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Ocean Literacy: The Foundation for the Success of the Ocean Decade, Volume III

Accelerating Communication, Technology, and Global Initiatives

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Teresa J. Kennedy
Editor

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Editor's Note



2021 United Nations Decade
2030 of Ocean Science
for Sustainable Development

This book series is an officially Endorsed Activity of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), submitted by the International Council of Associations for Science Education (ICASE), an NGO in Official Partnership with UNESCO, as the Lead Institution. Volume III advances this vision by emphasizing communication, technology, and global collaboration as key pathways for scaling Ocean Literacy and empowering societies to work together for the health of our shared Ocean.

Volume III opens with three forewords by esteemed global leaders whose careers have shaped international Ocean science and policy. Their voices highlight the broad relevance and profound significance of Ocean Literacy within the framework of the United Nations (UN) Decade of Ocean Science for Sustainable Development (2021–2030); referred to as the Ocean Decade (OD).

Foreword 1—Pierre-Yves Cousteau

Marine conservationist and Ocean filmmaker Pierre-Yves Cousteau, founder of Cousteau Divers and Goodwill Ambassador for the International Union for Conservation of Nature (IUCN), developed Project Hermes at the European Space Agency (ESA) to connect Oceanography with Earth observation. In his foreword, he urges a renewed human connection with the Ocean grounded in solidarity, empathy, and shared responsibility. He highlights the Ocean Decade as an opportunity to unite science, emotion, and innovation in pursuit of a sustainable future for the Ocean we share.

Foreword 2—Orla Doherty

Ocean explorer, author, and filmmaker at BBC Studios, Orla Doherty has been instrumental in transforming public awareness through storytelling. The emotional and visually striking films she has helped create, most notably BBC's *Blue Planet II,* have sparked global conversations about marine conservation, inspiring individuals, communities, and governments to reduce plastic waste and protect Ocean habitats. Her foreword reflects on the power of storytelling to connect people with the Ocean and emphasizes how creativity and empathy can inspire meaningful change for our shared planet.

Foreword 3—Jan Seys, PhD

Head of Science Communication and Spokesman at VLIZ (Flanders Marine Institute, Belgium) and member of the UNESCO Intergovernmental Oceanographic Commission (IOC) Group of Experts on Ocean Literacy, Dr. Jan Seys is a marine biologist and one of the pioneers of the Ocean Literacy movement in Europe. His foreword highlights the growing importance of international collaboration and communication in advancing Ocean Literacy, calling for scientists, educators, and citizens to work together in building a more Ocean-literate and sustainable world.

In addition to these forewords, Volume III presents reflections from international scientists, communicators, and advocates working to accelerate progress through technology, education, and global partnerships. Their insights reveal how effective communication and cross-sector collaboration can amplify the impact of Ocean Literacy across society. Together, these perspectives embody the unifying purpose and shared commitment that anchor this three-volume series.



International Council of Associations for Science Education

Foreword 1

"The sea, once it casts its spell, holds one in its net of wonder forever."
—Jacques-Yves Cousteau

From the mirroring surface to the unfathomed depths, the Ocean baffles the human mind, inspiring science and myth, exploration and exploitation, awe and fear. My father, Captain Cousteau, was one of the pioneers who helped reveal its wonders and inspire humanity to reach beneath the surface, and I have spent many years exploring its beauty and documenting the mysteries it holds. Today, Cousteau Divers continues this quest through citizen science, by witnessing the impacts of human development on the Ocean's fragile ecosystems, and by raising awareness to the importance of creating marine sanctuaries.

The United Nations Decade of Ocean Science for Sustainable Development invites us to rediscover our interdependence with the Ocean and to act upon it, to shift our mindset from exploitation to conservation and thus help avert our own extinction. Our survival and well-being are deeply intertwined with all the natural systems of our planet, and no lasting civilisation can rely solely on greed and special interests at the detriment of the common good. "Humanity is condemned to solidarity," my father used to say, and this applies not only between people but also with all of life. "We are partners to the fish, the snail, the crab, the grasses that grow in hidden places beyond our sight. Upon their survival hangs our own."

This three-volume series, *Ocean Literacy: The Foundation for the Success of the Ocean Decade*, embodies that spirit of reconnection. Across 65 chapters and voices from more than forty nations, these pages reveal a growing global movement of educators, scientists, artists, community leaders, NGOs, and innovators who unite knowledge with emotion, technology with tradition, and science with empathy. Each one a drop in an Ocean of efforts towards a sustainable future. Just as the diversity of nature breeds its resilience: the diversity of the voices expressed in this work fosters hope for our actions.

The Ocean Decade reminds us that restoring our relationship with the Ocean requires both intergenerational responsibility and inclusive participation. Young people must become leaders whose creativity and courage can reshape how humanity engages with the Ocean. We must bridge science and society, transforming awareness into meaningful and lasting action.

As you turn the pages of these volumes, listen to the voices of those who teach, create, and protect. Listen to the wisdom of Indigenous and local communities whose expertise and experiences remind us that the Ocean is an inseparable part of who we are, and take comfort that your actions, no matter how small, are significant, and that you are not alone.

Every drop of water that cycles through us has come from the Ocean, has flown through the clouds, and fallen to the Earth as rain. Every step we take towards reconciling with the Ocean brings us closer to a sustainable future.

We are the Ocean.

Pierre-Yves Cousteau

Marine Conservationist, and founder and CEO of Cousteau Divers
Paris, France

Foreword 2

I've learned first-hand that the Ocean is not just a backdrop to our lives; it is the beating heart of our planet. It shapes our climate, feeds billions, and holds mysteries beyond our wildest imaginings. Yet, for most of us, the Ocean remains out of sight and out of mind, a disconnect that the United Nations Ocean Decade seeks to change.

The Ocean Decade, officially the *UN Decade of Ocean Science for Sustainable Development (2021–2030)*, is a global call to action. Its mission is ambitious: to generate the knowledge we need to reverse the cycle of decline in Ocean health and create a sustainable future. But science alone cannot achieve this. We need stories, voices, and understanding. We need Ocean Literacy: the ability for everyone, everywhere, to understand the Ocean's influence on us and our influence on the Ocean.

As a television producer, I've spent years bringing the wonders of the Ocean to screens around the world. From the icy depths of the Antarctic to the vibrant coral reefs of the tropics, I've seen first-hand how storytelling can ignite curiosity and inspire change.

But I've also seen how fragile these ecosystems are, and how urgently we need to act. The Ocean Decade is not just about scientists in labs or explorers in submersibles; it's about all of us, including teachers, policymakers, filmmakers, and citizens, working together to protect the Ocean for future generations.

This book series, *Ocean Literacy: The Foundation for the Success of the Ocean Decade*, is a landmark contribution to that mission with its exploration of education, community engagement, technology, the arts, and global collaboration. It demonstrates that Ocean Literacy is not a single discipline; it is a movement that connects science with society. From innovative teaching models and inclusive community programs to creative arts projects and cutting-edge technologies, these chapters show how communication and collaboration can transform understanding into action. They highlight why Ocean Literacy matters: because informed citizens make better choices, and those choices shape the future of our planet.

The importance of communication runs through every page. Knowledge locked in scientific journals will not save the Ocean; knowledge shared through classrooms, media, art, and dialogue can. This series amplifies voices from 42 countries and regions, weaving a global narrative of hope and respon-

sibility. Its impact could be profound: empowering communities, influencing policy, and inspiring generations to see the Ocean not as a distant frontier, but as our shared home.

Orla Doherty Ocean explorer, author, and filmmaker at BBC Studios
London, England

Foreword 3

In the early 1990s, I took my first steps in marine research as part of my PhD on the occurrence of seabirds in the North Sea. This led directly to many, often lonely days spent on the monkey bridge of various ships, gazing—like a sailor—at the endless horizon. Confronted with the enormous vastness and intrinsic power of the Ocean. Later, as a researcher and science communicator, that awe only grew, greatly enriched by countless facts, figures, and stories.

At the center of it all was, again and again, the Ocean and the awareness of the crucial role it plays on "Earth." And yes, in hindsight, it remains astonishing how long it took before the upgrading of Ocean Literacy, i.e. teaching basic knowledge and awareness of that Blue Wonder to every citizen, gained a foothold. Isn't (salt) water the element that characterizes our planet? How is it possible that we have lived with our backs to the sea for so long?

As head of science communication at VLIZ, we organized the First Conference on Ocean Literacy in Europe (Bruges) in 2012, inspired by pioneers from the United States. It would mark the start of the role that the UNESCO-IOC has been playing with great enthusiasm and success in globalizing the Ocean Literacy movement.

Later, the movement would also be essential as a stronghold of the UN Ocean Decade. On the other hand, various national and regional successes show how much networking and/or the development of strategies or curricula for education need a more local touch. The need for Blue School networks, once the driving force behind the movement, remains important, but so does the focus on inclusion and local communities and knowledge, collaboration with the emerging Blue Economy, and the optimization of broad communication.

This volume reviews successes from 25 countries and regions worldwide, written by nearly a hundred authors. It includes examples of how bridges can be built between scientific knowledge, public understanding, and meaningful action. And let's not forget the role of tools and innovative technology. What the legendary French Oceanographer Jean-Jacques Cousteau achieved for the diving world in the 1950s, AI/virtual reality, citizen science, and Digital Twins of the Ocean will undoubtedly achieve for a global audience.

Allowing us to feel the beauty and power of the Ocean as intensely as possible, so that we can then cherish our alliance with it. A sustainable alliance, in which nature conservation and the Blue Economy are in balance, or better

still, reinforce each other where possible. An alliance of scientific insight, innovation, and responsibility. Perhaps this will make us all a little more "seafaring"?

Jan Seys Marine biologist, Head of Science Communication at VLIZ (Flanders Marine Institute), and member of the IOC Group of Experts on Ocean Literacy
Ostend, Belgium

Reflections from the Ocean and Science Education Community

The voices featured here offer reflections from both Ocean and science education leaders whose work continues to shape the dialogue, reach, and impact of Ocean Literacy around the world.

"As the Lead Institution for this officially Endorsed Ocean Decade Activity, ICASE is honored to introduce this third volume, which captures the momentum of a truly global movement. Volume 3 explores the essential role of communication, digital innovation, and international collaboration in advancing Ocean Literacy and responding to the pressing challenges of our time. It highlights how educators, communicators, scientists, and civil society actors are bridging divides—geographical, generational, and disciplinary—by harnessing powerful tools for outreach, co-design, and engagement. Whether through immersive technologies, multilingual storytelling, or national strategy development, these chapters illuminate how Ocean Literacy can be scaled, adapted, and amplified around the world. ICASE is proud to champion this work and the incredible network of contributors driving it forward. Together, the three volumes of this series provide a robust foundation for science education that is as forward-thinking as it is inclusive, empowering a new generation to lead with knowledge, empathy, and global solidarity."

—Declan Kennedy, PhD, President, International Council of Associations for Science Education (ICASE), Cork, Ireland

"Highlighting the latest in digital outreach, technological innovation, and international partnerships, this volume charts a forward-looking course for scaling Ocean Literacy efforts worldwide and ensuring that the Ocean's voice is heard in every corner of society."

—Niccolò Bassan, Science Officer, Intergovernmental Oceanographic Commission (IOC) of UNESCO, Paris, France

"As someone whose job it is to develop and implement Ocean science-related programs for the general public, this Ocean Decade-endorsed book series is a fantastic resource, particularly Volume III. Having a collection of chapters by others in the field of Ocean science outreach and science communication

sharing their initiatives and experiences while discussing what works and what doesn't, really is invaluable."

—Emily H. King, Development Coordinator, Consortium for Ocean Science Exploration and Engagement (COSEE) and State Key Laboratory of Marine Environmental Science, Xiamen University, China

"The most comprehensive publication on Ocean Literacy to date, bringing together an impressive pool of international experts. Definitely a must-read for all those engaged in changing our relationship with the Ocean."

—Luis Menezes Pinheiro, Ph.D., Chair of the Portuguese Committee to the IOC, Coordinator of the Portuguese Ocean Decade Committee, and Associate Professor of Marine Geology and Geophysics at the University of Aveiro, Portugal

"In Central America, Ocean Literacy is not just a framework, it is a call to rediscover and revalue our deep-rooted connections to the Ocean. While the Ocean may not always be at the center of regional discourse, it has always been central to our lives: shaping our cultures, economies, and ecosystems. This volume affirms that Ocean Literacy is not just about information, it's about transformation and inclusion. It recognizes that Ocean Literacy must evolve with the tools and networks of our time, bridging digital divides, amplifying local voices, and connecting regional efforts to global movements."

—Xochitl Édua Elías Ilosvay, ECOP Central America Coordinator, El Salvador

"To me, Ocean Literacy is about curiosity and never-ending learning and sharing. At the ECOP Programme, we have learnt about diverse educational projects around the world that inspire the sharing of Ocean knowledge. This three-volume book series has done a splendid job showcasing innovative tools and strategies and will be an incredible asset for youth and the ECOP community worldwide, sparking their interest in developing efficient, cutting-edge Ocean Literacy initiatives."

—Evgeniia Kostianaia, UN Ocean Decade ECOP Programme Global Coordinator, Russia



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1 Amplifying Global Impact: Accelerating Communication, Technology, and Ocean Literacy Initiatives

Teresa J. Kennedy

Abstract

The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) provides an unprecedented framework for strengthening society's relationship with the Ocean through communication, technology, and collaboration. Building on the foundations established in Volumes I and II of *Ocean Literacy: The Foundation for the Success of the Ocean Decade*, this introductory chapter to Volume III examines how strategic communication, digital innovation, and international partnerships accelerate Ocean Literacy and amplify global impact. The chapter explores emerging tools and practices, including digital media, immersive and virtual environments, artificial intelligence, science storytelling, and participatory platforms, that expand access to Ocean knowledge and transform information into action. It also highlights how global, regional, and national networks link policy, education, and community engagement to advance the goals of the Ocean Decade, particularly Challenge 10: Restore Society's Relationship with the Ocean. In addition to framing these themes, the chapter provides a concise overview of the contributions in Volume III, showcasing how communication, technology, and collaboration collectively advance Ocean Literacy. Together, these interconnected pathways demonstrate that they are not merely supports for education but central forces shaping an informed, inclusive, and sustainable future for the one Ocean that connects us all.

Keywords

Artificial intelligence (AI) in marine education · Digital media · Inclusive communication · Indigenous Knowledge Systems (IKS) · International collaboration · Multimodal learning · Ocean Decade (OD) · Ocean Literacy (OL) · Science communication · SDG 14 Life Below Water · Sustainable Development Goals (SDGs) · Technology-enabled engagement · United Nations (UN) Decade of Ocean Science for Sustainable Development · Ocean Decade Challenge 10 · Virtual/immersive learning · Youth engagement · Non-Governmental Organizations (NGOs) · NGO contributions to the Ocean Decade

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1.1 Introduction

The three-volume series *Ocean Literacy: The Foundation for the Success of the Ocean Decade* documents how Ocean Literacy is advanced through education, community engagement, creative and economic practices, communication, technology, and policy in diverse regions of the world. Across the series, more than 250 authors from 42 countries and regions contribute their expertise and perspectives shaped by local contexts, disciplinary backgrounds, and cultural knowledge systems. Contributors span every continent, with representation from Argentina, Australia, Bangladesh, Belgium, Bosnia and Herzegovina, Brazil, Canada, Cabo Verde, Chile, China, Croatia, Denmark, Ecuador, England, Finland, France, Germany, Greece, Hong Kong SAR, the Republic of Ireland, Italy, Japan, Kenya, Kuwait, Lebanon, Malta, Mexico, the Netherlands, Norway, Northern Ireland, Peru, Poland, Portugal, Romania, Scotland, South Africa, Spain, Sweden, Taiwan, Türkiye, the United States, and Wales (see Fig. 1.1 previously shared in Volumes I and II).

The 65 chapters underwent a rigorous scholarly pathway, including double-blind peer review by more than 80 international reviewers and a final editorial review by Springer Nature, ensuring academic integrity and fidelity to how the work was developed and represented. This series reflects Ocean Literacy in action, highlighting authentic practices, programs, and experiences across classrooms, inland communities, laboratories, coastal regions, and professional networks worldwide. It aligns closely with the Ocean Decade equity and inclusion goals by demonstrating that distance from the Ocean does not limit engagement. Ocean Literacy is expansive and relevant everywhere, not only in places near the Ocean.

The breadth of participation across this series is substantial, with regional detail that extends far beyond national borders. In large countries such as Canada and the United States, this diversity is especially pronounced. For example, Canadian authors represent institutions across British Columbia, Nova Scotia, Ontario, and Quebec—from west coast to east coast. Contributors from the United States come from 17 states (Alabama, California, Florida, Georgia, Iowa, Maine, Massachusetts, Missouri, New Jersey, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Texas, Virginia, and Washington) and Washington, D.C. Similar regional representation appears across many other countries involved

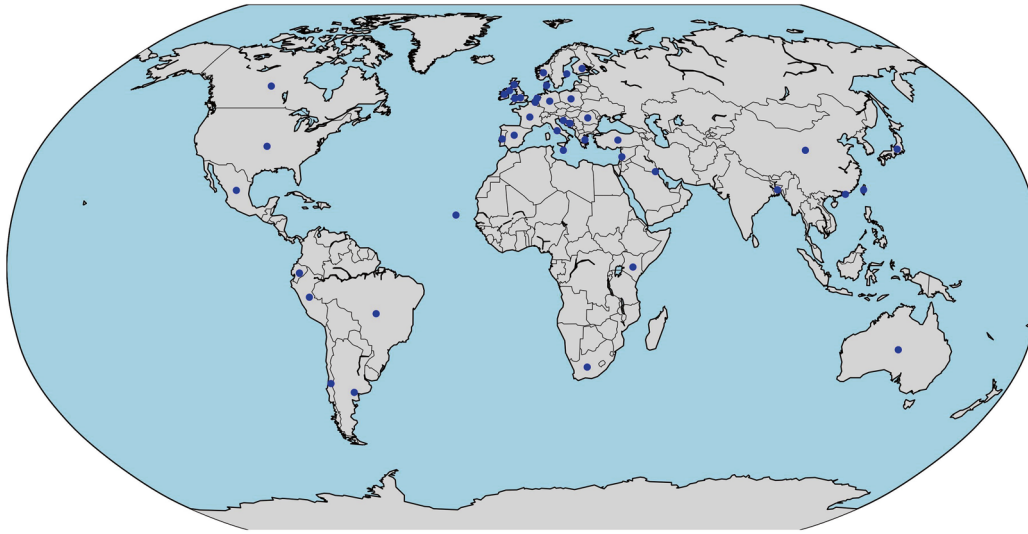


Fig. 1.1 Author affiliations across the *Ocean Literacy: The Foundation for the Success of the Ocean Decade* three-volume book series

in the project, underscoring both the scale and inclusivity of participation in global Ocean Literacy initiatives.

1.2 Foundations from Volumes I and II

Volumes I and II established the conceptual, educational, and societal foundations for why Ocean Literacy is essential and how it is advanced through education, community engagement, creativity, and equitable participation. Grounded in the Ocean Decade Challenge 10 White Paper (Glithero et al. 2024), these volumes show that Ocean Literacy is more than knowledge acquisition; it is a societal process rooted in equity, cultural relevance, shared responsibility, and action. The framework has evolved from the early 2000s emphasis on "what every citizen should know" to the Seven Principles of Ocean Literacy (NOAA 2024), which highlight processes, Earth-system connections, the Ocean's role in sustaining life on Earth, and actions to protect it.

In response to escalating climate impacts, the Ocean Literacy community broadened its focus from knowledge to transformative action. Research in the 2010s and early 2020s expanded to include affective and behavioral components, examining how emotions, values, and identity shape decision-making (Fauville et al. 2023). As described by Glithero et al. (2026) in Volume I of this series, Ocean Literacy was positioned as a societal outcome, defined as a society that better understands, values, and cares for the Ocean, and as a key driver for restoring society's relationship with the Ocean under the Ocean Decade's Challenge 10. Building on this foundation, McRuer et al. (2026) describe the evolution of this concept into a transdisciplinary, cross-sector approach that strengthens people–Ocean relationships by connecting policy, governance, communication, and community practice, enabling governments, institutions, and communities to embed Ocean considerations in sustainability planning.

This transition is exemplified by Glithero et al. (2026) in their Volume III chapter, which illustrates how the Centre for Ocean Literacy Collaboration (formerly the Canadian Ocean Literacy Coalition) operationalized this framework through national mapping, integration of Indigenous knowledge, and policy partnerships to advance collective Ocean Literacy action across Canada. Together with other contributions across the three volumes, these chapters demonstrate how Ocean Literacy has evolved from an educational framework into an applied, research-informed, and policy-relevant movement advancing the goals of the Ocean Decade.

In support of this framework, Wang et al. (2025) found that Ocean Literacy promotes pro-Ocean environmental behavior through two key psychological mediators: marine environmental responsibility and marine environmental values. Their study demonstrated that cognitive understanding of Ocean systems enhances a sense of moral obligation, which in turn strengthens altruistic and biospheric values, ultimately encouraging behaviors that support the well-being of the Ocean. Because values, identity, and responsibility shape how people relate to the Ocean, the language we use to describe it matters. This understanding informed the intentional writing choices adopted in this series.

The capitalization of Ocean and Ocean Literacy, first introduced in Volume I (Kennedy 2026a) and reinforced in Volume II (Kennedy 2026b), reflects the recognition of the Ocean as a single, interconnected global system, and of Ocean Literacy as a collective human capacity essential for sustainable decision-making. Ocean Literacy is an internationally recognized framework for understanding the Ocean's influence on us, and our influence on the Ocean, through science education, informed action, and shared responsibility. Restoring society's relationship with the Ocean depends on engagement across all sectors of civil society.

Building on these foundations, both Volumes I and II highlight how Ocean Literacy aligns with worldwide priorities such as the United Nations Sustainable Development Goals (SDGs), particularly SDG 14: Life Below Water and the Ocean Decade Challenges, which together call for solutions-oriented approaches that connect sci-

ence, policy, and civil society sectors (Kennedy 2024). This integrated focus underscores the need for educational innovation that prepares learners to meet the complex demands of the twenty-first century (Kennedy and Cherry 2023). Strengthening understanding of marine and Earth system science not only builds environmental awareness but also cultivates critical thinking, problem-solving, technological fluency, and collaboration: skills essential for addressing real-world challenges such as climate change, resource management, and sustainable development (Kennedy and Sundberg 2020, 2025). The earlier volumes also emphasized the importance of Indigenous Knowledge Systems (IKS) as complementary ways of knowing that enrich scientific understanding and reinforce community-centered approaches to sustainability. Collectively, these perspectives affirm that all actors must have both the voice and agency to participate in shaping an equitable and sustainable Ocean future. Building on these foundations, Volume III explores how communication, technology, and collaboration accelerate the advancement of Ocean Literacy and strengthen society's connection with the Ocean.

Pedagogically, the series has emphasized the central role of science, technology, engineering, and mathematics (STEM) education and the use of inquiry-based frameworks such as Problem- and Project-based Learning (PBL/PrBL), along with its counterpart, Phenomenon-Based Learning (PhBL), supported through evidence-based models (Kennedy and Fields 2023, 2024; Kennedy and Odell 2024; and Kennedy and Tunnicliffe 2022). In the context of marine education, these STEM-focused approaches expand naturally into STEAM, reflecting the integration of the Arts highlighted in Volume II and demonstrated through projects across Volumes I to III. This interdisciplinary perspective helps learners connect scientific understanding with creativity, communication, and cultural expression, strengthening their ability to interpret complex Ocean systems. These approaches demonstrate how hands-on, place-based, experiential, interdisciplinary, and student-centered learning can cultivate curiosity, deepen connection, and support responsible Ocean engagement.

Equally important is the recognition that transforming society's relationship with the Ocean requires the participation of all civil society actors. Drawing from the UNESCO IOC *Ocean Decade Manual for NGOs* (Kennedy et al. 2024) and work on civil society engagement in the Ocean Decade and beyond (Kennedy and Mascarenhas 2025), earlier volumes showed how NGOs, youth networks, local communities, educators, scientists, and industry partners play indispensable roles in advancing the goals of the Ocean Decade. Their contributions reinforce that Ocean Literacy thrives when knowledge, creativity, governance, and lived experience come together in a shared sense of purpose, accelerated through communication, technology, and collaboration, the focus of Volume III.

1.3 Why Promoting Ocean Literacy Is Essential

Despite the centrality of the Ocean to life on Earth, global awareness of its importance remains critically low. Findings from three successive *Listening to Leaders* surveys conducted by AidData Institute for the Theory and Practice of International Relations at William & Mary, in 2017, 2020, and 2024, demonstrate that SDG 14: Life Below Water continues to rank among the least known, least prioritized, and least funded of all the SDGs. Across this seven-year span, the surveys reveal a consistent trend: national leaders, citizens, and international donors prioritize education, jobs, and institutional development while placing minimal emphasis on the health of the Ocean and broader environmental systems (Custer et al. 2018, 2021; Horigoshi et al. 2025). In contrast, the 2024 data revealed that leaders have consistently identified Quality Education (SDG 4) as one of their top priorities since 2017.

AidData's *Listening to Leaders* survey, conducted every 3–4 years, gathers insights on development priorities from public, private, and civil society leaders across 148 countries and

regions. Most participants represent low- and middle-income countries, although the survey also includes some countries that have graduated into high-income status since the first wave of surveys in 2014. The term "leader" refers to "various stakeholder groups including executive branch officials, parliamentarians, civil society and private sector leaders, members of domestic think tanks, academia, or media, and the local representatives of development partners in the relevant country of interest" (Horigoshi et al. 2025, p. 2). Survey respondents are asked to select a given SDG as one of their top priorities for advancing their country's development.

1.3.1 Persistent Neglect of Ocean-Related Goals

The 2017 *Listening to Leaders* survey, encompassing responses from nearly 3500 public, private, and civil society leaders in 126 low- and middle-income countries, found that over 60% of the respondents identified Quality Education (SDG 4), Peace and Justice (SDG 16), and Decent Work and Economic Growth (SDG 8) as top priorities. By contrast, environmental goals, including Life on Land (SDG 15), Climate Action (SDG 13), Responsible Consumption and Production (SDG 12), and particularly Life below Water (SDG 14), fell to the bottom of the global policy agenda (Custer et al. 2018).

The report concluded that leaders were "loath to tackle issues that require large upfront costs in exchange for uncertain future benefits" (p. 2), suggesting that long-term environmental sustainability was often sacrificed for short-term development gains. See Figs. 1.2 and 1.3.

The trend persisted in the 2020 survey, administered during the COVID-19 pandemic to more than 6800 leaders across 141 countries. Although the global crisis heightened attention to public health and governance, environmental and Ocean-related priorities remained peripheral. Development partners were largely aligned with leaders on health and governance but were "less attuned to education and jobs that leaders see as gateways to growth," and even less aligned on environmental protection or marine sustainability (Custer et al. 2021, p. 7). The 2021 report characterized the international development system as operating in an "era of contested cooperation," where pressing social and political concerns often overshadowed ecological challenges and delayed progress toward SDG 14. See Fig. 1.4 for the breakdown by SDG.

By 2024, the picture showed incremental progress but persistent imbalance. AidData's *Prioritizing Agenda 2030* brief analyzed nearly

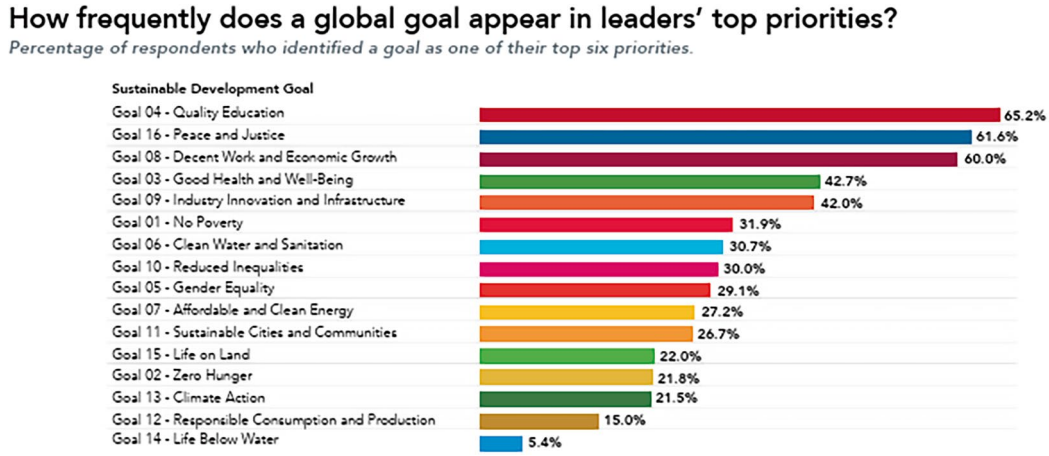


Fig. 1.2 Frequency of UN Sustainable Development Goals appearing in leaders' top priorities (2017). Graphic reproduced with permission from AidData: A Research Lab at William & Mary, Virginia, USA (Custer et al. 2018, p. 6)

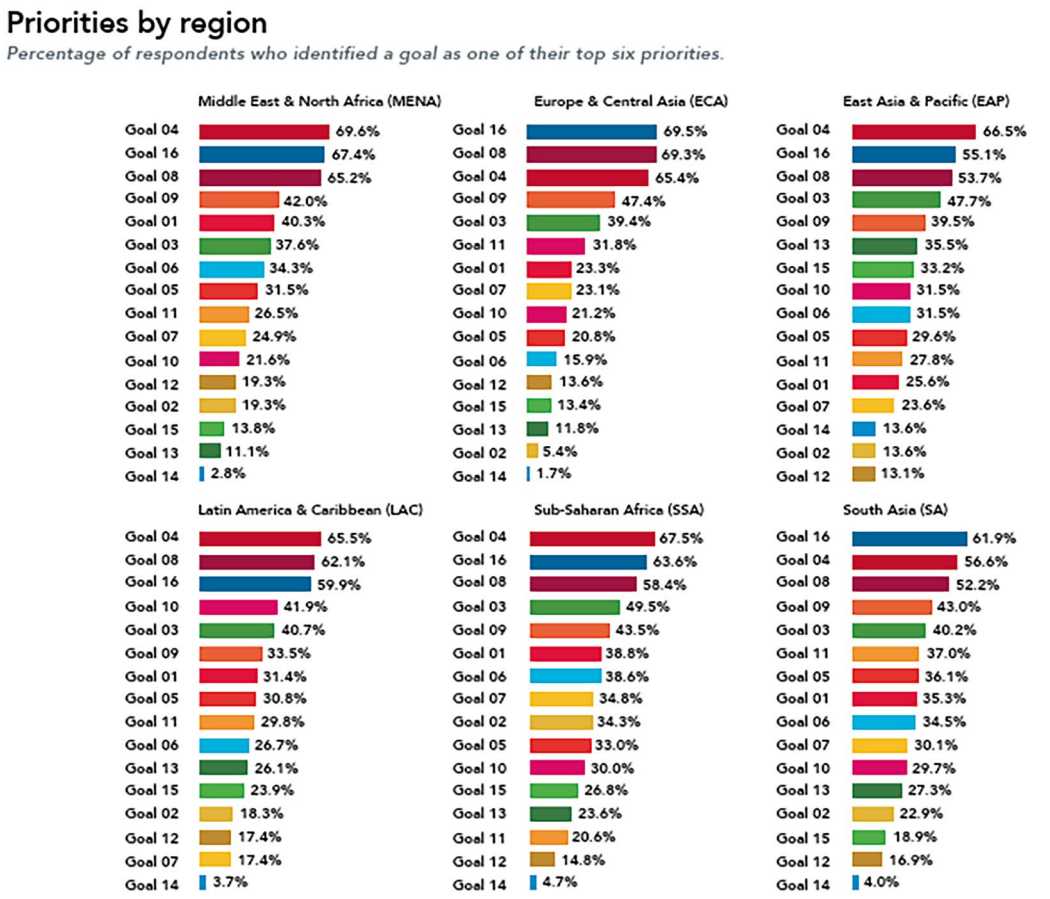


Fig. 1.3 Frequency of UN Sustainable Development Goals appearing in leaders' top priorities by region (2017). Graphic reproduced with permission from AidData: A Research Lab at William & Mary, Virginia, USA (Custer et al. 2018, p. 6)

10,000 responses from leaders in 148 countries and territories. The authors reported that while climate action (SDG 13) gained traction, particularly among small island developing states (SIDS) and Asia-Pacific nations, SDG 14 continued to receive the least attention and investment (Horigoshi et al. 2025). Over 90% of respondents were aware of the SDGs, and more than 60% found them influential in shaping national planning. However, awareness did not translate into policy prioritization or funding. Spending patterns remained dominated by health, education, and governance, leaving Ocean-related issues marginalized. The report emphasizes that even though the Ocean serves as a critical foundation for developing economies, many leaders do not draw the connection between daily life and Ocean-derived services. See Fig. 1.5.

Horigoshi et al. (2025) observe that national leaders do not prioritize all Sustainable Development Goals (SDGs) equally, as their selections often reflect the unique conditions, pressures, and vulnerabilities within their respective countries and regions. The report emphasizes that local context shapes how leaders define and rank the most urgent problems to address. Although the Ocean plays an essential role in sustaining life on Earth, national leaders rarely prioritize SDG 14: Life Below Water because their policy agendas are driven by the most immediate pressures facing their populations. AidData's *Listening to Leaders* findings show

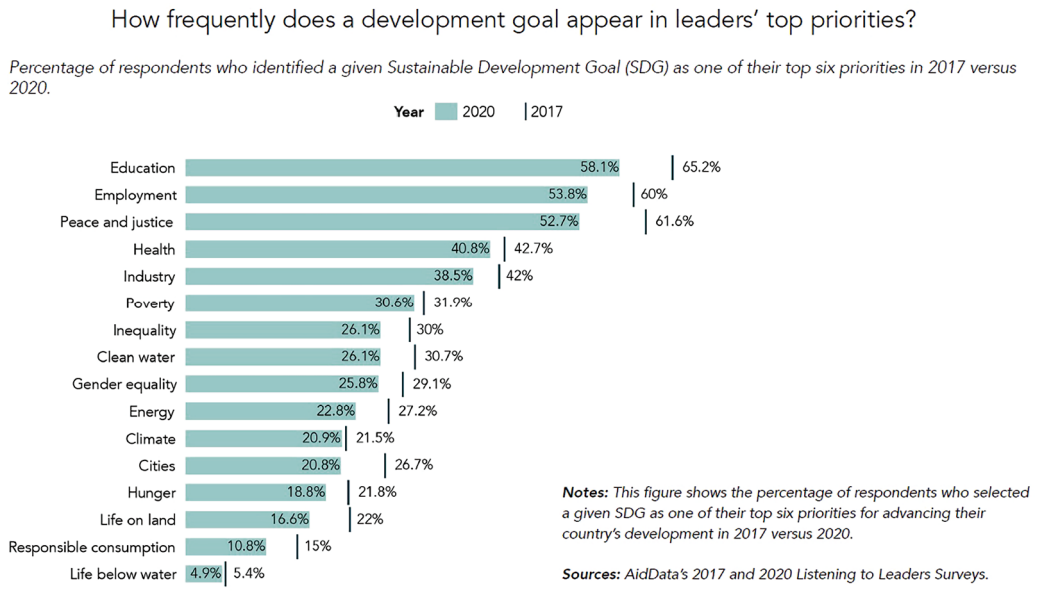


Fig. 1.4 Frequency of UN Sustainable Development Goals appearing in leaders' top priorities (2017 and 2020). Graphic reproduced with permission from AidData: A Research Lab at William & Mary, Virginia, USA (Custer et al. 2021, p. 8)

that in many regions, particularly across Sub-Saharan Africa, the Middle East and North Africa, and parts of Latin America, leaders confront daily challenges such as food insecurity, water scarcity, energy shortages, limited infrastructure, and the need for employment and educational expansion. These urgent, visible needs consistently overshadow environmental concerns, which are often viewed as longer-term issues with benefits that are less immediate for citizens. Leaders from fragile and conflict-affected states place even greater emphasis on survival, stability, and governance, leaving little political space to elevate environmental SDGs. Inland and arid regions also perceive fewer direct links to Ocean health, reinforcing the tendency to focus on land-based priorities. Combined with historically low international investment in SDG 14 and limited donor attention to marine issues, these factors contribute to its chronic underprioritization, even as climate-vulnerable coastal and island regions increasingly recognize its importance.

As Molony et al. (2022) emphasize, SDG 14 is among the most challenging of the 17 SDGs because of the Ocean's vast scale and its deep interconnections with nearly every other goal. The Ocean underpins livelihoods, food security, and health for billions of people while functioning as a critical carbon and heat sink that stabilizes the global climate. Achieving SDG 14 is therefore inseparable from progress on related goals such as No Poverty, Zero Hunger, Good Health and Well-Being, and Climate Action. The authors call for a co-designed, transdisciplinary approach that integrates natural, social, and cultural knowledge systems, including Indigenous and local knowledge, to accelerate Ocean sustainability. This perspective underscores that progress on SDG 14 cannot occur in isolation: it depends on cross-sector collaboration, inclusive governance, and innovation that bridges science, policy, and society.

Building on this perspective, Singh et al. (2019) warn that accelerating climate impacts on the Ocean are fundamentally reshaping the global sustainability landscape. They describe how Ocean warming, acidification, deoxygenation, and sea-level rise are producing cascading effects on marine ecosystems, food security, and livelihoods,

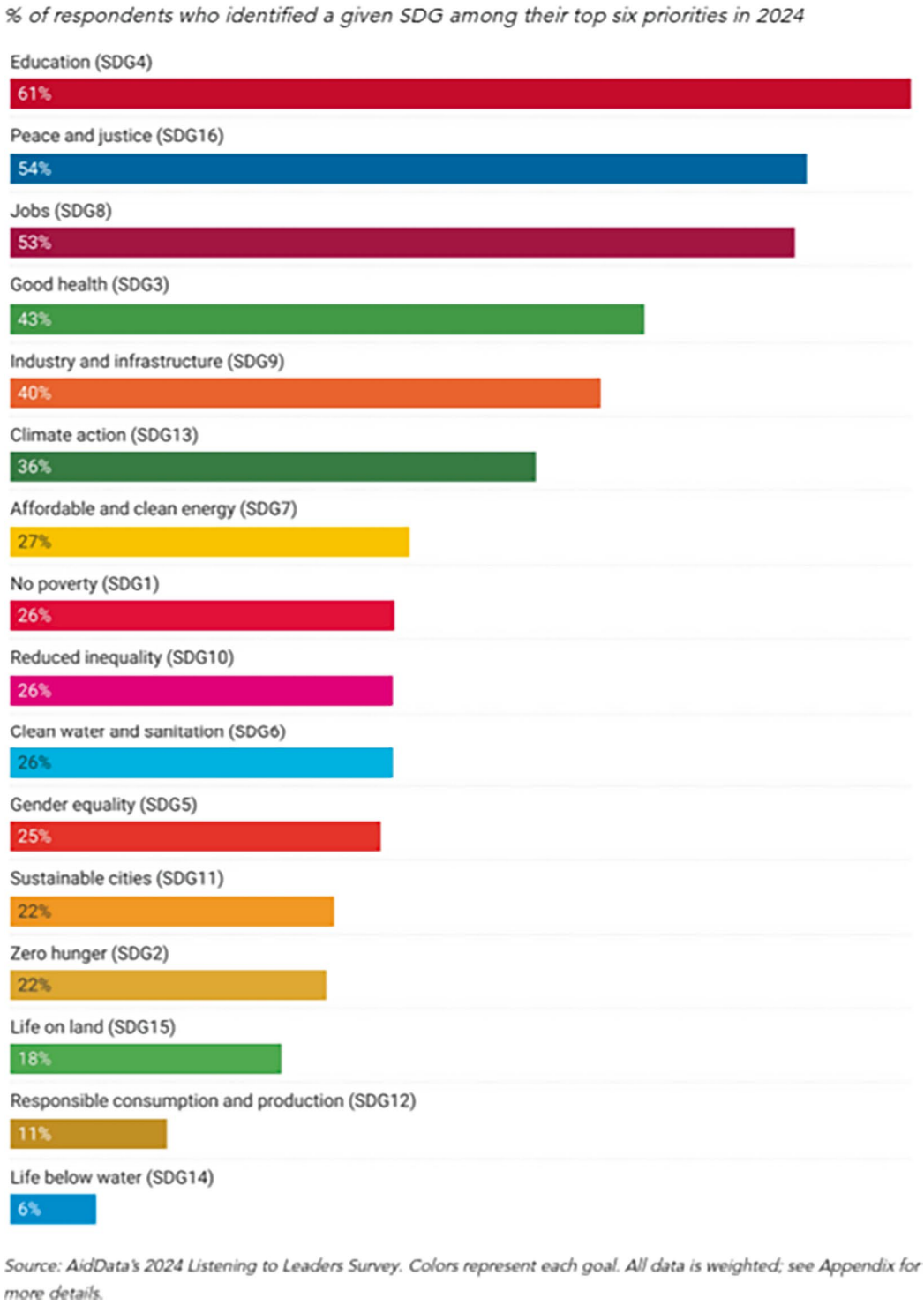


Fig. 1.5 Frequency of UN Sustainable Development Goals appearing in leaders' top priorities (2024). Graphic reproduced with permission from AidData A Research Lab at William & Mary, Virginia, USA (Horigoshi et al. 2025, p. 4)

turning the Sustainable Development Goals into "a moving target traveling away from us." These compounded impacts threaten not only SDG 14, but also interconnected goals such as Zero Hunger, Good Health and Well-Being, and Climate Action, reinforcing the urgency of integrated approaches that link Ocean science, climate action, and sustainable development policy.

