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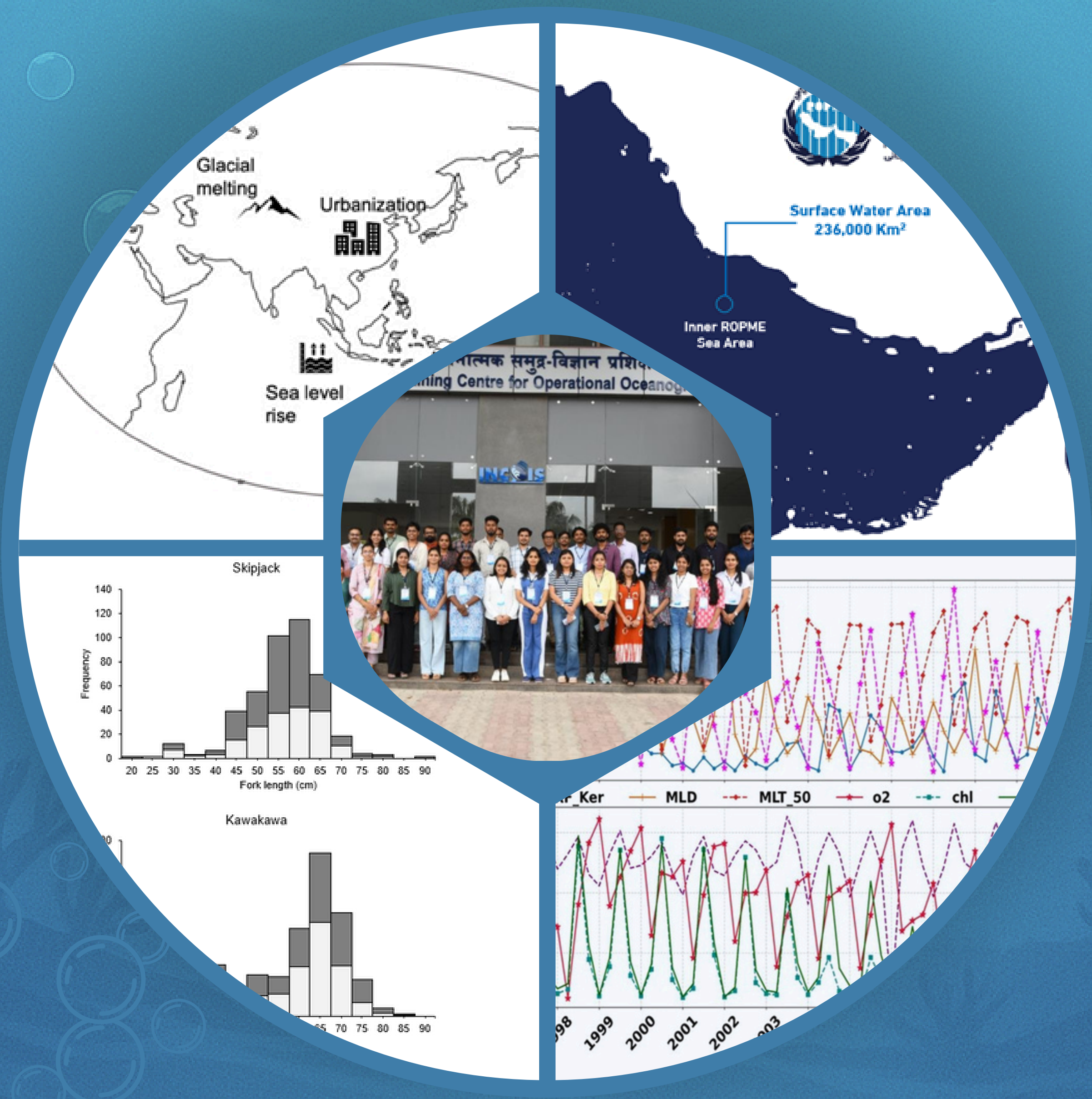
INTERNATIONAL INDIAN OCEAN EXPEDITION - II

The Indian Ocean Bubble 2



EDITORIAL

Dear IIOE-2 member,

Greetings from the Indian Ocean region!

Welcome to the latest issue of IO-Bubble. This edition explores Indian Ocean science, including ocean data, circulation, and fisheries. We also share an inspiring piece from an Early Career (EC) scientist.

This issue highlights collaborative pathways to strengthen climate resilience across the Indo-Pacific by connecting science, policy, and communities. The **first-ever ECOP–National Node India workshop** is featured as a milestone in empowering young ocean professionals. Building on this, "**Rising Tides, Rising Voices**" brings forward perspectives from Early Career Scientists on climate challenges in the Indian Ocean.

We also present the **ROPME Strategic Plan (2026–2030)**, which deepens engagement with IIOE-2 and IOCINDIO, alongside new insights on **skipjack and kawakawa fisheries**—covering their population demography, genetic structure, and value chains. The **IIOE-2 Science Plan** has been submitted to SCOR requesting a five-year extension, ensuring continuity of this landmark program.

Research highlights include the use of **statistical and machine learning models** to study Indian mackerel distribution in the Malabar upwelling region, while the narrative piece "**Ocean Beyond the Shores**" shares the lived experience of a marine biologist at sea.

We also cover the elevation of IOCINDIO to an IOC-UNESCO sub-commission, enabling wider collaboration. Lastly, explore details of the upcoming 7th International Conference on Ocean Engineering (ICOE-2025). We hope you enjoy this issue.

On behalf of the IIOE-2 PO team
N. Kiran Kumar, Hrishikesh D. Tambe and Aneesh Lotliker

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IN THIS ISSUE

Regional Collaboration and Strategic Engagement

Bridging climate science, policy, and communities: collaborative pathways for strengthening climate resilience in the Indo-Pacific

Aditi Modi[1], M K Roxy[1], Shipra Jain[2], Chi Huyen Truong[3], Quang-Van Doan[4], Chris Jack[5], Svetlana Jevrejeva[6], Arvind Singh[7], Chirag Dhara[8], Sahana Ghosh[9]

The Indo-Pacific region, home to over two-thirds of the global population and a fulcrum of geopolitical and economic activity, is undergoing rapid transformation driven by escalating climate risks. Sea-level rise, extreme urban heat, and glacial retreat across the Hindu Kush Himalaya are no longer distant threats—they are present and intensifying stressors that demand urgent, coordinated responses. Recent scientific syntheses from the Indo-Pacific “My Climate Risk” Hub at the Indian Institute of Tropical Meteorology (IITM) Pune, under the WCRP’s Lighthouse Activity, emphasize the need for transdisciplinary approaches that bridge climate science, governance, and communities to catalyze climate resilience across the region. This synthesis is a follow-up to the international webinar session titled ‘Leveraging Climate Research and Modeling for Action in the Indo-Pacific region’, organized by the IITM hub in 2023 (Figure 1).

Despite significant advances in climate projections, regional adaptation is hamstrung by several structural challenges: low-resolution and poorly localized models, institutional fragmentation, inaccessible data, and under-resourced local governance systems. These limitations are particularly acute in climate-vulnerable zones—low-lying island nations, urban megacities in Southeast Asia, and the rapidly transforming Hindu Kush Himalayan belt—where compounding physical and socio-economic vulnerabilities magnify exposure to climate extremes. The Indo-Pacific currently accounts for over half of global greenhouse gas emissions, and yet regional adaptation and mitigation capacity remain uneven, constrained by legacy gaps in capacity, coordination, and knowledge integration. The synthesis by Modi et al. (2025) advocates a decisive shift from a linear value chain—where knowledge flows unidirectionally from science to policy—to a value cycle, where community experience and local governance realities inform research priorities. This framework is already finding resonance in early warning systems and disaster risk reduction efforts. In particular, regional collaborations through platforms such as the WCRP My Climate Risk Hub at IITM offer a powerful mechanism for integrating physical climate science with community-based action, policy engagement, and communications tailored to sociocultural realities.

A key concern is the accelerating pace and uneven impacts of sea-level rise across the region. In Southeast Asia and the western Pacific, sea levels are rising up to four times faster than the global mean, driven by a combination of thermal expansion, ice melt, and subsidence. These changes, along with accelerating urbanization and glacial retreat in the Hindu Kush Himalaya, are reshaping physical and social geographies across the Indo-Pacific(see Figure 2)

Megacities such as Jakarta, Ho Chi Minh City, and Kolkata are subsiding at rates of 6–9 cm per decade, amplifying the risk of compound flooding, saline intrusion, and ecosystem degradation. Traditional infrastructure-led responses (e.g., seawalls, breakwaters) have proven inadequate in the long term and risk maladaptation if not combined with ecosystem-based adaptation, such as mangrove restoration and coral reef protection. However, the feasibility of such measures varies significantly across ecological and governance contexts and demands long-term monitoring and community co-ownership. Rapid urbanization in the Indo-Pacific poses another axis of vulnerability. Urban centers are not only heat hotspots and carbon emitters but also highly exposed to localized hydrometeorological shocks. While AI/ML-enabled climate modeling offers pathways to improve sub-grid-scale urban process representation, high-resolution urban modeling remains prohibitively resource-intensive for most countries. Hybrid models combining AI with process-based frameworks, supported by local data and open-access platforms, offer a promising yet nascent frontier. More crucially, participatory modeling and scenario-building must become standard practice in regional planning, enabling cities to develop robust heat action plans, urban cooling strategies, and nature-integrated designs.

