

TOWARD EFFECTIVE CAPACITY SHARING FOR THE OCEAN SCIENCES

OPPORTUNITIES FOR COLLABORATION WITH UNESCO/IOC'S CAPACITY DEVELOPMENT PROGRAMME

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ABSTRACT. Sustainable development, including conservation of the ocean, its habitats, and resources, requires integrated global efforts. As a leading United Nations body for oceanic matters, the Intergovernmental Oceanographic Commission of UNESCO (UNESCO/IOC) plays a pivotal role in facilitating and developing mechanisms to improve ocean science, management, and services worldwide. This paper examines UNESCO/IOC's approach to capacity sharing, highlighting empowerment of individuals, organizations, and governments in achieving sustainable development goals following guidelines established by the family of nations under various multilateral environmental agreements. It presents the Commission's strategic capacity development framework, analyzes lessons from regional coordination mechanisms, and explores collaborative strategies for addressing capacity development barriers. The manuscript also underscores the UN Decade of Ocean Science for Sustainable Development (2021–2030) as an opportunity to foster transformative capacity and effective sharing of ocean science knowledge and resources.

INTRODUCTION

The ocean's significance in sustaining life implies urgency for comprehensive and inclusive participation of all countries. The Intergovernmental Oceanographic Commission of UNESCO (UNESCO/IOC) is recognized as the authority within the United Nations system for marine scientific research and the transfer of marine technology, as mandated by the United Nations Convention on the Law of the Sea (UNCLOS). Operating with functional autonomy within UNESCO, the IOC serves as a platform for international cooperation, facilitating knowledge sharing and advancing the sustainable use of ocean resources (UNESCO/IOC, 2022).

Capacity development is a cornerstone of IOC's mission, encapsulated in numerous resolutions and strategic frameworks since its inception. Central to the IOC

Capacity Development Strategy is leveraging countries' capacities as catalysts for achieving the high-level objectives outlined in the IOC Medium-Term Strategy 2022–2029 (UNESCO/IOC, 2022). Through targeted initiatives, the IOC has significantly contributed to enhancing critical elements of ocean science, including the development of human resources, knowledge dissemination, infrastructure enhancement, and the provision of tools and technologies that empower nations to effectively manage their marine environments.

The IOC's holistic approach—incorporating a coherent strategic framework, regional coordination mechanisms, strategic partnerships, and collaborative networks—reflects its commitment to overcoming persistent barriers to capacity development. These mecha-

nisms empower individuals, institutions, and nations, ensuring equitable access to ocean science and technology while addressing both regional priorities and global sustainability goals.

A COHERENT STRATEGIC FRAMEWORK FOR CAPACITY DEVELOPMENT

The IOC Capacity Development Strategy is designed to strengthen the scientific capabilities of Member States to observe, understand, and sustainably manage the ocean and its ecosystems (Diwa et al., 2021). Since its establishment in 1960, the IOC has fostered technical training, scholarships, and fellowships through initiatives such as its Training, Education, and Mutual Assistance (TEMA) program. These efforts have been complemented by successive publication of IOC criteria and guidelines on the transfer of marine technology and strategies for capacity building (UNESCO/IOC, 2005a, 2005b, 2016, 2021, 2022, 2024), endorsed by several United Nations General Assembly resolutions. The guidelines have been instrumental in advancing the objectives of the UN 2030 Agenda for Sustainable Development (<https://sdgs.un.org/2030agenda>), particularly, but not limited to, Sustainable Development Goal 14 (SDG 14), which prioritizes enhancing scientific knowledge, research capacity, and technology transfer to safeguard ocean health and

support developing nations, including Small Island Developing States (SIDS) and Least Developed Countries (LDCs). IOC’s science-based knowledge-sharing initiatives led to the formal establishment of the IOC Capacity Development framework. They also provide a rich and diverse learning environment for IOC programs and Member States as they co-design long-term actions.