Ocean Literacy aligns directly with this vision. It provides the connective framework linking education, communication, and participation to the global sustainability agenda. By translating scientific understanding into shared values and collective action, Ocean Literacy helps transform SDG 14 from an under-prioritized goal into a catalyst for achieving multiple SDGs across environmental, social, and economic dimensions.

1.3.2 Incremental Progress but Continuing Gaps

Taken together, these three surveys reveal a troubling disconnect between the Ocean's global significance and its perceived relevance in national development agendas. The Ocean is indispensable to climate regulation, biodiversity, weather systems, and human livelihoods, yet it remains a too often neglected goal within the broader 2030 Agenda. Promoting Ocean Literacy is therefore not optional; it is essential. Ocean Literacy fosters an understanding of the Ocean's influence on people and people's influence on the Ocean, empowering citizens and decision-makers alike to recognize that sustaining the Ocean is inseparable from sustaining humanity itself. After all, "The global Ocean generates an economic value of goods and services around USD 2500 billion for humanity each year, which is equivalent to the seventh largest economy …More than half of this economic value is generated by coastal seas and depends on their health status" (Roobaert 2025, p. 245). By equipping societies with the knowledge, values, and sense of responsibility necessary to protect the Ocean, we can bridge the persistent awareness gap identified by international leaders and advance a more integrated and informed approach to sustainable development.

Volume III of this series, *Accelerating Communication, Technology, and Global Initiatives*, builds directly upon this evidence by highlighting innovative strategies to elevate Ocean Literacy worldwide. Through communication, technological innovation, and cross-sector collaboration, the chapters that follow illustrate how knowledge can become participation, how participation can inspire collective action, and how informed networks can transform understanding into enduring Ocean solutions on an international level.

1.3.3 Why this Series Aims to Strengthen Global Understanding of the Ocean

This three-volume series is offered as one contribution among many global efforts already underway to strengthen understanding of the Ocean. Rather than attempting to solve these issues alone, the series adds a small but purposeful piece to the broader puzzle being assembled by educators, researchers, practitioners, artists, policymakers, and leaders around the world. Through the collective work of its 65 chapters and more than 250 authors, the series seeks to support the shared movement toward awareness, understanding, and action. Volume III responds directly to the persistent gaps revealed by the *Listening to Leaders* surveys by bridging scientific evidence with public engagement, and by using communication, storytelling, and digital innovation to help make the Ocean visible, valued, and vital in every conversation about humanity's future.

Each volume contributes a different dimension of this work. *Volume I: Transforming Education, Research, and Engagement* established the educational and scientific foundations for building Ocean Literacy. *Volume II: Fostering Community, the Blue Economy, and the Arts* expanded the focus to society, creativity, and culture, illustrating how Ocean understanding can be lived, expressed, and embedded in daily experience. *Volume III: Accelerating Communication, Technology, and Global Initiatives* extends this vision to the international stage, emphasizing the

power of technology, storytelling, and partnerships to amplify impact.

By showcasing evidence-based approaches that bridge science, culture, and policy, this series aims to strengthen how humanity understands its relationship with the Ocean, not as a distant or expendable resource, but as a living system essential to all life and central to planetary well-being. In doing so, it contributes directly to the goals of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) and specifically to Challenge 10: Restore Society's Relationship with the Ocean. The series stands as both a collaboratively developed scholarly contribution and an invitation to collective action, affirming that Ocean Literacy is not merely a concept to be taught, but a shared culture to be cultivated. To help advance this culture of Ocean understanding and participation, communication and technology become essential tools for connecting people. By extending access, visibility, and meaningful engagement, these tools provide the bridge between scientific insight and public engagement.

1.4 Communication and Technology as Accelerators

Across sectors, digital technologies and open data are transforming how people learn about and engage with the Ocean by turning abstract science into lived experience and shared purpose. Digital storytelling platforms communicate scientific information through narrative, imagery, and interactive media, translating complex ideas into experiences that resonate with diverse audiences. Virtual and augmented reality extend these approaches by immersing learners in marine environments they may never physically visit, from deep-sea ecosystems to polar regions, supporting experiential learning in both coastal and inland communities. In this volume, AI is included for a specific reason: it functions as a catalyst for communication and engagement. By turning raw observations into plain-language explanations, timely alerts, translated captions, interactive maps, and classroom-ready visuals, AI helps connect more people, especially inland learners and non-specialist audiences, to authentic Ocean knowledge. In other words, AI is not a goal in itself; it is one of the tools that broadens access, deepens understanding, and enables more equitable engagement with the Ocean.

While communication, storytelling, and participatory platforms remain essential to public engagement, the Ocean Decade also calls for tools that can interpret enormous volumes of environmental data and translate them into forms people can understand and use. Artificial intelligence (AI), machine learning (ML), and deep learning (DL) therefore function as extensions of communication and participation, not replacements for them. They help transform large, complex environmental datasets into clear, usable, and actionable knowledge that educators, communities, scientists, and policymakers can interpret and apply responsibly, guided by human judgment and ethical awareness. These technologies also convert vast datasets into accessible visualizations, real-time alerts, and decision-support tools that strengthen communication and participation across the Ocean community and civil society as a whole. In this way, AI becomes part of the same continuum of accelerators seen throughout this volume: tools that expand access, deepen understanding, and connect more people to the Ocean in meaningful and actionable ways.

Digital platforms, immersive environments, and open data systems provide opportunities for people everywhere, from coastal areas to inland regions, to engage directly with authentic Ocean observations and contribute to locally grounded projects connected to global initiatives. Through citizen and participatory science portals, online monitoring networks, and collaborative mapping tools, students, educators, and communities can explore real-time Ocean data and share their findings using the same types of information available to researchers. Open-access systems hosted by research institutions and government agencies further expand this reach, enabling classrooms and individuals to investigate temperature, chemistry, biology, and climate trends through authentic datasets that foster inquiry, problem-solving,

and informed decision-making. Together, these technologies demonstrate how data-driven exploration can make Ocean learning accessible to all.

The U.S. National Oceanic and Atmospheric Administration (NOAA) has long applied Artificial intelligence (AI) to improve weather forecasting, climate modeling, and environmental monitoring, beginning with satellite-data analyses in the 1980s and expanding to advanced machine-learning tools that enhance prediction accuracy and environmental insight (NOAA 2023, p. 1). AI tools are beginning to appear in marine science communication and education, primarily in the form of data-driven visualizations, pattern-recognition systems that support ecological monitoring, and emerging tools that help translate complex scientific information into accessible language or interactive formats. While still developing, these applications illustrate the potential for technology to complement human expertise and understanding by enhancing analysis, communication, and participation. For educators and communicators, these advances reveal practical ways AI can transform data into stories, images, and simulations that make Ocean science more relatable for diverse learners.

The NOAA Artificial Intelligence Strategy (NOAA 2020, p. 3) explains that AI encompasses a broad field of systems capable of tasks associated with human intelligence, such as reasoning, pattern recognition, and decision-making, and involves techniques in machine learning and deep learning including neural networks, evolutionary computation, as well as probabilistic and statistical methods. The NOAA Center for Artificial Intelligence (AI at NOAA) illustrates the hierarchical relationship among these technologies (NOAA 2023, p. 1). Figure 1.6 shows how artificial intelligence encompasses both machine learning (ML) and deep learning (DL), with each representing progressively specialized subsets.

- Machine Learning (ML): A subset of AI, enables computers to learn from data and improve performance over time without being explicitly programmed.
- Deep Learning (DL): A subset of ML, uses multilayered neural networks to process large, complex datasets, allowing computers to detect subtle patterns and produce highly accurate predictions in ways that mimic aspects of human perception.

Together, AI, ML, and DL underpin many emerging tools in marine science and education, from automated species detection to real-time environmental monitoring, demonstrating how data-driven technologies can enhance analysis, communication, and participation across diverse Ocean contexts.

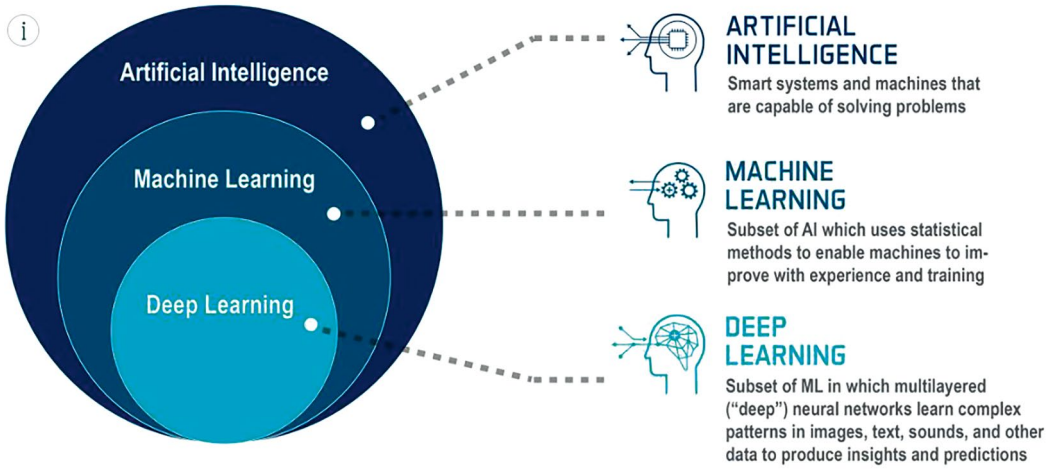


Fig. 1.6 Conceptual relationship among Artificial Intelligence, Machine Learning, and Deep Learning. Graphic reproduced with permission from AI at NOAA. (NOAA 2023, p. 1)

Advances in data science and AI are transforming the ways in which Ocean information is collected, interpreted, and communicated in research and monitoring efforts. Machine-learning models now support species detection in acoustic and video datasets, strengthening biodiversity monitoring and informing conservation decisions. Evaluations of automated video post-processing systems demonstrate how AI/ML tools can accurately detect and count fish by comparing machine outputs with human-annotated datasets, marking an important step toward integrating AI-driven optical analysis into routine fisheries assessments (NOAA Fisheries 2023). Satellite-based tools from NOAA and NASA apply automated image analyses to monitor coral bleaching, coastal change, harmful algal blooms, coastal mapping, and rip current detection, translating complex Earth-observation data into environmental information usable by educators, communities, and policymakers (National Ocean Service 2023; NOAA n.d., 2025). These advances illustrate how technologies first developed for research are now being adapted for communication, curriculum resources, and participatory science.

Additional efforts across the Ocean research and technology community further demonstrate how AI and machine learning are advancing observation, modeling, and exploration. The Integrated Ocean Observing System (IOOS) is actively incorporating AI/ML into its observing, processing, and data-management systems to automate, interpret, and apply Ocean observation data (U.S. Integrated Ocean Observing System n.d.). Researchers at MIT CSAIL and University of Wisconsin–Madison developed an AI-driven design pipeline that uses neural networks and physics simulation to generate unconventional underwater "glider" shapes optimized for high lift-to-drag ratios. These designs were fabricated using 3-D printing and tested in wind tunnels and water, and performed more efficiently than traditional torpedo-shaped gliders (Shipps 2025). This research demonstrates how AI and machine learning can accelerate innovation in marine robotics by exploring design spaces that humans have scarcely considered, with implications for oceanographic monitoring, climate research, and autonomous underwater exploration. These examples show how creative engineering and computational science intersect with Ocean Literacy by expanding humanity's capacity to observe, understand, and care for the Ocean.

AI-assisted navigation strengthens the performance of autonomous underwater vehicles and gliders used by institutions worldwide, improving habitat mapping, water-column monitoring, and long-duration Ocean observing missions (Levin 2023). For example, Roobaert (2025) demonstrates how artificial neural networks, a form of DL, can improve the mapping of coastal Ocean regions and refine estimates of sea–air CO_2 fluxes in shallow seas. By training AI models on observational and remote-sensing data, the study revealed fine-scale patterns in how coastal regions absorb carbon, helping to clarify their role in the global carbon cycle. When combined with existing biogeochemical models, these neural-network findings highlight previously under-recognized coastal contributions to carbon storage, providing stronger evidence to support climate research and policy. These research advances reinforce that data science and Ocean Literacy share a common goal: transforming information into understanding that guides responsible action.

Placed alongside the communication, storytelling, cultural, and collaborative initiatives presented in the chapters that follow, these AI examples represent another pathway through which the Ocean Decade is expanding who can access Ocean knowledge and how that knowledge becomes meaningful in society. Beyond their technical applications, they highlight how communication and innovation converge to make the Ocean more visible, understandable, and accessible to all. Together, these technologies turn abstract Ocean processes into lived experience and shared purpose. They expand who can participate in Ocean learning, support multilingual and multimodal forms of engagement, and foster collaborative understanding across geographic, cultural, and disciplinary boundaries, key enabling conditions identified in the Ocean Decade for restoring society's relationship with the Ocean.

Volume III therefore serves as a bridge between knowledge and action, emphasizing communication, creativity, and technological innovation as accelerators of Ocean Literacy. Through the stories, case studies, and research presented here, this volume captures how people and institutions are linking data with meaning, science with empathy, and innovation with inclusion. In doing so, it challenges readers to envision Ocean Literacy not only as an educational movement but as a connective framework for the Ocean Decade and a unifying force that transforms how the world understands, values, and acts for the Ocean.

1.5 Framing Volume III: *Ocean Literacy: Accelerating Communication, Technology, and Global Initiatives*

Volume III brings together 87 authors from 25 countries/regions to showcase how communication, digital innovation, and coordinated policy efforts are advancing Ocean Literacy during the Ocean Decade. This volume reflects contributions from Africa (Cabo Verde); Asia–Pacific (Japan, Taiwan); Europe (Belgium, Croatia, Denmark, England, Finland, France, Greece, the Republic of Ireland, Italy, Malta, Northern Ireland, Poland, Portugal, Romania, Scotland, and Spain); Latin America (Brazil, México); the Middle East/Western Asia (Kuwait, Lebanon); and North America (Canada—Nova Scotia and Québec; the United States—California, Florida, Maine, Michigan, New York, Oregon, Texas, and Virginia). Together, these authors document how Ocean Literacy is moving beyond awareness-raising toward scaled, systems-level action through national strategies, regional networks, technology- and media-based outreach, virtual learning environments, emerging AI-supported tools in marine science education, citizen science platforms, and Ocean Decade–endorsed initiatives.

Where Volume I established the educational, research, and engagement foundations for Ocean Literacy, and Volume II demonstrated how communities, the Sustainable Blue Economy, and the arts can activate and sustain Ocean connections, Volume III turns to the question of reach: how do we communicate the Ocean to broader, more diverse publics, in more languages, through more inclusive channels, and in ways that motivate informed participation? The chapters in this volume illustrate how strategic communication, storytelling, digital platforms, and cross-border coalitions can help realize Ocean Decade Challenge 10 by bringing science, culture, and civil society into closer alignment. Rather than presenting communication as an "add-on," this volume positions it as core Ocean Decade infrastructure that connects scientists, educators, Indigenous knowledge holders, NGOs, youth organizations, and policymakers in a coordinated global effort. The preview below of Volume III's themes highlights how communication, technology, and collaboration advance Ocean Decade goals, especially Challenge 10: Restore Society's Relationship with the Ocean.

Chapter 2, *From Education to Engagement: Rethinking Ocean Literacy through Strategic Communications,* examines how Ocean Literacy has expanded beyond its educational origins toward broader public engagement. The authors outline the historical development of Ocean Literacy and highlight the need to close gaps between knowledge, emotional connection, and action. They emphasize that strategic communications, supported by audience research, inclusive messaging, and lessons from climate and social campaigns, can strengthen this transition. Through illustrative examples from worldwide initiatives, the authors propose an integrated "Ocean Literacy 2.0" approach that aligns education, communication, and public engagement to support the goals of the UN Ocean Decade and foster a more connected relationship with the Ocean.

Chapter 3, *Bridging the Worlds of Science and Communication to Foster Literacy on Ocean–Climate–Biodiversity Interactions*, examines how the Ocean & Climate Platform strengthens public and policy understanding by translating complex scientific knowledge into accessible communication. Uniting more than one hundred

organizations, the Platform operates through a knowledge-dissemination working group that brings together scientists, educators, and communication experts. The authors describe the Platform's role in reviewing Ocean-related content for the French government during recent IPCC assessment cycles and its development of fact sheets, outreach materials, and visually engaging resources. The chapter highlights how collaborative processes, clear design, and inclusive communication approaches advance Ocean Literacy and support informed engagement during the Ocean Decade.

Chapter 4, *BlueNIGHTs: Bringing a Touch of Blue in the EU Researchers' Nights for a More Sustainable Use of the Ocean,* presents a pan-European initiative designed to strengthen Ocean Literacy by integrating marine science themes into the European Researchers' Nights. Led by CNR-ISMAR with partners across all EU regional seas, BlueNIGHTs connect researchers with citizens through pre-events, school programs, hands-on activities, and virtual research vessel experiences. The chapter describes how the initiative promotes inclusive, multidisciplinary engagement, highlights diverse researcher profiles, and encourages young people, especially girls, to explore "blue" career pathways. BlueNIGHTs demonstrates how coordinated events, creative outreach, and strong partnerships can enhance public understanding of human–Ocean interactions and support the goals of the Ocean Decade.

Chapter 5, *World Ocean Explorer: A Transformational Tool for Ocean Literacy*, presents a free, open-access virtual immersion developed by the World Ocean Observatory to expand global Ocean learning. Built on the Unity engine and deployed through WebGL, the platform provides browser-based 3D environments that allow learners to explore Ocean systems, history, and culture without specialized equipment. Framed by the Ocean Literacy Principles and aligned with educational standards, World Ocean Explorer offers theme-based modules, interactive exhibits, and teacher-tested curriculum designed for students ages 12–16. Endorsed as a 2025 United Nations Ocean Decade Activity, it demonstrates how immersive technology, educator cohorts, and accessible design can broaden participation in Ocean education and strengthen society's understanding of human–Ocean connections.

Chapter 6, *Multimodal Ocean Literacy for the Ocean Decade*, examines how communications including visual, verbal, embodied, and digital forms, support deeper and more culturally inclusive Ocean learning. Drawing on three efforts in Taiwan and the United States, the authors describe how multimodal tools such as concept mapping, personal meaning mapping, and virtual and augmented reality platforms illuminate learners' values, worldviews, and environmental identities. These approaches show how producing as well as interpreting multimodal artifacts helps participants connect personal experiences with Ocean science. By integrating new media, informal learning contexts, and youth-led cross-reality (XR) platforms, the chapter demonstrates how multimodal methods foster accessibility, emotional engagement, and culturally responsive pathways that strengthen public understanding of human–Ocean relationships during the Ocean Decade.

Chapter 7, *Ocean Literacy Through Exploring the Ocean as a World of Sound*, presents an innovative approach to Ocean learning that uses listening to deepen public engagement with marine environments. The authors describe how biological, physical, and human-made sounds form distinctive Ocean soundscapes and how Passive Acoustic Monitoring (PAM) offers a non-invasive way to document biodiversity and detect ecosystem change. Through workshops, the 30-Day Ocean Sound Challenge, and community soundwalks in Mexico, the Ocean World of Sound (WOS) initiative integrates science, art, and participatory learning to help people notice, interpret, and reflect on what they hear. Emphasizing active and immersive listening, the chapter illustrates how sound-based experiences can broaden perception, strengthen emotional connection, and advance Ocean Literacy in support of the Ocean Decade's goal of renewing society's relationship with the Ocean.

Chapter 8, *BlueMinds4Teachers: The Chronicle of an EU4Ocean Project Fostering*

Ocean Literacy in Education for Sustainable Development, documents an EU4Ocean project designed to build educators' capacity in Ocean Literacy through collaboration among marine and freshwater scientists, social scientists, teachers, and youth ambassadors. The initiative aligns Ocean Literacy with Education for Sustainable Development (ESD) and Blue Economy frameworks while supporting formal and non-formal educators across Europe. Through a co-designed online training course, surveys, and an open-access digital toolkit, participants develop knowledge and resources to integrate Ocean topics and Blue Careers into teaching. Emphasizing participatory pedagogy, the project links freshwater and marine perspectives and encourages project-based learning and civic engagement. With representation from more than 20 countries, BlueMinds4Teachers demonstrates how transdisciplinary networks can empower educators to advance Ocean Literacy.

Chapter 9, *Heritage for an Oceanic Culture: The Essential Role of the Past in Ocean Literacy*, argues that understanding humanity's long relationship with the Ocean is essential for strengthening Ocean Literacy today. The authors show how cultural heritage, including traditional ecological knowledge, maritime practices, languages, and lived experience, connects past and present, enriching how societies understand marine environments. Through examples from Rising from the Depths, the Cultural Heritage Framework Programme, and the SeaVoice initiative, the chapter illustrates how heritage-based approaches can inform marine conservation, sustainable livelihoods, and community empowerment. The 2024 Venice Declaration for Ocean Literacy in Action is highlighted as a key step in recognizing heritage within global Ocean Literacy efforts. By integrating cultural perspectives into education, policy, and interdisciplinary research, the chapter positions heritage as a vital dimension of the Ocean Decade's call to renew human–Ocean relationships.

Chapter 10, *Peace Boat: Navigating Ocean Literacy through Global Voyages*, examines the work of Peace Boat, a Japan-based international NGO that advances Ocean Literacy, peace education, and sustainability through its global voyages. With more than four decades of experience and Special Consultative Status with UN ECOSOC, Peace Boat offers ship-based educational programs shaped by experiential learning, intercultural exchange, and SDG-focused training. Two flagship initiatives, the Ocean and Climate Youth Ambassador Programme and Youth for the SDGs for the UN Ocean Decade, bring youth, particularly from Small Island Developing States (SIDS), into workshops, port-based field programs, and international advocacy aligned with SDG 14. Through partnerships with UNESCO, UNFCCC, and civil society, and with its forthcoming Ecoship, Peace Boat demonstrates how education at sea can foster youth leadership, global collaboration, and stronger human–Ocean connections.

Chapter 11, *Fostering Ocean Literacy and Youth Empowerment through Education: A Case Study in São Vicente, Cabo Verde*, presents a case study developed by the NGO Biosfera 1 with support from the University of Cádiz and the University of Edinburgh's Ocean Leaders Program. The team created a four-session educational sequence for students aged 8 to 12 that combined Ocean learning with leadership development. Through participatory activities such as mapping, poster creation, games, and classroom presentations, students strengthened their understanding of marine ecosystems, increased their confidence, and developed a shared sense of group identity. The chapter shows how locally grounded, co-designed programs that integrate science education, empowerment strategies, and cultural context can support youth engagement in marine conservation and provide a model for similar initiatives across Small Island Developing States (SIDS).

Chapter 12, *From Ocean Literacy to the Sustainable Blue Economy: Empowering Youth through SOI Foundation's Blue Futures Pathways Global Initiative*, showcases the Students On Ice (SOI) Foundation's Ocean Decade endorsed initiative, Blue Futures Pathways (BFP), an international program connecting youth with education, mentorship, and career opportunities. Designed to support Indigenous, underrepresented, and remote commu-

nities in Canada and beyond, BFP fosters Ocean Literacy through experiential learning, leadership development, and professional training. The authors describe how the program bridges education and workforce innovation by linking the Ocean, freshwater, wastewater, and cryosphere sectors and by strengthening inclusion among Early Career Ocean Professionals (ECOPS). Through partnerships with universities, NGOs, community organizations, and industry, BFP cultivates confident young leaders who are prepared to support equitable and resilient water futures. SOI Foundation's work contributes directly to Ocean Decade Challenge 10 by helping youth connect knowledge with action and deepening society's relationship with the Ocean.

Chapter 13, *Co-designing Ocean Science with Small Island Developing States' Local Stakeholders: A Tool for Ocean Literacy,* examines how co-design can strengthen Ocean Literacy and guide locally relevant Ocean science in Small Island Developing States (SIDS), with Cabo Verde as the central case study. Through interviews with researchers, NGO leaders, policymakers, educators, and community representatives, the authors identify a set of Local Decade Challenges (LDCs) that adapt the ten Ocean Decade Challenges to the social, cultural, and ecological realities of SIDS. The chapter shows how inclusive, participatory processes can link local knowledge with scientific inquiry, build capacity, and support decision-making across sectors connected to marine and coastal systems. By demonstrating how communities and scientists can shape research agendas together, the study presents a transferable framework for engaging SIDS in sustainable Ocean governance and advancing the goals of the Ocean Decade.

Chapter 14, *Integrating National Resources to Build a Benchmark Nation for Ocean Literacy*, presents Taiwan's national effort, led by the Ocean Affairs Council and the National Academy of Marine Research, to build a coordinated framework for Ocean Literacy across education, policy, and industry. The authors describe how the Ocean Literacy Benchmark Nation project establishes digital learning platforms, leadership training, competency models, and international collaboration to strengthen Ocean education and professional development. The chapter highlights Taiwan's role within the Asian Marine Educators Association (AMEA) network and its commitment to aligning national initiatives with the UN Ocean Decade framework and Sustainable Development Goals. By connecting students, teachers, community members, and industry professionals, the project offers a model for countries seeking to develop integrated, nationwide approaches to Ocean Literacy.

Chapter 15, *The Evolution of a National Ocean Literacy Network: Challenges and Achievements of the Irish Ocean Literacy Network (IOLN) from 2016 to 2026*, traces the development of the IOLN from its beginnings in 2016 as an informal community of advocates to its formal establishment as a Company Limited by Guarantee in 2023. During this time, the network has united individuals and organizations across the Republic of Ireland and Northern Ireland in a shared effort to build an Ocean-literate society. The chapter highlights major milestones, including creative engagement campaigns, participation in European projects such as PREP4BLUE, and the creation of the 2024–2030 strategy. By overcoming challenges in funding, governance, and stakeholder engagement, the IOLN shows how community-driven networks can strengthen national Ocean Literacy and support the goals of the Ocean Decade.

Chapter 16, *Ocean Literacy in Portugal: Three Decades of Experience and Innovative Educational Initiatives Supporting the Ocean Decade*, examines Portugal's longstanding national commitment to Ocean Literacy and the development of initiatives across formal and informal education. The chapter reviews 115 programs created by universities, government agencies, NGOs, and private organizations, illustrating the scope of Portugal's efforts to strengthen Ocean-related learning and public engagement. Using a mixed-methods approach, the authors describe how these initiatives have been shaped by national strategies and global frameworks, including the UN Sustainable Development

Goals and the Ocean Decade. By tracing developments over 30 years, the chapter offers perspectives that may inform future Ocean Literacy work in Portugal and contribute to broader international conversations.

Chapter 17, *The BlueSchoolsMed Project Experience: An Overview of the Conception, Implementation, Evaluation, and Dissemination of the "Blue Challenges" within Mediterranean Schools,* describes how the Erasmus+ BlueSchoolsMed initiative brought together educators, scientists, and students from France, Greece, Italy, and Malta to advance Ocean Literacy in the Mediterranean region. Through nineteen "Blue Challenges," participating schools engaged in hands-on, interdisciplinary activities that linked marine science with fieldwork, creative arts, and community engagement. The chapter outlines the project's four phases, including its co-design process and its approaches to teaching marine biodiversity, pollution, and sustainability. Despite pandemic-related obstacles, the initiative fostered eco-citizenship, strengthened school-community partnerships, and demonstrated how experiential, cross-cultural collaboration can connect schools, scientists, and society while supporting the goals of the EU4Ocean Coalition and the Ocean Decade.

Chapter 18, *Bridging the Knowledge Gap: Ocean Literacy as the Cornerstone for Achieving the UN Ocean Decade's Vision in the Arabian Gulf Region*, examines how Ocean Literacy supports sustainability in a region of unique biodiversity and growing environmental pressures. The chapter outlines factors that contribute to a widening knowledge gap, including limited access to marine science education, low public awareness, and fragmented coordination across Gulf nations. Drawing on national initiatives, community programs, and regional cooperation through the Regional Organization for the Protection of the Marine Environment, the author presents approaches that connect science, education, and policy. By integrating curriculum development, traditional knowledge, and public outreach, the chapter demonstrates how strengthening Ocean Literacy can support regional efforts to achieve a healthy, productive, and resilient Ocean.

Chapter 19, *Hybrid Artificial Reefs in Ocean Literacy and Conservation: Insights from the Ocean Rescue Alliance International* (ORAI), presents the work of a nonprofit organization that merges marine science, engineering, art, and community engagement to support coastal restoration and Ocean Literacy. The chapter describes how ORAI's hybrid artificial reefs combine ecological and artistic design to create habitats that enhance biodiversity while serving as accessible platforms for education and public engagement. Through initiatives such as the 1000 Mermaids Artificial Reef Project and Guardians of the Reef, ORAI demonstrates how underwater art installations can strengthen community involvement, expand experiential learning, and support regional conservation goals. The authors highlight how this creative approach aligns with efforts to build stronger human connections with the Ocean.

Chapter 20, *Ocean Literacy in Action: Advancing Sustainable Coastal Futures through the Foundation for Environmental Education* (FEE), showcases how FEE's worldwide network and its flagship Blue Flag Programme have become powerful drivers of Ocean Literacy, sustainable tourism, and community-based conservation. Through international standards for clean water, safety, and environmental education, Blue Flag sites foster public awareness and responsible coastal management. Complementary initiatives, including Global Action Days and the GAIA 20:30 Strategy, mobilize schools, local authorities, and civil society in hands-on environmental action linked to the Ocean Decade's goals. By integrating experiential learning, citizen science, and policy engagement, FEE strengthens coastal resilience and nurtures a global culture of sustainable Ocean connection and collective responsibility.

Chapter 21, *Ocean Literacy in Formal Education: The Case of the Network of European Blue Schools* (NEBS), examines how NEBS has grown into a leading initiative for integrating Ocean Literacy into formal education across Europe. Originating within the EU4Ocean Coalition, the network now includes more than 600 schools from EU and associated countries that engage students in project-based learning

and open-schooling approaches focused on Ocean themes. The chapter traces NEBS from early surveys and focus groups through the development of curriculum analyses, teacher handbooks, and professional-development opportunities such as the "Bring the Ocean into Your School" MOOC and BlueMinds4Teachers. By highlighting regional examples and collaborative structures, the chapter illustrates how NEBS supports educators and empowers students as young Ocean ambassadors.

Chapter 22, *Building a Coalition and National Strategy to Advance Ocean Literacy in Canada: The Story of COLC,* traces how the Centre for Ocean Literacy Collaboration (formerly the Canadian Ocean Literacy Coalition) brought together more than 400 organizations and thousands of contributors to co-develop Canada's first national Ocean Literacy strategy. Beginning with a country-wide study across Canada's five Ocean watersheds, the authors show how this collaborative groundwork informed *Land, Water, Ocean, Us: A Canadian Ocean Literacy Strategy*, released in 2021 at the start of the Ocean Decade. The chapter illustrates how COLC's work honors Indigenous knowledge systems, regional diversity, and the interconnection of freshwater and marine environments. Through initiatives such as Ocean Week Canada and cross-sector partnerships, COLC demonstrates how a collaborative model can unite education, community action, and national vision to strengthen Ocean engagement.

As Volume III moves from these diverse chapter contributions toward the closing pages, a concluding reflection synthesizes the work. It revisits the themes woven throughout the book and documents how the authors collectively advance Ocean Literacy through communication, education, technology, and collaboration. The reflection identifies shared threads across the three volumes, underscoring the importance of inclusive partnerships, the integration of cultural and regional perspectives, and the power of linking learning with opportunities for meaningful action. It situates these efforts within the broader goals of the Ocean Decade, demonstrating how the initiatives presented here contribute to strengthening society's relationship with the Ocean and brings the series to a purposeful close.

1.6 Conclusion

Volume III: Accelerating Communication, Technology, and Global Initiatives brings the three-volume series full circle, linking the educational foundations of Volume I and the creative, community-driven engagement of Volume II to the digital, technological, and collaborative accelerators shaping the future of Ocean Literacy. Across the 22 chapters of Volume III, authors demonstrate how communication, innovation, and international cooperation are transforming the ways society understands and interacts with the Ocean.

The chapters reveal that effective communication is not an accessory to science but its lifeline, translating complex data into shared meaning. They showcase how inclusive messaging, strategic storytelling, and immersive experiences make the Ocean visible and relevant to people across all sectors of society, bridging distance and connecting communities worldwide. They also highlight how technology, whether digital platforms, open-data systems, or emerging AI-supported tools, can extend reach and accessibility, turning information into participation, and participation into sustained collective action.

Together, these efforts reflect a worldwide shift toward integration. Artificial intelligence, virtual environments, and participatory science platforms are redefining how knowledge is created, visualized, and shared. Rather than replacing human insight, technology enhances it, opening new pathways for multilingual, multimodal, and cross-cultural engagement. These advances illustrate that Ocean Literacy thrives when communication and innovation are guided by ethics, inclusivity, and respect for multiple knowledge systems, including Indigenous and local perspectives.

Equally powerful are the partnerships featured throughout this volume, scientists, educators, NGOs, youth organizations, and policymakers aligning through regional and national frameworks to amplify impact. From Europe's BlueSchools

networks to Canada's national strategy, from Cabo Verde to Taiwan, and from youth ambassadors aboard Peace Boat to artists designing hybrid reefs, each contribution underscores the transformative potential of collaboration. When data, creativity, and culture converge, Ocean knowledge becomes a living, participatory practice.

As with the preceding volumes, Volume III invites readers to recognize that restoring society's relationship with the Ocean requires both human connection and systemic coordination. Communication translates understanding into unity, technology transforms potential into access, and collaboration turns action into momentum. By bringing these forces together, Ocean Literacy evolves from an educational goal to an international collaborative movement capable of inspiring informed decisions, equitable governance, and sustainable futures.

On behalf of all contributing authors in Volume III, I invite you to explore the innovations, collaborations, and reflections shared in these pages. The knowledge and experiences presented here are intended to inform collective action, strengthen collaboration, and inspire new discoveries for the Ocean we share. By engaging with these ideas and applying them within your own context, whether through education, research, art, policy, or civic action, you contribute to a shared mission: building a more Ocean-literate and sustainable world. Through communication, technology, and global collaboration, each of us helps advance the goals of the Ocean Decade and move closer to restoring humanity's enduring relationship with the one Ocean that connects us all.

1.6.1 Summary

Key concepts included in this chapter include:

- Volume III builds upon Volumes I and II by showing how communication, technology, and collaboration serve as accelerators that strengthen Ocean Literacy.
- Communication is presented as essential Ocean Decade infrastructure, connecting science, culture, education, and civil society to expand understanding and participation.
- Digital media, immersive and virtual environments, and open data platforms broaden access to authentic Ocean knowledge for both coastal and inland communities.
- The inclusion of Artificial Intelligence (AI), machine learning (ML), and deep learning (DL) reflects their growing role in transforming large environmental datasets into accessible tools, visualizations, and educational resources that complement human expertise.
- Ocean Literacy is framed as a societal capacity that depends on shared understanding, equitable access to information, and culturally responsive communication.
- Multimodal and inclusive approaches, including storytelling, sound-based learning, youth-led media, and culturally grounded communication, strengthen emotional connection and public engagement.
- National, regional, and international networks demonstrate how coordinated strategies can advance Ocean Literacy through policy integration, co-designed initiatives, and cross-sector partnerships.
- Youth leadership and capacity-building programs offer promising pathways for connecting knowledge with action and preparing young people to participate in sustainable Ocean futures.
- Diverse contexts shape Ocean Literacy practices, highlighting the importance of local relevance, cultural identity, and community empowerment.
- Restoring society's relationship with the Ocean requires communication that informs, technology that expands access, and collaboration that supports collective responsibility for the Ocean.

1.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- The United Nations Decade of Ocean Science for Sustainable Development (2021–2030): https://www.unesco.org/en/decades/ocean-decade
- UNESCO IOC Ocean Literacy Portal: https://oceanliteracy.unesco.org/
- Ocean Decade Vision 2030 White Papers—Challenge 10: Restoring Society's Relationship with the Ocean: https://unesdoc.unesco.org/ark:/48223/pf0000390126
- Ocean Decade Manual for Non-Governmental Organizations (NGOs): https://unesdoc.unesco.org/ark:/48223/pf0000392198
- Ocean Literacy: The essential principles and fundamental concepts of Ocean sciences for learners of all ages (Version 3.2): https://cdn.oceanservice.noaa.gov/oceanserviceprod/education/literacy/ocean-literacyenglish.pdf

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I extend my heartfelt thanks to the Intergovernmental Oceanographic Commission of UNESCO for recognizing this book series as an official Ocean Decade Activity. Their endorsement provided vital affirmation of the relevance and contribution of this work to the United Nations Decade of Ocean Science for Sustainable Development. This recognition has been truly encouraging, and it is gratifying to see this final volume continue to support the mission of the Ocean Decade.

My sincere thanks go to the many individuals across the global Ocean Literacy community who helped disseminate the call for proposals, broaden participation, and strengthen the reach of this final volume. Their efforts shaped the diverse authorship and perspectives represented across the series. I also extend my appreciation to all the authors whose contributions make up this volume and to the reviewers who generously offered their time and expertise to support the rigor and quality of the work.

Bringing together contributors from around the world for this project, from Volume I to this concluding volume, has been both humbling and inspiring. The insights, experiences, and collective commitment demonstrated by the authors and reviewers reflect the growing international movement to advance Ocean Literacy and strengthen society's relationship with the Ocean. It has been an honor to work with all 250+ authors and 80+ expert reviewers that contributed to this project.