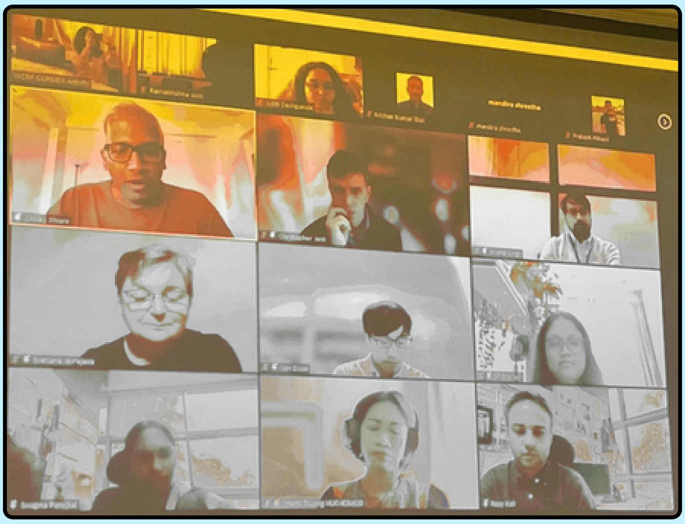

Figure 1: A snapshot from the international webinar session organized by the IITM hub in 2023.

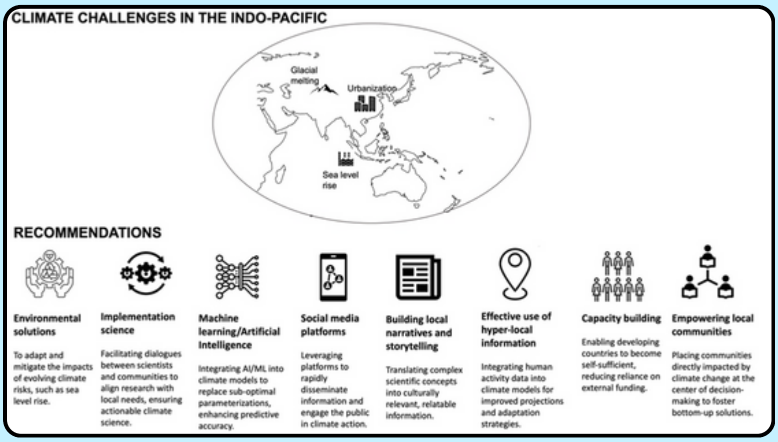

Figure 2: Schematic representing the climate challenges in the Indo-Pacific region, namely, the sea-level rise, urbanization and glacial melting in the Hindu-Kush Himalayas. Several recommendations are proposed for tackling these climate challenges.

In the Hindu Kush Himalaya, warming is advancing at rates surpassing global averages, accelerating glacial retreat and altering the hydrological regimes of 10 major river systems. The vulnerabilities here are multidimensional—ecological, infrastructural, and deeply cultural. Mountain communities are increasingly witnessing land-use changes, ecosystem degradation, and climate-induced displacement. While climate modeling and cryosphere observations are improving, scientific frameworks must integrate indigenous knowledge systems grounded in scientific principles, which are often the first line of detection and adaptation. The success of initiatives such as HiRISK and "Cryosphere and Society" underscores the value of science-policy-community dialogues in fragile geographies. Equally important is the science-society interface. Communication of climate risks—especially through social media and non-traditional platforms—has the potential to democratize climate information but also carries the risk of misinformation and oversimplification.

The Indo-Pacific's linguistic and cultural diversity necessitates a shift toward multilingual, culturally embedded communication strategies. Institutions must invest in dedicated climate communication teams and build regional networks of translators, artists, and educators who can bridge epistemologies and geographies. Initiatives such as Climate Cardinals and Himalayan bootcamps point to scalable models for engaging young people in climate storytelling rooted in science. Looking ahead, climate resilience in the Indo-Pacific must be underpinned by localized expertise, co-designed research frameworks, and sustained capacity building. Policy, research, and community networks must converge to produce regionally tailored solutions. The WCRP My Climate Risk Hub's role as a boundary-spanning institution grounded in science and responsive to local realities is an exemplar of how collaborative models can help operationalize global climate frameworks at regional scales. As the IPCC and UNFCCC gear toward mid-century targets, the Indo-Pacific cannot afford to wait. The time to act is now by embedding science in local systems, foregrounding equity in adaptation, and building networks that not only observe but transform the future of one of the most dynamic and vulnerable regions on the planet.

Affiliations

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ROPME Charts Strategic Plan (2026–2030) to Deepen Engagement with IIOE-2 and IOCINDIO

Faiza Al-Yamani and Wahid Moufaddal (ROPME Expert)

The Regional Organization for the Protection of the Marine Environment (ROPME) was initially established in early 1979 based on Article XVI of the agreement to implement the Kuwait Action Plan and the Kuwait Regional Convention and its Protocols. Its main mandate is to protect and conserve the marine environment and coastal areas as designated in the Kuwait Convention and its protocols. Initially, a UNEP Interim Secretariat administered the programs and activities of the Organization until the ROPME Secretariat was formally established in Kuwait on 1st January 1982.

Geographically, ROPME covers the ecologically and geopolitically valuable ROPME Sea Area (thereafter; RSA), a marginal sea of the northwestern Indian Ocean that includes the Arabian / Persian Gulf (Inner RSA), the Sea of Oman (Middle RSA), and part of the northwestern Arabian Sea off Sultanate of Oman's coast (Outer RSA) (Figure 1). This aquatic area extends over 460 square kilometers and encompasses the coastal and marine environments of Bahrain, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. As a unique semi-enclosed sea region, the ROPME Sea Area faces many critical environmental challenges notably climate change, loss of biodiversity and marine pollution, but it offers on the other hand vital opportunities for integrated research and cooperation.

Main Environmental Characteristics of ROPME Sea Area

ROPME is currently developing new Strategic Directions for the period 2026–2030, with more holistic vision to support and enhance marine conservation, environmental protection, and regional collaboration. These directions are built around three main goals: securing resilient ecosystems, advancing knowledge and innovation, and enhancing advocacy and public engagement. These directions align with the broader objectives of the Indian Ocean community and closely linked to the initiatives of the recently launched IOC Sub-Commission for the Central Indian Ocean (IOCINDIO), and the proposed “Addendum to the IIOE-2 Science Plan”, which was submitted to SCOR requesting a 5-year Extension (2026 – 2030) of IIOE-2. They also align with global environmental priorities, including the UN Sustainable Development Goals (SDGs) and the Strategic Directions (2026-2030) of the UNEP’s Regional Seas Programme. This forward-looking strategy also reflects ROPME’s commitment to both regional stewardship and global environmental goals.

Key Priorities of the New ROPME Strategic Directions

Implementation of new ROPME’s strategic directions (Figure 2) relies on several key priority areas:

- Regional Partnerships and Policy Development: Strengthen collaboration among Member
- States and align regional policies with global standards Technological Innovations and Capacity Building: Utilizing advanced tools for monitoring and investing in education and training for stakeholders.
- Financial Mechanisms and Monitoring Systems: Ensuring sustainable financing and robust monitoring to track progress and adapt strategies as needed.
- Emergency Preparedness: Enhancing readiness to respond to oil spills, extreme weather, and other risks

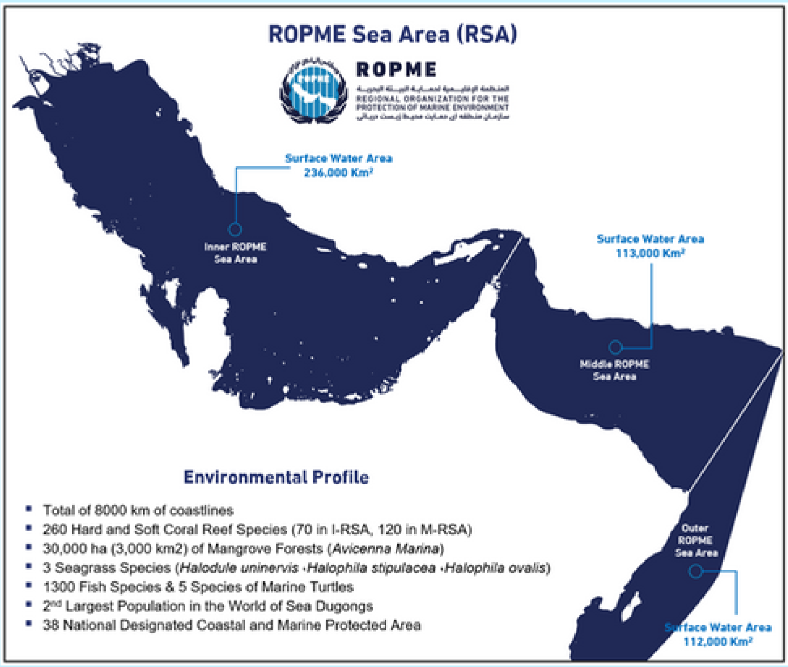

Figure 1: A map of the different sections of the ROPME Sea Area.

