IPOs. At the beginning of the IMBeR in 2016, IPO started at the Institute of Marine Research in Bergen, Norway, with support from the Norwegian National Research Council and assistance of a regional project office at SKLEC supported by ECNU. At the end of 2019, IMBeR established dual IPOs in China (IPO-China) and Canada (IPO-Canada). On 4 April 2023, at the Paris SSC meeting on 3-5 April 2023, Dalhousie University informed the SSC to close the IPO-Canada on 31 March 2024.

Upon the scheduled closure of IPO-Canada, IMBeR made a few open calls for a new IPO to succeed IPO-Canada but failed to secure it and stopped searching for it in February 2024. IMBeR started negotiating with ECNU to take over essential activities of the IPO-Canada in late March 2024. Consequently, IPO-

China became a single remaining IPO in June 2024. IMBeR sincerely thanks all the IPO-Canada sponsors and its staff (John Claydon, Lisa Maddison, Paula George) for their contribution during the period of February 2020-March 2024.

The IPO-China hosted by ECNU in Shanghai, China, supported by SKLEC remains open and commits to assisting the IMBeR community for the rest of the IMBeR period (i.e., 31 August 2025).

8. List of Publications

Since 2016, IMBeR has produced more than 1117 publications (Class 1 and Class 2), and 63 papers were published over the last year (19 Class 1; 44 Class 2). A full list of Class 1 publications (2023-2024) can be found in the Appendices.

IMBeR Publication databases: since 2016 (2016-2024)
IMBER Publication database: prior to 2016 (1999-2015)

Appendices

Class 1 Publications 2023-2024

The publications listed below are 'Class 1' - i.e. they have been specifically generated through/by/from/during IMBeR activities (e.g. publications arising from IMBeR conferences, and from the activities of the working groups and regional programmes). Where stated, the activity in question is listed under the publication.

CLIOTOP publications

Médieu, A., Point, D., Sonke, J.E., Angot, H., Allain, V., Bodin, N., Adams, D.H., Bignert, A., Streets, D.G., Buchanan, P.B., Heimbürger-Boavida, L.-E., Pethybridge, H., Gillikin, D.P., Ménard, F., Choy, C.A., Itai, T., Bustamante, P., Dhurmeea, Z., Ferriss, B.E., Bourlès, B., Habasque, J., Verheyden, A., Munaron, J.-M., Laffont, L., Gauthier, O., Lorrain, A., 2024. Stable Tuna Mercury Concentrations since 1971 Illustrate Marine Inertia and the Need for Strong Emission Reductions under the Minamata Convention. Environ. Sci. Technol. Lett. 11, 250–258.
https://doi.org/10.1021/acs.estlett.3c00949
Class 1; CLIOTOP

ESSAS publications

Almeida, L.Z., Laurel, B.J., Thalmann, H.L., Miller, J.A., 2024. Warmer, earlier, faster: Cumulative effects of Gulf of Alaska heatwaves on the early life history of Pacific cod.
https://doi.org/10.1525/elementa.2023.00050
Class 1; ESSAS

ICED publications

Constable, A.J., J. Melbourne-Thomas, M.M.C. Muelbert, S. McCormack, M. Brasier, J.A. Caccavo, R.D. Cavanagh, S.M. Grant, H.J. Griffiths, J. Gutt, S.F. Henley, J. Höfer, A.B. Hollowed, N.M. Johnston, S.A. Morley, E.J. Murphy, M.H. Pinkerton, I.R. Schloss, K.M. Swadling, A.P. Van de Putte (2023) Marine Ecosystem Assessment for the Southern Ocean: Summary for Policymakers. Integrated Climate and Ecosystem Dynamics in the Southern Ocean, Scientific Committee on Antarctic Research, Scientific Committee on Oceanic Research, Integrated Marine Biosphere Research.
https://zenodo.org/records/8359585
Class 1; ICED

Bonnet-Lebrun, A.-S., Sweetlove, M., Griffiths, H.J., Sumner, M., Provoost, P., Raymond, B., Ropert-Coudert, Y., Van de Putte, A.P., 2023. Opportunities and limitations of large open biodiversity occurrence databases in the context of a Marine Ecosystem Assessment of the Southern Ocean. Frontiers in Marine Science 10.
https://www.frontiersin.org/articles/10.3389/fmars.2023.1150603
Class 1; ICED

Constable, A.J., Kawaguchi, S., Sumner, M., Trathan, P.N., Warwick-Evans, V., 2023. A dynamic framework for assessing and managing risks to ecosystems from fisheries: demonstration for conserving the krill-based food web in Antarctica. Frontiers in Ecology and Evolution 11.
https://www.frontiersin.org/articles/10.3389/fevo.2023.1043800
Class 1; ICED