This spirit of shared commitment is also reflected in the support provided by the institutions that made Open Access publication possible for this volume. The author teams of five chapters in *Volume III: Accelerating Communication, Technology, and Global Initiatives and one chapter in Volume II: Fostering Community, the Sustainable Blue Economy, and the Arts generously contributed to the Open Access publication fee, ensuring that all chapters in Volume III could be freely accessible to readers around the world. This collective commitment to equitable knowledge sharing reflects the spirit of the Ocean Decade and the global Ocean Literacy movement. I gratefully acknowledge the support of the following institutions whose authors made this possible:*

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- Chapter 12: Students On Ice (SOI) (Gatineau, Quebec, Canada)
- Chapter 15: The Irish Ocean Literacy Network (IOLN) (Galway, Ireland)
- Chapter 22: The Centre for Ocean Literacy Collaboration (COLC) (Halifax, Nova Scotia, Canada)
- Volume II, Chap. 18: Bow Seat: Creative Action For Conservation (Westwood, Massachusetts, USA).

And to my family, once more, I give thanks. Your steady presence across all three volumes has carried me through every long day and late night of this project. Your patience, encouragement, and unwavering belief in the value of this work made it possible to bring this series to completion. I am deeply grateful for the strength you give me and for the love that continues to guide every step of my professional journey.

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She played a key role in shaping the international science initiatives of the U.S. National Science Teaching Association (NSTA), serving five terms on its International Advisory Board (2004 to 2024) and contributing as a member of the writing team for the joint NSTA and NMEA Ocean Literacy position paper (2024–2025). As former Deputy Director of NASA's GLOBE Program, she collaborated with science education leaders in over 100 countries, deepening her commitment to global cooperation and environmental education.

Dr. Kennedy has dedicated her career to advancing global science education, promoting Ocean Literacy, and contributing to international STEM and sustainability initiatives. As the editor and driving force behind this project, she conceived the initiative and guided its development, ensuring a cohesive and impactful collection that unites diverse perspectives to advance Ocean Literacy.

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2 From Education to Engagement: Rethinking Ocean Literacy Through Strategic Communications

Vinicius Ferreira Grunberg Lindoso, Natalie Hart, and Ronaldo A. Christofoletti

Abstract

This chapter explores the evolving relationship between Ocean Literacy and Strategic Communications, offering insights into how integrating these disciplines can advance the UN Ocean Decade's Challenge 10: Restore society's relationship with the Ocean. By analyzing historical developments, identifying gaps in current frameworks, and leveraging lessons from related fields, it proposes a reimagined framework—Ocean Literacy 2.0—that integrates Strategic Communications to drive public engagement and action. This integration emphasizes creating emotional connections, using evidence-driven strategies, and upholding Justice, Equity, Diversity, and Inclusion (JEDI) principles to foster systemic change.

Keywords

Strategic communications · UN Ocean Decade · Public engagement · Environmental action · Evidence-driven communications · JEDI principles · Ocean Literacy (OL) · Early Career Ocean Professionals (ECOPs)

2.1 Introduction

The Ocean is integral to life on Earth, influencing climate, providing food, and sustaining biodiversity. Despite its importance, public understanding of the Ocean—commonly referred to as Ocean Literacy—remains limited. Ocean Literacy has traditionally focused on education, particularly in schools, to raise awareness about Oceanic processes and the human-Ocean relationship. More recently, however, the concept has expanded beyond education. Recent advances in the conceptual framework of Ocean Literacy consider that all sectors of society should understand their relationship with the Ocean and that Ocean Literacy should not only promote individual behavior changes but also push for systemic and institutional transformations. The onset of the UN Decade of Ocean Science for Sustainable

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Development (2021–2030), commonly known as the Ocean Decade, also opened an opportunity for Ocean Literacy to encompass broader and more impactful forms of strategic public engagement.

The primary objective of this chapter is to explore the evolving relationship between Ocean Literacy and Strategic Communications, providing insights into how these disciplines can be effectively integrated to advance Ocean Decade Challenge 10. Specifically, the chapter aims to:

1. Analyze the historical development of Ocean Literacy: This involves examining how Ocean Literacy has evolved from its educational origins to its current state, and how it has interacted with related fields such as advocacy and media coverage.
2. Identify gaps in the integration of Strategic Communications with Ocean Literacy: The chapter will highlight the limitations of current Ocean Literacy frameworks, particularly in terms of their reach, inclusivity, and impact on behavior change.
3. Propose a new framework for Ocean Literacy: Building on the analysis of existing gaps, the chapter will propose a new, more inclusive, and effective framework for Ocean Literacy. This framework will fully integrate Strategic Communications, ensuring that Ocean Literacy efforts are not only educational, but also engaging and action-oriented.
4. Demonstrate the relevance of this integration to the Ocean Decade: The chapter will connect its proposals directly to the goals of the Ocean Decade, particularly Challenge 10, showing how a reimagined approach to Ocean Literacy can contribute to transforming humanity's relationship with the Ocean.

This chapter is organized into four main sections. The first section defines Ocean Literacy and Strategic Communications, establishing a common understanding of these concepts and their importance in broader educational and advocacy contexts. The second section provides a historical review of the evolution of Ocean Literacy, highlighting its intersections with Strategic Communications and related fields. The third section identifies the gaps and weaknesses in current Ocean Literacy frameworks, drawing lessons from other environmental contexts, such as climate change communication, to suggest how these gaps can be bridged. The fourth and final section proposes new approaches for Ocean Literacy that integrates Strategic Communications from end to end. This framework emphasizes creating demand for Ocean connection, gathering public perception evidence, collaborating with educators, promoting existing resources, upholding Justice, Equity, Diversity, and Inclusion (JEDI) principles, and establishing a new theory of change for how a successful merger of Ocean Literacy and Strategic Communications could provide vital momentum for realizing the potential of the Ocean Decade.

2.2 Defining Ocean Literacy and Strategic Communications

As the world faces unprecedented and interconnected socio-planetary challenges, the importance of effective communication about the Ocean towards change of behavior has never been greater. The intersection of Ocean Literacy and Strategic Communications offers a unique opportunity to bridge the gap between knowledge and action. Ocean Literacy, traditionally focused on imparting science-based understanding, serves as the foundation for informed public awareness about the Ocean's vital role in sustaining life. However, as McKenzie-Mohr (2011), and countless other studies such as Kollmuss and Agyeman (2002) and Fishbein and Ajzen (2011) highlight, providing information alone often fails to change behavior. The Ocean Literacy community have taken note of this challenge and have broadened the concept and scientific research around the topic. But the changes have trickled down to the practice of Ocean Literacy in slower steps.

This is where Strategic Communications comes into play. More than just the dissemination

of information, Strategic Communications involve deliberate, targeted efforts to influence perceptions, mobilize communities, and drive meaningful action. By effectively combining Ocean Literacy and Strategic Communications, we can create a more comprehensive theory of change from Ocean understanding, through evidence-based communication strategies that inspire and empower individuals and societies to take action.

This section defines the key concepts of Ocean Literacy and Strategic Communications, shedding some light on their potential integration.

2.2.1 Ocean Literacy

Ocean Literacy is a concept that has gained traction over the past two decades, particularly as global awareness of environmental issues has increased. It is defined as an understanding of the Ocean's influence on individuals and society, and how individuals and society influence the Ocean (Cava et al. 2005).

The roots of Ocean Literacy lie in the recognition that the Ocean, despite covering over 70% of the Earth's surface, remains one of the least understood and appreciated ecosystems (NOAA 2005). Ocean Literacy aims to bridge this gap by educating people about the Ocean's fundamental role in sustaining life on Earth, the impact of human activities on marine environments, and the critical importance of conserving Oceanic resources (Cava et al. 2005).

Ocean Literacy was introduced in the early 2000s to address the lack of Ocean-related content in formal education, aiming to foster an understanding of the reciprocal influence between humans and the Ocean. The development of the Ocean Literacy Framework in the early 2000s by organizations such as the National Oceanic and Atmospheric Administration (NOAA) and the Centers for Ocean Sciences Education Excellence (COSEE) marked a significant milestone (NOAA 2005). This framework outlined seven essential principles and 45 fundamental concepts that define what it means to be Ocean literate. These principles range from understanding the physical and biological processes of the Ocean to recognizing the complex interactions between the Ocean and humans, including the Ocean's role in weather and climate systems (Cava et al. 2005).

The primary focus of Ocean Literacy has traditionally been on education, with the original goal of ensuring that students from kindergarten through 12th grade would receive education about marine science and the Ocean's role in global ecosystems (NOAA 2005). Taking a broader approach that goes beyond formal education, the European Union has promoted Ocean Literacy through initiatives like *Sea Change*, which aimed to empower citizens with the knowledge and tools to engage with marine issues (Sea Change Project 2016).

While these educational efforts have been successful in raising awareness among certain segments of the population, they often fall short in translating knowledge into action. Ocean Literacy, as traditionally practiced, tends to focus on the cognitive aspects—what people know—without sufficiently addressing the affective and behavioral dimensions—how people feel about the Ocean and what they do as a result of that knowledge (McKenzie-Mohr 2011).

New emerging practices and approaches to Ocean Literacy are actively incorporating more action-based theories of change to try and reduce the gap between knowledge and action. In recent years Ocean Literacy has expanded to include active participation, connection, and engagement with Ocean issues, adopting a broader approach beyond academic knowledge. McKinley et al. (2023) propose 10 dimensions to better capture the complexity of the human-Ocean relationship: knowledge, communication, behavior, awareness, attitudes, activism, emotional connection, access and experience, adaptive capacity, trust and transparency. This discussion also emphasizes the importance of incorporating local and Indigenous knowledge and fostering awareness of solutions to Ocean-related problems.

Despite advances in the Ocean Literacy field, much more could be achieved—and at a faster pace—by systematically integrating, and adopting, Strategic Communications into Ocean Literacy frameworks.

2.2.2 Strategic Communications

Strategic Communications is an approach that, by nature, goes beyond simply disseminating information. It's about establishing an interaction between two or more individuals toward a "common action". Strategic Communications involves the deliberate planning and execution of communication activities designed to achieve specific objectives. These objectives might include changing public attitudes, influencing policy decisions, or mobilizing communities to take action (Hallahan et al. 2007).

Strategic Communications is not confined to a single medium or message; it encompasses a broad range of activities, including media relations, digital marketing, advocacy campaigns, and public engagement initiatives (Smith 2020).

The core principle of Strategic Communications is that communication should be purposeful and aligned with broader organizational or societal goals. In the context of environmental advocacy, Strategic Communications have been crucial in raising awareness about issues such as climate change, deforestation, and biodiversity loss (Wilson and Ogden 2016). For instance, the strategic communication efforts surrounding climate change have successfully shifted public discourse from skepticism and denial to acceptance and urgency. This has been achieved through a combination of scientific reporting, visual storytelling, public demonstrations, and targeted campaigns aimed at specific audiences (Manheim 2011).

While successful climate initiatives like the UN *Act Now* campaign demonstrate how strategic communications can mobilize public action through targeted messaging and engagement, the pursuit of excellence and innovation in Ocean-related Strategic Communications means we must also look to other public policy issues, such as gender equality. Campaigns like UN Women's *HeForShe* highlight the importance of inclusive messaging and diverse stakeholder involvement, offering valuable insights for shaping Ocean sustainability narratives.

A global solidarity movement aimed at advancing gender equality by encouraging men and boys to actively engage in the fight for women's rights, *HeForShe* departed from traditional gender equality initiatives that primarily target women. The Campaign uniquely focuses on involving men as advocates and stakeholders in creating a gender-equal world. The objective is to inspire men and boys to recognize that gender inequality negatively impacts everyone, and that they can play a vital role in addressing systemic barriers to equality.

As a prime example of how Strategic Communications can be leveraged to not only raise awareness about social issues but also drive engagement and meaningful action across diverse audiences, *HeForShe* has relied on targeted messaging, use of celebrity endorsements, wide digital and social media engagement and partnerships with Governments, the private sector and academia. Since its launch, millions of men and women around the world have taken the HeForShe pledge, demonstrating the power of communications to mobilize citizens for action.

In terms of environmental campaigns, from Greta Thunberg's grassroots campaigning to Bill McKibben's 350.org (McKibben 2010), Strategic Communications has also been successfully used to generate what is now a fragmented but nevertheless very active global climate movement. But in the Ocean context, these mobilization tools have not been as widely or effectively employed. The Ocean remains the "poor cousin" of climate and biodiversity when it comes to attention and action by not just the public, but by policy makers and, notably, funders (CEA Consulting 2017).

Of course, Strategic Communications is not completely absent from the Ocean sphere. There have been successful cases where Strategic Communications has played a key role in advancing Ocean-related causes. Examples include aligned campaigning by the NGO community around the High Seas Treaty; Ocean Conservancy's public awareness campaign The Ocean Is Us (Ocean Conservancy 2017); the UN Environment Programme's Clean Seas campaign (UNEP 2017); and Sylvia Earle's well-known initiative Mission Blue (Earle 2014). These efforts show how Ocean actors have used strategic messaging, social media outreach, partner-

ships with influencers, and visual storytelling to make the Ocean's relevance to everyday life more tangible to the public.

2.2.3 What Lies Between Ocean Literacy and Strategic Communications?

Despite successful case studies from both the Ocean Literacy and Strategic Communications communities, the fact remains that up to very recently the two approaches to public Ocean engagement have pursued very distinct paths, with little exchange between Ocean Literacy professionals and professional communicators.

Since 2016, an increasing group of Ocean science communication specialists, a mix of communicators working in scientific institutions and scientists who specialized in or have an affinity for communications, have met biennially at the CommOCEAN Conferences organized by the European Marine Board's Communications Panel. This is the world's only regular meeting focused solely on Ocean science communications, and while the conference holds a lot of potential to become the key forum for promoting a merger of Ocean Literacy and Strategic Communications practices, it needs to promote a more inclusive and accessible approach to ensure the participation of professionals from the Global South and Early Career Ocean Professionals (ECOPs).

If CommOCEAN arose from the camp of Ocean Literacy professionals who saw the need to get closer to the Strategic Communications community, a new effort sprung in early 2024 from the Strategic Communications community to help close this longstanding gap. The Advancing Strategic Ocean Communications Project, launched in 2024 by Communications INC, the Calouste Gulbenkian Foundation, the David and Lucile Packard Foundation and UNESCO aim to bridge gaps between Ocean Literacy and strategic communications. Building on initiatives like the UK's Marine CoLABoration and the OneOcean Flotilla, the project focuses on capacity-building, promoting best practices, and creating tools to align messaging with diverse audiences. By fostering global networks and advocating for increased funding, it seeks to transform public perceptions and behaviors, advancing the UN Ocean Decade's goals for Ocean sustainability.

these higher-level efforts are mirrored by on-the-ground initiatives from around the world that are seeking to merge Ocean Literacy with Strategic Communications in order to educate, inspire, and mobilize citizens as well as decision-makers from all segments of society.

This is notably the case for the Blue Schools initiative in Brazil, a project aimed at fostering Ocean Literacy among school-aged children and their communities, while also raising awareness about the importance of marine conservation in coastal areas. This program is part of a broader global movement of Blue Schools, which began in Europe and the Global North but has since been adapted and expanded into the Global South. The program's central goal is to integrate Ocean Literacy into the school curriculum, but it also utilizes Strategic Communications to extend its reach beyond classrooms, encouraging broader public engagement with marine conservation efforts.

2.2.4 Untapped Potential

The full potential of integrating Ocean Literacy with Strategic Communications remains largely untapped. Traditional Ocean Literacy efforts often focus on knowledge dissemination in formal educational settings, while Strategic Communications is more commonly associated with advocacy and public relations (Wilson and Ogden 2016). Bridging the gap between these two fields requires a shift in perspective: Ocean Literacy should not be seen merely as an educational tool, but also a means to engage, inspire, and mobilize the public (Heath and Coombs 2006).

This integration can be further enhanced by incorporating elements of behavioral science, which examines how people make decisions and take action. For example, the use of social norms

in Strategic Communications—such as highlighting that "most people" are taking action to protect the Ocean—can be a powerful motivator for behavior change (Ajzen 1991; McKenzie-Mohr 2011). Similarly, framing Ocean issues in ways that resonate with people's values and identities can make Ocean Literacy more relevant and compelling (Fishbein and Ajzen 2011).

While Ocean Literacy and Strategic Communications have traditionally operated in separate spheres, their integration offers a promising pathway to achieving the goals of the Ocean Decade. By combining the strengths of both approaches, it is possible to move beyond mere awareness to foster deeper public engagement, drive behavior change, and ultimately transform humanity's relationship with the Ocean. The case studies discussed here demonstrate the potential of this integrated approach, but much work remains to be done.

2.3 Ocean Literacy and Strategic Communications: A Short History

Ocean Literacy as a concept consolidated in the early 2000s as environmental organizations and educators recognized the critical importance of fostering a deeper understanding of the Ocean and its influence on human life. One of the major milestones in this process was the development of the Ocean Literacy Framework, which was pioneered in the United States by the National Oceanic and Atmospheric Administration (NOAA) and the Centers for Ocean Sciences Education Excellence (COSEE). The framework, published in 2005, outlines seven principles of Ocean Literacy, which aim to define what it means to be "Ocean literate" (Cava et al. 2005).

These principles emphasize the Ocean's role in shaping Earth's climate and weather, its biodiversity, and its interconnectedness with human societies. The framework was adopted into educational curricula primarily in the Global North, focusing on schools and universities to teach students about Ocean ecosystems, Oceanographic processes, and human impacts on the Ocean (NOAA 2005).

Initially focused on spreading knowledge within formal education, the Ocean Literacy framework lacked a strategic approach to engaging broader audiences or driving behavior change. However, growing challenges like climate change and Ocean pollution pushed practitioners to explore how Strategic Communications can extend Ocean Literacy's impact beyond classrooms and into societal action.

In the late 2010s, as part of the United Nations Decade of Ocean Science for Sustainable Development 2021–2030 (The Ocean Decade, for short), UNESCO and its Intergovernmental Oceanographic Commission began federating in a coordinated approach national and cross-national efforts, first in Europe, and progressively with a global ambition, to focus on expanding the concept of Ocean Literacy for a wider range of stakeholders—such as journalists, media professionals, and the general public—in Ocean Literacy initiatives. The UNESCO-IOC's *Ocean Literacy for All* program marked a key turning point by introducing training opportunities and resources designed for a variety of key societal segments (such as journalists and media professionals) to help them understand and communicate Ocean issues effectively (UNESCO-IOC 2017).

Despite these efforts, Ocean Literacy has remained loosely tied to strategic messaging. While the educational framework (in and beyond the classroom) has helped countless individuals around the world understand basic Ocean science and its importance for key challenges we face as a planet, as a community of practice, Ocean Literacy has struggled to fully integrate strategic communication tools that are designed to mobilize broad public engagement or inspire behavior change on a large scale (UNESCO-IOC 2017).

2.3.1 Communicating Ocean Literacy: Advocacy and the Media

Advocacy and journalism have long played essential roles in amplifying Ocean Literacy beyond the classroom, engaging a broader audience in issues related to Ocean health, climate

change, and marine conservation. Advocacy campaigns, such as those led by Greenpeace and Oceana, have utilized Strategic Communications to convey emotionally charged messages that highlight pressing environmental concerns. These campaigns have often been highly visual, using imagery of marine life, pollution, and human interaction with the Ocean to evoke empathy and urgency.

Similarly, journalism has been instrumental in spreading Ocean Literacy by translating complex scientific data into accessible narratives for the general public. Documentaries such as BBC's "The Blue Planet" and Netflix's "Chasing Coral" have educated millions about Ocean issues by blending compelling storytelling with scientific facts. These productions have successfully used strategic communication techniques—such as powerful visuals, narratives that create emotional connections, and calls to action—to elevate public engagement with Ocean conservation.

Institutions like UNESCO and the Calouste Gulbenkian Foundation have recognized the importance of journalism in furthering Ocean Literacy, and in recent years, the *Ocean Literacy for All* programme of the Ocean Decade, as well as initiatives with institutions specialized in raising capacities among media professionals (i.e., Sparknews, the Pulitzer Center's Ocean Reporting Network, etc.), have provided training and resources for more effective and impact-driven reporting on marine issues.

2.3.2 Recent Alignments in Ocean Literacy and Strategic Communications

While Ocean Literacy and Strategic Communications have often operated in separate spheres, there are several notable examples where these two fields have been effectively integrated, yielding successful outcomes in terms of public engagement and action.

2.3.2.1 Transforming how Humanity Views the Ocean

A recent example of the successful integration of Ocean Literacy and Strategic Communications can be seen in the University of the Arts London (UAL)-UNESCO project, which was part of the UN Decade of Ocean Science for Sustainable Development. This collaborative initiative, led by the London College of Communication (LCC) in partnership with UNESCO, The Ocean Agency, and the UN Decade of Ocean Science, tasked over 200 students across 16 postgraduate courses with tackling Ocean Decade Challenge 10: "Transforming how humanity views the Ocean."

The project focused on the idea that the Ocean holds immense potential to help solve humanity's greatest challenges—such as climate change—yet most people remain unaware of its importance. The brief challenged students to develop innovative and creative communication solutions that could enhance public awareness and inspire action.

Supported by UNESCO's Strategic Communications team, Ocean scientists, and industry experts, the students developed 38 creative projects, with eight being selected to be showcased at the UN Ocean Decade Conference. These projects included interactive exhibitions, digital campaigns, and visual storytelling that connected real-world Ocean challenges to creative solutions.

By merging creative communications expertise with Ocean Literacy principles, the UAL-UNESCO project demonstrated how strategic communication can be used to reframe public perceptions of the Ocean (see the Resources section for more information).

The collaboration between interdisciplinary creatives and Ocean advocates provided a unique platform for translating complex marine science into engaging, digestible content, ultimately contributing to a broader public understanding of the Ocean's critical role in addressing the climate crisis (UAL-UNESCO 2021).

2.3.2.2 Getting Creative with Ocean Literacy

Another compelling example of the integration of Ocean Literacy and Strategic Communications is the Ocean Decade Creative Communication Toolkits, launched by The Ocean Agency in partnership with UNESCO's IOC. These toolkits, released in 2021, provide free online communication resources designed to support the objectives of the UN Decade of Ocean Science for Sustainable Development. The first series of toolkits covers general Ocean awareness as well as specific ecosystems, such as coral reefs, mangroves, and seagrass (The Ocean Agency 2021).

The toolkits were created with the understanding that effective Ocean communication is crucial for increasing public support for marine science and conservation action (see the Resources section for more information). They provide media professionals, educators, communicators, and creators with curated content, including visuals, key messages, and issue summaries, to help raise awareness about the Ocean and inspire action. The inclusion of stunning imagery from over 100 of the world's top Ocean photographers has been a particularly powerful element of these toolkits, capturing attention and sparking emotional engagement with the issues.

The toolkits are also interactive, with creative challenges that encourage users to create and share their own content. This hands-on approach not only facilitates learning but also helps to generate a broad array of shareable artworks and media, further amplifying the reach of Ocean Literacy efforts.

By making Ocean communication more accessible, inspiring, and actionable, these toolkits embody the merging of Ocean Literacy with Strategic Communications, showing how digital tools and creative media can help transform how people view and engage with the Ocean. The toolkits have been widely adopted by educators, activists, and media professionals, helping to drive support for Ocean science and conservation around the world (The Ocean Agency 2021).

2.3.3 Advancing Strategic Ocean Communications

A key example of the recent integration of Ocean Literacy and Strategic Communications is the *Advancing Strategic Ocean Communications Project*, an ongoing initiative led by Communications INC, the Calouste Gulbenkian Foundation, the David and Lucile Packard Foundation and UNESCO. This multi-stakeholder project addresses priorities identified in the sector and aligns with recommendations from the UN Ocean Decade white paper Restoring Society's Relationship with the Ocean (UNESCO-IOC 2024a, 2024b).

The initiative focuses on developing resources and delivering training—both virtual and in-person—to enhance global Ocean communication efforts. A central goal is to establish a global network of practitioners to share strategies, foster collaboration, and promote evidence-based approaches to Ocean messaging. Crucially, it incorporates Justice, Equity, Diversity, and Inclusion (JEDI) principles to ensure underrepresented regions, particularly from the Global South, have a stronger voice in Ocean communications.

The project's workshops and discussions address key challenges, such as increasing investment in Ocean messaging, leveraging audience data to craft tailored messages, and advancing inclusive, data-driven communication strategies. One of the anticipated outcomes is the creation of a global network to share insights, conduct audience research, and improve the diversity of perspectives in Ocean storytelling.

As the project evolves, its success will hinge on its ability to transform public perceptions of the Ocean, inspire action, and advance Ocean

Literacy. By merging traditional educational approaches with professional communication techniques, the initiative aims to achieve a broader and more impactful societal reach.

2.4 Learning from Strategic Communications and Marketing to Fill Gaps in Ocean Literacy

While Ocean Literacy frameworks, such as the Ocean Literacy Framework developed by NOAA and COSEE in 2005, have successfully raised awareness about the Ocean's role in sustaining life, several gaps persist in their integration with Strategic Communications. These gaps often prevent Ocean Literacy from translating into broader public engagement and action. Table 2.1 below summarizes some key gaps in the current frameworks and proposed solutions through improved communication strategies.

Current Ocean Literacy frameworks are effective in promoting scientific knowledge but often fall short in addressing how to effectively communicate that knowledge to drive behavior change. There is a need for frameworks that integrate Strategic Communications to make Ocean issues relatable, emotional, and actionable, particularly by focusing on public engagement beyond the academic sphere (Cava et al. 2005; UNESCO-IOC 2024a, 2024b).

2.4.1 Some Lessons from Climate Change Communications

The success of climate change communication in mobilizing public opinion and policy action offers valuable lessons for advancing Ocean Literacy in a way that is more aligned with and reliant on Strategic Communications approaches. Over the last decade, these approaches have played a significant role in raising awareness of climate change, and these strategies can be

Table 2.1 Gaps in Ocean Literacy

Identified Gaps in Ocean Literacy	Description	Strategic Communications Solutions
Limited audience reach	Current frameworks primarily target students and institutions adjacent to school and academia.	Use digital platforms, social media, news, entertainment and community engagement to reach broader, diverse audiences.
Lack of emotional engagement	Traditional Ocean Literacy often focuses on facts without emotional storytelling.	Integrate narratives and personal stories to evoke emotional connections.
Minimal focus on behavioral change	Frameworks emphasize knowledge over action, missing behavioral components.	Apply behavioral science techniques such as social norm messaging and nudge techniques.
Underrepresentation of global south communities	Many initiatives remain global north-driven and targeted, lacking inclusion of voices from the global south and unable to reach less technologically resourced communities.	Incorporate JEDI (Justice, Equity, Diversity, and Inclusion) principles and JEDI-driven practices to include diverse voices and foster content that can appeal to diverse communities and backgrounds.
Weak integration of media and strategic communications	Traditional Ocean Literacy efforts lack collaboration with media professionals.	Provide training for media professionals to effectively communicate Ocean issues.
Lack of use of and attention to evidence and market research	Limited attention to audience data and market research in shaping messages.	Conduct and incorporate audience research to inform and adapt communication strategies
Lack of misinformation management and response strategies	No comprehensive approach to counter misinformation about Ocean issues.	Develop proactive misinformation management strategies, including fact--checking and public education campaigns.

applied to Ocean Literacy to achieve similar outcomes. Examples include the following:

- Framing for Relevance: Climate change communicators have successfully framed the issue as a direct threat to people's daily lives, highlighting how it affects health, economies, and weather patterns. Similarly, Ocean Literacy efforts should emphasize the direct benefits of a healthy Ocean, such as its role in food security, oxygen production, and climate regulation (Corner et al. 2018).
- Visual and Emotional Storytelling: The use of powerful visuals, such as melting glaciers and wildfire footage, has proven effective in climate campaigns. Ocean communication can use similar strategies, showcasing the beauty of marine life and the devastation caused by plastic pollution or coral bleaching, creating emotional engagement that encourages people to act (Corner et al. 2018).
- Partnerships with Influencers and Media: Strategic partnerships with high-profile figures and media organizations have helped disseminate climate change messages widely. In Ocean Literacy, engaging with influencers, journalists, and organizations like The Ocean Agency could extend the reach and impact of Ocean messaging (Nisbet and Markowitz 2016).
- Localized Messaging: Tailoring messages to local communities have been successful in climate action. Similarly, Ocean Literacy efforts should focus on local marine environments, connecting global Ocean health to regional livelihoods, coastal protection, and community well-being (Corner et al. 2015).

By adopting these strategies, Ocean Literacy initiatives can build stronger emotional connections with the public and drive concrete action in Ocean conservation. Just as climate change communication has shifted from awareness to action, Ocean Literacy must follow a similar trajectory (Corner et al. 2015; Nisbet and Markowitz 2016).

2.5 Proposing a New Framework for Ocean Literacy by 2030

The evolution of Ocean Literacy requires a reimagined approach to public engagement, education, and communication—one that integrates Strategic Communications and addresses current gaps identified in Ocean Literacy frameworks. Based on insights from climate change communication and environmental campaigns, a new Ocean Literacy 2.0 framework can align more closely with the goals of the UN Decade of Ocean Science for Sustainable Development.

2.5.1 Creating Ocean Connection

One of the major gaps in traditional Ocean Literacy efforts is the lack of prioritization of emotional engagement (see Table 2.1). Current frameworks tend to focus on scientific facts but fail to foster an emotional connection with the Ocean. Ocean Literacy 2.0 must include strategies to cultivate this connection by using visual storytelling, personal narratives, and emotional appeals to help individuals understand the Ocean's direct relevance to their daily lives. For example, showcasing the critical role of the Ocean in producing oxygen, regulating climate, and providing livelihoods can build an emotional bridge that motivates individuals to care more about Ocean conservation (Nisbet and Markowitz 2016).

To deepen the public's connection to the Ocean, this new framework could incorporate interactive campaigns similar to those used in successful climate change efforts. For instance, initiatives using virtual reality experiences and direct in-situ experiences within marine and coastal environments can and have successfully engaged diverse audiences through immersive, interactive storytelling. By allowing people to experience marine environments virtually or through direct engagement, such efforts can create a stronger sense of personal responsibility and connection to the Ocean.

2.5.2 Gathering and Utilizing Public Perception Evidence

One of the central pillars of Ocean Literacy 2.0 is the use of evidence-based communication strategies, addressing the gap of limited audience research in shaping messages (see Table 2.1). One valuable tool is the Ocean and Society Survey (OSS), formerly known as *Global Ocean Literacy Survey, GOLS*. The OSS is an international initiative designed to measure people's understanding of and connection to the Ocean. By analyzing global trends in Ocean Literacy and societal attitudes toward the Ocean and related issues, the OSS provides critical insights into knowledge gaps, regional attitudes, and how public perception varies across demographics. These insights can help refine Strategic Communications by creating more targeted, relevant, and impactful messaging campaigns (COL Coalition 2023). Using the findings from the OSS, communicators can ensure their messages resonate with diverse communities, making Ocean Literacy efforts more inclusive and effective globally. Additionally, this survey can help track progress over time, offering a measurable framework to assess the impact of new communication strategies and improve ongoing campaigns.

Just as climate change campaigns have utilized audience research to shape their messages—the successful work of the Yale Center for Climate Change Communications being a notable example—Ocean Literacy 2.0 should include regular public perception surveys to assess knowledge gaps, attitudes, and barriers to engagement. This data can then be used to refine communication strategies, tailoring them to specific regional or cultural contexts to maximize impact. For example, a campaign addressing overfishing in coastal communities could highlight the economic and cultural importance of marine resources, while urban campaigns might focus on the Ocean's role in mitigating climate change and providing food security (Corner et al. 2015).

2.5.3 Back to Roots: Strategic Engagement with Educators

Educators remain at the heart of Ocean Literacy efforts, but Ocean Literacy 2.0 must go back to bring the power of Strategic Communications and public engagement to the heart of the educational frameworks. Attention spans of students have greatly reduced since the concept of Ocean Literacy came into being. And curricula around the world are much more crowded, relegating more than ever the Ocean to the side lines of formal education. The lack of effective collaboration with educators and promotion of existing resources has limited the reach of Ocean Literacy efforts (see Table 2.1), but by partnering with schools, universities, and educational organizations, a new framework can ensure that Ocean Literacy becomes a core component of environmental education curricula at all levels, making it a matter of public policy through Strategic Communications campaigns targeted at municipal and sub-national policy-makers. The example of many Brazilian cities, starting with Santos, where Ocean Literacy in education has become law, is very encouraging (Ocean Decade 2021).

In addition to enhancing formal education, Ocean Literacy 2.0 should promote the development and widespread distribution of creative resources, such as digital toolkits and interactive materials. The Ocean Decade Creative Communication Toolkits, launched by The Ocean Agency and UNESCO, offer an example of how Ocean Literacy can be enhanced through engaging, visually compelling materials (The Ocean Agency 2021). These resources should be widely available to educators, communicators, and media professionals to ensure that Ocean Literacy messages reach broader audiences, including youth.

2.5.4 Upholding JEDI Principles in Ocean Literacy

A major limitation of current Ocean Literacy efforts is the underrepresentation of Global South communities (see Table 2.1). To create a truly inclusive Ocean Literacy framework, Justice, Equity, Diversity, and Inclusion (JEDI) principles must be integrated into all aspects of communication and education efforts. Ocean Literacy 2.0 should prioritize elevating the voices of underrepresented and marginalized communities, particularly those in coastal areas disproportionately affected by Ocean degradation.

This could be achieved by forming partnerships with community leaders, local NGOs, and educational institutions in the Global South to co-create Ocean Literacy materials that reflect local cultures, languages, and experiences. The Advancing Strategic Ocean Communications Project, with its emphasis on inclusion and a 50/50 representation between Global North and South participants, is a promising model for how JEDI principles can be effectively applied (UNESCO-IOC 2024b).

2.6 Conclusion: Establishing a New Theory of Change for Ocean Literacy 2.0

The Theory of Change underpinning Ocean Literacy 2.0 must focus on achieving behavioral change through Strategic Communications that are grounded in audience research and inclusive messaging. Drawing from successful climate communication strategies, the framework should prioritize:

- Creating demand for Ocean connection by engaging people emotionally and personally.
- Using data-driven approaches to craft targeted messages that resonate with diverse audiences.
- Collaborating with educators and promoting accessible resources that make Ocean Literacy a fundamental part of environmental education.
- Upholding JEDI principles, ensuring that Ocean Literacy reaches marginalized and vulnerable communities.
- Fostering global networks of communicators and educators to share successful strategies and resources for enhancing Ocean Literacy globally.

By combining these elements, Ocean Literacy 2.0 can help shift public perception of the Ocean, inspiring individuals and policymakers to act toward the sustainable management of marine resources. The integration of Strategic Communications with traditional Ocean Literacy efforts will enable a broader, more inclusive movement capable of driving the systemic change required to meet the UN Ocean Decade goals.

2.6.1 Summary

Key concepts explored in this chapter include:

- Ocean Literacy needs a broader scope beyond education to drive societal action.
- Strategic Communications offer tools for emotional engagement and behavior change.
- Data-driven approaches, such as the Ocean and Society Survey, can enhance message relevance and impact.
- Upholding JEDI principles ensures inclusivity and global representation in Ocean Literacy efforts.
- Ocean Literacy 2.0 provides a reimagined framework to align education, advocacy, and action.

2.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Advancing Strategic Ocean Communications Project: https://communicationsinc.co.uk/

Ocean_isu_blog/launch-advancing-strategic-Ocean-communication/

- UAL Showcase Collections—UN Ocean Decade Challenge 10: https://ualshowcase.arts.ac.uk/collection/Ocean-decade-challenge-10
- Ocean Decade Image Bank and Toolkits: https://Oceandecade.org/actions/the-Ocean-decade-image-bank-and-toolkits/
- https://pulitzercenter.org/journalism/initiatives/Ocean-reporting-network
- UN *Act Now* Climate Initiative: https://www.un.org/en/actnow
- Justice, Equity, Diversity, and Inclusion (JEDI) Collaborative: https://jedicollaborative.com/
- John Hopkins Bloomberg School of Public Health Center for Teaching and Learning: Best Practices in Justice, Equity, Diversity, and Inclusion (JEDI): https://www.ctltoolkit.com/best-practices-jedi
- Advancing Strategic Ocean Communications Project Webinars: https://www.youtube.com/channel/UCIK4XwQ_wgGWs2pObWA-SOTQ/about
- Emma Watson at the HeForShe Campaign 2014—Official UN Video: https://www.youtube.com/watch?v=gkjW9PZBRfk
- BBC Earth Blue Planet Collection Part 1: https://www.youtube.com/watch?v=s4aQqx_Zo00
- BBC Earth Blue Planet Collection Part 2: https://www.youtube.com/watch?v=G3oTmkSFDuw
- Chasing Coral Trailer: https://www.youtube.com/watch?v=aGGBGcjdjXA
- Sparknews TV: https://www.youtube.com/user/SparkNewsTv

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3 Bridging the Worlds of Science and Communication to Foster Literacy on Ocean-Climate-Biodiversity Interactions

Anaïs Deprez, Sarah Palazot, Françoise Meyer, and Céline Liret

Abstract

Despite its crucial importance for the climate, the Ocean has long been overlooked by decision makers and the general public. However, in alignment with the political and scientific milestones achieved at COP21—with the integration of the Ocean in the Paris Agreement preamble—and with the release of the IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate*, the Ocean & Climate Platform and its members have dedicated the past decade to highlighting the crucial role the Ocean plays by bridging the gap between science and decision-making.

This chapter aims to underscore the Ocean & Climate Platform's mission of promoting and advancing understanding of the interactions between the Ocean, climate, and biodiversity among decision-makers and the general public through its "knowledge dissemination" working group. Convening experts from diverse disciplines spanning natural and social sciences, as well as incorporating both scientific and non-academic perspectives, including communication and science education, this group has been devoted to the creation of science-based and easily accessible content. Drawing from its participation in the French governmental review of IPCC reports, notably the *Special Report on the Ocean & Cryosphere in a Changing Climate* (2019) and the *Sixth Assessment Report* (2021–2023), the Ocean & Climate Platform has leveraged this collective expertise around the production of two publications of Ocean Literacy: *Ocean & Climate Change: New Challenges* (2019) and *What Ocean for tomorrow? Marine ecosystems in a changing climate: insights from the IPCC's Sixth Assessment Report* (2023).

The efforts of the Ocean & Climate Platform's knowledge dissemination working group and the publications curated since 2018 align closely with the ambition of the UN Ocean Decade to "restore humanity's relationship with the Ocean." Through collaborative

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endeavours, the Platform contributes to fostering a deeper understanding of the Ocean's role in the climate system and empower stakeholders to make informed decisions for a sustainable future.

Keywords

Ocean Literacy (OL) · Knowledge dissemination · IPCC · Special report on the ocean and cryosphere in a changing climate · Sixth assessment report · Decision-makers · Climate change

3.1 Introduction

Since its foundation, the Ocean & Climate Platform has been committed to fostering Ocean Literacy for informed action in favour of the Ocean, climate and biodiversity. In line with this, the Ocean & Climate Platform builds on and mobilises the scientific and on-the-ground expertise of its Scientific Committee and a network of over a hundred organisations, including research institutes, aquariums and museums, civil society and non-governmental organisations from across the globe. To ensure the policy uptake of the current science on Ocean-climate-biodiversity interactions, a "knowledge dissemination" working group, composed of scientists and experts in science communication and education, has been established to produce accessible content.