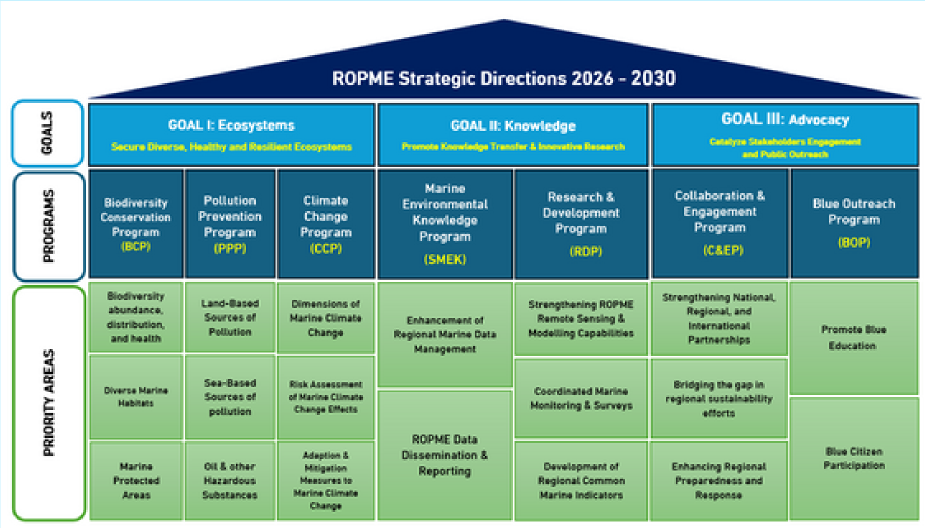

Figure 2: Structure and components of the new ROPME Strategic Directions (2026-2030).

Core Pillars

The forthcoming strategic plan for ROPME outlines a broad yet focused vision, emphasizing enhanced coordination among member states and aligning its marine protection goals with those of Indian Ocean research agendas under IIOE-2 and IOCINDIO. Key relevant strategic pillars include:

- **Protecting Coastal and Marine Water Quality:** Emphasis will be placed on controlling pollution from land- and –sea-based sources, marine litter, and operational discharges, using both regulatory frameworks and innovative monitoring technologies.
- **Safeguarding Marine Ecosystems:** Conservation of biodiversity, critical habitats, and vulnerable species will be prioritized, supported by ecological assessments and restoration efforts.
- **Abating Pollution from Coastal Development:** As coastal urbanization and industrial projects intensify, ROPME seeks to implement stringent Environmental Impact Assessment (EIA) standards and promote sustainable infrastructure planning.
- **Enhancing Environmental Capabilities:** Capacity building among ROPME member States will focus on strengthening technical expertise, laboratory networks, environmental data systems, and early warning mechanisms.
- **Promoting Human Health and Well-being:** Marine environmental health will be linked explicitly to human well-being, addressing seafood safety, recreational water quality, and exposure to harmful algal blooms and chemical contaminants.

Building Climate Resilience: The plan integrates climate change adaptation by addressing sea surface temperature anomalies, sea level rise, marine heatwaves, and hypoxic zones. A new Regional Marine Climate Change Strategy is in development to advance regional preparedness.

Specific Initiatives in Focus

In addition to its strategic themes, ROPME's 2026–2030 plan features a suite of initiatives that reflect the shared interests of the Indian Ocean scientific and policy communities:

- **Establishing a Regional Center for Marine Biodiversity:** Proposed by the Islamic Republic of Iran, this Center aims to serve as a hub for taxonomic research, genetic resource conservation, and biodiversity data integration.
- **Enhancing Pollution Monitoring and Environmental Assessment:** Strengthening long-term marine observation networks will be central to tracking pollution trends, marine ecosystem health, and cumulative impacts.

- **Coordinating a New Regional Marine Cruise:** The proposed cruise aims to assess status of pollution by micro-plastics and health of marine ecosystems in the various subdivisions of the RSA, through partnership with The International Atomic Energy Agency (IAEA), Kuwait Research Institute for scientific Research (KISR), Kuwait Foundation for the Advancement of Sciences (KFAS).
- **Promoting Public Awareness and Ocean Literacy:** Outreach campaigns and educational programs will be scaled up to foster environmental stewardship among communities, youth, and decision-makers.

Taking all of this into consideration, it is obvious that ROPME's evolving strategy aligns naturally with the priorities of the Second International Indian Ocean Expedition (IIOE-2) and IOCINDIO's 2025–2029 Roadmap, especially regarding marginal sea dynamics, ecosystem resilience, ocean observation systems, and sustainable development of marine resources.

By embedding itself more deeply into the Indian Ocean research and governance landscape, ROPME is positioning the ROPME Sea Area not only as a regional priority but also as a critical component of global ocean health and other regional seas. The Strategic Directions Plan 2026–2030 will serve as a vital tool for transforming shared science into coordinated action—ensuring that the unique marine ecosystems of the region are preserved for future generations.

For more information on ROPME's ongoing activities and its potential future engagement with IOCINDIO and IIOE-2, please visit: www.ropme.org

Addendum to the IIOE-2 Science Plan Submitted to SCOR Requesting a 5-year Extension (2026 – 2030) of IIOE-2

Hood, R. R., F. Al-Yamani, L. E. Beckley, G. L. Cowie, N. D'Adamo, J. Hermes, H. T. Kobryn, N. Kiran Kumar, Aneesh A. Lotliker, R. M. Koll, A. Modi, E. Pattabhi Rama Rao, M.A. Sicre, V. Sudheesh, and P. N.Vinayachandran (Eds.)

In response to a strong consensus in the Second International Indian Ocean Expedition (IIOE-2) community, an Addendum to the IIOE-2 Science Plan was drafted and submitted to the Scientific Committee on Oceanic Research (SCOR) last Fall on behalf of the sponsors of IIOE-2, requesting continued support for the Expedition from 2026 to 2030. The Addendum was sent out for peer review with SCOR leading the process, subsequently revised following the reviewer comments, and submitted to SCOR for final consideration in June, 2025.

The IIOE-2 Science Plan Addendum provides the motivation and scientific justification for extending IIOE-2 for an additional five years. It encourages scientists from all relevant fields to collaborate and implement the IIOE-2 Science Plan and Addendum to ensure that major outstanding questions about the Indian Ocean and Earth System are addressed in a fully integrated manner. The following text is based on the Executive Summary from the revised Addendum:

SCOR, the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the Indian Ocean GOOS program (IOGOOS) are jointly coordinating this international research effort focused on the Indian Ocean, which began in late 2015 and has continued through 2025.

The goal is to support ongoing research and stimulate new initiatives in this time frame as part of the IIOE-2. This initiative has been highly successful, but has not yet achieved all of its stated objectives. In particular, there is still work that needs to be done to fully examine the biogeochemical and ecological impacts of global to local anthropogenic influences on the ocean and how these will, in turn, impact coastal marine environments and human populations. There is also a need to focus more on coastal monitoring and management, data sharing, scientific engagement of Indian Ocean rim countries, and capacity development. The COVID-19 pandemic led to the cancellation or postponement of numerous planned meetings and research cruises during 2020–2022 but there has been a rapid resumption of cruise activity since the COVID-19 lockdown and several new projects have been endorsed since. Given the current momentum of IIOE-2 and the remaining challenges that need to be addressed, and the context of the UN Decade of Ocean Science for Sustainable Development that was launched in 2021, the IIOE-2 community is seeking to extend IIOE-2 for an additional 5 years to 2030.

The IIOE-2 has structured its research around six scientific themes (Figure-1). Core questions from Theme 1 (Human Impacts) are reiterated in the Addendum because they articulate many of the challenges and research questions that will be prioritized in the final phase of IIOE-2 (2026 – 2030). Key overarching questions under Theme 1 include:

How are human-induced ocean climatic and non-climatic stressors impacting the biogeochemistry and ecology of the Indian Ocean? How, in turn, are these impacts affecting human populations? It is important to emphasize that this document does not supersede the IIOE-2 Science Plan and that the science priorities identified in the Science Plan will continue to be priorities in the final phase of IIOE-2. Rather, this document highlights areas of the Science Plan that will be strengthened in the final phase of IIOE-2, and describes some new initiatives and opportunities that have emerged under IIOE-2 that did not exist when the Science Plan was written, such as the launch of UN Decade of Ocean Science for Sustainable Development and the IOC regional sub-commissionfor the Central Indian Ocean (IOCINDIO).

Since the first IIOE-2 cruise from India to Mauritius in December 2015, the IIOE-2 has grown to involve over 50 endorsed multi-disciplinary and multi-national projects, with some 20 participating countries. These often involve multiple “voyages of discovery” cruises that have now covered much of the Indian Ocean, engaging many of the world’s major international ocean scientific institutions through a wide global constituency of leading ocean and climate scientists and institutions. The emphasis on engaging small island developing states is paramount, as is the focus on providing material opportunities for capacity development for early career scientists, ocean managers and policy makers from countries having relatively low levels of expertise in coastal and ocean sciences.

The IIOE-2 has motivated numerous synthesis papers and a book on the Indian Ocean, and it is continuing to compile and publish a Deep-Sea Research II Special Issue Series that is well underway to publish an eighth volume. More than 100 papers have been published thus far via these avenues, and yet they represent only a fraction of the total, considering the publications generated by the many programs and research expeditions that have been motivated under IIOE-2. Several examples of specific projects, research expeditions and achievements motivated under IIOE-2 are highlighted in the Addendum.