With increased understanding of the connections between the ocean and weather, climate change mitigation, the economy, and livelihoods, improved capacity became a priority for all sectors: political, commercial, science, and society. In order to reflect a strategic response

to evolving global demands, the IOC Capacity Development Strategy was grounded in extensive consultations and reviews by the IOC Group of Experts on Capacity Development (GE-CD). The updated strategy emphasizes inclusive capacity development and incorporates gender, geography, and generational equity, while prioritizing Africa, SIDS, LDCs, and other under-represented regions.

IOC Capacity Development Strategy 2023–2030

The newest IOC Capacity Development Strategy (2023–2030) (UNESCO/IOC, 2024) positions capacity development as

a catalyst for strengthening ocean science capabilities for the long term among all Member States. It outlines six expected outputs (Table 1), each linked to targeted activities for transformative change. These outputs not only align with IOC’s overarching capacity development ambitions but also contribute to global initiatives such as the UN Decade of Ocean Science for Sustainable Development (2021–2030), referred to in this article as the Ocean Decade. There is an emphasis on investing in people and institutions to enhance access to scientific tools and methodologies, strengthen IOC’s service capabilities, facilitate science-policy communication, promote ocean literacy, and mobilize resources.

Critical actions within the strategy are:

- Reinforcing global and regional coordination by engaging national ocean science and governance institutions
- Expanding Member State participation in IOC programs through the integration of global and regional mechanisms
- Empowering IOC regional sub-commissions and other subsidiary bodies to identify and address region-specific capacity development needs
- Strengthening global science programs to foster increased scientific engagement among Member States
- Prioritizing partnerships with UN agencies, scientific organizations, and civil society to maximize impact
- Mobilizing resources, including personnel, funds, knowledge, and observing networks, through collaborative approaches, to ensure the effective delivery of capacity development initiatives
- Continuously building an enabling environment of institutions for capacity development to create a conducive environment for capacity development

The desired outcomes of this strategy include empowering Member States to deepen their understanding of oceanic and coastal resources and applying this knowledge to enhance governance, sustainable development, and environmental protection.

TABLE 1. The six expected capacity development outputs and associated activities as described in more detail in the IOC Capacity Development Strategy (2023–2030) (UNESCO/IOC, 2024).

OUTPUT	ACTIVITY
1. Human resources developed at individual and institutional levels	1.1 Academic and higher education
	1.2 Continuous professional development
	1.3 Sharing of knowledge and expertise including through community building
	1.4 Integration of ocean science in basic education
	1.5 Improving gender, generational, and geographic diversity
2. Access to technology, physical infrastructure, data, and information established or improved	2.1 Facilitating access to technology and infrastructure
	2.2 Facilitating equitable access to and sharing of ocean data and information
3. Global, regional, and sub-regional mechanisms strengthened	3.1 Further strengthening and supporting secretariats of regional commissions
	3.2 Enhancing effective communication between regional sub-commission secretariats and global programs as well as other communities of practice (including other organizations)
	3.3 Identifying specific national and regional capacity development needs through regular needs assessment
	3.4 Encouraging regional and sub-regional organizations to be leaders in, and amplifiers of, capacity development
4. Development of ocean research policies in support of sustainable development objectives promoted	4.1 Fostering the development of ocean research policies
5. Visibility, awareness, and understanding on the roles and values of the ocean and ocean research in relation to human wellbeing and sustainable development increased	5.1 Fostering the development of ocean-related public information and communication services
	5.2 Fostering the development of ocean literacy
6. Sustained resource mobilization reinforced	6.1 Enhancing sustained support (in-kind and financial) to the IOC for its international coordination role
	6.2 Promoting sustained bilateral and multilateral support among Member States

REGIONAL COORDINATION MECHANISMS AMPLIFY CAPACITY DEVELOPMENT

Regional coordination mechanisms play a critical role in addressing the unique environmental, institutional, social, and political contexts of different ocean regions. Recognizing that each region faces distinct challenges, the IOC tailors its capacity development initiatives to meet region-specific priorities. These efforts are informed by comprehensive capacity development needs assessments, such as the IOC's biennial surveys (UNESCO/IOC, 2021), which guide targeted interventions through participatory processes, international cooperation, and collaborative frameworks.