This collective work resulted in the release of a series of educational and scientific fact sheets decoding Ocean-climate-biodiversity interactions. With the Ocean & Climate Platform participating in the French governmental review of the Intergovernmental Panel on Climate Change (IPCC) reports since 2019, the working group has also focused on translating "Ocean issues" from these comprehensive yet complex reports. Translating intricate scientific reports like those from the IPCC into accessible formats for both decision-makers and the general public, and ensuring effective dissemination, presents substantial challenges. This chapter delves into the history, mission, and achievements of the Ocean & Climate Platform's knowledge dissemination working group. It also reflects on the lessons learned from the 2023 publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate*, highlighting the challenges and effective strategies for successful knowledge dissemination.

3.2 Ocean & Climate Platform: History

The following section contains a brief history of the Ocean & Climate Platform's mission, working groups, and publications aimed at dissemination of knowledge on Ocean-climate biodiversity interactions.

3.2.1 The Starting Point: Scientific and Educational Fact Sheets

Between 2015 and 2019, the Ocean & Climate Platform released 33 scientific sheets, offering a comprehensive and up-to-date understanding of the interactions between the Ocean and climate change. These sheets cover a wide range of topics, including biological, physical, socio-economic, and governance aspects. Authored by over forty international scientists composing the Ocean & Climate Platform's Scientific Committee, and representing diverse fields, including Oceanography and social and human sciences, the sheets were primarily intended for an academic audience. They provided in-depth analysis and curated literature on subjects such as coral bleaching, the deep Ocean, the carbon pump, coastal adaptation, small islands, and the Arctic Ocean.

To complement these efforts and effectively disseminate knowledge to decision-makers, the Ocean & Climate Platform established an initial knowledge dissemination working group. This group focused on producing informative factsheets designed to reach broader audiences. The working group brought together professionals in science communication and education from museums, universities, and aquariums, leveraging their expertise while maintaining the scientific rigour provided by the Scientific Committee

involved in the production of the scientific factsheets. In total, 13 informative factsheets, along with numerous infographics, were published in 2015 and 2016. These materials underscored the importance of improving current research and understanding of the Ocean to fill critical knowledge gaps. They expand on fundamental mechanisms such as the regulation of atmospheric temperature by the Ocean, the biological and physical carbon pumps, and Ocean circulation and currents. Additionally, they emphasise the impacts of climate change on the Ocean, including Ocean acidification, as well as the effects of human activities like fishing. The factsheets also shed light on key ecosystems and habitats, such as the deep Ocean, and their contributions to biodiversity and human societies.

Gathering and disseminating this extensive body of information on the Ocean has established the Ocean & Climate Platform as a credible intermediary between science, society and policy-making. This role has become particularly significant in the context of the IPCC sixth assessment cycle that began in 2018, which has placed a strong emphasis on improving communication with decision-makers.

3.2.2 The Turning Point: Reviewing the IPCC Reports and Filling the Gap with Decision-Makers

3.2.2.1 Participation in the French Governmental Review of IPCC Reports

Since 2018, the Ocean & Climate Platform has been the only non-governmental organisation mandated by the French government to participate in its governmental review of "Ocean issues" in the IPCC reports. Starting with the review of the *Special Report on Global Warming of 1.5 °C* (2018), the *Special Report on the Ocean and Cryosphere in a Changing Climate* (2019) marked a significant milestone for both the Ocean community and the Ocean & Climate Platform. The *Special Report on the Ocean and Cryosphere in a Changing Climate* is the first IPCC report specifically dedicated to the Ocean, offering a comprehensive overview of the latest science on the impacts of climate change on the Ocean and cryosphere, while highlighting potential avenues for adaptation. A report of such magnitude is the result of long-term collaborative work, synthesising around 7000 articles and coordinated by 400 authors. It was further enriched by 31,000 comments from governments, including contributions from the Ocean & Climate Platform for the French governmental review.

Through collaborative coordination with its network of scientists and mediators, the Ocean & Climate Platform's expertise has gained increasing recognition from both the scientific and political communities. Its involvement continued with the review of three volumes of the Working Groups I, II, and III, as well as a synthesis report of the IPCC Sixth Assessment Report (2021–2023). For volumes II and III, the Ocean & Climate Platform notably submitted over 500 specific and general comments. These comments were thoroughly discussed with the French focal point for the IPCC, and most of them were accepted and submitted to the IPCC.

3.2.2.2 From Reviewing to Decoding the IPCC Reports

The IPCC reports offer a comprehensive synthesis of the latest and most credible scientific literature on climate change. However, their impact on decision-makers and the general public is still insufficient, particularly when it comes to Ocean-related issues. To address this gap, the Ocean & Climate Platform recognised the need to "translate" these long and complex reports into more accessible content, aiming to increase awareness, combat misinformation and miscommunication, inform decision-making more effectively, and empower the public with a deeper understanding of the Ocean, climate, and biodiversity interlinkages.

The Ocean & Climate Platform leveraged its dual expertise in science and communication, drawing on its previous experiences of both reviewing complex IPCC reports and producing informative content. It convened several professionals of member organisations and

experts of its Scientific Committee within a permanent knowledge dissemination working group to create accessible materials of Ocean Literacy adapted from IPCC reports. This endeavour resulted in two major publications: *Ocean & Climate Change: New Challenges* (2019), which focuses on five key themes of the Special Report on the Ocean and Cryosphere in a Changing Climate, and *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate: Insights from the IPCC Sixth Assessment Report* (2023).

3.3 Current Methodology and Challenges

The following section outlines the methodology used by working group to facilitate collaboration among scientists, science dissemination specialists, and communication experts, as well as the challenges encountered in this process.

3.3.1 Composition of the Knowledge Dissemination Working Group

The knowledge dissemination working group is dedicated to both promote scientific and non-academic, wide-ranging expertise of the hundred organisations composing the network of the Ocean & Climate Platform. The working group is thereby consisting of scientists from diverse disciplines, including Oceanography (physics, chemistry, biology, and geology) and socio-economic fields, and includes professionals in science communication and education, from museums, aquariums, universities, and media.

The working organisation of the knowledge dissemination working group is in fact divided into different groups, based on respective status, missions and expertise. The Secretariat (1), composed of members of the Ocean & Climate Platform staff (non-academics), is responsible for coordinating the publications. This includes defining the scope, drafting and writing, coordinating external service providers (e.g., graphic designers), and developing the communication strategy. Each of these tasks is supported by the review and advice of the so-called "permanent working group" (2). This permanent working group, consisting of scientists and experts in science dissemination, is responsible for defining strategic orientations, deliberating, and participating in the scientific review of the Secretariat's work. Since 2023, the permanent working group has been complemented with thematic working groups (3), comprising representatives from various member organisations of the Ocean & Climate Platform, to work on "thematic cycles." These temporary groups enable to promote on-the-ground experiences and thematic expertise from the Ocean & Climate Platform's member organisations on specific topics related to Ocean-climate-biodiversity interactions, such as fisheries or the polar Ocean. The Scientific Committee (4) of the Ocean & Climate Platform, is occasionally mobilised to provide inputs and proofread the publications. Finally, strategic communication and dissemination meetings (5) convene heads of communication of the different member organisations of the Ocean & Climate Platform to discuss and coordinate efforts for the dissemination of the production, reflect and report on drivers of successful communication, requests from partners and the general public for additional material.

3.3.2 Main Objectives and Outcomes

By leveraging the expertise of this working group, the Ocean & Climate Platform aims to achieve several key objectives. First, to decode the complex interactions between the Ocean, climate and biodiversity presented in major scientific reports, primarily IPCC reports. Second, to build upon science to inform international and national policies on Ocean-climate-biodiversity issues, including the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, as well as Nationally Determined Contributions and National Adaptation Plans. Finally, to promote Ocean Literacy among various audiences, includ-

ing journalists, students, and teachers, to foster informed actions and discussions.

The outcome of these efforts are initially in the form of publications (e.g., *Ocean & Climate Change: New Challenges* and *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate*), from which various communication and information materials are derived (visuals for social media, articles, exhibitions, videos).

3.3.3 Critical Steps and Working Processes

A first critical step to the knowledge dissemination working group is to thoroughly review the reports it aims to "translate" in accessible terms. In addition to being essential to ensure the scientific accuracy of the publication, this literature review helps determine a scope and identify key topics and concepts—especially those poorly understood or known by decision makers and the general public. In this regard, after reviewing the *Special Report on the Ocean and Cryosphere in a Changing Climate*, five key phenomena have been identified to articulate the first publication *Ocean & Climate Change, New Challenges* (2019) which are Ocean warming, sea level rise, the impacts of climate change on Antarctica, extreme climate events and deoxygenation of the Ocean. Likewise, noting the emphasis on the impacts of climate change on marine biodiversity in the Sixth Assessment Report, the second publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* (2023) consequently focused on marine ecosystems in a changing climate. In addition, the publication aimed to shed light on and define concepts of current debates or little known by the general public which were central to the Sixth Assessment Report, such as tipping points, marine heatwaves, Nature-based Solutions, marine carbon dioxide removal or even the deep Ocean.

Following this literature review and scoping phase, most of the efforts are divided between the writing and production of infographics ensured by the Ocean & Climate Platform Secretariat, and regular proof-readings by the scientists of the working group. A final, decisive review—carried out mainly by the experts in science communication and dissemination—is dedicated to simplifying the writing style and ensuring that all concepts and definitions are clearly and accessibly presented.

Significant attention is also being given to the publication's layout. This reflects the core belief that the format is just as important as the content in effectively conveying the message. The IPCC reports, for example, include numerous infographics that, while informative, are often complex and visually unappealing. This insight has driven the knowledge dissemination working group to not only simplify the content of these infographics but also enhance their visual appeal by refining the use of colour and graphic designs. Infographics can also be used to summarise key elements from IPCC reports as illustrated by the schematics "Ocean and climate change: overview of consequences" which synthesises the series of impacts of climate change in the Ocean, for biodiversity and societies as detailed on the IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate* (Fig. 3.1).

The long-term dissemination and communication strategy is pivotal for any publication, particularly given the dual challenge of reaching both decision-makers and a broader audience. To address this, the communication campaign combines traditional formats, such as reports, and channels like mailing, with the production of shorter, visually appealing content tailored for various social media platforms. This content includes videos, social media carousels, and web articles that highlight key topics from the publication. Mailing lists and newsletters are strategically used to target key individuals, such as public figures, elected officials, and other influential representatives. Meanwhile, social media serves to engage a broader audience, necessitating content that is both concise and visually engaging. Ambassadors can occasionally be associated during these campaigns, based on their followers base and influence in public and political spheres.

Additionally, the Ocean & Climate Platform leverages its network of over a hundred organisa-



Fig. 3.1 Schematics from *Ocean & Climate Change: New Challenges* (2019). Ocean & Climate Platform

tions to strengthen the dissemination of the publication through their channels and social media platforms. In the lead-up to the publication, the Ocean & Climate Platform activates its network through communication meetings that bring together the organisations' heads of communication. These meetings focus on discussing and sharing experiences, gathering input on the communication campaign, and exploring content needs, potential dissemination strategies, and opportunities for future collaboration to ensure that the publication continues to live and be shared, way beyond its initial release.

3.3.4 Tracking the Dissemination

The analysis of website consultations, document downloads, and social media impressions offers a partial yet valuable insight into the immediate impact of a communication campaign. Typically, a variety of tools are employed to extract data, including Google Analytics and MonsterInsights for website and page consultations, Bitly for document downloads, social media analytics for growth and impressions across platforms (e.g., X/Twitter, Instagram, LinkedIn, and Facebook), and Mailchimp for tracking engagement via email campaigns.

However, these tools and statistics often underestimate the reach and fail to provide detailed insights into the identities or roles of those accessing the publication—an especially critical factor when the target audience includes decision-makers. As a result, direct interventions and presentations to key audiences and forums often serve as more reliable indicators of the dissemination's success.

For instance, in 2019, the Ocean & Climate Platform marked the release of the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate and the publication Ocean and Climate Change: New Challenges through active engagement in high-profile events. The Ocean & Climate Platform organised a press briefing in collaboration with the knowledge dissemination

working group, bringing together 15 journalists to inform and train them on this critical topic. The Platform consequently participated in a press conference organised at the French Ministry of the Environment, alongside IPCC scientists and leading research institutions. Additionally, the Ocean & Climate Platform and its Scientific Committee were invited to present the publication to Members of Parliament at the French National Assembly. Furthermore, the Platform organised a dedicated meeting with governmental and state representatives from the Ministry of the Environment, the Ministry of Food and Agriculture, and the Ministry of European and Foreign Affairs.

3.4 Ensuring Inclusivity and Relevance

This section examines how the Working Group has evolved in its efforts to foster inclusivity and ensure the continued relevance of its work, including the challenges encountered along the way.

3.4.1 A Thematic Approach to Knowledge Dissemination

Since 2023, a thematic approach has been developed. Operating on 6-month cycles, they are structured around specific issues of the interactions between Ocean, climate, and biodiversity. By producing shorter and more focused publications, the goal is to streamline the production process and better align with the rapidly shifting political agenda. For instance, the first thematic cycle concentrated on fishing and aquaculture in the context of climate change, a topic of significant political and societal relevance.

Regarding the working process, thematic groups have been established, periodically involving member organisations of the Ocean & Climate Platform along the Secretariat and the permanent working group on the production of knowledge dissemination content. The so-called "thematic groups" intervene at different stages of the production, that is to define the scope and to review the outline, to provide resources and examples of leading practices, to provide inputs on the creation of schematics and infographics and finally to discuss the communication and dissemination strategy.

Therefore, this thematic approach not only enhances the timeliness of publications but also allows for the effective mobilisation of member organisations' diverse expertise—whether scientific or practical—including contributions from NGOs, researchers, and academic institutions.

3.4.2 Fostering Inclusivity and Expanding the Scientific Foundation

A thematic approach has allowed to include more diverse and practical expertise to the publications of the knowledge dissemination group. To support these efforts, the bibliographic foundation for publications has been significantly broadened, incorporating a wider range of scientific reports and papers. This shift arose from the necessity to continuously provide the most current knowledge on Ocean-climate-biodiversity interactions in the productions. While the IPCC reports initially served as the primary source for the knowledge dissemination working group, due to their climate-focused analysis and the Ocean & Climate Platform's involvement in reviewing them, the conclusion of the IPCC's Sixth Assessment Cycle highlighted the need for a more expansive approach. Consequently, the bibliographic review now includes additional reports from other authoritative bodies, such as the FAO, the World Ocean Assessment, and IPBES, all of which are based on scientific consensus.

3.4.3 Anticipating the Political Priorities While Remaining Flexible to Shifting Political Agendas

To ensure the effective uptake of Ocean science by both political leaders and the general public, it is crucial for the knowledge dissemination work-

ing group to address topics that resonate with their target audiences. The group's strategy involves anticipating the political agenda while maintaining the flexibility to address emerging "hot topics."

Two key mechanisms have shaped this agenda. First, the Ocean & Climate Platform's mandate and prominent position within international and national decision-making frameworks allow it to anticipate political priorities. Second, the Platform has intensified its efforts to engage with its network to identify priorities that matter to a diverse range of stakeholders. As part of this process, consultations and workshops with member organisations have been held, bringing to light critical international priorities and issues of public concern, such as food security and health. In response to these findings, the knowledge dissemination working group initiated a new cycle focused on fishing and aquaculture in the context of climate change, tackling the interconnected challenges of food security and public health.

The knowledge dissemination working group maintains flexibility in adapting to shifting political agendas and emerging issues by developing shorter, more accessible content formats and creating supplementary materials. To this end, besides long publication, concise articles are produced and published on the Ocean & Climate Platform's website and "Blog Le Monde"—a community blog of the renowned French newspaper *Le Monde*. These articles are often distilled from the Platform's more detailed scientific sheets and publications. For example, in 2023, as marine temperature records were shattered and marine heatwaves occurred globally, the Ocean & Climate Platform published a clear and informative article to help the public understand the phenomenon and its connection to climate change. This article drew on content such as texts, definitions, and infographics developed for broader publications, as well as insights from contributing scientists.

3.5 Example from the Latest Publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate—Insights from the IPCC 6th Assessment Report*

What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate (2023) is the latest major publication of the knowledge dissemination working group. Drawing on the Sixth Assessment Report of the IPCC, this publication sheds light on the key role of marine ecosystems for the climate, marine life, and human societies, while raising awareness of the risks associated with their deterioration. It further explores the adaptation and mitigation solutions that marine ecosystems offer for meeting climate and environmental goals, along with the conditions necessary for their successful implementation.

3.5.1 About the Publication: Purpose, Working Process and Content

3.5.1.1 Source Material: Insights from the IPCC Sixth Assessment Report

The publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* draws on the findings of the Special Report on the *Ocean and Cryosphere in a Changing Climate*, along with a comprehensive review of the working groups I, II, and III, with a particular emphasis on the second, "Adaptation, Impacts, and Vulnerability," specifically its 3rd Chapter on "Oceans and Coastal Ecosystems and their Services."

3.5.1.2 A Product of Collective Intelligence: Where Science Meets Mediation

This publication reflects the combined expertise of both scientists and communication specialists

from the knowledge dissemination working group mentioned earlier. Having contributed to the review of the Sixth Assessment Report, the working group supported the Secretariat in scoping, drafting, reviewing, and simplifying the content. Meanwhile, the Ocean & Climate Platform leveraged its network of organisations to support the conception and development of the communication and dissemination strategy at the international level.

3.5.1.3 Purpose and Focus: Bridging Science and Action for Marine Ecosystems

The aim of the publication is to highlight and make the latest scientific conclusions on the Ocean in the context of climate change more accessible. A deliberate focus is placed on underscoring the critical connections between climate change and biodiversity, viewed through the lens of marine ecosystems. The publication addresses three main questions: (1) What service do marine ecosystems provide? (2) What are the consequences of degrading marine ecosystems? and (3) How can the protection of marine ecosystems help us achieve a sustainable future?

3.5.1.4 Content: More than Just a Summary

Much more than just a summary of what is known about marine ecosystems, this publication features infographics inspired by the *Sixth Assessment Report*, an 'Ocean-climate-biodiversity' glossary and is illustrated by numerous examples and key figures to highlight the links between marine ecosystems, climate change and sustainable development goals.

The publication opens with an overarching illustration (Fig. 3.2), reflecting a dual representation of the Ocean. On one side, it depicts the present or near future, where marine ecosystems are degraded by climate change and human activities. On the other, it envisions an ideal future where societies work to protect and restore these ecosystems. Without the need for words, this illustration encapsulates the central message and structure of the publication.



Fig. 3.2 Illustration from *What Ocean for Tomorrow? Marine Ecosystem in a Changing Climate* (2023). Ocean & Climate Platform

The publication highlights key concepts and ecosystems that are often misunderstood or unfamiliar to the general public. These include the role of plankton in the carbon cycle, the impacts of climate and human-induced stressors on the deep sea, cautionary insights on Ocean-based carbon dioxide removal, the contribution of marine ecosystems to achieving sustainable development goals, and strategies within the maritime sector to reduce greenhouse gas emissions.

Enhanced by infographics adapted from the IPCC, the publication strives to make complex data more accessible with figures on the "Impacts of climate change on deep-sea ecosystems", "Examples of tipping points reached by kelp forest and reef ecosystems", on how "Marine heatwaves are affecting marine life and human communities" as well as on "Achieving the sustainable development goals thanks to marine nature-based solutions."

3.5.2 Challenges Met (and how to Overcome Them)

3.5.2.1 Tailoring the Content to the Target Audience

The primary target audience of *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* is decision-makers. However, recognizing the importance of Ocean Literacy, the publication also extends to a broader range of stakeholders, including journalists, teachers, students, and science communication professionals, all of whom play a key role in raising awareness among current and future decision-makers. This shift was prompted by the high engagement with the Ocean & Climate Platform's scientific factsheets, which are widely consulted by these groups.

To meet the needs of this diverse audience, a key strategy has been simplifying the language to a level accessible to a 15-year-old, significantly younger than the Platform's typical target audience. Science communication experts, experienced in writing for the public, played a vital role in the final review to ensure clarity and avoid scientific jargon.

Acronyms and scientific or political jargon are avoided as much as possible. If mentioned, specific concepts and words are either developed in specific "focus" and/or in the glossary. Another guiding principle was the idea that images and examples can often communicate more effectively than words. In response to increasing demand for actionable insights, this publication includes numerous infographics and illustrations, with careful attention to layout and design. Real-world examples are woven throughout the analysis to provide practical, relatable context, making the content both informative and engaging.

3.5.2.2 Navigating Through Scientific Accuracy and Accessibility

The publication is grounded in the findings of the IPCC reports, which are built on a robust scientific consensus, providing a reliable foundation and helping to avoid controversy. However, translating these complex reports for broader audiences posed significant challenges, particularly in simplifying nuanced observations, diverse scenarios, and varying levels of confidence. For example, the publication features an adapted infographic on the "Impacts of Climate Change on Deep-Sea Ecosystems" (Fig. 3.3), which simplifies a more intricate and detailed schematic. This process required carefully selecting key information while omitting others to ensure the core message was conveyed accurately, remaining faithful to the original source without oversimplifying critical details. The involvement of scientists who contributed to the IPCC reports, in this particular case Dr. Nadine Lebris, was crucial in ensuring both the accuracy and fidelity of the adapted content.

3.5.2.3 Ensuring the Long-Term Diffusion of the Publication

As a reviewer of the IPCC reports, the Ocean & Climate Platform benefited from exclusive access to these reports, allowing to anticipate and align its publications with the release schedule of the IPCC Synthesis Report of the Sixth Assessment Report. This strategic synchronisation enhanced the relevance and timeliness of this publication.

Simultaneously, designing a robust and collaborative communication campaign was cru-

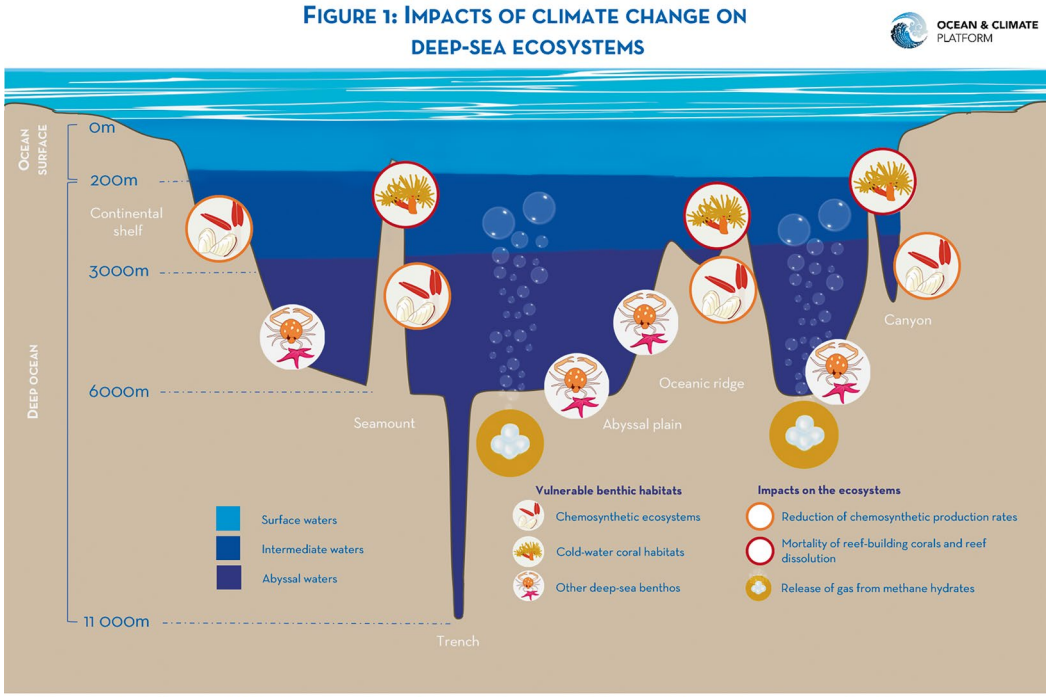


Fig. 3.3 Schematic "Impacts of Climate Change on Deep-Sea Ecosystems" from *What Ocean for Tomorrow? Marine Ecosystem in a Changing Climate* (2023), Ocean & Climate Platform

cial to ensure widespread dissemination of the publication. The communication campaign was articulated around three phases. The first phase, leading up to the release, focused on generating anticipation by highlighting the publication's relevance in the context of the upcoming IPCC Synthesis Report. To engage the public, the Ocean & Climate Platform created social media carousels that explained the role of the IPCC and its Sixth Assessment Report, emphasising its significance in shaping international climate policies and its conclusions regarding the Ocean and marine ecosystems. The second phase, aligned with the release date, concentrated on promoting the publication itself. This included a summary article and social media posts centred around the main illustration (Fig. 3.2) to spotlight the publication's key sections and arguments (Fig. 3.4). The final phase, following the release, aimed to highlight specific ecosystems and concepts from the publication, such as tipping points (Fig. 3.5) and Corals. These topics, chosen for their resonance with public interest and their focus on iconic species, helped sustain engagement and further reinforce the publication's core messages.

The data analysis for the communication campaign conducted between March 13, 2023, and April 13, 2023, revealed a significant increase in engagement. Specifically, the Ocean & Climate Platform website attracted over 13,000 new visitors, compared to the previous month. On social media, posts on X garnered more than 60,000 impressions, benefiting from wider diffusion through the accounts of key partners, including the UN Ocean Decade. A LinkedIn post reached over 16,000 impressions during the same period. Even nearly 2 years after its release, the document's URL on Bitly has been accessed over 4000 times, indicating continued interest. The majority of the audience reached is based in France, reflecting the strong engagement from French stakeholders and the Ocean & Climate Platform's network.



Fig. 3.4 Social media card derived from the illustration of *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* (2023), Ocean & Climate Platform

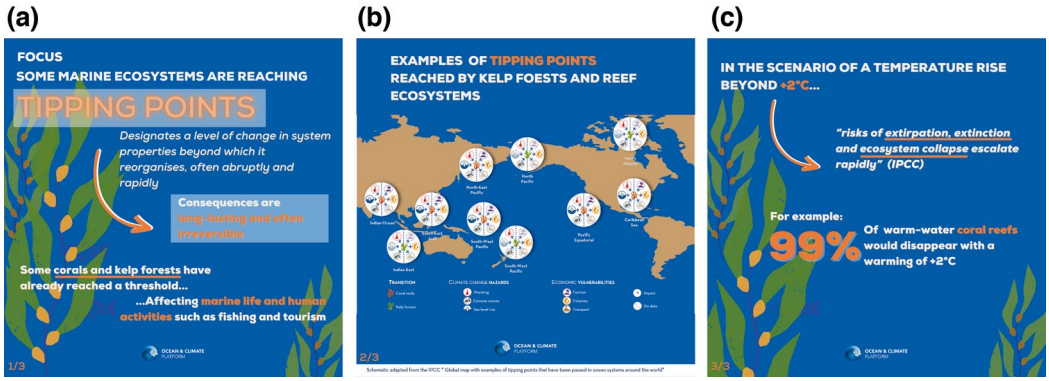


Fig. 3.5 Social media carousel "Focus: Some marine ecosystems are reaching tipping points" derived from *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* (2023), Ocean & Climate Platform

However, these figures should be interpreted with caution. They likely underestimate the full extent of the publication's dissemination and represent only a partial picture. Other dissemination channels, such as conference presentations and exhibitions, may have also contributed to reaching additional audiences. Moreover, these statistics do not provide detailed insights into the identity or roles of those who accessed the publication, which is especially important when the target audience includes decision-makers.

To ensure the long-term dissemination of the publication, leveraging the Ocean & Climate Platform's extensive network of organisations and partnerships has been vital. Member organisations were actively involved in shaping the communication and dissemination strategy ahead of the release, contributing their own distribution channels to significantly broaden the publication's reach. For example, universities within the Platform's network play a crucial role in engaging students and teachers, while museums and aquariums serve as key partners by offering additional resources and expertise to create new formats, such as exhibitions. One such collaboration, involving the Ocean & Climate Platform, the French National Centre for Scientific Research

(CNRS), and Océanopolis, led to the development of an exhibition featuring the publication's text alongside photographs of marine ecosystems by CNRS researcher Erwan Amice. On display since July 2023 in various public places, including Océanopolis at Brest, this exhibition has been seen by over 250,000 people. This partnership not only amplified the publication's visibility but also enhanced its presentation to the public, making the content more accessible and impactful.

3.6 Conclusion

This chapter explored how the Ocean & Climate Platform works to bridge the gap between scientific research and public understanding by uniting more than 100 organizations, including research institutes, museums, NGOs, and civil society groups. To achieve this mission, the Platform focuses on three core objectives: knowledge dissemination, mobilisation, and advocacy.

A key initiative of this work is the knowledge dissemination working group, which brings together scientists and communication experts to translate complex scientific data into accessible information. Since 2015, the group has developed a series of factsheets highlighting Ocean–climate interactions, ensuring that both decision-makers and the general public have access to reliable and timely information. In 2019, the group expanded its role by serving as an official reviewer of IPCC reports for the French government, with a particular focus on making the findings understandable and actionable. Translating intricate scientific reports like those from the IPCC into accessible formats for both decision-makers and the general public, and ensuring effective dissemination, presents substantial challenges. Diversifying formats, sources and thematic, fostering inclusivity in the expertise, and a collective approach in the dissemination strategy have been key in maintaining relevance and engaging a wide audience.

These efforts culminated in the 2023 publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate*, which emphasized the critical role of marine ecosystems in regulating climate, supporting biodiversity, and sustaining human societies. Through collaboration, inclusivity, and innovative communication strategies, the Ocean & Climate Platform demonstrates how scientific knowledge can be transformed into powerful tools for informed action and global Ocean Literacy.

3.6.1 Summary

Key concepts explored in this chapter include:

- The Ocean & Climate Platform, established in 2014, unites over 100 organizations to strengthen understanding of the connections between the Ocean, climate, and biodiversity.
- Knowledge dissemination, mobilisation, and advocacy are the three core objectives of the Platform's work.
- A dedicated knowledge dissemination working group brings together scientists and communication experts to translate complex scientific data into accessible information.
- Since 2015, the group has produced scientific factsheets to share up-to-date insights on Ocean–climate interactions with decision-makers and the public.
- Beginning in 2019, the group has reviewed IPCC reports for the French government, ensuring accuracy and accessibility of Ocean-related findings.
- Transforming technical IPCC reports into clear, public-facing content requires diverse formats, inclusive expertise, and collaborative strategies.
- The 2023 publication *What Ocean for Tomorrow? Marine Ecosystems in a Changing Climate* highlights the vital role of marine ecosystems in climate regulation and the risks posed by their degradation.

3.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Ocean & Climate Platform. (2019). *Scientific Factsheets: Ocean and Climate.* Ocean &

Climate Platform. 130 pages. https://Ocean--climate.org/wp-content/uploads/2020/01/200114_FichesScientifiques_EN_ppp.pdf

- Ocean & Climate Platform. (2016). *Scientific Factsheets: Ocean and Climate. Volume 2.* Ocean & Climate Platform. 100 pages. https://www.Ocean-climate.org/wp-content/uploads/2016/10/internet-161024_ScientificNotes_Oct2016_BD_ppp.pdf
- Ocean & Climate Platform. (2015). *Scientific Factsheets: Ocean and Climate. Volume 1.* Ocean & Climate Platform. 128 pages. https://www.Ocean-climate.org/wp-content/uploads/2015/10/151022_ScientificNotes_07.pdf
- Ocean & Climate Platform. (2016). *Factsheets: The Interactions Between Ocean and Climate. Volume 2.* Ocean & Climate Platform. 12 pages. https://www.Ocean-climate.org/wp-content/uploads/2016/11/161115_DIFFCO_EN_06.pdf
- Ocean & Climate Platform. (2015). *Factsheets: The Interactions Between Ocean and Climate. Volume 1.* Ocean & Climate Platform. https://www.Ocean-climate.org/wp-content/uploads/2016/10/161011_FactSheets_EN.pdf

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IPCC (2023) In: Core Writing Team, Lee H, Romero J (eds) Climate change 2023: Synthesis report. Contribution of working groups I, II and III to the sixth assessment report of the intergovernmental panel on climate change. IPCC, Geneva, Switzerland, pp 35–115. https://doi.org/10.59327/IPCC/AR6-9789291691647

Ocean & Climate Platform (2019) Ocean & climate change: New challenges. Focus on 5 key themes of the IPCC special report on the Ocean and cryosphere. Ocean & Climate Platform. 40 pages. https://Ocean-climate.org/wp-content/uploads/2019/12/fiches-EN-web.pdf

Ocean & Climate Platform (2023) What Ocean for tomorrow? Marine ecosystems in a changing climate, insights from the IPCC's sixth assessment report. Ocean & Climate Platform. 36 pages. https://bit.ly/3YVWZSV

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[2]Sarah Palazot: Co-conceptualization; Project Coordination; Writing—Original Draft, Review, and Editing.
[3]Françoise Meyer: Writing—Original Draft.
[4]Céline Liret: Project Administration and Supervision; Writing—Review and Editing.

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4 BlueNIGHTs: Bringing a Touch of Blue in the EU Researchers' Nights for a More Sustainable Use of the Ocean

Francesca Alvisi, Daniela Figueiredo, Erica Villa, Sacha Bernet, Edward Bratfanof, Rute Candeias, Alan Deidun, Guillaume Lheureux, Olga Mashkina, and Ljudmila Vesikko

Abstract

The main objective of BlueNIGHTs was to plant 'blue' seeds across Europe to improve Ocean Literacy (OL) and grow a new network of European Researchers' Nights (ERNs) focused on Ocean issues and the achievement of the Sustainable Development Goals (SDGs). The initiative, specifically targeting SDG 14, aligns with the United Nations (UN) Decade for Ocean Science, the EU Starfish Mission and major European initiatives dedicated to OL, such as EU4Ocean. Our aim was to show European citizens the different facets and faces involved in marine research by organising a series of interconnected ERNs. BlueNIGHTs brought together researchers from different European countries who collectively address Ocean challenges and solutions to demonstrate their deep understanding of the complexity of human-Ocean interaction.

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In this chapter, we illustrate the process of developing such a project, from conception to partnership building and work package development. We believe that sharing this experience is essential because it fosters fruitful interactions between the scientific community and society, connecting researchers with pupils and teachers and bringing Ocean issues to local communities, both near and far from the sea.

Keywords

Ocean Literacy (OL) · European Researchers' Night · Science & society · Human-Ocean interaction · Blue careers · Scientific approach

4.1 Introduction

4.1.1 The Background

In 2015, the UN General Assembly adopted "*a plan of action for people, planet and prosperity*": the Agenda2030 for Sustainable Development (UN 2015). It indicates 17 major SDGs to be achieved by 2030 to ensure a sustainable development that can benefit all. The choice of these goals reflects the major, interconnected global issues that affect society, from poverty to health care, quality education to gender equality, clean energy to sustainable economic growth, climate change to environmental degradation. Among them, SDG 14 is devoted to the "*conservation and sustainable use of the Ocean, seas and marine resources for the development of a new, inclusive, interconnected and healthier global (Ocean) literate society*". Two years later, the UN proclaimed the Decade of Ocean Science for Sustainable Development (2021–2030) to "*support efforts to reverse the cycle of decline in Ocean health and gather Ocean stakeholders worldwide behind a common framework that will ensure Ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean*" (UNESCO-IOC 2021).

SDG 14 is indeed cross-cutting and interconnected to the other SDGs, beyond its relevance to Ocean issues themselves (Singh et al. 2018). A healthy Ocean contributes to poverty eradication (SDG 1) by creating sustainable livelihoods (SDG 2) and decent work (SDG 8) for over three billion people depending on marine and coastal resources. Ocean is also crucial for global food security (SDG 2) and human health (SDG 3 and 6). It is the primary global climate regulator (SDG 13), an important sink for greenhouse gases (SDG 7, 9, 11 and 12) and it contributes to clean water (SDG 6) and oxygen. Finally, the Ocean is an amazing reservoir of biodiversity (SDG 15). Furthermore, the importance of the Ocean for sustainable development is widely recognized by the international community and embodied in the Agenda2030 (UN 2015), the Johannesburg Plan of Implementation (UN 2002) and several decisions taken by the UN Commission on Sustainable Development. The EU Commission (EC) also received this message and elaborated the EU Mission Starfish 2030 strategy (Lamy et al. 2020) to define priorities and challenges regarding its Regional Sea Areas (RSAs).

4.1.2 Empowering the Connection Between Science and Society

Within this landscape, the global marine science community has been called upon to play an important role in driving change towards a more Ocean-literate society for a more sustainable use of the Ocean (Uyarra and Borja 2016; Claudet et al. 2020; Cappelletto et al. 2021). Among the available initiatives, we chose to take advantage

of the ERN that is already a consolidated and widespread event series across EU. This is one of the most important opportunities for public and media promotion of research careers across the EU, aimed at young people and their families. The ERN addresses and attracts people regardless of their scientific background (Jensen et al. 2021), with a special focus on families, pupils and students, and notably those who do not have easy access to and thus are less motivated to engage in STEAM fields and research activities. It takes place every year, on the last Friday of September, involving more than 1.5 million EU citizens every year, in an informal atmosphere in more than 350 cities across EU (Roche et al. 2017, 2018). Pre-events, prior to the main event, and related post-events, such as wrap-up meetings or small-scale follow-up events, are already an integrative part of the main event and, year by year, they act as a driving path between ERNs. The ERN also brings researchers to schools to interact with pupils at any time during the school year. The recently introduced *Researchers at School* initiative allows researchers and pupils to directly interact on societal and environmental challenges and on the key role of research to address them. Thus, pupils learn directly from researchers about their projects and initiatives related to key EU priorities thus becoming informed citizens with increasing skills and knowledge to actively participate in decisions and strategies for the Ocean (Devenport et al. 2021).

4.1.3 The Leading Idea

BlueNIGHTs relied on the idea to plant BLUE seeds across EU to strengthen OL for all and favour the growth of a new network of ERNs dedicated to Ocean issues and to the achievement of the SDGs, responding to the UN Decades of Ocean Science and to key EU initiatives on OL (e.g., EU Blue School Network). It was led by the National Research Council (CNR), Italy's main public research body, through the Institute of Marine Sciences (CNR-ISMAR). Since 2008, CNR-ISMAR has provided valuable support in the coordination and organisation of successful ERNs in several Italian cities. With the support of ACTeon sarl (ACTEON), a French consultancy and research company, coordinator of the EU4Ocean project, the CNR guided the partners towards a cost-effective implementation of local events in a wider network perspective.

The word BLUE of its acronym reflects the partners and activities common (Ocean) ground. Recognizing the challenges faced by ERN organisers in 2020 and 2021 due to COVID-19 pandemic (Jensen et al. 2021), BlueNIGHTs offered the opportunity to look beyond daily challenges in a more visionary way, building on past and present knowledge and understanding. BlueNIGHTs was an opportunity to remind participants that researchers from different disciplines working beyond geographic and political boundaries are a valuable resource for the society that can help address these challenges.

4.2 The BlueNIGHTs Project

4.2.1 Objectives

BlueNIGHTs aimed to strengthen the link between science and society, between marine researchers and the community in which they live, by preparing and organising ERN events and activities in cities representing major EU RSAs. The initiative brought together researchers whose daily work addresses Ocean challenges and solutions in a truly collective European initiative. Far from hiding in their laboratories and institutes, researchers from all disciplines were able to show how research is deeply rooted in and aware of the complexity of human-Ocean interaction.