The IIOE-2 Science Plan places considerable emphasis on ocean observations and human influences on biogeochemical cycles and marine ecosystems and how these will, in turn, impact coastal marine environments and human populations (Figure1). The plan also emphasizes the need for coastal monitoring, data sharing, scientific engagement of Indian Ocean rim and island countries, and capacity development. Despite this emphasis, much of the research that has been carried out to date in IIOE-2 has been focused on the open ocean, and additional effort needs to be placed on engagement of Indian Ocean rim and island countries.

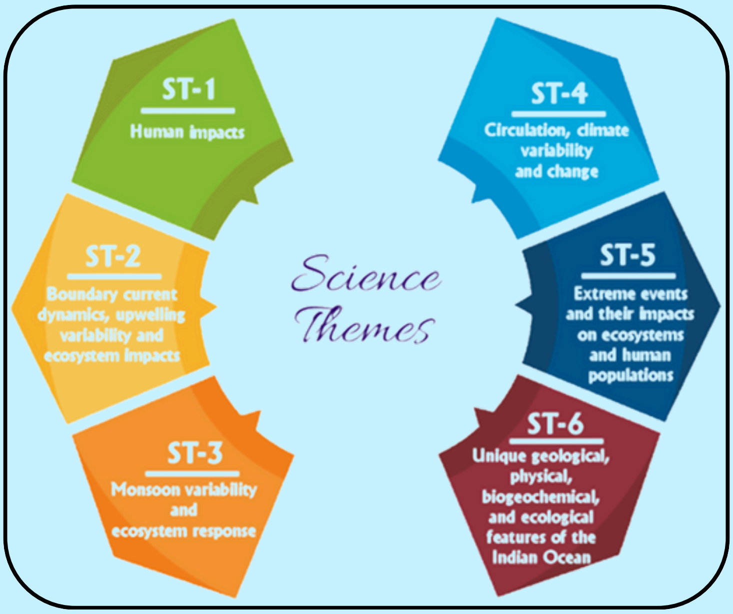

Figure 1: The six scientific themes of the IIOE-2 Science Plan

Knowledge gaps and challenges articulated include:

- The need for more coastal monitoring and metadata sharing in exclusive economic zones (EEZs) of Indian Ocean nations;
- The need to engage with and promote marine spatial planning (MSP) efforts in the Indian Ocean;
- The need to increase scientific understanding and engagement of research communities in the western Indian Ocean, the eastern Bay of Bengal and the marginal seas of the north-western Indian Ocean; and
- The need to increase capacity development efforts and promote early career scientists.

The Addendum also highlights four initiatives that will greatly facilitate addressing these needs: the Sustained Indian Ocean Biogeochemistry and Ecosystem Research, **SIBER program**, an established IMBeR/IOGOOS regional program on biogeochemistry and ecosystem research, that the IIOE-2 community proposes to include in IIOE-2; the Korea-US Indian Ocean Scientific Imperatives, the **KUDOS program**, which is an ongoing effort on the Seychelles-Chagos Thermocline Ridge that will continue to be a major component of IIOE-2 in its final phase; the emerging UN Decade-endorsed Coastal Observations Laboratory in a Box, **COLaB initiative**, which is a major opportunity for building a regional network for cross-validated coastal oceanographic data collection, and for building capacity and training multi-skilled coastal oceanographers; and a proposed new **Marginal Seas Research initiative** (that includes the ROPME Sea Area - an environmentally protected region under the mandate of the Regional Organization for the Protection of the Marine Environment, ROPME), that will not only advance scientific understanding in several understudied regions of the Indian Ocean (Andaman Sea, Arabian Sea/Persian Gulf, Gulf of Aden, Red Sea, Sea of Oman), but will also provide new opportunities for scientific engagement of Indian Ocean rim countries which are not currently actively participating in IIOE-2.

New in situ observation, remote sensing, modeling and assimilation efforts that need to be embraced in the final phase of IIOE-2 are also articulated in the Addendum. The revised IIOE-2 Implementation Strategy and the new Data and Information Management policy are summarized. The need for integration with the new IOC regional Sub-Commission IOCINDIO, the UN Decade of Ocean Science for Sustainable Development, the WCRP My Climate

Risk Program, the Global Ocean Observing System's (GOOS) Coast Predict program, and the Western Indian Ocean Marine Science Association (WIOMSA) is emphasized. The Addendum also articulates the requirement to improve ocean literacy and communication efforts, especially those aimed at a wider audience, including policy makers, managers and the public. The Addendum emphasizes that the IIOE-2 will continue to promote engagement between Indian Ocean scientists and associated institutions from developed and developing countries that are planning to undertake science activities in the region. This includes capacity-building components that should accomplish collaborative use of expertise and physical resources from within and outside the Indian Ocean region to accomplish training, joint research and analysis, and other activities.

Population increase in Indian Ocean rim countries has contributed to multiple stressors on both coastal and open ocean environments, including eutrophication, depletion of fresh groundwater, deoxygenation, atmospheric contamination, wastewater discharge, hydrocarbon and plastic pollution, harmful algal blooms, and overfishing. These regional to local environmental stressors, combined with warming and acidification due to global climate change, are resulting in the loss of biodiversity in the Indian Ocean, as well as changes in the phenology and biogeography of many species. The main focus of the research that will be carried out in the final phase of IIOE-2 will be aimed at better understanding the impacts of multiple stressors on coastal environments, and efforts will be motivated to communicate these findings to decision makers. Research in the final phase of IIOE-2 will bring together data and model analyses to improve our ability to predict extreme events and monsoon variability and facilitate the development of early warning systems and national strategies to mitigate their impacts on human populations.In its final phase, the IIOE-2 will focus on motivating studies for improving our understanding of higher trophic level species and the impacts of fishing pressure and habitat destruction on these species. The IIOE-2 will also motivate studies of direct anthropogenic impacts on coastal environments, including coastal erosion, loss of mangroves, and degradation of coral reefs and how these, in turn, might impact food security and fisheries. The IIOE-2 will work to raise awareness of the pressing need for ecosystem conservation in the Indian Ocean in order to safeguard both tourism and fisheries. The success of IIOE-2 will be gauged not just by how much it advances our understandng of the complex and dynamic Indian Ocean system, but also by how it contributes to the sustainable use of marine resources, environmental stewardship, ocean and climate forecasting, and training of the next generation of ocean scientists from the region. This vision of success can be fully realized in the final phase of IIOE-2.

To request an electronic copy of the revised Addendum please email Dr. Raleigh Hood (rhood@umces.edu).

Youth and Capacity Building

Report on the First ECOP India Workshop
Conducted at INCOIS Hyderabad | 5 - 6 June 2025

Report curated by Midhila Varna V (Project scientist, INCOIS and member of ECOP Core committee)

The first-ever workshop led by ECOP (Early Career Ocean Professionals), National node-India was held on 5th and 6th June, 2025 at the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. The event was conducted in collaboration with the Decade Collaborative Centre for the Indian Ocean Region (DCC-IOR) and brought together nearly 40 ECOP participants from diverse backgrounds across India.

The workshop kicked off with a welcome address by Dr. T.V.S. Uday Bhaskar, followed by an inspiring guest address by Dr. T.M. Balakrishnan Nair, Director of INCOIS. Dr. Trishneeta Bhattacharya, Co-lead of ECOP National node-India, provided an overview of the ECOP network, its structure, and its objectives, setting the stage for the sessions to follow. Presentations from eight ECOP core and advisory committee members highlighted the relevance of their individual research to the United Nations Sustainable Development Goals (SDGs) for the ocean. An insightful talk on ocean literacy by Ms. Swetha Naik (Member, IOC UNESCO literacy group of experts and executive director, Jane Goodall Institute India, National coordinator, Blue schools India) invoked active thoughts and participation on advancing the ocean literacy dialogue in India. An engaging session by Dr. Abul Qasim explored the potential of blue carbon and marine carbon dioxide removal (mCDR) as vital ocean-based climate mitigation strategies. Dr. Avanti Acharya emphasised the value of collaborative, interdisciplinary research in developing actionable climate solutions. Dr. Anwesha Ghosh highlighted scientific and community-driven approaches to tackle marine pollution effectively. Dr. Fehmi Dilmahamod introduced the Early Career Scientist Network (ECSN), aimed at fostering support and visibility for young ocean professionals. Mr. Muneer provided practical insights into sustainable fisheries management within a blue economy framework. Ms. Midhila Varna discussed the importance of ocean modelling in understanding climate systems and supporting policy decisions. Dr. T.V.S. Udaya Bhaskar addressed capacity development under Challenge 9 of the UN Ocean Decade, focusing on equitable access to ocean science. Mr. Mohammed Munzil emphasised the role of open data in accelerating progress in ocean research and collaboration. Dr. Femi Anna Thomas concluded with innovative approaches to ecosystem restoration and biodiversity conservation, underscoring community involvement and scientific intervention. These talks underscored the vital role young researchers play in addressing the global challenges facing the marine environment.

Participants for the workshop had the opportunity to present their work through either flash talks or 15-minute oral presentations. To encourage excellence, awards were presented to the top three presenters in each category.

A major highlight of the two-day event was a panel discussion moderated by Dr. Trishneeta B. The hybrid panel (with both online and in-person participants) engaged in a rich dialogue on the future direction of ECOP India. Key outcomes from this session included :

- Plan to create a dedicated mailing list for Indian career and networking opportunities in the ocean sciences.
- Expansion of the climate comic series, originally developed by ECOP members (Dr. Sunanda N, Dr. Rony Peter and Ms. Midhila Varna), into multiple regional Indian languages.
- Innovative outreach strategies, including the use of short animations and ocean awareness messages printed on everyday objects like tissues and cups, to raise public awareness and support for ECOP and its partner institutions.