CMWG publications

Liang, W., Wang, Y., Mu, J., Wu, N., Wang, J., Liu, S., 2023. Nutrient changes in the Bohai Sea over the past two decades. Science of The Total Environment 903, 166696. https://doi.org/10.1016/j.scitotenv.2023.166696
Class 1; CMWG

MEBM-PEG publications

Haugen, J.B., Link, J.S., Cribari, K., Bundy, A., Dickey-Collas, M., Leslie, H.M., Hall, J., Fulton, E.A., Levenson, J.J., Parsons, D.M., Hassellöv, I.-M., Olsen, E., DePiper, G.S., Gentry, R.R., Clark, D.E., Brainard, R.E., Mateos-Molina, D., Borja, A., Gelcich, S., Guilhon, M., Ban, N.C., Pedreschi, D., Khan, A., Chuenpagdee, R., Large, S.I., Defeo, O., Shannon, L., Bailey, S.A., Jordan, A., Agnalt, A.L., 2024. Marine ecosystem-based management: challenges remain, yet solutions exist, and progress is occurring. npj Ocean Sustain 3, 1–11.
https://doi.org/10.1038/s44183-024-00041-1
Class 1; MEBM-PEG

IMECaN publications

Fostering diversity, equity, and inclusion in interdisciplinary marine science, 2024.
https://www.authorea.com/doi/pdf/10.22541/au.171052473.32741331
Class 1; IMECaN; SCOR

IMBIZO6 publications

VanderZwaag, D.L., Seck, S.L., Graham, L., Frontain, J., Simpson, K., 2023. Canada and ocean climate adaptation: tracking law and policy responses, charting future directions. Front. Mar. Sci. 10. https://doi.org/10.3389/fmars.2023.1168573
Class 1; IMBIZO 6

West Pacific Symposium publications

Hartog, J.R., Spillman, C.M., Smith, G., Hobday, A.J., 2023. Forecasts of marine heatwaves for marine industries: Reducing risk, building resilience and enhancing management responses. Deep Sea Research Part II: Topical Studies in Oceanography 209, 105276.
https://doi.org/10.1016/j.dsr2.2023.105276
Class 1; West Pacific Symposium 2021

Sartimbul, A., Nakata, H., Herawati, E.Y., Rohadi, E., Yona, D., Harlyan, L.I., Putri, A.D.R., Winata, V.A., Khasanah, R.I., Arifin, Z., Susanto, R.D., Lauro, F.M., 2023. Monsoonal variation and its impact on the feeding habit of Bali Sardinella (S. lemuru Bleeker, 1853) in Bali Strait. Deep Sea Research Part II: Topical Studies in Oceanography 105317.
https://doi.org/10.1016/j.dsr2.2023.105317
Class 1; West Pacific Symposium 2021

Sartimbul, A., Winata, V.A., Kasitowati, R.D., Iranawati, F., Rohadi, E., Yona, D., Anjeli, U.G., Pranowo, W.S., Lauro, F.M., 2023. Seasonal Indonesian Throughflow (ITF) across southern Java determines genetic connectivity of Sardinella lemuru (Bleeker, 1835). Deep Sea Research Part II: Topical Studies in Oceanography 209, 105295.
https://doi.org/10.1016/j.dsr2.2023.105295
Class 1; West Pacific Symposium 2021

Arina, N., Hidayah, N., Hazrin-Chong, N.H., Rozaimi, M., 2023. Algal contribution to organic carbon sequestration and its signatures in a tropical seagrass meadow. Deep Sea Research Part II: Topical Studies in Oceanography 210, 105307.
https://doi.org/10.1016/j.dsr2.2023.105307
Class 1; West Pacific Symposium 2021

Boschetti, F., Feng, M., Hartog, J.R., Hobday, A.J., Zhang, X., 2023. Sea surface temperature predictability assessment with an ensemble machine learning method using climate model simulations. Deep Sea Research Part II: Topical Studies in Oceanography 210, 105308. https://doi.org/10.1016/j.dsr2.2023.105308
Class 1; West Pacific Symposium 2021

Dirgantara, D., Afzal, M.S., Nakamura, T., 2023. Distinct patterns of coral lesion composition from national/quasi-national marine parks of Kerama and Yoron Islands, Ryukyu Archipelago. Deep Sea Research Part II: Topical Studies in Oceanography 210, 105309. https://doi.org/10.1016/j.dsr2.2023.105309
Class 1; West Pacific Symposium 2021