BlueNIGHTs wanted to show how scientific researchers can:

- make a concrete contribution to design a better present and a more sustainable Ocean management;
- help change gears and direction to strengthen the resilience of society;
- give greater visibility to women and girls involved in marine science and research;
- strengthen relationships and networks by sharing different types of knowledge and skills in an equal, respectful and constructive relationship.

Another fundamental objective of BlueNIGHTs was to increase awareness on Research & Innovation (R&I) with special attention to kids, pupils, students and young adults. By sharing concrete examples and testimonials from the research actors, it demonstrated particularly to girls and women that research and science to address Ocean challenges represent empowering and exciting opportunities for their future life and careers.

BlueNIGHTs also wanted to accompany people to capture and understand key objectives, principles and priorities of the EU Mission Starfish 2030. It contributed to the growth of a generation of Ocean-literate EU citizens, in line with the objectives of EU4Ocean, highlighting the importance of the Ocean for our society. Its focus was on priority areas that are central to the EU by developing and realising suitable pedagogical material and toolkit for further education and training on these issues.

4.2.2 Strategy and Approach

BlueNIGHTs strategy revolved around the following main assets to ensure that the objectives were achievable and measurable:

(a) *Promote a variety of approaches*: some people enjoy listening to interesting topics, while others like a greater degree of involvement or prefer approaching science through gaming. Proposing a wide range of activities and events is a way to attract different kinds of visitors to interact with researchers;
(b) *Organise pre-events to build momentum*: pre-events in different venues and times can capture attention in different urban environments and are additional opportunities for direct interactions between researchers and citizens. Organised into the "Getting ready" specific program strictly related to the ERN, pre-events substantially contributed to increase public awareness and disseminate information;
(c) *Multidisciplinary matters*: ensure the presence of researchers with very different backgrounds (e.g., geology, biology, oceanography, economics, architecture) and skills (i.e., people who work on the field and/or in labs), and involving experts from social sciences and humanities, art and music together with marine scientists;
(d) *Exploit unusual/informal locations*: provide scientific contents outside its usual venues to engage people, such as scientific coffee held in popular hangouts, and guided tours in local cities and their surroundings. Events had an informal tone and gathered small numbers of participants as key ingredients to promote the engagement and closer interactions;
(e) *Engage Schools*: high school students (ages 14–18) are perfect ambassadors of research content aimed at the public and younger pupils. Dedicated school collaborations were organised, using already available networks (e.g., the Blue School Network) or creating new initiatives (i.e., Adopt a School);

(f) *Stakeholders matters*: make use of available networks of stakeholders (e.g., EU4Ocean Coalition) to build local connections for designing joint initiatives to enrich the cultural and scientific contents and help widen dissemination locally;
(g) *Make the ERN available to everyone*: activities and events were recorded and proposed on-line to allows higher participation, ensuring greater visibility during and after the project. It provides a practical solution to the challenge of distance as everyone can be within 'virtual walking distance';
(h) *Visible and easy to find*: indoor/outdoor activities were carefully described and advertised in various channels, including the distribution of printed programs as well as through targeted communication social media campaigns. Existing networks can play a crucial role as multipliers tools;
(i) *One MSCA team*: young researchers supported by the EU Maria Skłodowska Curie Actions (MSCA) were asked to join the ERN, in person or virtually, to interact with the public that could appreciate the broad variety of international research efforts and the EU role in supporting them.

The project was therefore built on the following principles:

- Collective and truly EU—mobilising organisations from each of the EU's RSAs to present their own scientific research activities, on the one hand, and provide general information and how the EU funds scientific and educational cooperation, on the other;
- Inter−/multi−/transdisciplinary—consortium partners reflected the EU's scientific cultural diversity, such as different disciplinary fields and research experiences focused on the Ocean and its complex connections with human activities;
- Immersive, inclusive and (inter)connected—combining an interactive, hands-on on-site experiences, with direct contributions and experiences from the public by doing, touching, playing, testing, exploring, as well as an interactive virtual experience to learn more about real working conditions of marine researchers.

4.2.3 Partnership and Collaborations

BlueNIGHTs involved ten participants six of whom work in the EU's scientific Research & Innovation field: CNR-ISMAR, with its five local branches, and the R&I consortium represented by the Venetian District of Research and Innovation (DVRI) in Italy, the Finnish Environment Institute (SYKE) in Finland, the Danube Delta National Institute for Research and Development (INCDDD) in Romania, the Department of Geosciences of the University of Malta (UNI TA MALTA) in Malta and the Centre for Environmental and Marine Studies of the University of Aveiro (UA-CESAM) in Portugal. ACTEON, the French National Sea Center Nausicaá, the Portuguese Association for Environmental Education (ASPEA) and the private company Holo3 have in-house researchers who are experts in various disciplines.

All partners already had experience in managing EU-funded projects, organising public events, awareness-raising campaigns and evaluating the impact of activities. Therefore, the responsibility for the different WPs was shared among the consortium members. The tasks were then allocated to partners taking into consideration their specific expertise. Thanks to the nature of BlueNIGHTs consortium, it was easy to enlist researchers involved in marine research and technology development, as well as other research activities (e.g., design, art, economics, social sciences, education). CNR, ACTEON, SYKE, UNI TA MALTA, INCDDD, UA-CESAM and DVRI ensured the multidisciplinary aspect by also including the socio-economic sectors. They also represent national networks or/consortia of researchers, each of them centres of excellence in their specific RSA.

The Steering Committee (SC), which consisted of the project coordinator (plus one deputy) and one representative (plus one deputy) from each beneficiary partner, acted as the main decision-making body of the consortium and was responsible for the overall direction, coordination and evaluation of the project, as well as decision-making and conflict resolution. The SC also supported and stimulated cross-cooperation between different practices, countries and locations, ensuring cohesion and consistency within the project. The planned Advisory Committee (AC) was not created mostly due to language problems and to the site-specific nature of the stakeholder involvement. Instead, local ACs were informally created by the partners, each of them including relevant stakeholders and end-users particularly interested in the organisation/participation of/to local events.

BlueNIGHTs project reflected a focus on gender balance in the composition of the SC and management structure, with four out of six female WP leaders, and six out of ten female SC members. Gender balance was also applied to the organisation of pre-events and in the selection of activities and related objectives that contributed to the ERNs. It was also crucial to give visibility to the many female researchers involved in the dissemination and diffusion of marine research results, who are often much more active than their male colleagues.

4.2.4 Topics Considered and Research Areas

BlueNIGHTs partners solicited spontaneous contributions from all researchers of participating organisations and local/national/international stakeholders.

The wide range of research areas available within the project included, among others:

- marine sciences to understand, on the one hand, how the Ocean is made and how it works, and, on the other hand, how marine space and resources are/can be managed sustainably;
- marine technologies to understand how and why to monitor the Ocean system, including its connection to climate;
- educational sciences to analyse and understand people's attitudes towards the Ocean;
- economic sciences to grasp the economic and social importance of the Ocean and the ecological services the Ocean provides to society;
- communication sciences to highlight the role of science and media literacy in understanding the factors necessary for people's OL;
- humanities to explore the role of the Ocean as supporting social and economic development throughout history;
- digital technology and design to investigate new ways of approaching Ocean issues;
- arts to make science more inclusive, accessible and engaging.

4.2.5 The Implementation

The project was structured into five Work Packages (WPs) following the EC rules, plus an additional WP (i.e., WP2) added to help visitors virtually enter Ocean research.

The WP1 objective was to organise the awareness-raising campaign including the design of the visual identity, the creation of the website and social media, the promotion of all ERN events and several joint pre-events of different RSAs (Fig. 4.1).

To develop an effective awareness-raising campaign, we first had to define who would be the target audience for the different events/activities and how best to reach these audiences. We identified the following categories:

- researchers,
- pupils and teachers,
- students/young researchers,
- citizens.

Then we had to develop the following elements:

- an attractive visual identity,
- the website and social channels, and guidelines for their use,



Fig. 4.1 Examples of the communication materials: a) website home; b) social pages; c) post-cards; d) the virtual platform

- relevant communication materials and their adaptation to different countries/contexts/languages,
- the organisation and realisation of pre-events in different categories.

The aim of WP2 was to co-develop a digital twin of the real Aranda Research Vessel (R/V) in service at SYKE. This activity acted as a connector of knowledge being open, transversal and interdisciplinary according to the shared goal of connecting research places and activities and addressing the Ocean as a common object of study. This product (Fig. 4.2) presents the activities and work of the researchers onboard during oceanographic campaigns.

The virtual reality experience helped visitors to project themselves into the Ocean in a variety of situations and contexts that few could experience, such as diving to monitor the state of the marine ecosystem, collecting water and sediment samples or exploring the geomorphology of the seabed from the control room. This application is designed to evolve, become richer, obtain content extensions and enjoy a cost-effective annual update over its lifetime.

The WP3 (Fig. 4.3) was dedicated to design and implement all events and activities carried out during the two ERNs editions in the different RSAs: Tulcea/Galati (Romania) for the Black RSA; Bologna/Capo Granitola/La Spezia/Naples/Roma/Trieste/Venice (Italy) and Valletta (Malta) for the Mediterranean RSA; Cascais/Horta/Lisbon/Torreira (Portugal) for the Atlantic RSA; Boulogne-sur-Mer (France) for the English Channel/North RSA; Helsinki (Finland) for the Baltic RSA. In coherence with its truly EU character, activities were also organised in Strasbourg (France), one of the EU capitals hosting more than 20 EU institutions including the EU Parliament, the Council of EU and the EU Court of Human Rights.

The ERN programs were defined through a bottom-up approach starting from researchers' proposals, in close collaboration with the project coordinator and the SC to account for practical and conceptual needs. Collaboration with local cultural and/or scientific organisations (e.g., academia) was also crucial to the success of the events, as was the choice of informal and/or well-known venues. Proposing up-to-date and interesting topics and contents for the events was

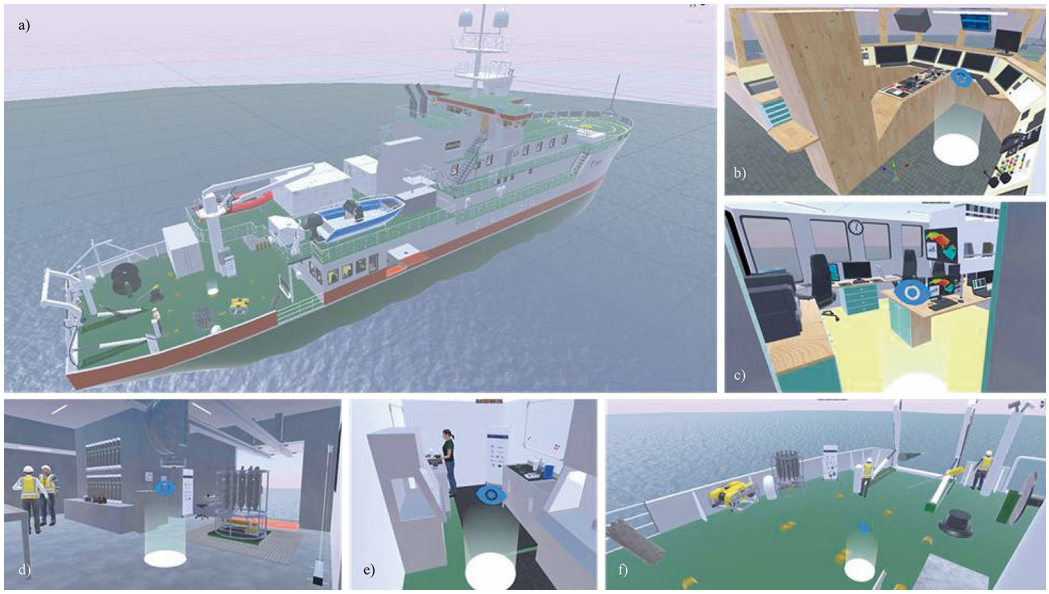


Fig. 4.2 Some examples of the virtual R/V Aranda prototype: a) aerial overview of the ship; b) captain's bridge; c) control room; d) Rosette sampling room; e) wet lab; f) rear deck



Fig. 4.3 ERN activities in: a) Torreira; b) Faial; c) La Spezia; d) Valletta; e) Lisbon; f) Bologna; g) Valletta

important to attract schools and citizens. Practical activities were considered the most interesting and received very positive feedback.

The WP4 was dedicated to meet the schools (Fig. 4.4). BlueNIGHTs brought researchers into schools and/or pupils to their own working spaces to raise awareness on the importance of research methods and approaches, strategies and results. By offering interactive lessons, hands-on activities and guided tours, researchers directly engaged



Fig. 4.4 Some activities realised within the WP4 with primary (ages 6–10), middle and secondary schools (ages 11–18)

pupils in their scientific activities. We also wanted to create local learning communities to promote the insertion of marine sciences into school curricula to grow a more Ocean-literate new generation and to promote the participation of pupils and teachers to ERN activities and pre-events.

Within this WP, we built a special program to promote a free space of interaction between researchers and pupils called *BlueScience meet BlueSchools*, focusing on blue challenges and the key role of marine research in addressing them. Each partner contributed to this WP with already consolidated or new activities related to its own research areas to contribute to grow *A new 'blue' generation*. In addition, several schools were deeply involved in the project through the *Adopt-a-School* initiative. The aim was to support pupils during the school year to enable them to participate in the ERN as *Young researchers to renew the BlueNIGHTs*, as well as the training of teachers to enlarge the *Network of Ocean Literate teachers*. Previous experiences and best practices of BlueNIGHTs partners in blue education were the basis for the development of a common shared pathway within the initiative offered to pupils to learn about research careers, marine research and initiatives addressing key EU marine challenges and priorities.

The offered lessons and interactions were to be adapted to the age of the pupils and they used alternative approaches such as tinkering, learning-by-doing, virtual reality, gaming, audiobook, photo competitions and hands-on activities adapted to several ages starting from primary school (ages 6–10).

In WP5, a thorough impact assessment (see Sect. 4.3 for more details) was carried out to assess the benefits and added-value of the different activities organised under BlueNIGHTs, from the pre-events (WP1) to the school-dedicated events (WP4), up to the two ERN events (WP3). The assessment gave particular attention to the: (a) truly EU identity of BlueNIGHTs, offering the opportunity to discover scientists from other EU countries and regional seas; (b) diversity of disciplines presented and how this helped to "find her/his way" to science topics closer to each person's interest; (c) complementarity between activities organised in person and those organised at a distance; (d) added value of the virtual Aranda R/V in facilitating the understanding of researchers' work and life.

The WP6 ensured coordination and technical evaluation of the project, including administrative, legal, financial and accounting management (see Sect. 4.2.3 for more details). By jointly tack-

ling common challenges such as activity reporting, bureaucratic-administrative issues and logistical coordination of events, BlueNIGHTs created cohesion and a spirit of cooperation among the partners and a greater awareness of the importance of this EU event. This demonstrates that the enormous effort to create shared structures, tools and strategies within the consortium during the first year of the project provided the valuable substrate to enable the partners to better organise themselves and exploit their potential during the second year of the project.

4.3 Impact Assessment and Obtained Results

The main objective of the WP5 was to assess the impact of BlueNIGHTs activities and events at all locations. Among the specific objectives, we had the: (i) assessment of participation and overall appreciation of the proposed activities/events; ii) evaluation of attitude to attend similar events in the future; (iii) assessment of the number of attendees and their socio-economic and cultural characteristics (e.g., age, sex, occupation, background); (iv) assessment of the most/least successful activities; (v) evaluation of changes in attitudes toward science and researchers with special reference to benefits that researchers bring to society, reduction of stereotypes about researchers and their profession that hinder the choice of a scientific career, and the role of the EU in supporting research.

4.3.1 Content and Implementation of the Assessment Methodology

The consortium designed a common system to monitor the impact of initiatives by defining quantitative and qualitative indicators to ensure their success and evaluate their usefulness. At the beginning of the project, we shared assessment methods and strategies to design standard materials and tools to be used for BlueNIGHTs.

We carried out multiple assessment studies (see Table 4.1). These consisted of: a) onsite and

Table 4.1 The different clusters used to group the questions in the survey questionnaires (from Villa 2024)

Cluster 1: Enjoyment and Effectiveness	How satisfied are you with the event?
	How would you quantify the increase in your knowledge after the event?
Cluster 2: Participant Information	What gender do you identify with?
	How old are you?
Cluster 3: Approach to Science	What is your most used source of scientific information?
	Have you ever participated in another European event such as the EU researchers' night?
Cluster A: Participants of pre-events; Questionnaire of pre-events	What is your profession?
	How did you find out about the event?
Cluster B: Researchers at school; Questionnaire for schools	Focusing on science subjects, do you think they are: Interesting? Burdensome? Boring? Easy?
	Have you ever thought of becoming a scientist?
Cluster C: ERN participants and science Questionnaire for the Night (public)	How did you find out about the event?
	Which of the topics discussed interests you the most?
Cluster D :Researchers and Outreach Questionnaire for Researchers	How comfortable were you with communicating with the public?
	Have you ever been educated on how to best disseminate science?
	Do you think you need a course to learn how to disseminate science?
	For each of these activities, how important do you think it is to have a targeted education in communicating with the public:
	−communication to non-academic audiences through traditional media.
	−communication to non-academic audiences through mass media and online.

online surveys, and face-to-face interviews with pre-events' attendees within WP1, as well as within WP3 on the ERNs; b) onsite and online survey and face-to-face interviews during the WP4 with school pupils; c) online questionnaires and face-to-face interviews with researchers. These data were analysed using quantitative and qualitative (e.g., content analysis) approaches (Villa and Sartori 2023; Villa 2024).

4.3.2 Assessment Results

The project encouraged skills development and fostered commitment to environmental stewardship through related initiatives such as EU4Ocean and the #MakeEUBlue campaign. Past assessments have shown significant positive shifts in perception as well as increased scientific knowledge among participants, validating the project's approach and reinforcing its potential future continuation (e.g., Pietrantoni et al. 2020). Moreover, around 90% of high school (ages 14–18) pupils found that interacting with researchers increased their awareness of research benefits for society.

The BLUE ERNs continued to showcase the role of research in sustainable Ocean development across various regions, facilitating public engagement with researchers and diverse topics. Researchers demonstrated how their work contributes to Ocean sustainability, including green (and blue) energy, predictive models for safety, personalized medicine, and marine biodiversity conservation. This insight helped citizens understand scientists' contributions to the marine environment's current and future health.

Stereotypes hinder young people, especially girls, from pursuing research careers, reflecting the low representation of women in STEAM fields. Events like ERNs aim to inspire youth, particularly girls, towards scientific careers by challenging gender biases. Surveys conducted during and after ERN activities gauged attitudes towards scientific careers and stereotypes (Table 4.1, Cluster B). BlueNIGHTs prioritized diversity among researchers to highlight diverse career paths and perspectives, fostering interest in STEAM studies and jobs. The virtual experiences on the R/V Aranda offered insight into researchers' daily lives, further enhancing understanding and engagement.

Throughout all pre-events and activities organised by BlueNIGHTs, a deliberate emphasis was placed on fostering interaction and collaboration between the public and researchers. Whether in person or through the virtual platform, visitors had the opportunity to engage with a diverse array of scholars representing various ages, genders, nationalities, and cultural backgrounds. This heterogeneous representation offered visitors a comprehensive view of the multifaceted nature of research and the people who carry it out.

In addition, visitors had the opportunity to connect with representatives of organisations that use the work and findings of researchers to inform decision-making processes, to design educational initiatives, and to organise awareness-raising campaigns. These interactions provided valuable insights into the practical applications of research to address pressing global challenges such as climate change and marine litter pollution. By facilitating these exchanges, ERN projects may not only facilitate knowledge sharing but also highlight the vital role of research in promoting positive changes in society and environmental management.

Encouraging young people to pursue careers in research is key to promote innovation and address global challenges (Akkok et al. 2021). Researchers (in any field) play a key role in advancing knowledge and finding solutions in various fields, from medicine to environmental sciences. Furthermore, investing in research training prepares young people for the demands of the economy of the future, where these skills will be increasingly valuable (Devenport et al. 2021). By fostering a passion for research, we empower young people to make a meaningful contribution to society, address global environmental changes and inequalities, and realise themselves.

Globally, with regards to the selected questions for the WP5 deliverables (Villa and Sartori 2023; Villa 2024), as well as for most of the other questions, the data showed:

1. A high outcome in the overall level of satisfaction derived from the participation to both ERN 2022 and 2023, ranging from 29% of "satisfied" participants to 66–68% of "very satisfied" participants;
2. An increase in the level of self-assessment of the knowledge acquired by pupils, improved by "a lot" for 33% in 2022 and for 96% in 2023;
3. A decrease in the age range of people who participated in the ERN 2023 (i.e., 63% of participants were under 30 years old);
4. A much wider participation of pupils in 2023 pre-events (i.e., 2800 in 2022 vs 7150 in 2023);
5. An increase of people that participated for the first time ever in the pre-events from 50% to 84% in 2022 and 2023, respectively, showing we reached a wider and "brand new" audience;
6. A much higher level of interest among pupils in science topics (Fig. 4.5);
7. The websites and social media for both years as the main source of scientific information for participants showing how important is, nowadays, to invest in the digital platforms;
8. A significant increase in the number of people reached by the consortium mailing lists, very important sources of information on the project activities;
9. In both years (42–52%), pupils responded that they had never thought about becoming researchers, implying that BlueNIGHTs was able to spark inspiration and curiosity for the first time in their lives;
10. A very high percentage of people (88–92%) who responded in both years that there should be more interaction between researchers and citizens;
11. Biodiversity & Conservation, but also Climate Change and Environment, are the topics that most of the attendees chose when asked about the themes they were more interested in (Fig. 4.6), again showing the BlueNIGHTs was indeed a kind of projects that well responded to the communities' interests;
12. In both years, researchers stated that they had learned to communicate their research through past experiences. But in 2023 (Fig. 4.7) there was an increase in people responding that they had attended a dedicated course in science communication, possibly because of the 2022 BlueNIGHTs experience and/or the availability of dedicated training courses organised within the framework of similar projects (e.g., SOCIETY riPENSAci).

Overall, we reached out to more than 2000 researchers, involved more than 25,000 citizens, organised more than 200 pre-events and 26 ERNs, and created a strong network of organisations that will take what they learnt during the BlueNIGHTs project into future OL-related

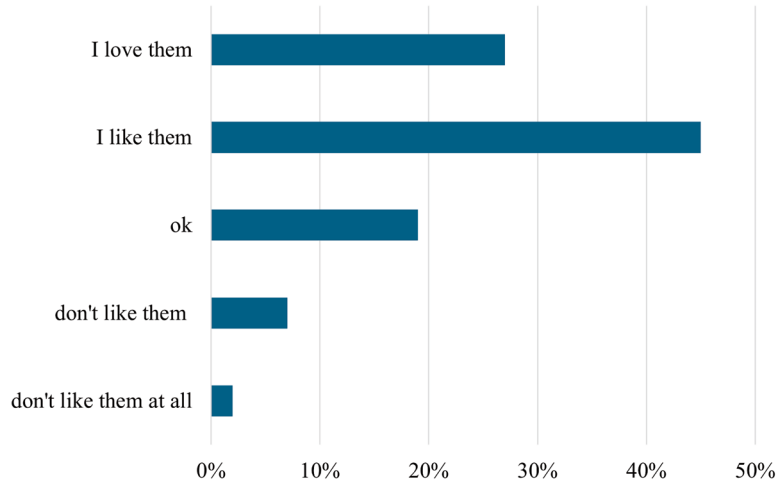


Fig. 4.5 Expression of interest towards scientific subjects by young participants in 2023 (from Villa 2024)

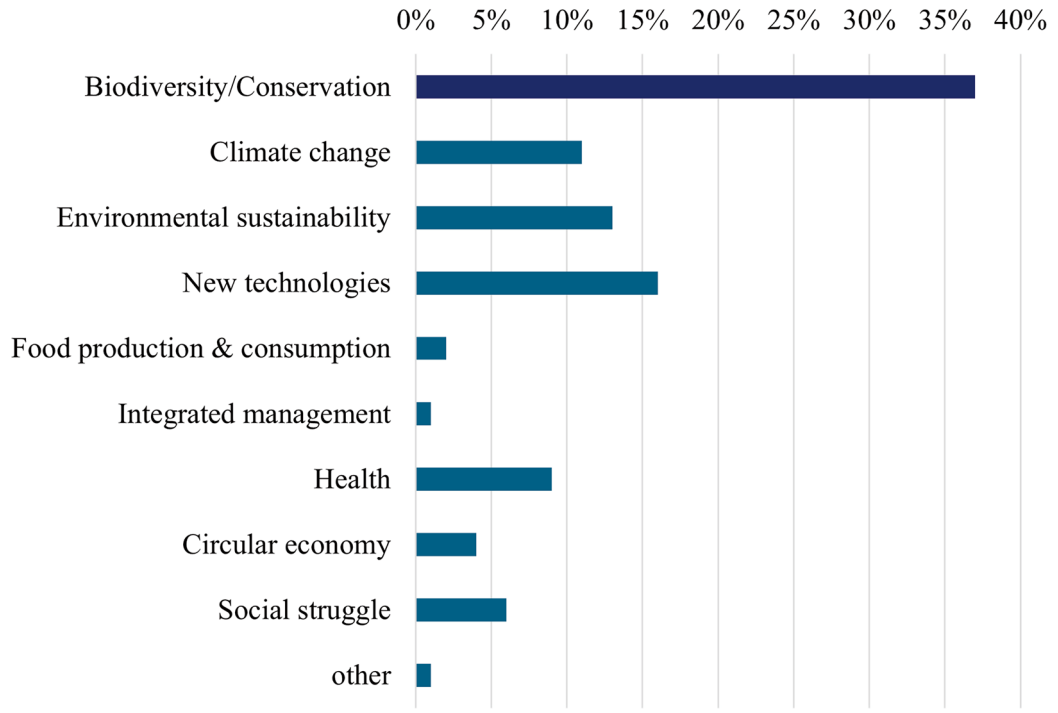


Fig. 4.6 Topics of most interest to participants in 2023 (from Villa 2024)

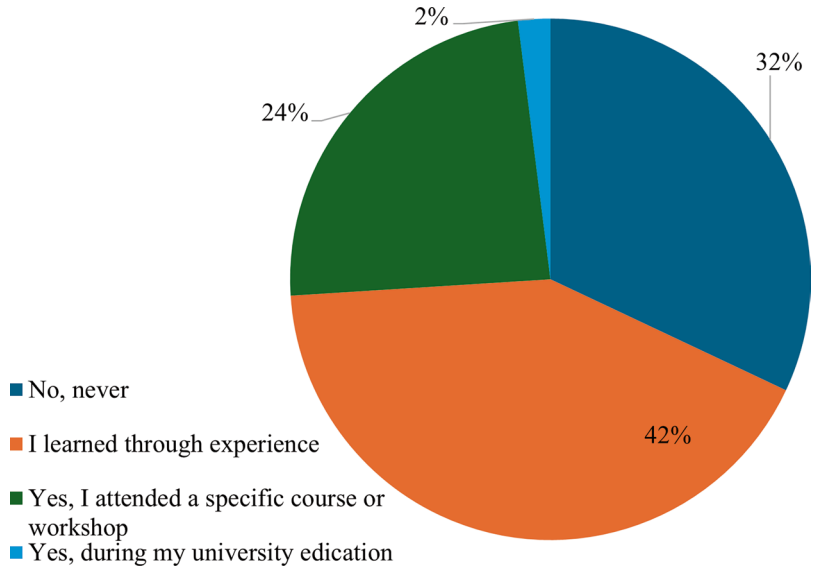


Fig. 4.7 Training experiences of researchers on scientific dissemination in 2023 (from Villa 2024)

activities. We have gathered evidence that demonstrates a strong need for people (young and old) to learn more, to get more involved and to find out (and understand) what researchers do and think. For their part, researchers want to learn how to talk to the citizens about their extraordinary careers to ignite curiosity and inspiration in future generations and to help shape a better future for our planet through their work.

4.4 Conclusions, Lessons Learnt, and Recommendations

Thanks to the work done in the BlueNIGHTs project, the consortium managed to create a large, interconnected team at EU level to promote OL through the ERN. Furthermore, by sharing best practices and strategies between different actors and organisations that had no experience in this type of project, the various partners were able to co-organise a series of interconnected events and activities with greater self-sufficiency and efficiency and to start germinating the blue seeds planted during the project.

By tackling common challenges together such as reporting activities, bureaucratic-administrative issues, the coordination of logistics in many different cities and places in EU, the expansion of the participation of new schools and stakeholders, it has created greater cohesion and spirit of collaboration between partners and greater awareness of the importance of this EU event. This demonstrated that the enormous effort aimed at creating shared structures, tools, and strategies within partner consortia during joint projects constituted a valuable substrate to allow the partners to better organise and exploit their potential during and after the projects.

About interaction with schools, it was sometimes difficult to manage the discrepancies between school schedules and activities prepared by researchers (e.g., research fairs and outdoor activities). With an early and shared planning with teachers, however, it is possible to solve some of the main problems and help pupils and teachers by training them appropriately. Transport costs and organisation to take pupils out of the school are also often a problem. Therefore, to stimulate their interest and commitment to participate, it is necessary to provide dedicated funds by also synergising with other funding programmes (e.g., Erasmus+).

In conclusion, the improvement in the general level of satisfaction of both partners and citizens/stakeholders resulting from participation in the ERN, the high percentage of people asking for greater interaction between researchers and citizens, and last but not least the fact that the researchers said they learned to communicate their research better thanks to this experience, confirmed that the ERN projects are a wonderful chance to create a permanent link between science and society.

Finally, the strong need on the part of citizens to know more, to be more involved, to find out what researchers do and, on the part of researchers, to learn to tell their extraordinary careers to the public in order to arouse curiosity and inspiration in the next generations, confirms how important it is for the EU to continue investing in this type of initiative, giving more and more researchers the opportunity to meet EU citizens in every corner of the continent and beyond its borders.

4.4.1 Summary

Key concepts explored in this chapter include:

- BlueNIGHTs is a pan-European initiative designed to promote Ocean Literacy by integrating marine science themes into European Researchers' Nights (ERNs) across diverse regions and disciplines.
- Human-Ocean interaction was a central focus, explored through informal, immersive events that made marine science approachable for citizens of all ages, cultural background, and scientific familiarity.
- Virtual tools like the digital twin of the Aranda R/V offered novel ways for the public to experience marine research and understand scientific practices onboard.
- STEAM education and gender equity were promoted by highlighting diverse researcher profiles and encouraging youth, especially girls, to see marine science as a viable and rewarding BLUE career path.
- Collaborative networks were strengthened among schools, researchers, and institutions across the EU, supported by EU initiatives such as the Mission Starfish 2030 and EU4Ocean, with a strong emphasis on inclusive, accessible engagement.

- Impact assessment demonstrated increased public engagement, improved understanding of Ocean science, and reinforced the importance of sustained dialogue between scientists and society to achieve the Sustainable Development Goals (especially SDG 4, 5, 11, 12 and 14).

4.4.2 Recommended Resources

The following resources provide further insights and support on this topic:

- European Researchers' Night: https://marie-sklodowska-curie-actions.ec.europa.eu/actions/msca-citizens/join-a-celebration-of-science
- BlueNIGHTs—A touch of Blue in the EU Researchers' Nights for a more Sustainable Use of the Ocean: https://bluenights.eu/
- United Nations Decade of Ocean Science for Sustainable Development (2021–2030): https://Oceandecade.org/
- EU4Ocean initiative: https://maritime-forum.ec.europa.eu/theme/Ocean-literacy-and-blue-skills/Ocean-literacy/eu4Ocean-coalition_en
- European Marine Science Educators Association (EMSEA): https://www.emsea-net.eu/
- National Research Council (CNR)—Institute of Marine Sciences (ISMAR): https://www.ismar.cnr.it/
- University of Aveiro (UA)—Centre for Environmental and Marine Studies (CESAM): https://cesamteste.web.ua.pt/
- Venetian Research and Innovation District (DVRI): https://www.distrettovenezianoricerca.it/
- Holo3: https://holo3.com/
- Danube Delta National Institute for Research and Development (INCDDD): https://ddni.ro/
- Portuguese Association for Environmental Education (ASPEA): https://www.aspea.org/
- University of Malta—Oceanography Research Group (UNI TA MALTA): https://www.um.edu.mt/research/Oceanographymalta/
- Nausicaá National Sea Centre: https://www.nausicaa.fr/
- ACTeon sarl: https://www.acteon-environment.eu/
- Finnish Environment Institute (SYKE): https://www.syke.fi/

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[2]Daniela Figueiredo: Co-conceptualization; Co-writing—Original Draft, Review; Methodology—Data Collection; Project co-administration; Activity and event co-organization in Portugal.

[3]Erica Villa: Co-conceptualization; Co-writing of the Original Draft, Review; Methodology—Data Collection and Analysis; Project co-administration; Activity and event co-organization in Italy.

[4]Sacha Bernet: Review of the original draft; Project co-administration; Co-organization of activity and event in France.

[5]Edward Bratfanof: Review of the original draft; Methodology—Data Collection and Analysis; Project co-administration; Activity and event co-organization in Italy.

[6]Rute Candeias: Review of the original draft; Methodology—Data Collection; Project co-administration; Activity and event co-organization in Portugal.

[7]Alan Deidun: Review of the original draft; Methodology—Data Collection; Project co-administration; Organization of activity and event in Malta.

[8]Guillaume Lheureux: Review of the original draft; Methodology—Data Collection; Project co-administration; Co-organization of activity and event in France.

[9]Olga Mashkina: Review of the original draft; Methodology—Data Collection; Project co-administration; Co-organization of activity and event in France.

[10]Ljudmila Vesikko: Review of the original draft; Methodology—Data Collection; Project co-administration; Co-organization of activity and event in Finland.

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Daniela Figueiredo, PhD, is a researcher at the Dep. Biology & UA-CESAM. Over the past two decades, her research has focused on the ecology of cyanobacterial blooms, integrating molecular approaches. However, simultaneously, she has developed an increasing interest in Science Communication, Environmental Education and Citizen Science, and has participated or coordinated several projects under these contexts. Presently, she is investing more in Science Communication approaches to better engage Youth with Science, namely through informal activities using Citizen Science, Multimedia and Gamification.



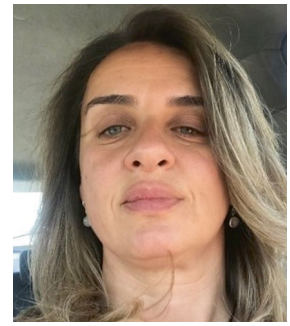
Erica Villa is an art science Venice-based curator with a scientific background and a science communication master's degree. With rich experience in researching, designing and curating projects at the art-science nexus, Erica is passionate about involving younger generations in addressing contemporary environmental challenges. Her focus extends to boosting collaborations between artists and scientists, driven by a desire to bridge the gap between scientific exploration and artistic expression. Her latest art science projects' curation deals with freshwater and marine ecosystems affected by climate change (glacier melting, river connectivity, Venetian lagoon's high tides) and creative non-formal youth education.



Sacha Bernet, PhD, is the director of Holo3, a Technological Resource Center (CRT) based in France. He holds a PhD in automation and vision and has gained solid experience in supporting large industrial groups through innovative projects, a field in which he has worked for 10 years. Armed with his scientific and technical skills, he joined Holo3, a company that excels not only in cutting-edge industrial projects but also plays an important role in the promotion of cultural heritage through immersive virtual reality experiences. Notable achievements of this initiative include the virtual modeling of Strasbourg Cathedral and several museums.



Edward Bratfanof is a Silviculture Engineer, licensed in Environmental Engineering, with another master's in environmental management and monitoring. He works for the Danube Delta National Institute for R&D in Tulcea since 2014, as Director of the Danube Delta Technological Information Center. The main objective is to create a pole of competitiveness and innovation in the Dobrogea region and to promote sustainability in the Danube Delta, so he initiated the setup of the 3D Edaphic-BLOOM Danube cluster. He organizes international events such as: "Deltas & Wetlands" International Symposium. He worked for 2 years for the Danube Delta Biosphere Reserve Authority as governor.



Rute Candeias is an environmental educator, teacher, science communicator, certified trainer, and projects manager. She holds a degree in Marine Biology at the University of Algarve, a postgraduate degree in Ethology at ISPA, and a postgraduate degree in Environmental Sciences and Technologies. Since 2000, she has worked as an environmental educator and as a project manager in environment and nature conservation, integrated projects related to science communication and participated as a trainer in multiple courses in environmental education. Since 2014, she has been collaborating with ASPEA where she currently coordinates oceanic affairs. She was involved in "RiOceanos", "EduCO2cean", "LifeInvasaqua" and "EduCO2cean" projects.



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World Ocean Explorer: A Transformational Tool for Ocean Literacy

5

Peter Neill, Trisha Badger, and Bjorn Grigholm

Abstract

World Ocean Explorer, a project of the World Ocean Observatory, is a free, open-access, web-based virtual immersion that offers teachers, students, and curious individuals a globally accessible platform for engaging learners—across formal and informal settings—with comprehensive Ocean curriculum framed by the Ocean Literacy matrix. It provides a visual, participatory exploration of the Ocean's contributions to the science, history, and culture of maritime civilization. Endorsed as a 2025 United Nations Ocean Decade Activity, the award-winning, teacher-vetted Explorer—developed by scientists, historians, curators, educators, and storytellers—provides access to responsible science. As a technological innovation for science communication, it engages diverse audiences across Ocean themes and, through the Ocean Literacy framework, offers an adaptable, scalable platform for students in grades 7–10 (approximately ages 12–16). This chapter describes the rationale, key concepts, and classroom applications of World Ocean Explorer.

Keywords

Ocean Literacy (OL) · Ocean curriculum · Deep sea · Games for change · Gaming for good · Educational technology in classroom · Serious play · Unity gaming platform · WebGL (web graphics library) · World Ocean Observatory (W2O) · World Ocean Explorer · Unity technologies

5.1 Introduction

There was a time when the best way to experience the wonders of the sea was to visit an aquarium, and even then, only a small portion of the world's population had opportunities to visit such institutions, as well as the many maritime museums and science centers around the world. Each plays an important role in Ocean conservation and education throughout our shared history: they help us understand Ocean processes, make us more Ocean-literate, and use on-site experiences to stimulate and explain the vast Ocean world. However, only a small portion of the world's population has ever visited an aquarium or a maritime center, and global public awareness of the Ocean and its issues has not significantly advanced over the last decade.

In July 2013, more than 110 Ocean explorers, enthusiasts, advocates, and scientists gathered at the Aquarium of the Pacific in Long Beach,

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California, for Ocean Exploration 2020: A National Forum. The first event of its kind, the forum brought together a significant segment of the U.S. Ocean exploration community to identify key characteristics of a national program for 2020 (Aquarium of the Pacific n.d.). Participants described Ocean exploration as a great opportunity, an urgent necessity, and a matter of national security.

The World Ocean Observatory (see Fig. 5.1) was there, as were most of the major American research vessels, Ocean institutes, universities with Ocean programs, and NGOs. The Ocean Exploration 2020 Conference surveyed its participants, and the prevailing priorities were:

- 94 percent of respondents identified secondary education and public outreach as the top priority for the future of American Oceanographic research; and
- 93 percent of respondents agreed that the science community must engage with the public in an active two-way dialogue to bolster support for Ocean exploration.