As a part of World Ocean Day, ECOP India, in association with the DCC-IOR, also organised an online essay competition for Indian ECOPs from across the globe. There were cash prizes for the winners of this competition. Four ECOP members judged this essay competition: Dr. Trishneeta Bhattacharya, Dr. Sunanda Narayanan, Dr. Avanti Acharya and Dr. Femi Anna Thomas, along with an external judge from INCOIS; Dr. Nidheesh A.G. The workshop concluded with the felicitation of Dr. Nidheesh A.G. by Dr. T.V.S. Uday Bhaskar. In addition to the scientific sessions, participants also had the opportunity to tour the Operational Service Systems and the SYNOPS lab at INCOIS, providing them valuable insights into real-time ocean services and operational technologies.

The enthusiastic engagement of participants, who also shared testimonials on their workshop experience, stood out as one of the most encouraging aspects of the event. The workshop successfully fostered collaboration, inspiration, and a shared vision among India's early career ocean professionals, marking a significant step forward in building a vibrant ECOP community in India.

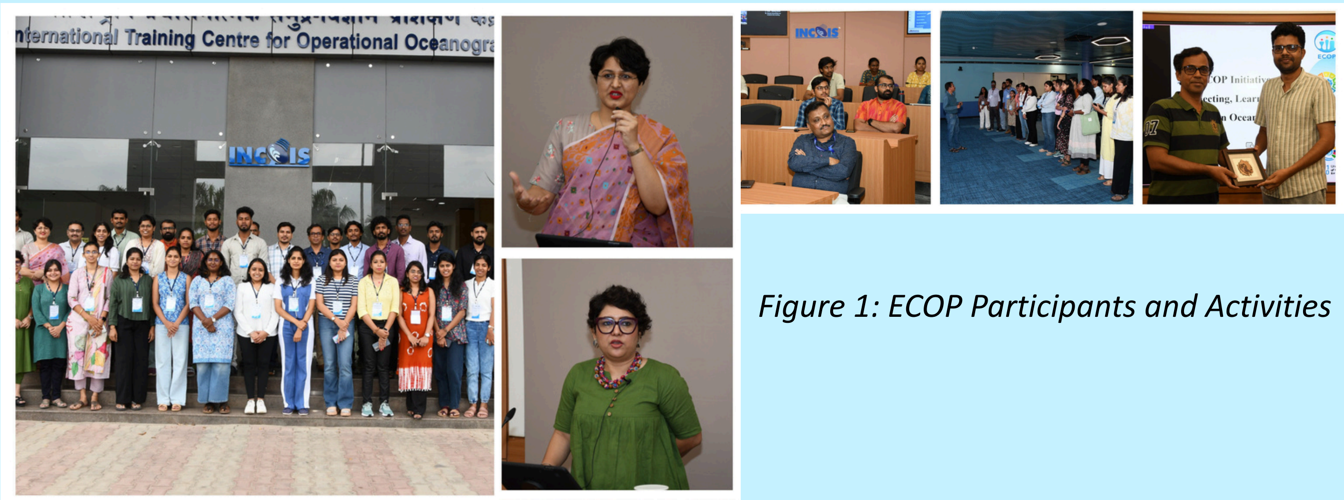

Figure 1: ECOP Participants and Activities

Rising Tides, Rising Voices: ECS on Climate Challenges in the Indian Ocean

Sudheesh Valliyodan[1], Daneeja Mawren[2], Aditi Modi[3]

A warming Ocean and rising concerns

As the Indian Ocean continues to warm at an unprecedented rate, early-career scientists (ECS) from across the region gathered on May 9, 2025 in Port Louis, Mauritius, to articulate the concerns of island and coastal nations facing escalating climate challenges. The session, titled "Voices of the Next Generation: ECS on Climate Action," was convened under the umbrella of the Integrated Meetings of IOGOOS, IIOE-2, IORP, SIBER, IRF, ECSN, and KUDOS. It brought together young researchers to share their experiences, identify key knowledge gaps, and propose actionable solutions to address the growing climate crisis across the Indian Ocean.

The Indian Ocean: A region under pressure

A major concern raised during the session was the intensifying vulnerability of coastal regions and Small-Island Developing States (SIDS).

These nations are facing severe consequences such as frequent and stronger tropical cyclones, flash floods, sea-level rise and shifts in the marine ecosystems. The voices of the ECS were especially poignant in highlighting the unique risks confronting SIDS like Mauritius. Among the impact discussed were longer and more intense marine heatwaves, which pose serious threats to biodiversity and food security. Participants also noted altered monsoon patterns and rainfall variability, which are disrupting agriculture and freshwater resources in east Africa and island nations. In addition, widespread coral bleaching reported in many tropical regions in the Indian Ocean is further stressing vulnerable economies. While climate stressors are intensifying, infrastructure, forecasting systems and adaptation resources remain inadequate, underscoring the need for improved regional models and localized climate strategies.

Data gaps and research barriers

The lack of long-term, high-resolution oceanographic data in many Indian Ocean regions was a recurring theme. Remote, deep-sea and archipelagic zones remain underexplored, making it difficult to assess climate impacts or anticipate extreme events like internal waves, marine heatwaves, or ocean acidification. This data gap limits both scientific inquiry and the development of effective policy and disaster preparedness measures.

ECS also face specific structural challenges. Many of them, especially those based in universities, lack access to key datasets due to limited collaborations with major oceanographic institutions. As a result, their ability to contribute to global and regional studies is restricted. There are also structural problems such as poor coordination between research institutions and universities, and funding systems that discourage interdisciplinary research. Given the inherently interdisciplinary nature of climate issues-spanning oceanography, ecology, economics and social sciences - breaking down silos is essential for impactful research.

Representation of ECS based in SIDS

A powerful message that emerged was the persistent underrepresentation of ECS from SIDS in global scientific forums. Despite being on the frontlines of climate impacts, scientists from these nations are often excluded from international dialogues. This exclusion leads to a critical knowledge gap, as locally grounded insights and traditional knowledge remain underutilised in shaping global response.

Solutions from ECS

To address these challenges, ECS participants outlined several forward-looking strategies. A key recommendation was to expand opportunities for ECS from SIDS to participate in oceanographic cruises, providing much-needed hands-on training and data access. Participants emphasised the importance of open-access data platforms that adhere to FAIR (Findable, Accessible, Interoperable, and Reusable) principles, enabling equitable research participation.

Improving ocean literacy and public engagement was also highlighted. Outreach programs tailored to schools and coastal communities – delivered in local languages and rooted in local culture - were proposed to foster interest in marine science and climate awareness. Participants also stressed the importance of training ECS in science-policy communication, as many lack exposure to formats and language relevant to decision-making. Capacity-building through workshops, mentorships, and science-policy fellowships was identified as a means to bridge this gap.

Bridging Science and Society

The audience included scientific experts from IIOE-2, IOGOOS, KUDOS, and senior faculty from University of Mauritius, who added valuable insights. There was a shared call for stronger interdisciplinary research platforms and institutional collaboration. Others emphasized the need to use digital tools - social media, podcasts, and visual storytelling - to make ocean science more accessible and engaging to the general public. Communicating Science in local languages and through familiar channels like community radio, newspapers, and traditional meetings was seen as essential, particularly in SIDS and rural coastal areas. and rural coastal areas.

Figure 1: Participants of ECSN Workshop

Participants highlighted the importance of partnerships with local NGOs, schools, and community leaders, which enable two-way learning: scientists gain insights from local knowledge, while communities receive scientific support for adaptation planning. Community-based monitoring was cited as a valuable tool for building trust, improving data collection, and increasing local ownership of science. A powerful message came from the Mauritian delegation, which shared how warming seas are already affecting the fishery industry. Fish are moving to new areas or changing their breeding cycles, disrupting local food supplies and livelihoods. Their plea was to support local scientists to lead scientific research that would guide fisheries policy and marine planning. They emphasized that empowering local scientists is essential to ensure that research is both relevant and impactful.

Summary: ECS steering Indian Ocean resilience

The ECSN session in Mauritius demonstrated that early-career scientists in the Indian Ocean region are not only ready to contribute - they are already leading. Their message is clear: empowerment, equity and access are key to building regional climate resilience. Supporting ECS through data access, interdisciplinary training, science communication, and policy engagement will be critical in the years ahead. With the right tools and platforms, this emerging generation of scientists can play a transformative role in protecting the Indian Ocean and the millions of people who depend on it. This workshop marked a significant step forward in amplifying the voices of early-career scientists and converting their insights into actionable strategies for a sustainable ocean future.

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Fisheries and Marine Ecosystem Research

Fishery characteristics, genetic structure, population demography and value chain of skipjack and kawakawa exploited in coastal waters of the Western Indian Ocean

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General abstract

Tuna represents a highly valuable global fishery, comprising 7.9% of the total 67.9 million metric tons (MT) of marine finfish catch. Among tuna species, Katsuwonus pelamis, skipjack and Euthynnus affinis, and kawakawa are commercially important, particularly for artisanal fisheries. Skipjack is the most dominant tuna species globally, contributing over 60% to total tuna production. In the Indian Ocean (IO), skipjack catches approximately 420,000 MT annually. Kawakawa, the second most abundant neritic tuna in the IO, accounting for roughly 12% of neritic tuna landings, is primarily harvested by artisanal fleets, with annual catches of around 160,000 MT. While current assessments indicate that skipjack and kawakawa stocks in the IO are not overfished, maintaining their long-term health is crucial.