IOC Regional Subsidiary Bodies

The IOC leverages the strengths of its Regional Subsidiary Bodies (RSBs) to enhance capacity development outcomes. These bodies—comprising IOCARIBE (Caribbean and Adjacent Regions), IOCAFRICA (Africa and Adjacent Island States), WESTPAC (Western Pacific), and IOCINDIO (Central Indian Ocean)—serve to engage Member States, support collaboration, and implement regionally relevant capacity development initiatives.

RSBs also play a pivotal role in coordinating regional training platforms, webinars, and matchmaking exercises. By synthesizing input from Member States and partners, these bodies ensure that capacity development efforts are well aligned with regional and global strategic goals. Their activities not only amplify the impact of the IOC's Capacity Development Strategy but also promote cross-regional knowledge exchange, helping Member States adapt to emerging challenges and opportunities.

Delivering impactful capacity development at global, regional, and national levels requires highly coordinated mechanisms. The IOC emphasizes the importance of synergy among its global and regional programs to maximize efficiency and minimize redundancy. Regional subsidiary bodies' secretariats actively

contribute to the refinement of capacity development strategies, offering insights that ensure alignment with regional priorities, through working closely with the IOC global capacity development coordination program.

OceanTeacher Global Academy

The IOC has adopted a decentralized approach to knowledge exchange, prioritizing mechanisms that empower experts and learning institutions worldwide to develop their own training programs. The OceanTeacher Global Academy (OTGA; <https://classroom.oceanteacher.org/>) is IOC's global network of regional and specialized training centers and affiliated partner institutions, delivering training on ocean sciences, services, and management relevant to IOC programs and contributing to the Ocean Decade. This network includes region-focused and topic-focused organizations, endorsed by IOC Member States, with proven means and capacity to sustain training programs relevant to their regions or expertise. Training topics include tools that can help Member States achieve the Sustainable Development Goals and research emerging topics, such as data management, environmental DNA, marine spatial planning, and blue carbon. Leveraging existing infrastructure and human resources within each region, the IOC creates more training opportunities, and, as importantly, covers a wide variety of knowledge systems and learning needs.

OTGA provides a comprehensive internet-based training platform that supports on-site training (face-to-face), blended training (combining on-site and distance learning), and online (distance) learning. All training courses are delivered using the OceanTeacher e-Learning Platform that enables sharing of standardized, quality training content in a coordinated framework, while allowing the use of different languages as well as local/regional case studies. Following IOC Capacity Development Strategy priorities (UNESCO/IOC, 2016, 2024), OTGA collaborates with other

intergovernmental agencies, such as the World Meteorological Organization (WMO) and the International Hydrographic Organization (IHO), to plan and coordinate training activities for the broader community. OTGA also supports international programs, for example, the Early Career Ocean Professional (ECOP) Network and the European Commission project Erasmus Maris, to host and deliver training courses and activities targeting the demands of specific audiences (i.e., university students, science teachers, citizen scientists). Regional capacity development priorities are achieved through close collaboration with the RSBs to ensure the capacity development needs of the regions are being met through the support of the OTGA Regional Training Centres.

The introduction of online instructor-led and self-paced training options on the OTGA eLearning Platform has resulted in a tenfold increase in the number of enrolled learners over the last five years. OTGA continues to provide equitable capacity related to ocean research, observations, and services for the marine community. This successful IOC training program complements global knowledge-sharing efforts, filling gaps and integrating into other marine and maritime specialized training academies (e.g., IMO e-Learning and Training, WMO Global Campus Initiative, Partnership for Observation of the Global Ocean training programs).