De La Cruz, M.A.M., Hingpit, B.W., Guillou, L., Onda, D.F.L., 2023. Effects of monsoons and storms on the structuring and diversity of picoeukaryotic microbial communities in a tropical coastal environment. Deep Sea Research Part II: Topical Studies in Oceanography 209, 105294. https://doi.org/10.1016/j.dsr2.2023.105294
Class 1; West Pacific Symposium 2021

Bagarinao-Regalado, A., Campos, W.L., Felix, L.R., Piloton, R.D., 2023. The Lobo-lobo fry fishery in the western Visayan Sea, Philippines: Abundance, catch composition, and potential fisheries impact. Deep Sea Research Part II: Topical Studies in Oceanography 212, 105324. https://doi.org/10.1016/j.dsr2.2023.105324
Class 1; West Pacific Symposium 2021

Hong, G., Zuo, F., Qin, K., 2024. Changing marine biosphere in the West Pacific Ocean. Deep Sea Research Part II: Topical Studies in Oceanography 214, 105357.
https://doi.org/10.1016/j.dsr2.2024.105357
Class 1; West Pacific Symposium 2021; SCOR

OC-PC publications

Setiawati, M.D., Rachman, H.A., As-syakur, A.R., Setiawan, R.Y., Syahailatua, A., Wouthuyzen, S., 2024. The habitat preference of commercial tuna species based on a daily environmental database approach in the tropical region of the Eastern Indian Ocean off Java-Bali waters. Deep Sea Research Part II: Topical Studies in Oceanography 216, 105400.
https://doi.org/10.1016/j.dsr2.2024.105400
Class 1; OC-PC

Class 2 Publications 2022-2024 – Class 2 publications benefitted from some interaction with IMBeR or IMBeR activities and are listed in the online database.

List of Acronyms

AGU	American Geophysical Union	link
AMT	Atlantic Meridional Transect	link
BRIN	National Research and Innovation Agency	link
CEFAS	Centre for Environment, Fisheries and Aquaculture Science	link
CLIOTOP	Climate Impacts on Oceanic Top Predators	link
CMWG	Continental Margins Working Group	link
CoLaB	Coastal Lab in a Box	
CREPSUM	Collaborative Research and Education Project in Southeast Asia for Sustainable Use of Marine Ecosystems	link
EBM	Ecosystem-Based Management	
ECNU	East China Normal University	link
ECOP	Early Career Ocean Professionals	link
ECR	Early Career Researcher	
EO-WPI	Expanding EO data usage to address climatic changes in the marine biosphere of the northwest Pacific and the Indo-Pacific regional seas	link
ESA	European Space Agency	link
ESG	Eutrophication Study Group	link
ESSAS	Ecosystem Studies of Sub-arctic and Arctic Seas	link
GC	[IMBeR] Grand Challenges	link
GoTTs	Gulf of Trieste – Time-series	link
HDWG	Human Dimensions Working Group	link
IC	[IMBeR] Innovation Challenges	link
ICED	Integrating Climate and Ecosystem Dynamics in the Southern Ocean	link
ICES	International Council for the Exploration of the Sea	link
IMBeR	Integrated Marine Biosphere Research	link
IMECaN	Interdisciplinary Marine Early Career Network	link
IOCAS	Institute of Oceanology Chinese Academy of Sciences	link
IOC-R	Integrated Ocean Carbon Research Working Group	link
IPO	International Project Office	link
IPR	Indo-Pacific Region: Marine Biogeochemistry, Biodiversity, Sustainability Study Group	link
MEBM-PEG	Marine Ecosystem-based Management Progress Evaluation Group: tracking the global progress of EBM	link
MOU	Memorandum of Understanding	
MTZ	Marine Transitional Zone	
NOAA	National Oceanic and Atmospheric Administration	link
NoCRISES	Negotiating Ocean Conflicts among Rivals for Sustainable and Equitable Solutions	link
NUTS&BOLTS	Importance of Physico-Chemical cycling of nutrients and carbon in Marine Transitional Zones	link

OC-PC	Ocean Colour Based Plant Species Identification and Carbon Flux in the Indo Pacific Oceans Study Group	link
OGS	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale	link
RP	[IMBeR] Regional Programmes	link
SCOR	Scientific Committee on Oceanic Research	link
SIBER	Sustained Indian Ocean Biogeochemistry and Ecosystem Research	link
SIOA	SOLAS-IMBeR Ocean Acidification	link
SKLEC	State Key Laboratory of Estuarine and Coastal Research	link
SOLAS	Surface Ocean – Lower Atmosphere Study	link
SPIS	[IMBeR] Science Plan and Implementation Strategy 2016-2025	link
SSC	Scientific Steering Committee	
UNESCO	United Nations Educational, Scientific and Cultural Organization	link
WG	[IMBeR] Working Groups	link