This research addresses three key areas: genetic diversity, population structure, and connectivity of skipjack and kawakawa tuna in the Western Indian Ocean (WIO); size structure and reproductive characteristics of these species within the WIO; and the value chain of the Kenyan artisanal tuna fishery, focusing on skipjack and kawakawa. To achieve these objectives, skipjack and kawakawa samples were collected from Kenya, Tanzania, Mozambique, and South Africa (Figure 1). A non-random sampling approach was employed to obtain specimens and data from artisanal and recreational fisheries. Biological and genetic sampling were conducted concurrently. The economic value chain of the Kenya artisanal tuna fishery was examined through questionnaires and catch data. The analysis focused on the socio-demographic profiles of key actors, the value chain structure, and associated economic benefits across four Kenya landing sites.

To investigate stock of skipjack and kawakawa tuna in WIO, we employed tunable Genotyping-by-Sequencing (tGBS) to generate genome-wide Single Nucleotide Polymorphism (SNP) data. Skipjack analysis revealed 7005 SNPs with an average observed heterozygosity (Ho) of 0.206. While overall genetic differentiation (FST) among samples was low (global FST = 0.003) between samples (F_{ST} = 0 – 0.013), significant genetic differences were observed between skipjack samples taken north of Mtwara in southern Tanzania (i.e., northern Tanzania, Kenya and Sri Lanka) and those to the south (i.e., southern Tanzania, Mozambique and South Africa), with Seychelles falling closer to the southern grouping (Figure 2).

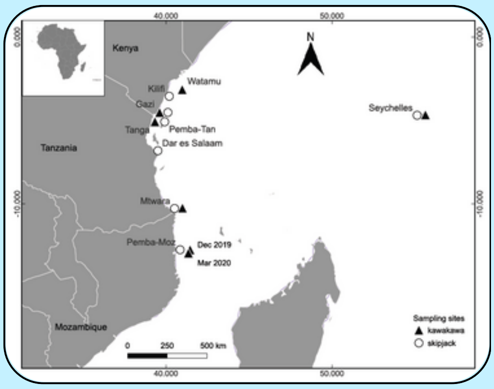

Figure 1: A map showing sampling sites of skipjack and kawakawa in WIO during the study period.

Kawakawa analysis, based on 14806 SNPs and an average Ho of 0.2585, indicated a patchy distribution of low but significant genetic differentiation among WIO populations (global FST = 0.018) between-sample (F_{ST} = 0.003 – 0.036) but with no obvious geographically-based pattern (Figure 3). However, unlike skipjack, a clear geographic pattern in genetic structure was not evident for kawakawa.

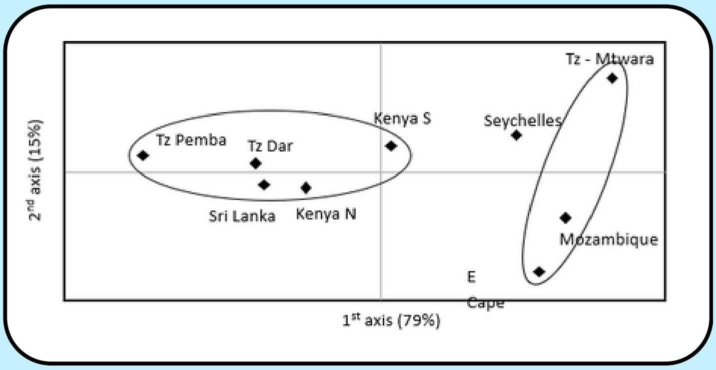

Figure 2: PCoA analysis, with a percentage of total dataset variation represented by 1st and 2nd axes, of genetic similarity among skipjack tuna samples, based on genetic differentiation (F_{ST}) estimated from 7005 SNP loci.

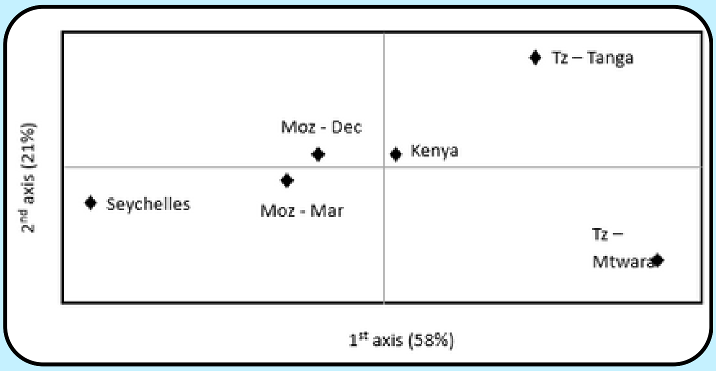

Figure 3: PCoA analysis, with the percentage of total dataset variation represented by 1st and 2nd axes, of genetic similarity among kawakawa samples, based on genetic differentiation (F_{ST}) estimated from 14806 SNP loci.

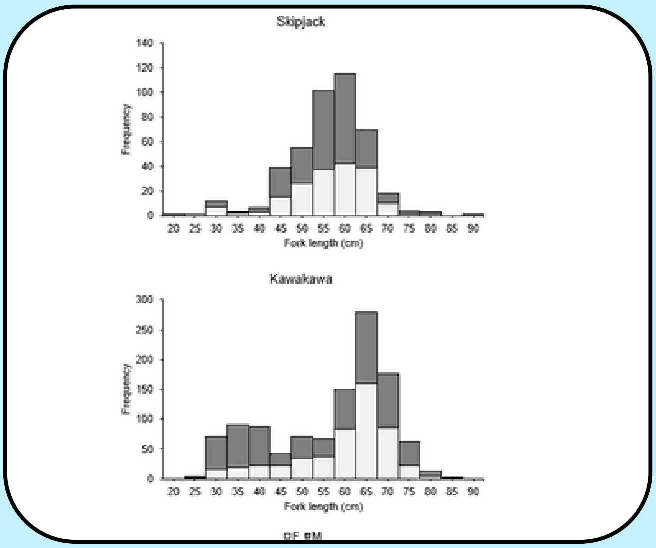

Figure 4:Monthly variations in sex ratios of skipjack and kawakawa across the WIO during the 2019–2022 survey period.

Skipjack and kawakawa populations in the WIO exhibited seasonal fluctuations in size distribution, potentially influenced by environmental conditions and fishing practices. Landings of both species were male-biased, with sex ratios of 58% and 53% for skipjack and kawakawa, respectively (Figure 4). Female skipjack reached sexual maturity at a fork length (FL) of 42.0 cm, while males matured at 47.0 cm FL. For kawakawa, female and male maturation lengths were 44.0 cm FL and 45.3 cm FL, respectively. Spawning occurred throughout the year, with peak activity coinciding with the Northeast Monsoon (NEM) season (Figure 5 and 6).

Our analysis of the artisanal tuna value chain indicates that fishers primarily sell their catch to agents (53%), with the remaining proportions going to traders (20%) and processors (18%) (Figure 7). Processors, predominantly women, play a key role in the value chain and realized the highest net profit margin (49.5%) (Figure 7). Limited post-harvest infrastructure, inadequate transportation, and poor marketing conditions were identified as key challenges impacting the quality of fish lowering their income. These challenges disproportionately affect fishers with limited access to market information and financial resources. The findings demonstrate the need for multi-level interventions to optimize benefits from the artisanal tuna fishery along the entire value chain taking into consideration the economic, environmental, and social dimensions

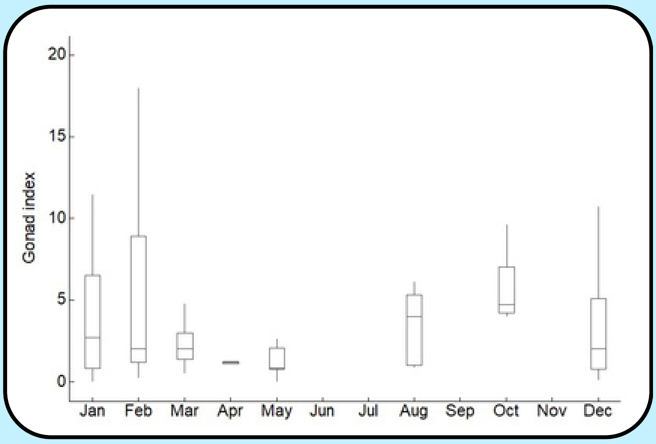

Figure 5: Monthly variation in Gonad Index of female skipjack (Katsuwonus pelamis) collected from sampling sites in WIO during the survey period.

This research provides crucial information for effective tuna management in the IO. Current management practices treat skipjack and kawakawa as a single, homogenous population across the entire IO. However, our genetic findings suggest the presence of distinct population groups (stocks) for both species within the WIO. Moreover, seasonal variations in size structure and reproductive characteristics observed support this hypothesis of multiple stocks. These results emphasize the need for a precautionary approach to tuna management in the region. Collaborative efforts among countries are essential to develop sustainable fisheries management strategies that consider biological, economic, and social factors. By integrating these perspectives, we can ensure the long-term health of tuna populations while supporting the livelihoods of fishing communities.