COLLABORATIVE APPROACHES: BOLSTERING PARTNERSHIPS TO MUTUALIZE RESOURCES

Collaboration and networking are central to the IOC's capacity development strategy. These approaches enable institutions and stakeholders to pool resources, exchange knowledge, coordinate actions, and build resilient and sustainable knowledge systems that empower Member States to achieve long-term ocean sustainability goals. By fostering trust and promoting shared responsibility, collaborative frameworks address transboundary challenges

more effectively and ensure that capacity development initiatives deliver tangible socioeconomic benefits, such as job creation, improved livelihoods, and sustainable resource management.

IOC Ocean Traineeship

The IOC Ocean Traineeship Program, a collaborative initiative launched in 2024 as a pilot program, facilitated the exchange of early-career ocean professionals through a three-month place-based learning experience. Seven trainees from countries that included Brazil, Indonesia, Madagascar, and Uruguay participated in hands-on learning at host institutions in Argentina, Australia, Colombia, Germany, India, and the United States. Applications for upcoming cohorts are typically invited during the first quarter of the year.

The traineeship was designed to enhance professional expertise in research, services, and capacity development related to IOC's mandate. Participants benefited from mentorship by field experts and contributed to the creation of new resources with global or regional applicability. The program was co-designed in collaboration with IOC global and regional programs, partner organizations, and regional training centers—including two Ocean Biodiversity Information System nodes (Australia and deep-sea nodes), two OTGA Regional Training Centres (Colombia and India), two OTGA Specialized Training Centres (Argentina—also a National Oceanographic Data Centre), and the International Tsunami Information Centre in the United States—underscoring the value of joint capacity development efforts in institutional resilience and networking competence.

Combining local mentoring with international cooperation is a critical element behind sustaining capacity that can outlast each of the capacity development efforts themselves (Shackeroff Theisen et al., 2016). This IOC initiative, like other international traineeship programs, integrates higher education, research

institutions, and operational facilities to enhance ocean science capacity. Even covering short periods, these traineeship programs often result in extended outcomes such as scientific innovation, strengthening institutional capacities, and promoting access to scientific tools and resources.

IOC Ocean Data and Information Services and Products

IOC's integrated work and collaboration contribute to building the capacities to share oceanographic data, information, and knowledge. Coordinated by its Project Office on the International Oceanographic Data and Information Exchange (IODE), IOC has developed and sustains the operation of digital systems, such as the Ocean Biodiversity and Information System (OBIS), a global open-access data and information clearing house on marine biodiversity for science, conservation, and sustainable development that connects more than 500 institutions through its 20 nodes. Collaboration agreements, for instance, with the Global Biodiversity Information Facility, improve the volume and quality of biodiversity information available to policymakers for conservation and sustainable use of the ocean's biological resources. Likewise, the IOC Tsunami Programme's International Tsunami Information Centre (ITIC) coordinates global monitoring of international tsunami warning activities. ITIC provides guidance in communications, data networks, acquisition and processing, tsunami forecasting methods, and information dissemination to Member and non-Member States.

LEVERAGING THE UN OCEAN DECADE TOWARD EFFECTIVE CAPACITY SHARING

The UN Decade of Ocean Science for Sustainable Development (2021–2030) represents an opportunity for the global community to collectively advance ocean science, support sustainable management practices, and address critical challenges facing ocean ecosystems. As the coordinating body for the Ocean

Decade, the IOC ensures that the Ocean Decade's capacity development efforts meet the needs of Member States, particularly SIDS, LDCs, and emerging economies, and of early career ocean professionals (ECOPs).

Cross-Sectoral and Inter-Sectoral Collaboration

One of the Ocean Decade's defining features is its emphasis on cross-sectoral and inter-sectoral collaboration. The Ocean Decade-endorsed Actions promote the integration of diverse knowledge systems and expertise, facilitating the development of innovative solutions to global ocean challenges. This collaborative approach is essential for advancing capacity development, as it enables the pooling of resources and expertise from various sectors—science, policy, industry, and civil society—toward shared ocean sustainability goals.