The overwhelming consensus was the need for education at the secondary school level and for communications strategies that would amplify public awareness of Ocean science, conservation, and the meaning of the Ocean for the future. What, then, lies beyond the traditional aquarium setting? How do we bridge the considerable gap in public awareness and general understanding of Ocean systems? What tools can we use to excite young people about the Ocean and the importance of Ocean health? How do we promote enthusiasm in the classroom for knowledge of the Ocean world? What if the games we play could teach us the science of the Ocean?

The World Ocean Observatory is a Maine-based organization that was founded 22 years ago as a recommendation of the 1998 Independent World Commission on the Ocean and their final report, *The Ocean Our Future*.



Fig. 5.1 The WORLD OCEAN OBSERVATORY (W2O) is a leading organization advocating for the health and sustainability of the Ocean through an accessible worldwide network of communication and educational resources. Through support of educators and education, partnership, public connection, and relentless communications, W2O is committed to building an expansive global community of *Citizens of the Ocean* to promote and conserve marine resources for the future of all mankind. Through collaboration and information exchange, and by sustaining public connection and relentless communications, W2O bridges the gap between scientific knowledge and educational learning and builds an expansive community of Ocean-literate citizens worldwide. As a major utility for Ocean and climate communication, and as a means to advance public awareness, W2O is dedicated to providing standards-based educational resources about the health of the climate and the Ocean. We believe that informed citizens worldwide can unite to sustain the Ocean through mitigation and changes in human behavior on land and sea. Our focus is the full spectrum of Ocean issues: climate, fresh water, food, energy, trade, transportation, public health, finance, governance, security, recreation, and culture. It is our belief that the sea connects all things

5.1.1 From Knowledge to Action: Science, Policy, Education, Communication

To be *literate* is to study, understand, and communicate effectively as an expression of knowledge. To be *Ocean-literate* is to apply that knowledge to the marine environment, presumably in support of conservation and sustainability.

A successful strategy for transforming humanity's relationship with the Ocean from knowledge to action must contain four essential elements: *science, policy, education, and communication*. Historically, success has been based primarily on science and policy. We excel in science, with a never-ending need for further research to address what we don't know, and burgeoning technolo-

gies to take us to places we have never yet been. We do policy, though we do it less well—not for lack of effort, given the many treaties, agreements, and laws. But variables, interests, and consensus often slow enactment and change.

Education and communication we do least well of all. Both have been under-recognized, underfunded, under-strategized, and inadequately implemented to drive transformational change. Ocean science has primarily belonged within the halls of higher education—undergraduate, graduate, and postgraduate programs—specializing in the application of biology, chemistry, and physics. This has built a cadre of researchers that has expanded Ocean knowledge exponentially, primarily since the Second World War. What is required beyond those halls is a radical increase in investment and innovation in climate, Ocean, and environmental education, beginning at the elementary school level, alongside communications between scientific institutions and social communicators to engage and inform intergenerational demographics.

The major deterrent to successful communication and outreach has been the misunderstanding or lack of emphasis on five key factors:

1. The Ocean comprises both salt and freshwater systems, beginning at the mountaintop and descending to the abyssal plain.
2. The conjoined biodiversity and sustainability depend on this realization and the integration of scientific, political, financial, and social responses.
3. The Ocean relates beyond conventional marine science to encompass additional issues, including freshwater, food, energy, health, trade, transportation, law and regulation, economics, community development, cultural traditions, and more.
4. The Ocean is the primary engine for climate change and, as such, is the most necessary solution. The Ocean must be understood as the primary context for exploration, mitigation, and the solutions and invention required to address the existential challenges we face.
5. Without communication, as an amplification of education, transformational change will not be forthcoming.

5.1.2 Development Rationale—The World Ocean Explorer

In September 2019, the United Nations Environment Programme (UNEP), in partnership with GRID-Arendal, a Norwegian non-profit foundation and UNEP collaborating centre, commissioned a report outlining the importance of online platforms to harness the UN Sustainable Development Goals and the urgent needs they represent. The report *Playing for the Planet: How Video Games Can Deliver for People and the Environment* summarized relevant developments in the online gaming sector, with perspectives from more than 50 thought leaders from the industry. It provided seven recommendations that provoke new thinking, collaborations, games, and real-world impacts of learning about environmental issues.

According to the Playing for the Planet Alliance, a program facilitated by the United Nations Environment Programme (UNEP 2023a), more than 3 billion people around the world are playing video games. Harnessing the power of online gaming to inspire wonder in young people to learn and act in support of the environment has unprecedented potential. The opportunities, both at home and in the classroom, can transform how we think about, engage with, understand, and solve environmental issues (UNEP 2023b). See the resources section for additional Playing for the Planet Alliance annual Impact Reports.

World Ocean Explorer is based on Unity gaming software; its virtual environments are educational and engaging. Students know how to game, the controls are intuitive, no special equipment or instruction is required beyond a Chromebook and a willingness to explore. Using online interactive learning and mission-based gaming, World Ocean Explorer has the power to trigger significant direc-

tional shifts in thinking and action, transforming education both in and out of the classroom, encouraging Ocean Literacy among students and educators, and inspiring people worldwide to explore and to understand the influence and importance of the Ocean and our relationship to it. To operationalize these recommendations in a classroom-ready medium, World Ocean Observatory partnered with Visual Solutions Lab (VSL) to design and develop World Ocean Explorer.

5.2 Deep Dive into World Ocean Explorer

5.2.1 The Beginning

The concept of World Ocean Explorer virtual immersion originated in a 2005 conversation between the founder of the World Ocean Observatory and Dr. Craig Strang, Associate Director for Teaching and Learning at the Lawrence Hall of Science, University of California, Berkeley: one of the first organizers of the Ocean Literacy concept and curriculum in the United States. From the beginning, World Ocean Explorer was conceived around the Ocean Literacy Principles and Matrix, as content for an imagined space that could be freely visited for exploration of the Ocean world. An early phase imagining of Explorer's profile would include the full complement of Ocean systems: from deep-sea to culture, coral reefs to polar regions, freshwater to human health, coastal ecosystems to science, transportation to trade, immigration to the exchange of ideas, art, and traditions.

Activities, lesson plans, and educational resources within World Ocean Explorer represent a trusted and comprehensive knowledge bank that educators can easily and safely access, adding increased Ocean Literacy curriculum to their class plans. Each module contains direct links to theme-based curriculum, in-class and take-home activities, group project ideas, thoughts on adaptation for specific class sizes, circumstances, local issues, and other modifications. An Ocean Classroom Educational Resource Center, located within The Nexus module, provides a virtual place where the Seven Principles of Ocean Literacy are on display, and where each of the 45 Fundamental Concepts are explored and explained, along with recommendations and live links to educator resources.

5.2.2 A Contribution Toward the Ocean Decade Shared Goals

World Ocean Explorer Virtual Immersion received an Ocean Decade Activity Endorsement for 2025. To be recognized by the United Nations Decade of Ocean Science for Sustainable Development, also known as The Ocean Decade, is to be tasked with contributing toward a shared goal of achieving a healthier and more sustainable Ocean. World Ocean Observatory and all resources made available through the free Explorer platform are created and consolidated as a comprehensive source of knowledge for more Ocean Literacy, a free and trusted resource for marine educators to turn to for activities, modules by theme, and peer-to-peer connection. Teachers crave ease of access and accessibility: Explorer offers learning opportunities for polar regions, coral reefs, maritime work, the deep-sea, the coastal region, culture and maritime history, science at sea, fresh water, and the Ocean and human health.

Explorer is award-winning, having been presented with the Unity for Humanity Social Impact Prize in 2025 and the Serious Play International Gold Award for Excellence in 2023. It presents an astonishing simulated aquarium visit, organized to reveal the wonders of Ocean life, with layers of detailed data, educational information, and rich visualizations representing the Ocean's beauty and complexity. Within each of the theme-based modules, middle and high school students can visit exemplary underwater sites, provided with directives and opportunities to understand the larger perspectives of scientific knowledge. Through immersion among displays, educational mixed media, 3D models, a theater experience with browsable short films, and an array of interactive exhibits, a

virtual aquarium visit experience can be brought into classrooms or home-school environments (Fig. 5.2).

5.2.3 World Ocean Explorer—Key Concepts and Ideas

World Ocean Explorer's free, web-based, open-access virtual immersion provides teachers and curious individuals with a trusted platform to engage students—both in formal and informal classrooms—by offering a stimulating portrait of Ocean systems. In addition to being visually and graphically complex and appealing to younger users, the platform provides access to comprehensive, theme-based Ocean curriculum, constructed with content collaborators and science-based resources, framed through the Ocean Literacy matrix, aligned with Next Generation Science Standards (NGSS), and offering a visual, participatory immersion into the full spectrum of the Ocean's contribution to science, history, and civilization.

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Fig. 5.2 World Ocean Explorer Virtual Immersion received an Ocean Decade Activity Endorsement for 2025

Explorer is an overarching web project that incorporates ten theme-based immersive environments, or modules: Deep Sea, Coral Reefs, How the Ocean Works, Science at Sea, Cultural Traditions: Sea & Civilization, Polar Regions, Maritime Work, Coastal Ecosystems, Ocean and Human Health, and a Submersible experience that students can pilot and explore. This is all available for free through a Chrome Web browser; a vast, immersive, fascinating Ocean world becomes accessible and close enough to touch in a virtual space. Explorer is teacher-vetted and tested, based on responsible science and technologically innovative, safe activities; it contains stimulating visual content and encourages experiential participation (Fig. 5.3).



Fig. 5.3 Explore the immersive Deep Sea exhibit hall, featuring interactive species displays and research highlights from Schmidt Ocean Institute's 2020 expedition

5.3 Explorer for Today

Explorer includes 3D model manipulation, interactive graphs and visualizations, searchable video libraries explaining concepts and discoveries by theme, glossaries of terms and species, drag-and-drop activities, narrative discoveries of special environments, immersion by students and interaction with the wonders of the Ocean. It is all there for students to discover within Explorer. Themed portal doors take users to different interactive environments, allowing them to explore rarely seen species and habitats, connect to trusted and free resources and curriculum, explore various Ocean locales piloting a submersible, collect data and images during exploratory play, and bring findings back to the classroom for discussion and further learning. Topics include bathymetry, Ocean currents, climate impacts, maps and data, deep-sea science, coral health, coastal issues, threats to marine species, transportation and trade routes, plastic pollution impacts, and much more. It is a technological innovation with no restrictions and no barriers to entry. Explorer requires only the Internet, a browser, a laptop, the directive to go explore, and a task to return to the class with a new-found bit of knowledge about how the Ocean works. World Ocean Explorer has no purchase price, no license or subscription fees, no technical limit beyond what exists today, no language barrier, and no discrimination for any reason against participation on any device by any student, anywhere, at any time. World Ocean Explorer is a platform as open, free, beautiful, wondrous, and dynamic as the Ocean itself.

5.3.1 Why It Matters

Educators have limited resources and time to seek out, examine, vet, and download activities and lesson plans related to Ocean systems. World Ocean Explorer provides a trusted, comprehensive platform to present teacher-tested curriculum that is fact-based, relevant, adaptable, organized, shareable, and free. Ongoing teacher cohorts throughout the year test Explorer in real-time classroom settings, allowing for adjustments and additions to ensure it can be adapted to any environment, any classroom, anywhere—from a one-room schoolhouse in Maine, to a charter school in the Bahamas, to beach classrooms in Liberia, and to classrooms in Nigeria and Thailand. Explorer provides what educators need most: to be liberated from the confines of limited time chasing down trusted and relevant resources in an effort to incorporate Ocean Literacy into their classrooms.

In addition to a collection of theme-based environments, the Explorer Curriculum Catalog, Resource Center, and Teacher Cohort and Engagement Strategy have six objectives:

1. Serve as a baseline content outline with specific learning methods, modules, and lesson plans by theme.
2. Be an accessible and trusted resource catalog of science-backed resources pertinent to outlined goals.
3. Host and instruct programs for in-class testing with selected instructors from around the world throughout the school year.
4. Develop a system for student/teacher evaluation, comment, suggestion, and Ocean Literacy connection.
5. Make space for additional capacity, further development, ease of modification, and creative instruction.
6. Provide a full catalog of Ocean Literacy curricula and resources as outlined by the Seven Principles and Concepts.

Central to World Ocean Explorer is education. For the Ocean Literacy movement to expand, thrive, and succeed, educators must be given the tools, resources, language, data, media, and all that is required to fully complement a class plan that embraces Ocean Literacy as a core value. This is not just for one class or one topic but as a perpetuation and a universal approach across all modalities of learning. As transformational virtual learning immersion, World Ocean Explorer brings the importance of Ocean understanding and the myriad ways it connects us all, into the classroom, into our homes, via our laptops, completely comprehensive and free.

5.3.2 Key Features

Each environment within World Ocean Explorer is filled with diverse plant and animal species, showcasing a mix of common and rarely seen Ocean locales and objects. Through videos, 3D models, and narrative overviews, students can engage in self-guided or mission-driven exploration of environments such as whale falls, coral reefs, and polar regions beneath the ice. These environments also simulate environmental disasters, presenting a rich terrain designed to spark wonder and encourage further discovery.

The expansive environments feature geological and mineralogical characteristics, which can be explored via manned submersible and various mixed media. Deep-sea spaces such as caves, canyons, and hydrothermal vents—largely unexplored—are now made accessible, brought to life by the scientists and research vessels that visit these special places and make data and media available to us all. Explorer presents this data in engaging and visually stunning detail, offering immersive, twenty-first-century educational experiences. Students can, for example, explore a hydrothermal vent through a manned submersible simulation, learning about real-world physical and chemical properties like pressure, temperature, and salinity—all from a classroom laptop.

5.3.3 Unity and WebGL: The Technology Behind World Ocean Explorer

World Ocean Explorer was developed using the Unity game engine, one of the most popular platforms in the game development industry. Unity's flexibility and comprehensive feature set made it the perfect choice for creating complex, immersive underwater environments, and maintaining them over time. Its ability to handle both 2D and 3D rendering, combined with powerful physics simulations, enabled the development of a dynamic and interactive Ocean exploration experience. The engine's robust scripting support and vast asset store also helped streamline the development process.

Unity's popularity is bolstered by its cross-platform capabilities, allowing the team to build the game once and deploy it across multiple devices. To make World Ocean Explorer accessible to the widest audience possible, WebGL was chosen as the deployment platform. With WebGL, the game runs directly in a web browser, eliminating the need for downloads, installations, or drivers, making it accessible to anyone with reliable connectivity. The browser-based approach ensures the most seamless and engaging experience for all users, regardless of their device or operating system.

5.4 The World Ocean Explorer—Theme-Based Modules

Focusing on *Ocean Literacy Principle 7: The Ocean is Largely Unexplored*, the first theme-based module of World Ocean Explorer, Deep Sea, was created with the support of Schmidt Ocean Institute. This philanthropic research organization provides marine scientists with the resources and vessels needed to explore and map the Ocean in ways that are rarely seen or studied.

Schmidt Ocean Institute supplied all the content for the Deep Sea module, including species data, whale fall information, and documentation of deep-sea dives to canyons, caves, and hydrothermal vent systems off the coast of Australia. The World Ocean Observatory team then transformed this data, resources, and media into an immersive, 3D experience, allowing users to explore these remote environments and interact with them in ways never before possible.

5.4.1 Deep Sea Module

The World Ocean Explorer Deep Sea module was developed to spotlight the groundbreaking 2020 research cruises conducted by Schmidt Ocean Institute of deep-sea environments in the waters surrounding Australia. This immersive module

offers users a new way to explore the mysteries of the deep Ocean, diving into environments studied during the expeditions and engaging directly with the unique ecosystems uncovered. Funded and developed in collaboration with Schmidt Ocean Institute, the Deep-Sea module reflects a dedication to blending scientific accuracy with engaging gameplay, making the fascinating, often hidden world beneath the Ocean's surface accessible to both students and general audiences.

One of the core features of Deep Sea module is a vast, underwater aquarium exhibit hall. Located on the seafloor, Deep Sea's exhibit hall serves as a central hub where users can explore detailed, interactive 3D species, a whale model, a diorama of a research vessel and its tethered ROV, and a hydrothermal vent that includes drag-and-drop activities designed to teach students about how vents form, the basis of the food web, and the elements of chemosynthesis. Most species featured in the hall are meticulously modeled based on high-resolution imagery and videos captured by Schmidt Ocean Institute's unmanned submersible, SuBastian. These visual references enabled the development team to create accurate digital representations, giving users a close look at creatures inhabiting some of the most remote and inhospitable environments on Earth.

Accompanied by both video and audio descriptions, these species displays offer not only a visual experience but also educational context, helping users understand the significance of these organisms and their unique adaptations. Additionally, the Deep Sea exhibit hall illustrates and celebrates the Seven Principles of Ocean Literacy, reinforcing key concepts about Ocean science and human interaction with marine environments (Fig. 5.4).

Users can explore the immersive environments at their own pace, interacting with displays and absorbing information at their leisure. For those seeking a more structured experience, a guided tour is available, leading players through the exhibits and explaining the importance of the species and research findings in a curated environment. Explorer also features a Species Identification List, which automatically checks

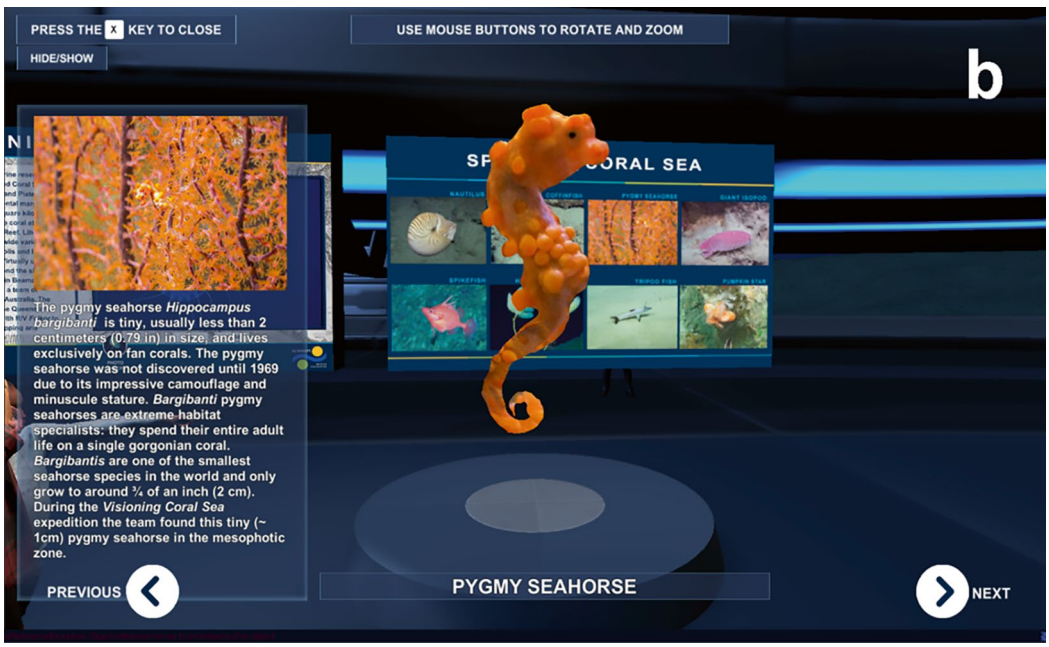


Fig. 5.4 Activated species display within Deep Sea module of World Ocean Explorer showing a Pygmy Seahorse (Hippocampus bargibanti) observed by Schmidt Ocean Institute ROV SuBastian in the Coral Sea off the coast of Australia, 2020

off each species as the user interacts, and notifies the user when all species in a particular environment have been discovered. This not only adds an element of discovery, but it also helps users and educators track their progress as exploration is occurring.

In addition to the main exhibit hall there are also three immersive environments within Deep Sea that offer an even more immersive experience. Each environment—a hydrothermal vent, a virtual whale fall at 1500 m, and a collection of newly-discovered species observed during Schmidt's cruises and dives—can be discovered, manipulated, cataloged, and aligned with more detail and activity. Immersive environments allow users to virtually explore, completely surrounded by the space they inhabit, immersed in the sound and the experience, with species swimming by, close enough to touch, interactive enough to click through and learn more. Each of these environments is unique, virtually located miles beneath the surface of the sea. Each environment is carefully modeled to reflect the real-world conditions observed by the ROV SuBastian; each provides a scientifically accurate representation of these ecosystems. Through interactive exploration, users can observe how species interact with other species and in what ways they each play a critical role in the diversity of the environments. Students will invariably deepen their understanding of the complex and often surprising ways in which life thrives under extreme conditions in the deep sea (Fig. 5.5).

One of the standout features of the Deep Sea module is a series of drag-and-drop learning assessments designed to deepen users' understanding of deep-sea ecosystems. For example, in the section on hydrothermal vents, these assessments are divided into three key components: how vents form; the fundamentals of chemosynthesis; and the basis of the food web and the creatures that inhabit and thrive at extreme environments.

Each assessment begins with an educational video, followed by an interactive slideshow, describing and illustrating key concepts in detail. To reinforce learning, students engage in a drag-and-drop activity where they match images and descriptions to an illustrated diagram, solidifying their grasp of the processes and organisms that define hydrothermal vent ecosystems (Fig. 5.6).

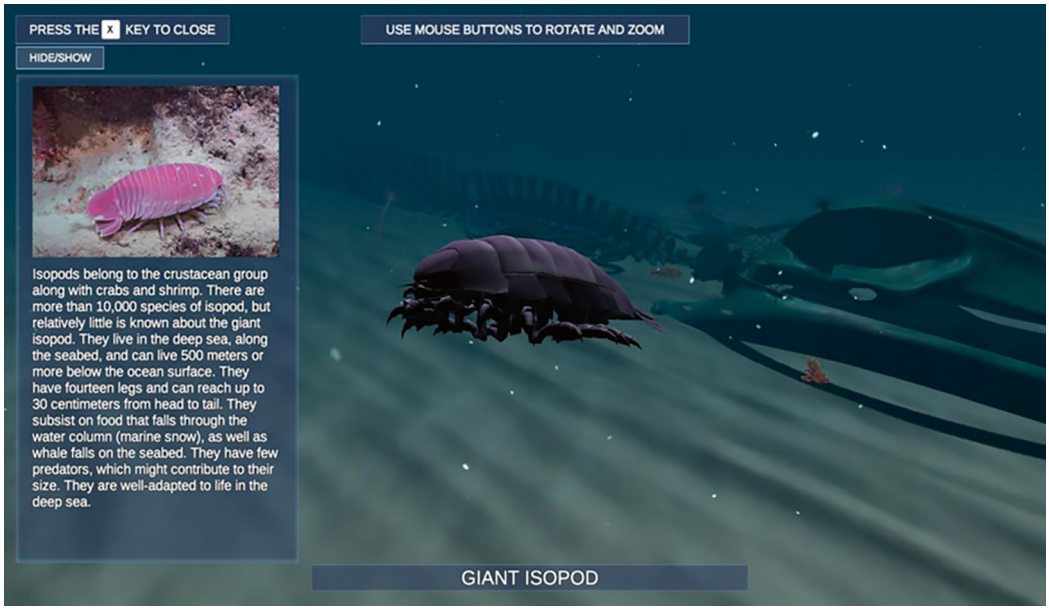


Fig. 5.5 Immersed in the Whale Fall environment, users interact with species that thrive on the nutrient-rich remains of a fallen whale at 1500 m, uncovering the intricate relationships within this unique deep-sea ecosystem

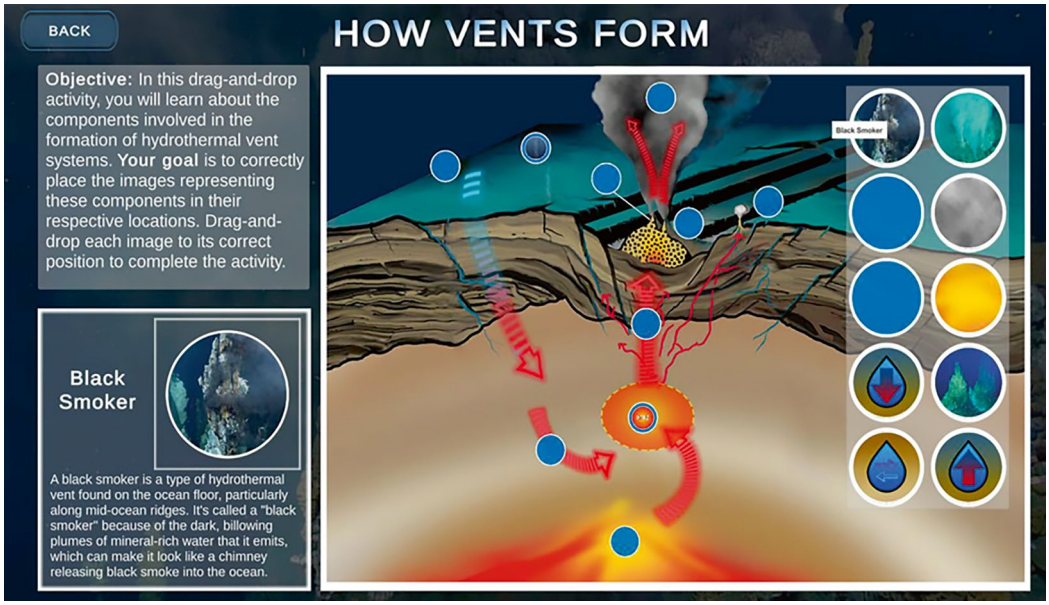


Fig. 5.6 Interactive drag-and-drop learning assessment on hydrothermal vent formation. Students match images and descriptions to an illustrated diagram

The success of this interactive learning format has inspired plans to expand assessments across other key areas of World Ocean Explorer. Future assessments and drag-and-drop learning activities will cover ecosystems such as deep-sea whale fall environments and topics that delve into the technical aspects of underwater exploration, providing a more comprehensive educational experience. This approach allows users to grasp complex scientific concepts through engaging, hands-on activities that promote active learning and retention.

World Ocean Explorer Deep Sea module launched in spring 2022 and has since seen continuous updates, many of which are based on feedback from middle and high school educators. These updates ensure the platform remains a relevant and effective classroom tool, allowing teachers to adapt its content to suit their curriculum. A key goal is to maintain the flexibility of World Ocean Explorer, ensuring it evolves alongside educational needs and offers new ways to engage students in marine science.

By combining immersive environments, interactive educational assessments, and scientific accuracy, World Ocean Explorer Deep Sea offers a unique platform for exploring the Ocean's depths. From detailed species models based on real-world data to engaging learning tools, the platform remains committed to fostering a deeper understanding of the marine world and the cutting-edge research that uncovers its secrets. As Deep Sea has expanded and been introduced to educators, a dedicated teacher cohort has been developed to test and provide feedback on its use in the classroom. This ensures the platform continues to meet the needs of both students and educators.

5.4.2 Earth Ocean Analyzer: An Interactive Globe

World Ocean Explorer features an interactive tool called the Earth Ocean Analyzer, allowing users to explore a vast catalog of geospatial maps and data (Fig. 5.7).

The Earth Ocean Analyzer tool offers detailed insights into a variety of oceanic parameters, from physical elements like Ocean temperatures and currents to biological distributions of marine species and global ecosystems. It also highlights

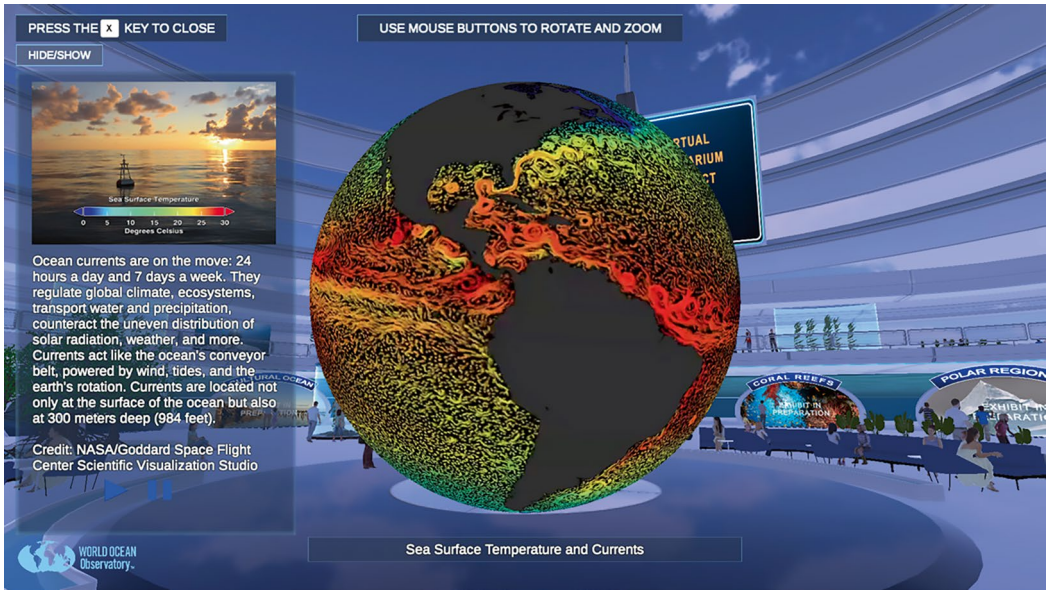


Fig. 5.7 The Earth Ocean Analyzer is a tool for visualizing a catalog of geospatial Ocean data, including physical, biological, and human impact layers

human influences, such as shipping lanes and plastic waste. The Earth Ocean Analyzer allows users to engage intuitively with critical environmental data, fostering a deeper understanding of Ocean complexities and the impact of human activities.

Currently in beta, the Earth Ocean Analyzer will eventually offer a complete geospatial map and data catalog, evolving into a robust exploration tool. As development progresses, additional data layers will be integrated, making it an invaluable resource for understanding Ocean complexities.

Comparable to NOAA's *Science on a Sphere*, Earth Ocean Analyzer provides interactive globe functions, including data plotting and import/export features, for viewing a wide range of geospatial datasets. However, the key difference lies in the Analyzer's focus on Ocean-specific datasets—geological, physical, chemical, biological, ecological, historical, and anthropogenic—offering users more in-depth exploration options.

Earth Ocean Analyzer will feature interactive maps that can be overlaid with other spatial data, manipulated by the student, sharing real-time tracking of research vessels, Ocean mapping data, bathymetry, circulation, temperature, ice cover, the water cycle, plastic pollution—all this and more for students to toggle timelines and track changes over time.

Analyzer is a powerful presentation tool for classrooms and an excellent starting point for offering environmental context to manned submersible missions or independent exploration of the platform.

5.4.3 Manned Submersible: 3D Rendered Environments for Exploration

World Ocean Explorer also offers fully rendered 3D environments for self-guided exploration and discovery. These underwater spaces—ranging from polar regions and shipwrecks to coral reefs and hydrothermal vents—are created using a variety of 3D models, encompassing diverse terrains and species. This allows for the creation of unlimited variations in landscapes and marine life, all accessible and explorable using submersible controls via the user's keyboard (Fig. 5.8).

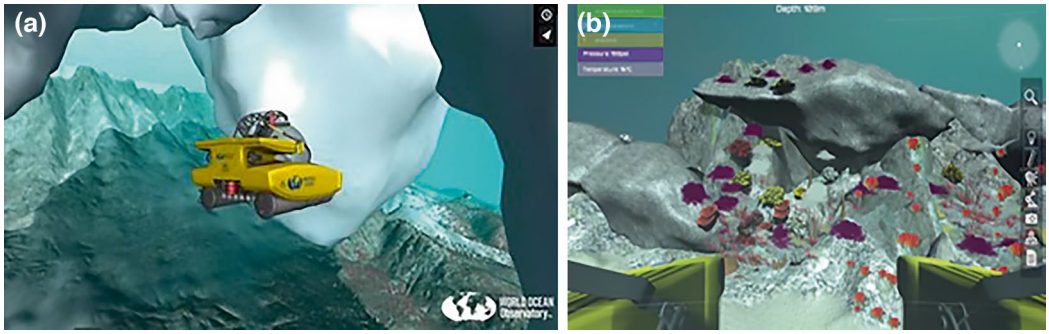


Fig. 5.8 Pilot the Explorer Submersible from the control seat, exploring deep-sea environments while interacting with marine life and ecosystems

5.4.4 Community Support

Communities reached by W2O programs are local, regional, US-based, global, inland, and coastal. Teacher Cohorts are connecting us with marine and science educators in Maine and New England, in other parts of the USA, Canada, The Bahamas, Jamaica, and Liberia. The Explorer educational platform is made up of distinct theme-based modules that are to be funded and constructed in collaboration: each has at least one major content collaborator that has already made investment in research and data, and concomitant media and materials. Content collaborations then require a funder with specific interest in the presented theme. Funding supports module creation and expansion, educator outreach, maintenance of the platform, creation of more educational materials and curriculum units. Each module has a group of educators and curriculum design experts that build themed curricular resources for use in the classroom. The content is shared, adapted, and used across our growing network of global classrooms, feeding information back to the Explorer team for better understanding and interpretation. A three-legged stool of collaboration: theme-based content, funding, and educator-vetted curriculum—provides the foundation for the collective success of the Explorer platform. World Ocean Observatory has millions of connections through social media and network outreach, yet we understand the importance of real teacher connections: true success begins with the close, foundational relationships that build educational and relevant successes over time.

5.4.5 Collaboration and Partnership

Together with educator partners, content collaborators, and other educational resources, Explorer becomes a storytelling device and vehicle for Ocean Literacy education and student engagement. Partnership, participation, and feedback all guide the creation of a repeatable process model to drive engagement with educators around the world. Key measurements of performance reach beyond teachers and students engaging with Explorer: partnerships, collaborations, and national and international organizational relationships are key to scalability and impact.

Schmidt Ocean Institute was the first collaborator to see the vast educational potential of Explorer, joining us in 2021 to build Deep Sea, the first main module exploring species and places newly discovered and rarely seen. Seth Sprague Educational & Charitable Foundation funded the construction of The Nexus (beta) in which the Seven Principles of Ocean Literacy and its Framework are explored in a virtual Ocean Classroom complete with videos, interactive displays, constellations, mapping tools, films, Ocean species, and more.

Since 2021 W2O has established MOUs and collaboration agreements with others who will

provide content for various aspects of the Explorer platform:

- Climate Change Institute, University of Maine:
  - Content collaboration and consultant, Polar Regions module
- Maribus/*World Ocean Review*:
  - Content collaboration, How the Ocean Works module
- Fram Museum, Oslo, Norway:
  - Content collaboration, Polar Regions module
- Living Oceans Foundation:
  - Content collaboration, Coral Reefs module
- Ocean School/National Film Board Canada:
  - Content collaboration, searchable theater in The Nexus
- The International Council of Maritime Museums (ICMM)
- Intergovernmental Oceanographic Commission of UNESCO (IOC):
  - Content collaboration: Ocean Literacy Principles and the Ocean Decade
- Educator Networks:
  - The European Blue Ocean School Network; the National Marine Educators Association; the European Marine Educators Association.

5.5 Educator Engagement: The Key to Ocean Literacy Success

In September 2024, World Ocean Explorer launched its inaugural teacher cohort, consisting of a diverse group of educators from The Bahamas, United States, Nigeria, Liberia, Portugal, Jamaica, and Canada. These educators played a key role in developing and curating both new and existing teacher-tested resources for middle and high school students. Each classroom contributed shared curricular resources and activities, along with adaptive learning tools and ideas for integrating the Deep Sea module and future thematic modules into classrooms around the world.

5.5.1 Learning Assessments and Teacher Cohorts

An expansive group of educators are vital to the adaptation, creation, and expansion of modules and activities aligned with Ocean Literacy Principles and Next Generation Science and Common Core Standards, and in support of Sustainable Development Goal 14: Life Below Water. The curriculum units will support thematic modules, offering science-backed data, visualizations, graphs, charts, and interactive models. These resources will be coupled with educator-created and -vetted Ocean curricula, including 3D activities, adaptable lesson plans, and guides. Ongoing Teacher Cohorts will help bring Ocean exploration and literacy to classrooms globally, providing opportunities and incentives for educators to use the platform, contribute their ideas, adaptations, and experiences to a growing catalog of thematic resources.

The development of World Ocean Explorer and the Teacher Cohorts has been made possible through the support of visionary individuals and foundations, as well as collaborations that provide content, data, resources, and visualizations. Private foundations and individual supporters have thus far backed Explorer as an innovative platform for twenty-first-century learning. Cohorts engage educators in distinct areas, using climate and Ocean curriculum via 3D activities, modules, and adaptable plans and curriculum guides, adding additional educators and schools over time, offering stipends for educator engagement and development of climate and Ocean-based curriculum.

Relationships with educators for grades 7–10 are key to the development and classroom demonstration of curricular resources and functions, based directly on user feedback: from students via educators and directly from educators to the Explorer team. Feedback from educators who can interact with a facilitator and each other, attend educator conferences and workshops, engage in-

person to guide the work and the content on the platform, will be invaluable as Explorer becomes a vast network of climate and Ocean resources for twenty-first century learning. Explorer is for anyone who wishes to learn about and explore all aspects of climate and Ocean, and how it impacts our lives, no matter where we live in the world. The curricular Ocean resources created are the key framing devices for how other educators worldwide will present Explorer in the classroom and the larger, integrated learning environment.

The path forward goal is to follow educator and student user feedback to inform the next iteration of educational content, features, and functionality of Explorer as the key, free Ocean resource for those wishing to instruct students in climate and Ocean issues local to global, to share interactive and beautiful visualizations and assets to learn about climate, weather, Oceanography, exploration, technology, marine biology, chemistry, Ocean careers, etc.

5.5.2 Teacher Testimonials

Nell Herrmann is a National Board Certified teacher with 25 years of classroom experience (Fig. 5.9). Nell was named the Hancock County Teacher of the Year in 2019. In 2014 and 2015, she was selected as a Nautilus Explorer Science Communication Fellow. She joined the World Ocean Explorer team in 2024 as the Educator Advisor, leading Teacher Cohorts for 2024–2025. As an educator, Nell is passionate about making science exciting and accessible to her students.

> The platform is amazing. Every time I've used it with students, I've witnessed similar reactions of wonder. Explorer is filled with high-quality resources and aligns well with NGSS and Ocean Literacy Principles. Specifically, I've found it connects to NGSS topics in life science, ecosystems, interactions, and energy, as well as Ocean Literacy Principles 5 and 6, which highlight the Ocean's incredible biodiversity and its largely unexplored nature. A new feature I've used includes drag-and-drop activities related to deep-sea hydrothermal vents and the basis of the food web. These classroom activities are not only engaging and fun but also serve as effective tools for assessing student learning.

Wendi Pillars is a National Board-Certified Teacher, a U.S. Army Veteran, and has spent three decades educating diverse learners across K–12 (Fig. 5.10). She believes that language and a connection to nature are powerful tools of diplomacy.

> I used Explorer for a two-day session recently and the kids loved it. We used the Deep Sea module to do some simple scavenger hunts, to draw photos of species discovered, we visited the whale fall interactive exhibit, and we had great discussions about habitats and ecosystems. I think Explorer is a great way to expose my students to things they may never otherwise encounter. And I like that it can be used to introduce new vocabulary. I'm very interested in the Maritime Work module: I frequently try to expose my students to different career possibilities, and the skills and tools needed to perform different jobs at sea.

Timothy Dwyer is a science teacher and member of the World Ocean Explorer First International Teacher Cohort (Fig. 5.11).