Affiliations

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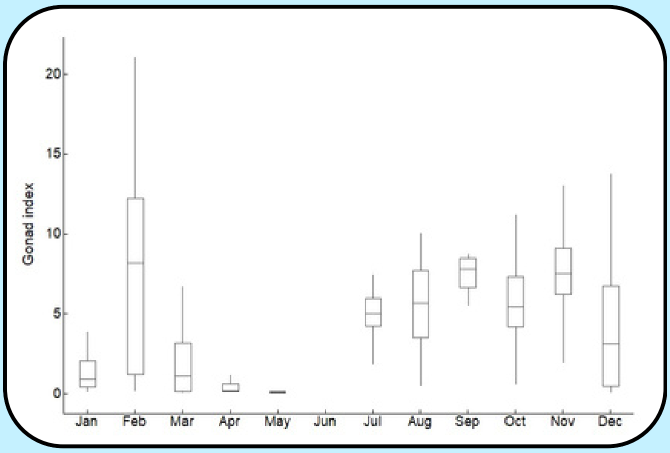

Figure 6: Monthly variation in Gonad Index of female kawakawa (Euthynnus affinis) collected from sampling sites in WIO during the survey period

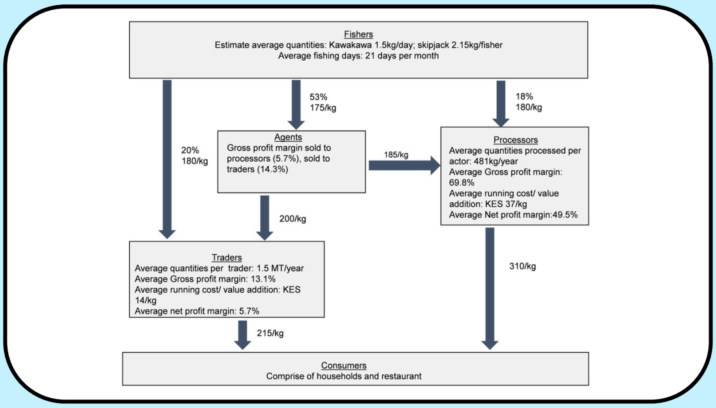

Figure 7: Flow of products and value chain of skipjack and kawakawa artisanal tuna fishery in Kenya.

Integrating Statistical and Machine Learning Models to Decode Environmental Influences on Indian Mackerel Distribution in the Malabar Upwelling Region, SE Arabian Sea

Sneha Jha, ESSO-INCOIS, Hyderabad

Introduction

India's Exclusive Economic Zone (EEZ), covering over 2 million square km, is globally recognized for its rich marine biodiversity, harbouring roughly 2,492 marine fish species, accounting for approximately 7.4% of the world's marine fish resources. The fisheries of the Malabar Upwelling Region (MUR)' region's fisheries account for nearly half of India's total marine fish landings and constitute a major livelihood source for millions in coastal Kerala and neighbouring states.

This region, extending from the coastal waters of Ratnagiri to Kanyakumari (73–77°E and 7–13°N), experiences intense seasonal upwelling, a process that brings cold, nutrient-rich waters from the depths of the ocean to the surface, leading to highly productive marine ecosystems. This ecosystem sustains abundant fisheries, forming the backbone of local economies and food security. Mechanized fishing methods such as trawl nets, purse seines, and gill nets dominate the fishery, capturing more than 95% of annual catches. Given this heavy reliance, understanding the environmental drivers behind fish stock variability is essential to ensure sustainable resource use.

The Indian mackerel (Rastrelliger kanagurta) is one of the most commercially important small pelagic fish species found along the southwestern coast of India, particularly in the nutrient-rich MUR. Indian mackerel primarily inhabit the epipelagic zone (surface to 150 m depth), often near thermocline layers where water temperature and plankton availability display strong gradients. Adult mackerel prefer plankton-rich coastal bays, harbours, and lagoons, feeding on larger planktonic organisms like larval shrimp and fish, while juveniles feed on smaller phytoplankton and zooplankton. These fish form large schools and undertake seasonal migrations influenced by ocean currents, monsoon-driven upwelling cycles, and breeding seasons. Indian mackerel alone contributed about 328,000 tonnes of landings in 2022, making up 9.39% of the total marine fish harvest in mainland India. This species is essential not only for commercial fishing but also as a vital link in marine food webs. Despite the ecological and economic significance of Indian mackerel fisheries, forecasting their stock abundance has remained a technical challenge, predominantly due to the complexity of environmental processes influencing their populations.

The present study investigates the complicated relationships between multiple environmental parameters and Indian mackerel abundance over 18 years (1995–2012) along the Kerala coast using a combination of statistical models and satellite-derived environmental data. The models employed offer complementary strengths in capturing linear, nonlinear, and complex interaction in ecological datasets. Understanding these relationships allows for better-informed fishery management decisions, which are critical for sustaining this valuable fishery amid growing fishing pressure and environmental variability.

Challenges Addressed by the Study

Traditional approaches to relating fish landings to oceanographic physical processes (such as currents, upwelling intensity, and temperature) have achieved limited success (Figure.1). This is due to the high complexity, nonlinear dynamics, and spatial-temporal variability inherent in marine ecosystems. Moreover, conventional oceanographic data collected via buoys, ships, or moorings are spatially and temporally limited, making large-scale, long-term ecological inferences difficult. This study leverages remote sensing data combined with fisheries landing records to overcome these limitations.Model data for environmental parameters such as rainfall, mixed layer depth (MLD),seawater temperature and salinity at 50 m depth, dissolved oxygen, chlorophyll-a concentration, and net primary productivity, with broad spatial coverage and consistent temporal resolution, were used. Analyzing these environmental variables over 18 years in conjunction with fishery data offers a robust framework to uncover previously undetectable relationships (Figure 2).

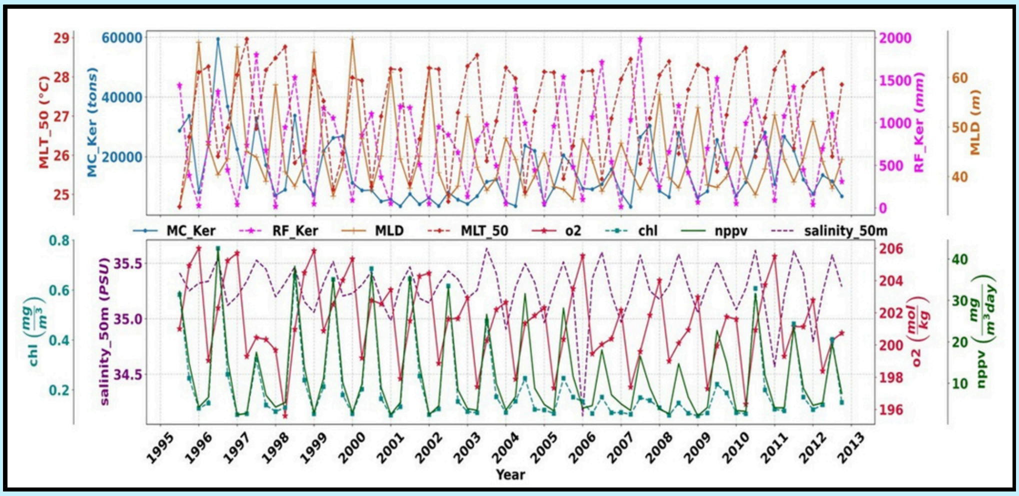

Figure 1: Plot showing the trend of mackerel landings in Kerala coast and the environmental variables during the study period. MC_Ker - mackerel landings, RF_Ker - rainfall in Kerala coast, MLD - mixed layer depth, MLT_50 - seawater temperature at 50 m depth, O2 - dissolved oxygen concentration, chl - chlorophyll-a concentration, nppv - net primary productivity volume, salinity_50 m – salinity at 50 m depth

Three key statistical modelling techniques are known for their utility in ecological research:

- **Generalized Linear Models (GLMs)** - extend traditional linear regression by allowing response variables to follow different statistical distributions (e.g., Poisson, binomial, etc.) and use link functions. GLMs provide interpretable linear relationships but may struggle with nonlinear patterns.
- **Generalized Additive Models (GAMs)**- improve upon GLMs by allowing predictor effects to be modelled as smooth, nonlinear functions, capturing complex and non-monotonic relationships without predefined assumptions about shape.
- **Boosted Regression Trees (BRTs)-** combine machine learning with ensemble methods. They iteratively fit many simple regression trees, using boosting algorithms to improve accuracy and capture intricate variable interactions. BRTs outrival in predictive modelling, even with complex datasets, though they can be harder to interpret.

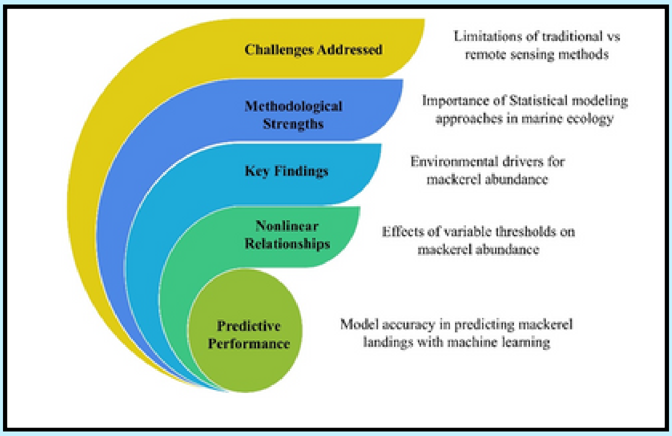

Figure 2: Insights of the study

The complementary use of these models allows the study to examine linear trends, nonlinear effects, and multifactor interactions carefully.