The UN Ocean Decade's Vision 2030 White Paper on Challenge 9 (Arbic et al., 2024) specifically highlights the need for comprehensive capacity development, including more access to data, information, technology, and participatory decision-making processes. By supporting the design and implementation of capacity-building initiatives that respond to the specific needs of different stakeholder groups, the Ocean Decade creates and facilitates mechanisms to support nations, regardless of their level of development, to participate in and benefit from the sustainable management of ocean resources.

Transformative Capacity Development for Lasting Impact

The Ocean Decade's vision for ocean science and sustainability is expected to influence capacity development initiatives worldwide. It was designed to guide Member States in the co-design of capacity development initiatives that are responsive to regional and global priorities and operationalized through its actions and supporting mechanisms, such as the Capacity Development

Facility. This collaborative process facilitates the creation of communities of practice, where trust is built across institutional and geographical boundaries, and where shared knowledge and expertise are expected to lead to meaningful outcomes for ocean science and policy.

In this context, the IOC's capacity development efforts within the Ocean Decade are not merely about transferring knowledge or technology—they are about building lasting, self-sustaining systems of collaboration that empower nations to address their own ocean challenges and contribute to the global collective good. By reinforcing the role of science in decision-making and promoting sustainable, inclusive practices, the Ocean Decade offers a unique platform for advancing the objectives of the IOC Capacity Development Strategy and ensuring that ocean science is accessible and beneficial to all.

BENEFICIARIES, IMPACTS, AND ENGAGEMENT

IOC Capacity Development's wide action has benefited thousands of individuals, collectives, and organizations worldwide. According to OceanExpert, the database that enables tracking participation in IOC actions, more than 32,300 users have directly benefited from these initiatives since 1997. User categories include research, natural data management, operational support (technical), institutional management, decision-making and policy, teaching/education, information management and library, commercial (sales and marketing), extension services (public awareness), technical advice and consulting, ECOPs, communication, and administrative support. These individuals belong to more than 9,000 institutions (academic, government, international/intergovernmental, nongovernmental organizations, and private commercial, private nonprofit, research), multiple ocean science disciplines (biological oceanography, marine ecology, chemical oceanography, climatology, meteorology, deep sea, emergency

management, fisheries, aquaculture, limnology, marine and coastal engineering, marine biotechnology, marine products, marine geology, geophysics, maritime archeology, molecular biology, physical oceanography, policy, law, economics, management, pollution, research support services, and *Sargassum*), all sea regions, and 215 countries. The OTGA secretariat or Regional and Specialized Training Centre host institutions provide access to the OTGA network and guidance on how to obtain support for training courses. A significant increase in interest in IOC initiatives has been noted in the last few years, driven by improvements in global and regional coordination, communication, and outreach, the advancement of the Ocean Decade, and open attendance opportunities.

CONCLUSION

Although the IOC has made notable progress in advancing global ocean science capacity through its strategic development initiatives, it still needs to refine and strengthen its global efforts to achieve more coherent, well-coordinated, and collaborative capacity sharing and to continue adapting its frameworks and interventions to address emerging challenges and regional needs. IOC future initiatives must focus on sustaining long-term partnerships, facilitating the mutual sharing of resources, and integrating diverse knowledge systems. By doing so, the IOC can ensure that its capacity development efforts continue to deliver meaningful, lasting impacts on ocean sustainability, reaching all levels of society and expanding cooperation across nations.

Capacity development must be at the heart of sustainable development, ensuring that all countries, particularly SIDS and LDCs, have the requisite tools, knowledge, and infrastructure to manage their ocean resources effectively. Addressing capacity gaps, especially in under-resourced regions, remains critical to inclusive ocean governance and participation in ocean science.

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