Fig. 5.9 Nell Herrmann, M.A., M. S, Blue Hill Consolidated School, Maine USA



Fig. 5.10 Wendi Pillars, 4–5th grade teacher, North Carolina USA



Fig. 5.11 Timothy Dwyer, Friday Harbor High School, San Juan Islands, Washington USA

> I used Explorer with my National Ocean Science Bowl team during our practice after school. They LOVED it, particularly the 3D experience rooms at the back of the Deep Sea module space. I look forward to debuting this for my Oceanography and Marine Biology electives. I can foresee so many amazing possibilities: I'm most enthusiastic about data collection and can envision having students conducting fish transects on scuba or with a submersible, chemical analysis of hydrothermal vents, sea surface wind, wave height calculations, deep Ocean pressure…it's all very exciting!

5.6 Conclusion

While the Ocean Literacy Principles have been applied by dedicated educators in certain and distinct areas, Ocean Literacy still lacks a universal strategy to reach a broader audience. The movement has shown success anecdotally but has yet to find an effective pathway to global implementation. World Ocean Explorer is one such revolutionary and transformational tool to get us there. It explains and contextualizes the Ocean's importance to life on Earth, highlights interconnected natural systems, incorporates both indigenous and non-indigenous knowledge, and focuses on the Ocean-climate nexus. It also explores the history of technology, engages communities worldwide in understanding the broader impact of the Ocean, employs transdisciplinary approaches, and is fun, visually rich, immersive, interactive, and accessible via the Internet. World Ocean Explorer offers an example of a meaningful Ocean Literacy intervention and is a significant new contribution to the Ocean Decade goal "to reshape humanity's relationship with the Ocean."

Explorer is a virtual, web-based initiative and therefore does not replace a real aquarium experience or the tangible experience of being outside, touching and interacting with things in the natural world. It does, however, make the Ocean available to all who have Internet access. It costs nothing to enter, and it offers a wealth of information and an engaging, expedition-like experience. It is available to educators everywhere, whether in classrooms, home-school settings, environmental organizations, or other educational institutions. Curious individuals seeking to learn more about the Ocean and the Principles of Ocean Literacy can also benefit. Explorer presents a virtual aquarium—without walls, fees, physical limitations, or special equipment requirements. It is a powerful tool for educating and engaging the public on Ocean Literacy, and above all, it is a democratic space as vast, deep, and dynamic as the Ocean itself.

5.6.1 Summary

Key concepts explored in this chapter include:

- Transforming humanity's relationship with the Ocean requires four elements working together: science, policy, education, and communication.
- Secondary-level education and two-way public dialogue are essential to expand Ocean-literate citizenship and support Ocean exploration.
- The Ocean Literacy matrix provides a framework to connect Ocean science with history, culture, and human well-being.
- Providing a globally accessible, browser-based platform that engages learners with Ocean science in formal and informal settings improves Ocean Literacy.
- Interactive exhibits (e.g., hydrothermal vents, whale fall) and mission-style activities

(including drag-and-drop assessments) model inquiry and reinforce core concepts.
- Online 3D environments introduce maps, datasets, species models, and visualizations that support classroom investigation.
- Unity/WebGL delivery enables no-install access on common devices, expanding reach to diverse classrooms.
- Engaging educator cohorts to co-create, vet, and adapt resources strengthens classroom usability.
- Content collaborators, funders, and educator networks work in concert to sustain modules, resources, and continuous improvement.
- Providing free, standards-aligned, and visually engaging online platforms broadens participation in Ocean learning and helps build an Ocean-literate society.

5.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- World Ocean Explorer (W2O): https://worldoceanobservatory.org/world-ocean-explorer
- Playing for the Planet: How Video Games Can Deliver for People and the Environment: https://www.grida.no/publications/432
- Playing for the Planet Alliance's Annual Impact Reports: https://www.playing4theplanet.org/annual-impact-report

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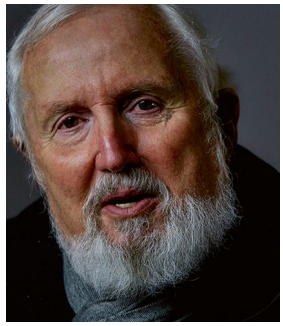
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[3]Bjorn Grigholm: Co-conceptualization; Methodology—Design, Data Collection, Data Visualization, and Analysis; Writing—Original Draft, Review, and Editing.

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Multimodal Ocean Literacy for the Ocean Decade

6

Shawn M. Rowe, Susan R. M. Rowe, Shu-Min Janet Tsai, Emily Nicholson, and Kristen Moore

Abstract

New media products about the Ocean and Ocean science draw on multiple modes of communication (images, videos, three-dimensional objects, virtual and augmented objects, bodily engagement, and interaction with both real and artificial other intelligences). Learners must be able to decode these multiple modes and their associated background commitments and be able to work critically with them in making meaning. Educational efforts must consider learners' worldviews, values, and modal preferences (individual and cultural) as well as issues of access to technologies and resources. In this chapter, we report on three efforts utilizing multimodality to engage learners in developing Ocean Literacy in new ways. Research and programming in Taiwan and the United States using multimodal research and evaluation tools as well as platforms and contexts for teaching and learning are described. By embracing diverse modes of communication and understanding, we may foster deeper bonds with the Ocean and may inspire action to preserve a healthy Ocean and biodiversity. Ultimately, by equipping learners with the ability to engage with diverse forms of Ocean-related content as both consumers and producers, we contribute to the collective effort to understand and address marine environmental issues, paving the way for a more sustainable future for our Ocean.

Keywords

Ocean Literacy (OL) · Personal meaning mapping · Concept mapping · Cross-cultural · Environmental identity · Informal learning · Virtual/augmented reality

6.1 The Cultural Challenge of Multimodal Science Communication About the Ocean

Education and communication aimed at addressing complex Ocean issues, especially those related to climate change and the Ocean/climate/human interface, require complex understanding of the relationships among the individual, social,

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cultural, and historical contexts that create human thinking and action in the world. Ocean Literacy education and communication efforts look quite different than a decade ago both because of changes in our understanding of Ocean Literacy and changes brought about in communication due to the growth of new media and wider access to multimodal resources for Ocean science communication.

Ocean and Ocean science media that we create or consume are no longer primarily language based, but draw on multiple modes of communication including images, videos and animations, three-dimensional objects, virtual and augmented objects, bodily engagement, and interaction with real and artificial others. Each of these modes carries its own distinct "epistemological commitments" and specialized affordances and constraints on meaning making (Kress 2010), all of which are embedded in worldviews, values, ways of knowing, and political and social agendas. A twenty-first century Ocean-literate learner not only is able to decode these multiple modes and their associated background commitments, but also is able to work critically with them in making meaning for themselves and communicating about those meanings with others. Thus, educational efforts aimed at shaping public Ocean Literacy must consider much more than the transfer of knowledge or even development of critical thinking skills. They must also acknowledge learners' worldviews, values, and modal preferences (individual as well as cultural) as well as issues of access to technologies, resources, and the ways in which multimodal objects and texts are complicit in or challenging of power dynamics.

In this chapter, we examine three contexts where we have used multimodal resources created by learners as platforms and contexts for teaching and learning. The first is an aquarium-based study of the relationships among values, worldview, and Ocean conservation knowledge and beliefs utilizing embodied experience and participant created concept maps with families and professionals to promote reflective activity. The second is a cross-cultural research project in Taiwan and the United States using Personal Meaning Maps created and interpreted by participants to examine the relationships among worldview, informal learning experiences, and Ocean Literacy among adolescents in both countries. Finally, we turn to our work in co-creating with high-school aged (ages 14–18) youth multimodal virtual and augmented reality experiences that support Ocean Literacy related to coastal hazards for both formal and informal audiences.

6.2 Defining Multimodality and Multimodal Literacy

We are so accustomed to interacting with multimodal communications that it is easy to overlook how prevalent they are in our lives. Multimodality can be as straightforward as using gestures, drawings, or other visuals while speaking; as everyday as the use of photos, words, and animations in advertising; or as complex as immersive cross reality environments. For decades, linguists have argued that language in use is inevitably constructed across multiple modes of communication, including speech and gesture not just in spoken language but through such contextual phenomena as the use of the physical spaces in which we carry out our discursive actions or the design, papers, and typography of the documents within which our texts are presented (Gee 2001; Scollon and LeVine 2004). A mode is defined in linguistics as one of the primary means of communication and includes spoken and written language as well as mixed and remixed images, layout, sound, gesture, and 3D objects (Kress 2010). Multimodality specifically refers to the combination of different modes within a single communicative act. Beyond linguistics, it is increasingly acknowledged that most communication draws on more than one mode and is thereby multimodal (e.g., Adami 2017).

This ubiquity of multimodal communications also makes it easy to overlook how much effort is required to both produce and make sense of multimodal communicative objects. Take the simple case of visual images embedded in science communication texts. As Forceville (2022) argues, "it should not be underestimated how much knowledge is needed for understanding pictures and other visuals." Not only do experts in an area process visual images in different ways than non-experts, the interpretation of all visuals is keyed to culturally and socially varying cues and contexts which tell us what is worth noticing, drawing attention to, and using for meaning making.

6.3 Defining Multimodal Ocean Literacy

While literacy has been a concept in communication and education for centuries, terms like "science literacy" and, more recently, "Ocean Literacy" first appeared in research and policy texts in the early 2000s. Broadly, literacy consists of two key components: understanding the relationship between humans and the Ocean, and developing the skills, knowledge, and willingness to communicate and act upon this understanding (NMEA 2021). To cultivate a society that is knowledgeable about the Ocean and motivated to take actions that protect and preserve marine environments in the spirit of the UN Ocean Decade, it encompasses knowledge of marine environments, their ecosystems, and the human-Ocean relationship (Cava et al. 2005). An Ocean-literate individual understands the Ocean's essential role in global systems, its impact on weather and climate, and the importance of conserving marine resources. This understanding empowers them to communicate meaningfully about the Ocean, fostering informed and responsible decisions regarding Ocean stewardship and sustainability (Cava et al. 2005; NMEA 2021).

One of the promises of having learners participate in the production of multimodal communication is the relative ease with which it allows learners to combine their personal, everyday, and socioculturally situated ways of knowing about, beliefs about, and values toward the Ocean with scientific and mathematical or technical representations of the Ocean. By incorporating various modes of communication with personal contexts, multimodality ensures that individuals with diverse learning needs can better understand and connect with Ocean science concepts. It also makes them more powerful advocates for Ocean issues. In the next sections we describe three efforts members of our team have engaged in to make multimodal opportunities for learners to articulate and share their knowledge, beliefs, values and worldviews relative to the Ocean and Ocean science while building multimodal Ocean Literacy. Following these, we reflect on the possibilities afforded by participating in such activities.

6.4 Concept Mapping as a Multimodal Task to Examine Zoos and Aquariums as Forums for Ocean Conservation Discourse

6.4.1 Background

Public aquariums are one of the only places in the Ocean learning landscape worldwide that provide an explicit focus on conservation science in the Ocean context. The larger project of which what is described here was part sought to describe families' and conservation professionals' Discourse about conservation in an aquarium context (Rowe 2018). In what follows, we draw a difference between discourse analysis as the study of language in use and Discourse analysis as the study of language plus extra-linguistic and non-linguistic ele-

ments of the context in use (multimodality) (Gee 2001). The study set out to 1) identify what counts as conservation d/Discourse accompanying interaction with live animal displays and 2) develop an appropriate measurement tool to identify conservation d/Discourse occurring while families interact with live animals. It was intended to address a particular gap among researchers in conceptual thinking about the environmental worldviews and associated value systems visitors bring with them to learning experiences.

6.4.2 Concept Mapping as a Multimodal Tool

The study employed observations, interviews, and the building of shared concept maps, a multimodal data collection tool that encourages groups of individuals to reflect on and articulate their own perspectives on a topic visually and hierarchically. In this case, to identify what Ocean conservation talk looks like among families and what professionals expect this kind of talk should look like while families interact with live animals, the second author conducted semi-structured interviews with families and a focus group with professionals, both mediated by the use of concept maps. Families were briefly interviewed about their experiences as visitors to the aquarium touch tanks and then asked to develop concept maps as visual representations of their definitions and understanding of conservation. Each family developed one concept map. The making of the map was followed by a conversational interview about the process of making the map as well as its components. This allowed the researcher to clarify words or phrases and what they might mean where unclear. In the professional focus group, after a conversation about their own understandings and definitions of conservation, professionals were asked to develop maps about what they expected family conservation Discourse to be like. A thematic analysis to identify common themes in the data was carried out and used to create a codebook to identify repeating themes containing salient language, concepts, and ideas about conservation.

6.4.3 Differences in Communication Expectations

Findings demonstrated that what professionals expect families to be talking about, if they are to be talking about conservation at live animal exhibits, is not fully reflective of what families actually talk about when asked to discuss conservation in these settings. Figure 6.1 shows eight conservation Discourse themes identified in concept maps professionals were asked to create. With a total of 61 code applications, the top eight codes account for 62% of all code applications.

Although professionals expected the conservation-related talk of families at live animal exhibits to be about animals generally, relating ideas about ecosystems, as well as recognizing their connection to nature, families discussed something quite different. Through their concept maps, families primarily talked about solutions and strategies to perceived environmental problems, highlighting the role of educational efforts more frequently than the professionals did on their concept maps, discussing broad environmental issues and threats, such as pollution, habitat loss and global climate change (Fig. 6.2).

Furthermore, when professional groups were asked to create concept maps about how they thought families would conceptualize conservation, they created linear models of conservation learning and talk for families different from the complex structure of the actual concept maps families constructed when asked to map their conservation thinking, representing a potential misalignment between the linear thinking professionals expect to be typical of families' thinking and the families' actual thinking, which demonstrated the ability and willingness to connect ideas and concepts in non-linear and complex ways. The maps professionals created represented family thinking and learning as strictly linear. That is, each of the maps produced by experts, in part or in whole, represented family

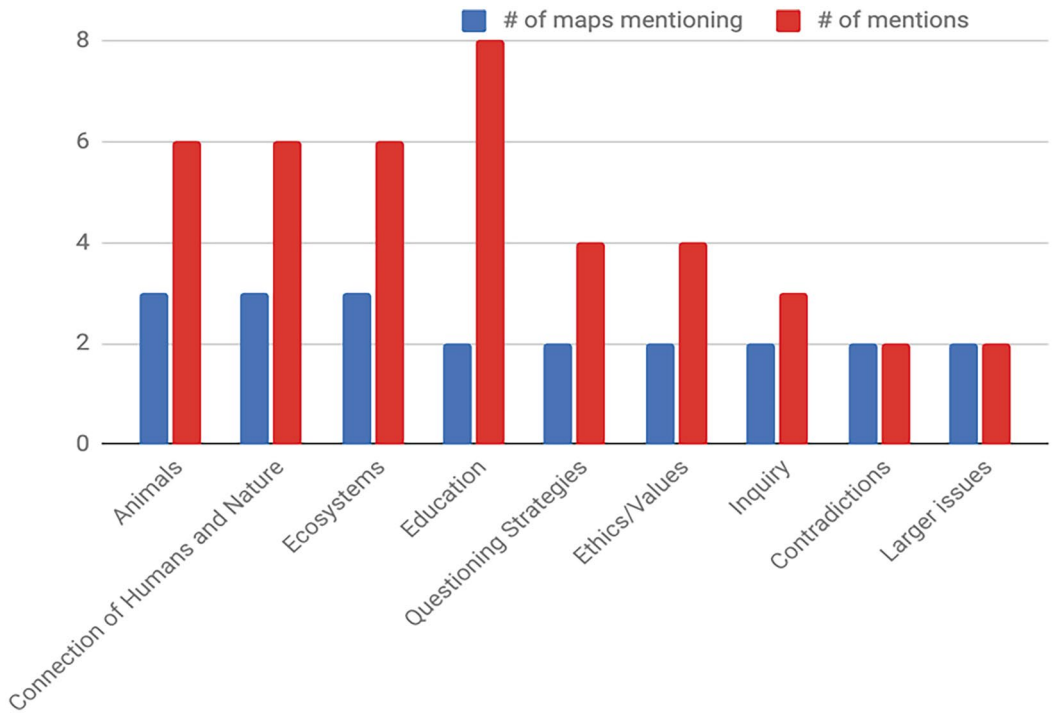


Fig. 6.1 Top conservation discursive themes highlighted by at least two of the three concept maps created by professional groups

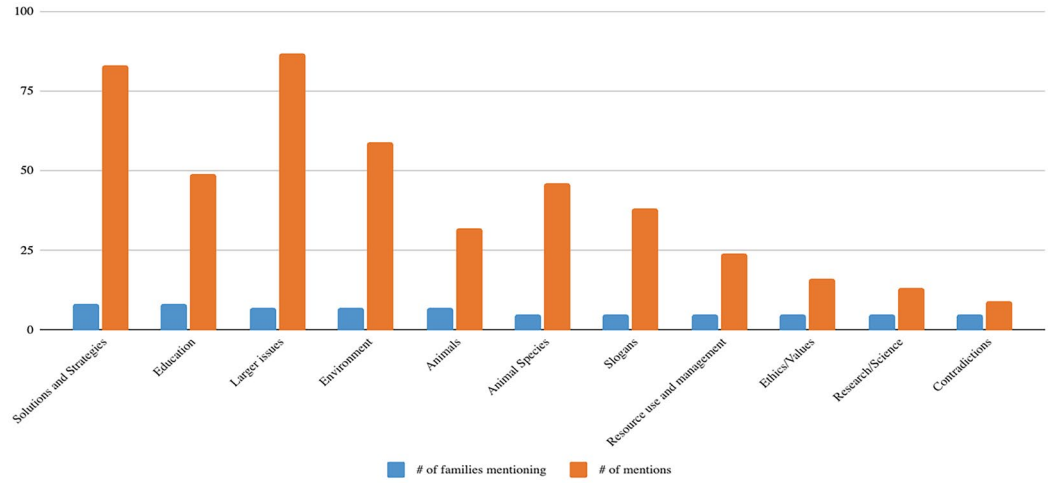


Fig. 6.2 Top conservation discursive themes highlighted in at least half of the concept maps created by the recruited family groups ($N = 10$)

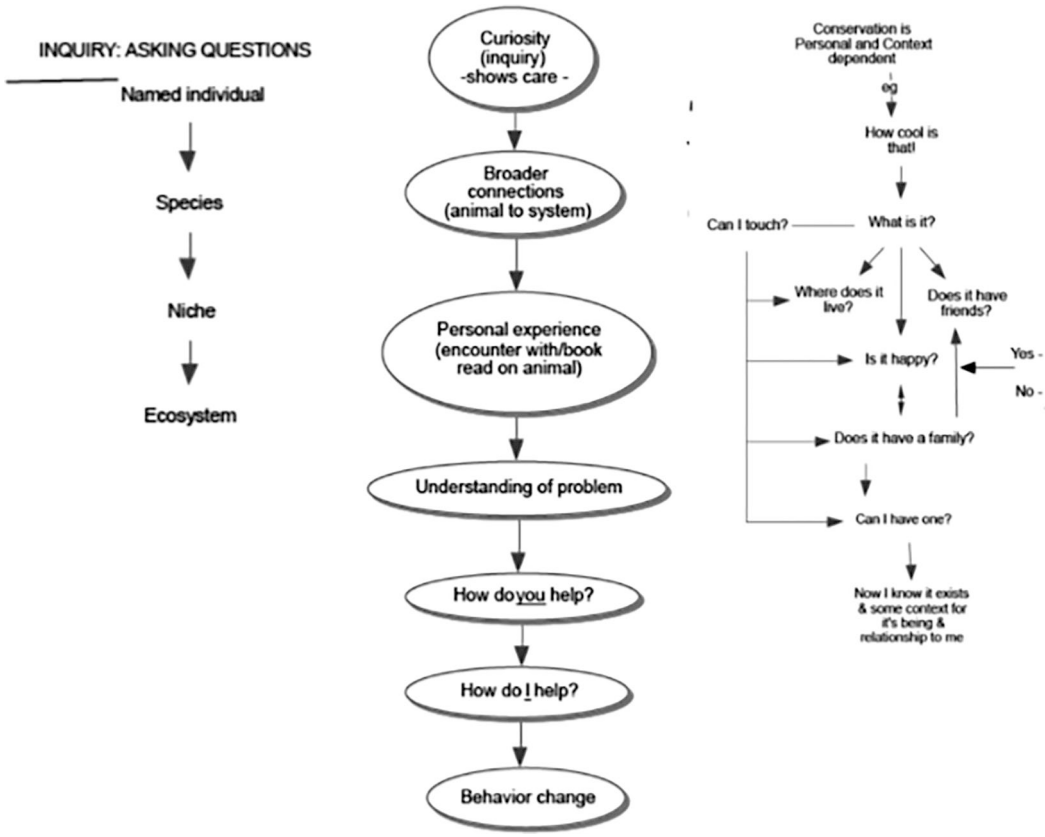


Fig. 6.3 Segments of all three professional concept maps illustrating the linearity assigned by professionals to expected family conservation discourse

conservation Discourse and learning as a step-by-step linear process with a predictable, even essential sequence (Fig. 6.3). For example, professionals thought that a family would move from curiosity about a particular animal, to making systemic connections through inquiry, moving on from there to understanding the problem and then finally becoming able to act upon the issue by modifying their behavior. As such, they posited a linear and hierarchical process that they expected would lead to conservation awareness and action.

On the contrary, family maps showed substantial depth, breadth, and interconnectedness with often well-developed hierarchical and distributed structures. For instance, depth within categories is represented by the number of "child" nodes attached to "parent" nodes (as in the color-coded Global Warming group of related nodes in Fig. 6.4). Breadth across categories is evident by the fact that there are five different parent/child category groups represented by the five different first level nodes off of the central node seen in Fig. 6.4. Similarly, interconnectedness is represented by the number and variety of types of connections among nodes within each category and occasionally across categories.

Even more interesting, what professionals thought should count as conservation Discourse for families interacting at live animal exhibits was not only different from what families talked about in their maps, but was also different from their own conservation Discourse. For the first 82 out of 120 min of a professional focus group conducted, participants talked about their own understandings of what conservation means to them in

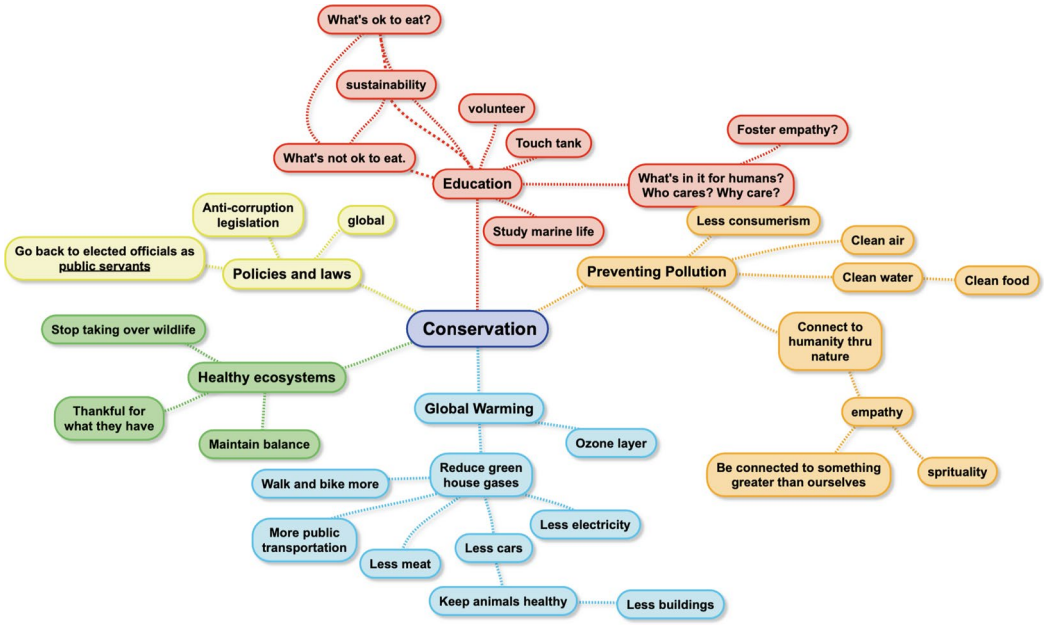


Fig. 6.4 Example of a family concept map (family map #7) showing breadth, depth and interconnectedness within categories of Discursive themes

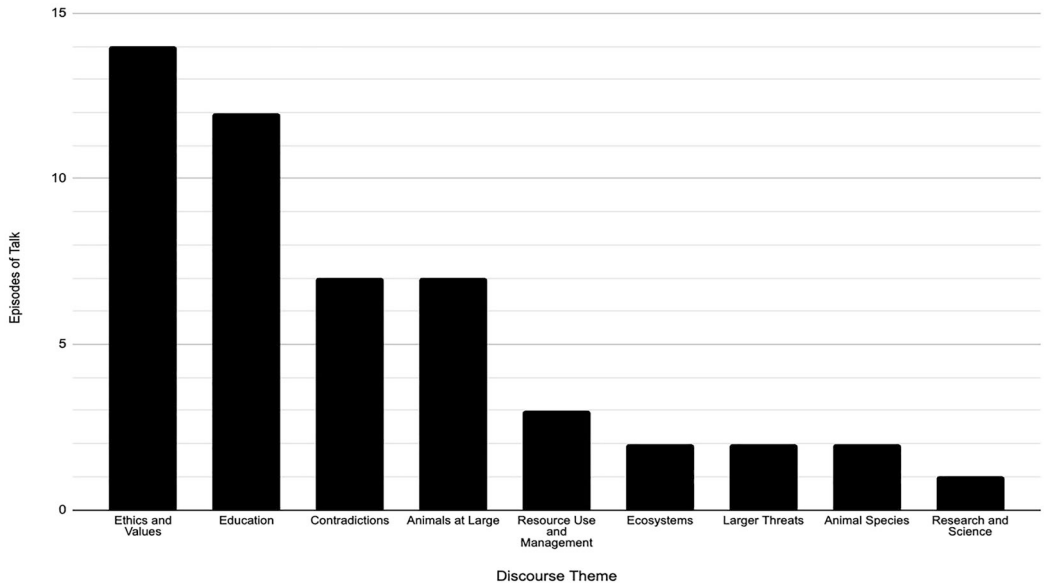


Fig. 6.5 Discursive themes present in professionals' talk by number of episodes of that talk

their work and lives. A rubric, created from top themes in the families' maps and to aid in identifying the presence of target Discourses, was applied to the recording of this portion of the focus group conversation. Fifty episodes of talk drawing on one of the 14 types of Discourse in the rubric were identified. Figure 6.5 shows the number of episodes of talk drawing on each of nine of the 14 types of Discourse identified by the rubric.

In this sense, professionals' conservation Discourse was not that different from families' conservation Discourse, but professionals expected much less of families. The use of concept maps as multimodal representations not only illuminated more diversity and depth to family conceptions of Ocean conservation, it also allowed a more nuanced understanding of professionals' perspectives and the potential misalignment between these two groups.

6.5 Personal Meaning Mapping as a Multimodal Tool for Examining the Relationship Between Ocean-Oriented Environmental Identity and Ocean Literacy

6.5.1 Background

The second project we examine also focused on using multimodal tools to illuminate the interrelationships among individual identity and worldview in construction of Ocean Literacy. Examining the relationship between Ocean-oriented environmental identity (EID) and Ocean Literacy helps understand how individuals, especially youth, develop a connection to the natural world. This study carried out by the third and first authors explored the relationship between Ocean Literacy and Ocean-oriented EID and how Personal Meaning Mapping (PMM), a simple multimodal data collection task involving drawing in response to an open-ended prompt, helps to examine youths' developing Ocean-oriented environmental identity and Ocean Literacy across two distinct cultural contexts: Taiwan and the United States. By engaging youth in creating PMMs, the study aimed to capture the internalization of Ocean-related knowledge, values, and attitudes, and how these are influenced by sociocultural backgrounds and learning contexts.

6.5.2 Ocean-Oriented Environmental Identity

Ocean-oriented environmental identity (EID) refers to an individual's sense of connection, relationship, and belonging to the Ocean. It encompasses how people perceive the Ocean's influence on their values, the emotions they express concerning Ocean-related fears and threats, and their attitudes toward marine environments (Kelly et al. 2023). This identity is shaped by personal experiences, cultural beliefs, educational exposure, and interactions with the Ocean, ultimately influencing behaviors, attitudes toward Ocean conservation, and engagement with marine issues.

6.5.3 Personal Meaning Mapping in Free-Choice Learning

Personal Meaning Mapping (PMM) is a research tool developed to analyze the dynamic learning processes especially within free-choice learning (FCL) environments (e.g., museums, aquariums, national parks) (see Fig. 6.6). FCL is characterized by its self-motivated nature, where individuals determine what, where, how, and with whom they learn. This type of learning extends beyond formal educational settings, occurring throughout people's lives in diverse contexts, including at home, school, work, libraries, museums, and online platforms. PMM aligns seamlessly with FCL by enabling researchers to examine how individuals' knowledge, attitudes, and interests evolve as they engage with open-ended, exploratory experiences (Falk 2003). By capturing these shifts in understanding and perspective, PMM offers valuable insights into the impact and effectiveness of FCL environments in fostering meaningful, personalized learning experiences for researchers and promotes multimodal reflective activity that supports learning through metacognition.

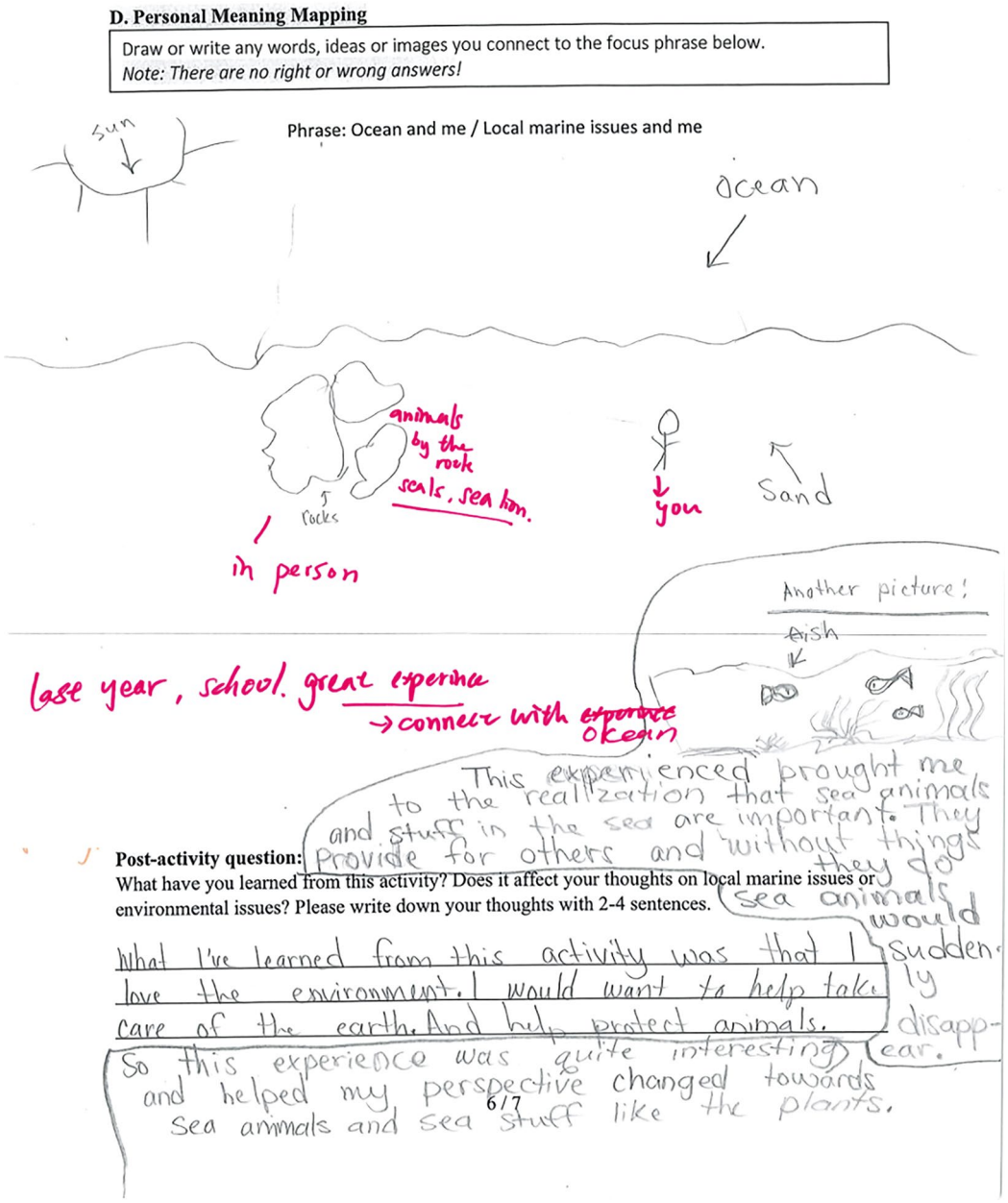


Fig. 6.6 Pre/Post-personal meaning mapping: This picture illustrates Participant 4's Ocean knowledge before visiting a marine science museum (picture in the top middle) and after when another picture and texts were added

6.5.4 Methods

Here we report on the relationship between Ocean-oriented EID and Ocean Literacy revealed through the quantitative analyses of PMM's collected as part of a larger project assessing participants' Ocean-oriented EID through surveys, investigating participants' perceptions of marine issues before and after visiting an aquarium or participating in a museum-led educational experience at school, and delving into how participants' life stories influence the

construction and refinement of their Ocean-oriented EID and Ocean Literacy (Tsai 2024). Data collection, observations, and narrative interviews were conducted with schools that partner with museums and aquariums in Taiwan and the United States. Participating classes of adolescents were recruited through partner museums reaching out to collaborating schools and inviting their participation in the study (Tsai 2024).

6.5.5 Instruments

Two scales were employed to assess participants' Ocean-oriented EID: the Environmental Identity Scale (EID) (Clayton and Opotow 2003) and the Extended Inclusion of Nature in Self Scale (EINS) (Martin and Czellar 2016). The EINS scale, which examines the extent to which individuals include nature in their cognitive representation of self, was divided into three subscales: EINS overlap, EINS distance, and EINS center. The EINS overlap subscale uses the metaphor of connectedness, visualized in a basic multimodal way as two overlapping circles, to express a person's affinity to nature. The EINS distance subscale employs parallel lines that move closer together or farther apart to represent physical proximity to nature. Finally, the EINS center subscale features a cross either inside or outside the center of a circle, symbolizing how central nature is in an individual's life, and reflecting the perceived importance of nature. Data from these scales were collected through surveys and graph-based visualizations, allowing for the quantitative analysis of participants' Ocean-oriented EID. Pre/post PMM exploring the types of life experiences and prior knowledge associated with Ocean-oriented EID and how these factors influence meaning-making and learning experiences related to human-Ocean relationships and marine issues were collected to complement the limitations of the Ocean-oriented EID survey.

6.5.6 Data Analysis

The Ocean-oriented EID survey was analyzed quantitatively. Pearson's correlation coefficient (r) was employed to assess the relationship between both scales, and an independent sample t-test was used to determine the impact of demographic data (such as age, gender, school type, country, etc.) on participants' Ocean-oriented EID. A cluster analysis grouped participants into three groups based on their Ocean-oriented EID, and an exploratory factor analysis (EFA) was conducted on the EID scale to categorize the 16 questions into a more valid and reliable measure of a specific concept based on participants' perceptions on the EID questions.

Data generated through PMMs was extremely rich, lending itself to both qualitative and quantitative analysis including thematic analysis and PMM structure scoring to evaluate individual knowledge changes (Tsai 2024). A four-dimensional rubric was adapted from prior research (Rollins 2010). Numerical scores assigned to the PMMs underwent paired t-tests to assess knowledge change and an independent samples t-test to explore differences between countries and birth states across the four dimensions (Tsai 2024).

6.5.7 The Interconnection of Ocean-Oriented EID and Ocean Literacy Through Survey and PMM

Participants' total Ocean-oriented EID values in the United States align with findings from other studies in Western countries, while the total Ocean-oriented EID values in Taiwan were lower than those observed in similar research. Results also showed that both Taiwan and U.S. participants who participated in free-choice marine courses had moderate to high Ocean-oriented EID. Additionally, the EFA extracted two compo-

nents from the Taiwan data while five components were extracted from the U.S. data. The U.S. study aligns with previous research. Given that the two components extracted from the Taiwan EFA were not sufficient to group specific aspects of the EID scale, the EID scale was broken down into five subgroups based on the U.S. findings and previous studies, along with the reliability test: (1) 'Enjoying nature,' (2) 'Environmental identity,' (3) 'Environmentalism,' (4) 'Appreciation of nature,' and (5) 'Learning about nature with loved ones.' These subgroups represent the components of adolescents' Ocean-oriented EID.

PMM results showed that the U.S. dataset had more sub-conceptual categories (n = 58) compared to the Taiwan dataset (n = 40). Notably, 19 of the 58 categories in the U.S. dataset were contributed by a single student with extensive knowledge and interest in marine-related topics. This finding indicates that PMMs capture not only collective experiences but also individual "islands of expertise," (Fig. 6.7) where specific interests and knowledge are deepened through social interactions, particularly within family activities (Crowley and Jacobs 2002). Regarding the average scores for 'Detail' and 'Accuracy,' both the U.S. and Taiwan averaged around 1.5 on a 3-point Likert scale, indicating that the participants had low to moderate Ocean content knowledge.

The Ocean-oriented EID scores could not predict PMM outcomes in terms of overall rubric scores across four dimensions (event, difference, detail, and accuracy) related to participants' Ocean Literacy. This suggests that adolescents' connections with the Ocean do not necessarily translate to detailed knowledge of marine ecosystems and issues. Although PMMs did not predict Ocean-oriented EID scores, they added a valuable component to the data collected through the EID and EINS scales. Participant produced PMMs as a multimodal activity offered a bottom-up approach, capturing ideas and statements from the participants' perspectives, contrasting with the top-down approach typically employed by researchers.

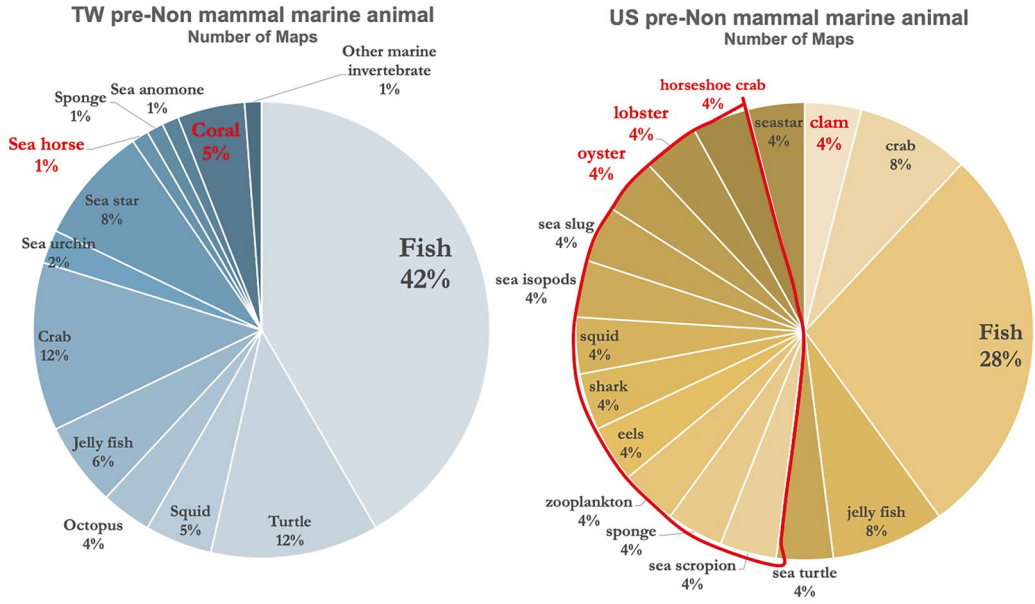


Fig. 6.7 This figure shows one of the sub-conceptual categories, 'Non-mammal marine animal,' recorded from the Pre-PMM drawing. The items circled (in red) in the U.S. pie chart were contributed by a single student, highlighting the student's "island of expertise"

6.5.8 Cultural Contexts in Ocean Literacy and Identity Construction

PMM results showed that participants in the US and Taiwan develop their Ocean-oriented EID and acquire Ocean knowledge in distinct ways, shaped by their unique cultural contexts. In the US, participants often engage with Ocean content through a combination of formal education and free-choice learning experiences, such as coastal field trips, aquarium visits, and exposure to media programs like *My Octopus Teacher* and other documentaries. These diverse learning opportunities allow students to explore Ocean science content in more interactive and self-directed ways. On the other hand, Taiwanese participants relied more heavily on formal classroom learning and traditional educational resources such as textbooks, structured curricula, and limited outdoor activities.