Key Findings

- GLM results revealed positive linear relationships between mackerel landings and chlorophyll-a, net primary productivity, rainfall, and salinity at 50 m depth, while temperature and mixed layer depth exhibited negative relationships.
- GAM models confirmed statistical significance for rainfall, chlorophyll-a, net primary productivity, and dissolved oxygen, with non-linear effects observed for temperature. Mixed layer depth and salinity, though important, were not statistically significant here.
- BRT analyses emphasized the dominant influence of net primary productivity (21.3% relative importance) on explaining fish abundance variations, followed closely by temperature and mixed layer depth (~17% each) (Fig.3).
- The GAM model uncovered nonlinear relationships that linear models couldn't detect, such as temperature effects exhibiting thresholds influencing mackerel abundance. Such patterns likely reflect physiological tolerances and behavioural ecology of mackerel, which prefer certain temperature and salinity regimes near the mixed layer interface.
- Using the top three drivers (net primary productivity, seawater temperature at 50 m, and mixed layer depth), a stochastic gradient boosting model showed decent predictive ability (r^2=0.6), suggesting environmental variables explain a substantial portion of the variability in mackerel landings. However, prediction errors indicate there is room for improvement, pointing to the value of adding refined variables or longer datasets.

Significance and Implications of the Study

- This study advances fundamental ecological understanding by quantifying how primary environmental factors govern the distribution and abundance of a key small pelagic fish species in an upwelling-driven ecosystem.
- It confirms the paramount role of net primary productivity, an integrative measure of nutrient and light-driven phytoplankton growth, in driving fish abundance. This validates classical ecosystem theories where energy transfer from primary producers influences higher trophic levels.
- The incorporation of sub-surface water parameters (temperature and salinity at 50 m) over surface measurements reflects a subtle appreciation of fish habitat preferences above mixed layer and thermocline zones.
- The study highlights the effectiveness of combining remote sensing, in-situ data, and advanced statistical tools to address ecological complexity, setting a methodological benchmark for future marine ecosystem research.

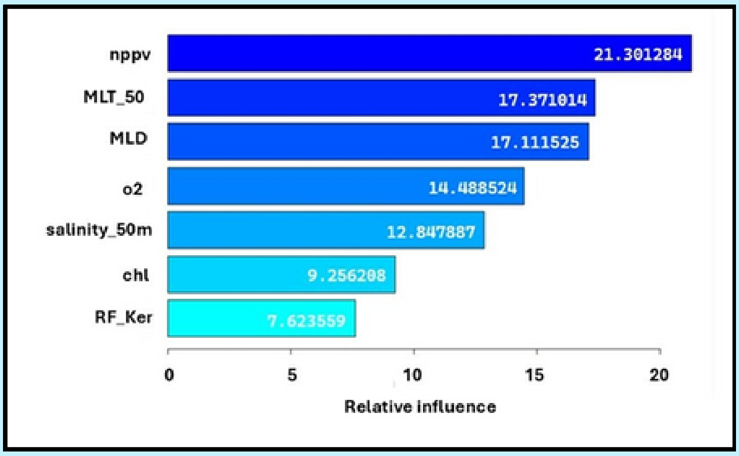

Figure 3: Relative influence plots of BRT showing the percentage of influence of each variable on the mackerel landing

Conclusion

Indian mackerel fisheries support livelihoods and food security for millions of coastal residents. Unpredictable fluctuations in fish abundance can cause economic adversities and threaten sustainable harvesting. By identifying environmental factors predictive of abundance, the study provides tools to improve fishery forecasting and management. The approach enables more adaptive management cognizant of ecosystem dynamics rather than relying solely on historical catch trends, critical under changing climate regimes threatening marine productivity and fish distributions. The methods and findings have relevance beyond the Malabar coast and Indian mackerel. They can be adapted to other pelagic fisheries globally influenced by upwelling or monsoon systems. Incorporating additional parameters, such as ocean currents, larval recruitment, predator-prey interactions, and anthropogenic pressures, could further enhance model accuracy and ecological comprehension. The study underscores the vital role of sustained satellite monitoring and long-term ecological datasets, advocating for investment in such infrastructure. From a climate change perspective, understanding how environmental shifts rework productivity and habitat conditions is essential for preparing fisheries to adapt.

Citation:

Jha, S., Jeevanand, N., Joseph, S., & Nair, T. M. B. (2024). Unravelling the dynamics of Indian mackerel abundance in the Malabar upwelling region: A comprehensive analysis of oceanographic influences using GLM, GAM, and BRT models. Indian Journal of Geo Marine Sciences, Special Issue on "Sustainable Utilization of Oceans in Blue Economy", Vol. 53, Issue 05, pp. 353–361. https://doi.org/10.56042/ijms.v53i05.21663

Cruise Insights

Ocean Beyond the Shores: A Cruise Chronicle of a Marine Biologist

Vrinda P K

Her dreams were always drifting beyond land. A researcher's purpose, after all, knows no boundary. As a marine biologist who first learned the ocean's heartbeat in Andaman Islands, and someone who has explored her silence firsthand as a certified SCUBA diver, I've always dreamt of research cruises, learning the oceans in her own embrace. Three research cruises, each was a floating classroom, unmatched in wisdom and wonders of the Arabian Sea and the Bay of Bengal. Aboard the Sagar Sampada and Sagar Nidhi, we ventured into the deep seamounts, where mysteries meet enthusiasm. The ships steered through the rough waves amidst rains, storms and tides, carrying the people bounded by the language of science and research. Like the boy, from the book The Highest Tide, Miles O'Malley a 13-year-old, who spent hours exploring the shore, deeply fascinated by marine life, I never spent a day confined to my cabin during any cruise. Looking back, I carry no regret, only gratitude for every salt-soaked memory.

Cruise calls often came without much notice, yet it's said: no research team ever truly sets sail unprepared. Scientific readiness and personal well-being are both keys to the success of such missions. Preparations for each cruise were a journey in themselves: designing the science, outlining the protocols, setting up instruments, gathering supplies, and building a team with vision and purpose. It's in these moments, onshore, before departure, that knowledge passes down through generations begins to take shape in the hands of the present

Excitements peaks like seamounts on the day of departure. After clearing inspection at the port authority, walking toward those majestic ships is always a moment of quiet awe. The captain's briefing inside the ship not only introduces the vessel but reminds us that we're walking toward our dreams on waves. The research and technical teams together form an ocean-bound powerhouse, battling the unknowns in the ocean realm.

Once the lab is set up and equipment is in place, the mission truly begins. Seasickness might challenge us, but we never let it steer us away from our purpose. We wait for stations with the patience of tide-watchers. Every station brings the team together. Marine biologists delicately handle the deep-sea creatures; the carriers of the hadal secrets, molecular biologists collecting DNA; stringing barcodes into science horoscope of marine life, the biogeochemists speaking in the verse of chemistry, and oceanographers unfolding the physics underneath the waves, unites in the lap of ocean. All disciplines converge, united in the lap of the ocean, working hand in hand to decode its endless mysteries

Sorting deep-sea specimens from seamounts and extracting DNA from seawater and sediment were not just my tasks, they were milestones. For a researcher at the dawn of her jouney each challenge was a doorway to deeper understanding, each moment a step further into the heart of the ocean's secrets. And yet, leisure time was never idle. Without phones, we exchanged stories of past legends who sailed these same ships, of discoveries made, of research carried in memory by the ship's crew. It empowered us all. I always carried books with me; because, they say, one who read a hundred books lived a hundred lives, and I wanted to live mine both on land and in the ocean. We celebrated Diwali, Holi, Republic Day, even my birthday onboard. These were ocean-made memories, woven into the waves. Stargazing from the deck became a nightly ritual, where the sky met the sea, and silence spoke in constellations, a quiet comfort in moments of solitude far from family and friends.

Imagine a moment: the ship sails between stations, and I'm quietly reading a book. Suddenly, someone shouts "Look!!! That's a blue whale out there!!" In that instant, the girl in me, once full of dreams about the ocean, stood still, in awe. I never imagined it would become one of the most unforgettable moments of my life. Spotting whales, dolphins, sea snakes, turtles, and flying fish lifted my spirit to the ninth cloud every time.

Learning beyond books has always been my favorite subject. The ocean taught in ways no classroom ever could, through patience, unpredictability.

Some people are born for their purpose in land. But the ocean researchers they live for a purpose beyond it. Because **they chose the ocean, never knowing the ocean had already chosen them long before.**

Call for Contributions

Informal articles are invited for the next issue. Contributions referring Indian Ocean studies, cruises, conferences, workshops, tributes to other oceanographers etc. are welcome. Articles may be up to 1500 words in length (MS-Word) accompanied by suitable gures, photos (separate .jpeg files).

Deadline: 15**th November, 2025**

Send your contributions as usual to **iioe-2@incois.gov.in**

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