The results (see Tsai 2024) indicated that formal education in both countries influences participants' knowledge levels; however, local environments and FCL experiences play an equally important role. From the PMM debriefings, we observed that while students from urban public schools demonstrated higher knowledge levels than their counterparts in rural districts, especially indigenous participants, their Ocean-oriented EID levels did not show a consistent positive relationship. Participants' Ocean-oriented EID and worldview were shaped more by their living environment, life experiences, and socio-cultural contexts—such as proximity to the coast, family members working as fishermen, or local myths about ancestral origins—than by formal education alone. The multimodal aspect of participant produced PMMs illuminated these nuances in the data for both researchers and for participants.

6.6 Development of Multimodal Ocean Literacy by Producing Virtual and Augmented Reality Applications

6.6.1 Background

One of the most promising areas of new media Ocean science communication is the use of cross-reality (XR) platforms such as augmented or virtual reality apps for creating mobile, available anywhere anytime learning environments where learners are immersed in contexts and engaging with multimodal content alone or in small groups. Virtual and augmented reality (VR/AR) tools have a long history in education to promote immersive experiences (Jowallah et al. 2018). VR experiences heighten immersion (Pausch et al. 1997), enable rich social experiences (Schroeder 2012), and can promote immersive learning for both distance and in-person science communication and education contexts. Because of the need for specific knowledge, skills, and equipment, most learners experience multimodal XR content solely as consumers (whether active or passive) rather than as active producers. One of the fundamental tenets of the project reported here, the Distant Immersive Virtual Experiences for Agriculture (DIVE4Ag) and the Distant Immersive Virtual Experiences for Ocean Literacy (DIVE4OL) project led by the second, fourth and fifth authors, is that when youth are guided through scaffolded opportunities to participate as experts in creating multimodal XR environments and experiences for other youth and adults, they develop critical multimodal literacies about the Ocean. The DIVE4 program partnered researchers, educators, an AR/VR production company, and youth to co-create a series of apps, two of which focused on Ocean themes: oyster aquaculture and coastal community resilience to tsunamis.

6.6.2 Methods

The DIVE4Ag and DIVE4OL projects bring state-of-the-art technology to provide immersive experiences for middle and high school (agers 11–18) youth and educators including AR/VR and online activities that youth participate in creating. The project's overall goal is to provide innovative, authentic, and immersive distance agriculture and Ocean education to middle and high school learners, educators, and trained volunteers. A second goal is to help participating youth and educators develop multimodal literacy through production of XR applications. Project experiences are designed to equip those involved with new communication tools to promote meaningful participation and impactful learning in virtual environments and with innovative technology. Each of the six produced apps is ultimately part of a full DIVE4Ag/DIVE4OL Toolkit which includes:

1. Virtual/augmented (VR/AR) reality experiences immersing users in a variety of contexts, including oyster farming and hazard resilience contexts, including coastal community resilience to tsunamis. Experiences are produced in both English and Spanish.
2. A project tailored Teens as Teachers training program through which youth work with scientists, educators, and software developers to design and produce elements of the VR/AR field experiences. In the process, youth master Ocean knowledge as needed to create storylines, images, narrations and visualizations. They also become photographers, videographers, new media writers, narrators, holograms, and content experts.

Youth participating in the project work with project partners to co-create programing and deliverables with teen participation focusing on youth from underserved and culturally/economically diverse groups. Specific project components included:

1. A 10-week Teens as Teachers virtual course for Community Emergency Response Team (CERT) trained and other youth to develop skill and knowledge necessary to work together with project educators, communicators, and scientists to complete the app and curriculum.
2. A capstone retreat for the course where youth participants and coordinators complete storyboarding, filming, scripts and audio for the app and associated curriculum content.
3. VR/AR field experiences development and deployment.
4. Development of associated curriculum for classrooms and informal experiences to go along with the app for use in formal and informal outreach, education, and engagement.

The Teens as Teachers (TAT) online course delivers a robust and engaging online learning program in selected Ocean science concepts that youth participants need to have some knowledge of in order to produce apps. Forty-eight teens completed the online DIVE4Ag or DIVE4OL course to date supported by a stipend for both the free course and the follow up retreat and materials completion. The 10-week hybrid training course includes both online course modules and bi-weekly video meetings. Participation rates of teens was high with 80% of teens who were recruited completing the online course and fulfilling their commitment to participate in all aspects of VR/AR app development (six apps and associated online curriculum). An important element of the Teens as Teachers model is a 3-day, 2-night capstone retreat and associated field trips where project staff, participating community partners and scientists, and the youth work together to complete storyboarding, scripts, filming on location, and audio to be included in the apps. Hosted at university field stations or similar locations, the capstone retreat serves as a bedrock testing site for teen participants to hone and apply the multimodal media production and curriculum development skills they have learned in the online course in situ and with expert scaffolded guidance.

The end result are VR/AR apps featuring key places, people and concepts identified by participating youth, educators, and scientists. VR/AR experiences integrate live-action footage, computer generated contexts and animations, and visual effects with increased interactivity through a gaming engine delivery system that results in

experiences that place learners in the center and make room for youth to investigate, define and deliver components to be included in the VR experience. The VR/AR experience itself consists of a projected space chosen by the team (see Fig. 6.8 for an example from the DIVE4Ag Oyster Aquaculture app) where individual elements are keyed to "pins" (Fig. 6.9). Touching or bumping the device against these pins opens 2D or 3D video, audio, or animation content (Fig. 6.10).

6.6.3 Outcomes for Participants

The process of designing and planning these AR/VR Ocean content focused experiences included identifying learning Ocean science content outcomes and key facts and topics associated with those; creating storyboards to inform media collection (videos, photos, animations) in the field sites; and writing, directing, and recording components as well as carrying out interviews and background research. Youth and project staff

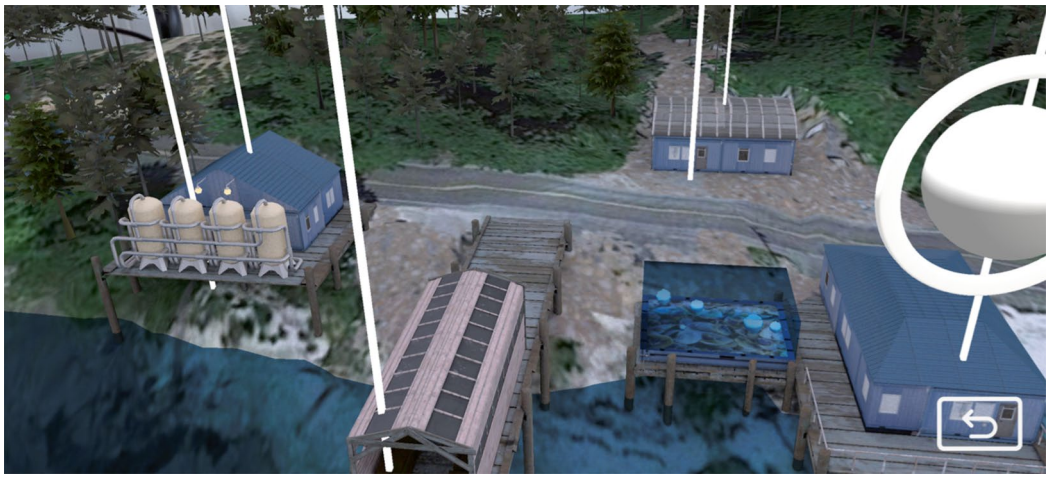


Fig. 6.8 Screen shot of virtual oyster farm made from GoogleEarth and photos of two sites on the Oregon Coast

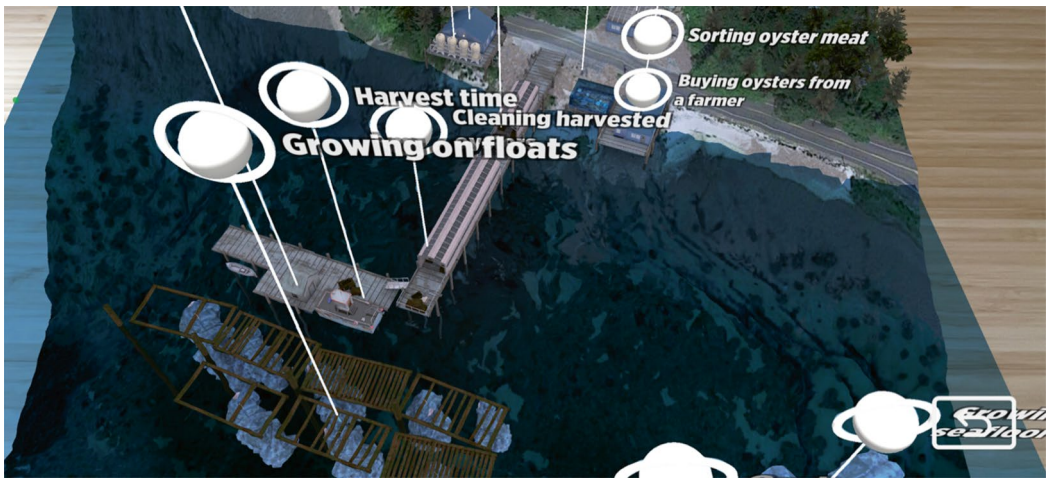


Fig. 6.9 Pins linked to content and keyed to specific features in the virtual Oyster Farm AR app projected via ipad on a tabletop



Fig. 6.10 Oyster Aquaculture Extension Faculty member discussing shell characteristics for market and projected via 3D hologram on desktop via ipad Oyster Aquaculture AR app

learned together how to use new technologies including 360-degree cameras and drones and how to build 3D models and holograms through their direct work with industry developers. Through this process, participating youth and the project team became comfortable as producers of multimodal educational media and programming, mastering technological and content knowledge and skills.

Youth participants themselves were explicit about the knowledge and skills they developed and how they changed their understanding of how XR experiences are created and how that shapes what such experiences can and cannot achieve. Focus groups and pre/post surveys with youth demonstrate that they highly valued the co-creation experience. Specifically, being immersed as co-creators in a technologically complex development process supported their communication and public speaking skills, teamwork and collaboration skills, leadership skills, building confidence/adaptability skills, presentation skills, and video and media production skills. Additionally, course produced materials and multimodal artifacts produced by participants including individually produced scripts, narrations, and app content demonstrated increased understanding of key Ocean science content related to published Ocean Literacy essentials (NMEA 2021) including geophysical, chemical and biological features of the Ocean, coastal areas and seawater; the role of tectonic activity in shaping coastal features and human life; Ocean food webs and protein production; coastal community and individual resilience to disasters; cultural and historical knowledge of and responses to tsunami and human nutrition; and the variety of scientific, industrial, engineering, communication, education and management careers available related to the Ocean and human interaction with the Ocean.

While digital technology mediated approaches like this hold great promise, we are still in the beginning phases of understanding how to address their limitations. On the cognitive front, for instance, further research is necessary to explore thoughtfully designed approaches that avoid overwhelming users with multiple communication modes, particularly when modes lack cohesion or demand simultaneous engagement. Additionally, multimodality may lead to fragmentation of focus, making it difficult for learners to synthesize information effectively. Socially, educators and communicators must address access to broadband and hardware for rural and underserved audiences. Finally, ecologically speaking, much of the hardware for x-reality requires often non-sustainably harvested natural resources and because it changes frequently creates a large deal of e-waste—all of which threaten

Ocean and human health and economies. To address these challenges, it is critical to take cultural-historical contexts into consideration and to address inequitable access to digital tools, broadband, and hardware. Despite these obstacles, as our first two examples make clear, it is possible to foster multimodal Ocean Literacy even with simple, non-digital tools.

6.7 Conclusion: Multimodality, the UN Ocean Decade, and Addressing Multicultural and Multimodal Aspects of Ocean Literacy

Multimodal communication and learning approaches play important roles in catering to cognitively, socially, and culturally diverse learning styles and experiences. Visual tools, for instance, play a key role in simplifying complex Ocean concepts, making Ocean content more accessible and easier to comprehend for a wide audience. By transforming intricate ideas into visual representations, learners can connect new information with their existing knowledge, enhancing their understanding and retention of the material. Furthermore, as our research with concept mapping and personal meaning mapping demonstrate, when learners produce visual tools as part of communicative acts, it helps them make sense of the ideas, beliefs, images, concepts, episodes, experiences, and knowledge they have assembled about the Ocean. Multimodal tools and texts as simple as concept maps and personal meaning maps serve as more than just data collection tools; when learners produce them, they aid in recall of prior knowledge and experiences and make it possible to intertwine personal experiences, socio-culturally situated knowledge and beliefs, Ocean science concepts, and disciplinary knowledge in powerful ways (Cone et al. 2013). The deeper understanding this effort affords underscores the importance of multimodal approaches in Ocean science education.

Building on the concept of multimodal literacy as defined by Jewitt and Kress (2003), we propose that a person who is multimodally Ocean-literate creates, distributes, receives, interprets, and reshapes images, texts, digital representations, and meanings related to the Ocean through various modes of communication and representation (Jewitt and Kress 2003). Unlike the traditional understanding of Ocean Literacy, multimodal Ocean Literacy involves not only cognitive understanding but also emotional engagement, social and cultural awareness, and behavioral commitment. This creates a richer, more inclusive, and impactful approach to Ocean education and advocacy.

Ocean Literacy, like identity, is shaped by a complex interplay of cultural, educational, and attitudinal factors. Recent research like that reported here underscores the importance of multimodal and multicultural approaches to enhance Ocean Literacy, aligning with the UN Ocean Decade's goals for sustainable Ocean. As we strive to meet the UN Ocean Decade's goals, it is essential to embrace innovative and multimodal approaches that reflect the rich diversity of global experiences and cultural contexts. This includes not only improving our measurement tools but also fostering educational practices that are adaptable and responsive to the needs of diverse learners allowing opportunity to create and refashion ideas in multimodal ways with multimodal tools. Our hope is that more opportunity for developing multimodal Ocean Literacy will enhance our collective Ocean Literacy and contribute to a more sustainable and informed future for our Ocean.

6.7.1 Summary

Key concepts explored in this chapter include:

- Most media are multimodal and require a multimodal literacy for learners' critical engagement.
- Multimodality may be as simple as using drawing or illustrations as part of texts or as complex as immersive digital learning environments.
- Having learners create multimodal artifacts (concept maps, personal meaning maps, virtual and augmented reality apps) can not only help us learn more about their literacy, but also

help create more inclusive opportunities for developing Ocean Literacy.
- A person who is multimodally Ocean-literate creates, distributes, receives, interprets, and reshapes images, texts, digital representations, and meanings related to the Ocean through various modes of communication and representation.
- This not only improves our measurement tools but also fosters educational practices that are adaptable and responsive to the needs of diverse learners worldwide.

6.7.2 Recommended Resources

The following resources provide further insights and support on this topic:

- The DIVE4OL App: https://seagrant.oregonstate.edu/outreach-and-engagement/coastal-hazards/DIVE4OL
- Oyster Farming and Related Virtual Reality Field Experiences: https://dive.oregonstate.edu/virtual-reality-field-experiences

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[2]Susan R. M. Rowe: Co-conceptualization; Writing—Original Draft, Review, and Editing; Grant Writing and Funding Acquisition; Methodology—Design, Data Collection, Data Visualization, and Analysis; Project Administration—Supervision and Coordination.

[3]Shu-Min Janet Tsai: Co-conceptualization; Writing—Original Draft, Review, and Editing; Methodology—Design, Data Collection, Data Visualization, and Analysis.

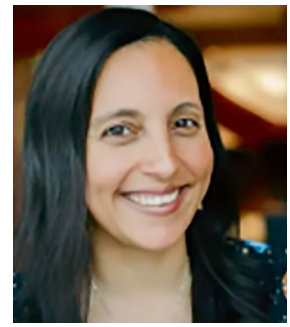
[4]Emily Nicholson: Co-conceptualization; Writing—Original Draft, Review, and Editing; Photography, Videography, Layout and Design; Project Administration—Supervision and Coordination.

[5]Kristen Moore: Co-conceptualization; Writing—Original Draft, Review, and Editing; Photography, Videography, Layout and Design; Project Administration—Supervision and Coordination.

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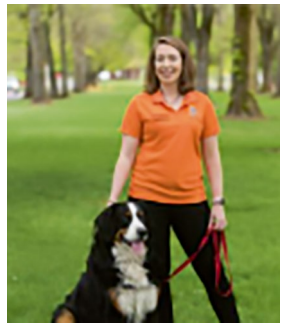
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Kristen Moore, PhD, is Oregon State University 4-H Youth Development and Campbell Family Small and Companion Animal 4-H Program Faculty. She also works alongside Ms. Nicholson as the DIVE4Ag and DIVE4 Ocean Literacy 4-H Program Coordinator and Coordinates 4-H Programs for the city of Portland, Oregon. Dr. Moore works to create programming that connects to young people in authentic ways and to curate learning environments where young people can explore their sparks and build skills.



Emily Nicholson is the DIVE4Ag and DIVE4Ocean Literacy Program Coordinator as well as a Precollege Programs Assistant Director at Oregon State University. She manages youth programs for and serves alongside Dr. Moore as program coordinator for the USDA-funded DIVE4Ag project and NOAA Sea Grant funded DIVE4OL project co-leading the Teens as Teachers component and creating content in partnership with industry and researchers.

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Ocean Literacy Through Exploring the Ocean as a World of Sound

7

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Abstract

The Ocean, a world distinct from terrestrial habitats, offers a unique acoustic environment shaped by its density, salinity, pressure, and temperature. Sound travels four times faster in water than in air, making it a central feature for understanding marine ecosystems. Ocean soundscapes, a mix of biological, physical, and anthropogenic sounds, indicate ecosystem health and biodiversity. This chapter explores how the shared exploration of these soundscapes fosters Ocean Literacy, enhances understanding of marine environments, and promotes conservation.

The Ocean World of Sound (WOS) initiative highlights the effectiveness of Passive Acoustic Monitoring as a non-invasive, cost-effective method to study marine soundscapes and engage communities. Through innovative outreach efforts, including workshops, the *30-Day Ocean Sound Challenge*, and citizen science projects, WOS empowers communities to actively contribute to research. By harnessing the immersive nature of sound, this initiative fosters emotional connections and motivates conservation efforts. Aligned with the UN Ocean Decade's goals—especially Challenge 10, which seeks to restore humanity's relationship with the Ocean—this chapter demonstrates the transformative potential of sound to strengthen people's connections with their marine ecosystems.

Keywords

Acoustics · Active listening · Mindful listening · Passive acoustic monitoring · Soundscape · Citizen science · Ocean Literacy (OL) · Ocean World of Sound (WOS)

7.1 Introduction

The Ocean is often described as a different world. The popular saying, "We have explored more of outer space than the bottom of our Ocean," underscores how much remains to be discovered in this vast part of our planet. While the Ocean is not actually in another world, it certainly possesses distinct characteristics from terrestrial habitats, such as its density, immense pressure at depth, current patterns, and diverse marine life that shaped the evolution of its geology and biology. Thus, trying to understand the Ocean the same way we know our land environment is scientifically inaccurate and fails to capture the Ocean's unique complexity. We should consider the

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Ocean's properties, from salinity to biodiversity, to find the best ways to "observe" this underwater environment and understand it so that we can study and learn from it.

One of the main differentiating features of the Ocean environment is density. Above the Ocean's surface, we move through the air. Water is denser than air (and seawater even more). A discussion of the complex dynamics of density (and salinity, pressure, and temperature) in the Ocean is beyond the scope of this chapter (but can be explored elsewhere, such as Liu et al. 2024). However, the denseness of seawater is a key oceanographic property. The difference in density between air and water influences movement at the most basic level (e.g., Nedelec et al. 2016).

Sound can travel and is a physical phenomenon, but not in the sense that a tangible object travels from one place to another. Sound travels in pressure waves. In the medium through which the sound is traveling, the particles themselves are not traveling but are becoming squished closer together and farther apart as the wave of pressure passes through. Sound waves are vibrations that propagate by compressing and decompressing regions of particles (Hansen 2001).

In water, the particles (molecular components) are much closer to each other than in air due to water's higher density. This proximity allows the vibrations, or pressure waves, to be transmitted more quickly between water and air particles. In air, the particles (mostly nitrogen and oxygen molecules) are more spread out than in water (hydrogen and oxygen molecules), so it takes longer for the vibration of one particle to pass to the next. Sound travels more than four times faster in water than in air (approximately 1500 m per second in water, compared to approximately 343 m per second in air), due to water's higher density and elasticity, not because it is louder or higher in pitch (DOSITS n.d.).

In the Ocean, sound propagation is also influenced by temperature, salinity, and depth. These factors create varying layers in the water column, affecting how sound waves move. Sound can refract, bending as it encounters changes in these conditions. This leads to phenomena like the SOFAR channel, a natural sound conduit that allows low-frequency sound to travel vast distances with minimal energy loss (Webb and Tucker 1970).

Visibility in the Ocean is significantly limited compared to on land. Water absorbs and scatters light much more effectively than air, with shorter wavelengths (like blue and green light, approximately 450–570 nm) penetrating deeper, while longer wavelengths (like red and orange, approximately 590–750 nm) are absorbed more quickly. This causes colors to fade and dim as depth increases, with visibility often dropping to just a few meters in turbid coastal waters. Additionally, suspended particles like plankton, sediments, and organic matter further scatter light, reducing visibility (Fig. 7.1). Water clarity, depth, and sunlight influence how far one can see underwater (Luria and Kinney 1970).

As a result, marine organisms have generally evolved to rely more on non-visual senses. Many marine organisms are adapted to use underwater sound in their behaviors and interactions, relying on sound as a primary means of communication and navigation. A notable and familiar example is dolphins, which use multiple features of sound to communicate in complex ways (Maust-Mohl et al. 2011) and navigate using echolocation. However, marine mammals are far from being the only creatures that have tapped into the sonic underwater environment. Snapping shrimp, a crustacean about the size of your pinky finger with one large claw and one small claw, are responsible for some of the highest-amplitude (loudest) sounds in the Ocean, though these sounds are short-range and high-frequency (Versluis et al. 2000; Spence 2008; Spence & Knowlton 2008). Some fish make mating calls so loud they disturb humans living near the shore and create the longest-known uninterrupted vertebrate vocalizations (Balebail and Sisneros 2022).

The characteristics of underwater sound propagation make it an invaluable tool for marine organisms, which rely on sound to communicate, navigate, and detect predators and



Fig. 7.1 Example of reduced visibility while Heather Spence and field diver Hildebrando Gonzalez deploy an underwater acoustic recorder inside an underwater sculpture named The Listener, a collaboration with artist Jason deCaires Taylor. (Photo: The Stills 2014)

prey, and for researchers using acoustic monitoring to study and conserve marine environments (DOSITS n.d.). Ocean soundscapes, comprising a rich tapestry of biological, physical, and anthropogenic sounds, are essential indicators of the health of marine ecosystems, and among other recognitions, Ocean sound has been designated as an Essential Ocean Variable (Miksis-Olds et al. 2018; Tyack 2018). Essential Ocean Variables are chosen by experts based on both their impact and feasibility to measure (GOOS n.d.; Simmons et al. 2022). Further, as Becker et al. (2023) emphasize, understanding these acoustics is crucial for supporting the UN Decade of Ocean Science for Sustainable Development, which aims to enhance our capacity to monitor and protect marine environments. To have a rich understanding of and connection with the dense underwater environment, we should address the role of sound. The name of our initiative (WOS) is based on a phrase coined by our founder, Heather Spence, who describes the Ocean as a "world of sound" (e.g. The Stills 2014).

This chapter will explore how sound is an entry point to enhance Ocean Literacy, mainly through community-based approaches that leverage existing capacities. We can adapt our sound-based education and engagement models in diverse regions worldwide by fostering a deeper connection to marine environments.

7.2 Understanding Ocean Soundscapes

Ocean soundscapes are intricate and dynamic, representing the overall acoustic environment within specific marine habitats. A soundscape is defined by the combination of biological, physi-

cal, and anthropogenic sounds, each contributing to the health and functioning of the Ocean. Much like how a forest's soundscape can signal the diversity and vitality of its ecosystem, Ocean soundscapes provide vital insights into the well-being of marine environments. As Spence (2018) highlights, soundscapes serve as crucial indicators for monitoring ecosystem health, offering a way to assess changes over time non-invasively.

A variety of natural sources shape Ocean soundscapes. Biological sounds come from marine life, including fish, crustaceans, and mammals. For example, snapping shrimp generate loud crackling sounds that dominate the acoustic environment in many shallow coastal areas. Fish also produce a range of sounds—grunts, croaks, and clicks—particularly during social interactions, territorial disputes, or mating. Marine mammals like whales and dolphins use complex vocalizations for communication, often over vast distances, with humpback whale songs being one of the most recognizable underwater sounds. Physical sounds, such as the rhythmic crashing of waves, the pitter-patter of rain, or the rumble of distant underwater earthquakes, also contribute to the Ocean's soundscapes (DOSITS n.d.).

Although humans live on land, the Ocean is not free from human influence. It is often disruptive when human-made sound is introduced into the underwater environment. Commercial shipping, fishing, tourism, sonar, and offshore construction contribute to this acoustic disturbance. Anthropogenic noise is widespread throughout the global Ocean and increasingly dominates certain regions. This human-made noise is more than just background disturbance; it has the potential to mask natural sounds, disrupting critical behaviors like communication, navigation, and foraging in marine species (Duarte et al. 2021). Noise pollution is increasingly recognized as a major environmental issue, with anthropogenic sounds overwhelming many natural soundscapes. Commercial shipping, in particular, produces low-frequency noise, which, even if not loud in volume, can travel for hundreds of kilometers, masking the calls of whales and other marine life. This interference can lead to communication breakdowns, behavioral changes, and increased stress among marine species. Further, noise can cause physiological impacts, such as disorientation and hearing damage (Duarte et al. 2021). As human activities continue to increase, managing noise pollution becomes essential to protect the natural acoustic environment on which many marine species depend.

From the point of view that a person's trash can be somebody else's treasure, could one creature's noise be another's music? Certainly, perspective plays a role in the value of various sounds in the marine environment. The fact that a human produces a sound should not automatically classify the sound as noise. However, most underwater sounds humans produce are not intentional but byproducts of various activities. The purpose of boat motors, pile drivers, or SCUBA regulators is not to produce sound. Instead, sound is emitted in the form of energy lost. In this way, it is essential to remember that the more efficient the activity, the less energy is lost in the form of sound. Wherever noise can be reduced and activities can be made more efficient simultaneously, this is a win-win solution for underwater noise.

Ocean soundscapes vary dramatically depending on the location. Each region's acoustic environment is influenced by its geography, depth, and the species that inhabit it. Shallow coral reefs are often filled with the sounds of snapping shrimp and fish grunting and eating. By contrast, the pelagic Ocean can have a quieter foundational soundscape punctuated with low-frequency baleen and high-frequency toothed whale calls. Physical sounds in shallow waters may be dominated by wave action, whereas areas farther from shore or at depth may be dominated by geological sounds like earthquakes, vents, etc. Further, these differences are not just a matter of sound sources; they also arise from how sound travels in different environments. The temperature, salinity, and pressure of the water affect how sound waves propagate, with deeper waters often allowing low-frequency sounds to travel farther, as we mentioned within the SOFAR channel, where sound waves can move over thousands of

kilometers with little energy loss (Moreira et al. 2020; Webb and Tucker 1970).

Ocean soundscapes also vary depending on the time of day or the season. As birds chorus in the air, so do fish underwater. At different times of the year, the same patch of the Ocean may sound different due to the movements and migrations of organisms or changes in the physical properties of the water. Over long periods of time, changes in the soundscape track with changes in the ecosystem (DOSITS n.d.).

While humans tend to think of the Ocean's soundscape as the calming sound of waves, marine species experience it very differently. For many organisms, sound is a lifeline. Dolphins, for example, rely on echolocation to "see" their environment through sound, while certain fish use vocalizations to establish territory or attract mates (DOSITS n.d.). In this context, the Ocean's soundscape can be considered an essential part of the sensory world for marine species.

7.3 Transformative Potential of Sound

Sound has a unique ability to foster a deeper understanding and emotional connections. Although humans are predominantly visual creatures, sound plays a critical role in how we perceive and relate to the world, often on a subconscious level. Even when we sleep, while our eyes are closed, our ears remain alert, constantly processing information. This sensitivity to sound can be harnessed to create profound connections with the Ocean, allowing individuals to engage with it in ways that visual observation alone cannot achieve. The immersive quality of sound has the potential to transform the way people perceive and care for the Ocean.

Music has long been recognized for its ability to evoke powerful emotional experiences. More broadly, soundscapes can elicit emotional responses (Fiebig et al. 2020; Cain et al. 2013; Moscoso et al. 2018; Spence & Ballora 2021). Natural soundscapes on land have been brought powerfully to the public by works such as Rachel Carson's Silent Spring (1962), in which readers imagine silenced voices and the absence of birdsong in spring. Similarly, the natural soundscapes of the Ocean can stir emotions, create a sense of wonder, and encourage reflection. Whale song was brought to mainstream attention by the album Sounds of the Humpback Whale (Payne 1970). It was immensely popular and helped lead to the Save the Whales movement, a conservation initiative to protect the Ocean and its inhabitants.

Furthermore, sound can bridge the gap between humans and the marine environment. By immersing people in the sounds of the sea, we foster empathy and care for marine life, motivating individuals to engage more actively in conservation efforts. Sound can be a powerful tool in environmental education, allowing participants to experience the Ocean in a visceral way that words and images alone cannot convey (Spence 2018). Integration of Ocean soundscapes into educational workshops has led participants to feel more connected to marine ecosystems on an emotional level (Spence and Santisteban Avila 2021). This emotional engagement is essential for fostering stewardship.

Active listening is a powerful tool for fostering understanding and improving relationships in human interactions and how we relate to the natural world. From a psychological standpoint, active listening involves fully concentrating, understanding, and responding to what is being heard, which can strengthen relationships by creating a deeper emotional connection. It is a skill that encourages empathy, reduces misunderstandings, and promotes effective communication (Tustonja et al. 2024). Mindfulness is valuable for improving well-being, and active listening is closely related to mindfulness as it involves being present and fully engaged at the moment (Jones et al. 2019).

In the context of Ocean conservation, active listening serves as both a tool and a transformative experience. By actively listening to the Ocean, we are not simply hearing sounds; we are engaging in a mindful practice that, as demonstrated in medical settings, can reduce stress, improve focus, and enhance emotional connection (Jones et al. 2019; Tustonja et al. 2024). This

heightened awareness promotes a sense of calm and reflection, which can be profoundly transformative for individuals participating in Ocean sound workshops, sparking a new level of understanding and connection with the marine ecosystem.

The universality of sound ensures that, regardless of auditory ability, everyone can experience and connect with the Ocean on a sensory level. Even for individuals who cannot hear, sound can still be experienced through vibrations. Underwater, sound waves travel as pressure changes that can be felt physically by humans and marine animals alike. This sensory experience is another way in which sound can foster connection. The physical sensation of sound plays a crucial role in how marine species, such as sharks and shrimp, navigate their world. Similarly, for humans, feeling these vibrations offers a unique, immersive way to experience the Ocean and its soundscapes. This multisensory approach helps break down barriers to engagement, allowing more people to connect with the Ocean through sound. The vibrations created by Ocean sounds, whether from waves crashing or fish calls, can be felt through touch, providing a tactile way to engage with the marine environment.

Sound has the potential to be a transformative tool for Ocean conservation, fostering emotional and intellectual connections that motivate people to protect the marine environment. By promoting active listening and creating opportunities for people to experience the Ocean's soundscapes, we can cultivate a sense of stewardship that transcends cultural and geographical boundaries. Sound-based approaches can be highly effective in promoting Ocean Literacy.

7.4 Ocean World of Sound Initiative

"The Ocean World of Sound" (WOS) initiative (see the Recommended Resources section for extensive information on WOS), founded by Heather Spence, was born out of the need to monitor the Mesoamerican Reef (MAR). The MAR is the world's second-largest barrier reef, stretching over 1000 km and spanning the waters of Mexico, Belize, Guatemala, and Honduras. This diverse and ecologically rich ecosystem is home to numerous fish species, invertebrates, mammals, and some of the most extensive coral formations in the world (SEMARNAT 2016; Spence 2018) (Fig. 7.2). It is crucial in supporting regional economies through tourism and fishing, generating billions annually in Mexico alone (Reguero et al. 2019). Despite its global importance, the MAR faces significant threats from human activities, including coastal development, pollution, and overfishing. These pressures are especially pronounced in tourist-heavy regions like Cancun, where the marine ecosystem is at constant risk from environmental degradation. Monitoring changes in the ecosystem is very important for local resource managers; however, it is challenging because of the limited funding and staff. Common monitoring methods include visual surveys of species (e.g. identifying fish species along a transect line), which require trained staff hours to complete on site (including not only the biologists but the boat captain and other staff) and provide just a small snapshot of the environment.

Recognizing the need for a cost-effective way to reliably collect long-term data on this vital ecosystem, Spence drew from her marine biology and music background to consider monitoring the reef's health by listening to it. Invited to collaborate by the Mexican federal government in 2005, she partnered with the resource managers overseeing the Cancun region's Marine Protected Areas (MPA). She developed the initiative Ears in the Caribbean, the MAR's first Passive Acoustic Monitoring (PAM). The first long-term listening station was established at Isla Contoy in 2010, the second at Isla Mujeres in 2011, and the third at Punta Nizuc in 2012. This was made possible thanks to the collaboration with local MPA authorities led by the late Dr. Jaime Gonzalez Cano, international consultants in particular Rusty Brainard, local researchers including Patricia Santos and Rafael de la Parra, and outreach lead Guadalupe Duran.



Fig. 7.2 Detail of soft coral formations on the North of the Mesoamerican Reef. (Photo: The Stills, 2021)

Through her collaborations on the outreach programs, Spence also recognized the potential for sound as a monitoring tool and to foster deeper connections between communities and their marine environment. In 2014, Spence invited Ray Santisteban, a local photographer and diver, to help her shape what later evolved into WOS. Currently, WOS has expanded its Marine Protected Area collaborations and scope of listening stations across the entire Mexican Caribbean down to Parque Xcalak at the southern border with Belize and has expanded its core team in Mexico, adding in Andrea Luengas, Gino Caballero, Arelly Blas, and Marcela Evia. WOS now consults globally on PAM for coastal environments and sound-based community engagement strategies.

Additionally, WOS is an officially recognized Non-Governmental Organization (NGO) engaged in advancing Ocean Literacy and conservation through community-centered, sound-based approaches. Reflecting its leadership in bridging science and society, WOS was selected to serve on the international UNESCO Intergovernmental Oceanographic Commission (IOC) Ocean Decade NGO Task Group, where it has helped shape strategies for inclusive and locally relevant Ocean action. As emphasized in the *UNESCO Ocean Decade Manual for NGOs*, "NGOs can be central actors of the Ocean Decade, engaging in the co-design of Ocean science that is accessible, actionable, and fit-for-purpose in their respective areas of work, such as environmental education, conservation, community work, coordination of science or education initiatives, and advocacy efforts" (Kennedy et al. 2024, p. 9). NGOs play a critical role in mobilizing diverse communities, connecting local knowledge to global efforts, and fostering inclusive engagement that ensures all voices are represented—during the Ocean Decade and beyond. WOS exemplifies this mission by leveraging the power of sound to foster emotional connection, accessible science engagement, and collaborative

conservation efforts that resonate across cultures and generations.

7.4.1 What Is Passive Acoustic Monitoring?

PAM is a non-invasive monitoring method crucial in understanding and recording the sounds produced in marine environments. It involves the deployment of underwater microphones which continuously or periodically record the sounds of marine life, environmental processes, and human activities (Fig. 7.3). Unlike active sonar, which sends sound waves and listens for their return, PAM listens to the existing sounds in the environment, making it a "passive" technology. By recording these natural soundscapes, scientists can gain insights into species' behavior, biodiversity, and ecosystem health without disturbing the environment. For instance, PAM allows researchers to track the vocalizations of whales and dolphins, map fish activity, and monitor coral reef ecosystems.

One of PAM's key strengths is its ability to function continuously and under various conditions, including at night and in harsh weather when traditional visual monitoring methods would be ineffective (Spence 2017). PAM sensor systems can be deployed at different depths, sometimes for months, recording large amounts of acoustic data. This feature makes PAM a critical tool for long-term monitoring of marine environments, particularly in sensitive ecosystems like the Mesoamerican Reef, where human presence might disturb marine life or where resources for monitoring are limited (Spence 2018). PAM's continuous and versatile functionality makes it a



Fig. 7.3 Field team Andrea Luengas and Ray Santisteban positioning an acoustic sensor in the Mesoamerican Reef. Xcalak, MX. (Photo: The Stills, 2023)

practical and reliable tool for marine conservation.

Additionally, underwater soundscapes can be used to assess the impact of human activities on marine environments. Anthropogenic noises, such as those from motorboats, tourism, and construction, have been shown to disrupt marine life (Duarte et al. 2021). PAM provides a way to quantify and, in collaboration with resource managers, mitigate these and other impacts. For example, by comparing a site with tourist visitation and one where tourists are not allowed, we can observe if there is a difference in the behavior of marine species. Alternatively, we might find differences even if we monitor the same site during the tourist and off-season.

Another advantage of PAM is its scalability and cost-effectiveness. The technology ranges from high-end devices used by governmental and scientific organizations to simpler, more affordable models that can be used by small research teams or even citizen scientists. For example, when our program started almost 20 years ago, there were no underwater acoustic recorders off the shelf. Most of the sensors were big and heavy and could not be bought; they were leased for thousands of dollars. Now, there is a range of options for shallow waters, and even new developers are creating programmable systems smaller than a cell phone for only USD 150.

The ability to inexpensively collect large amounts of data makes PAM an ideal tool for low-resource settings, especially in areas like the MAR, where conservation funding is often scarce. This affordability has allowed WOS to monitor multiple sites within the MAR and begin scaling to other locations globally.

Over time, as the price decreased, the storage capacity increased. Our first equipment had a 1 GB compact flash card and a 120 GB hard disk drive (HDD). The market standard for HDD now is 8 TB with options up to 100 TB, and micro SD Cards can store 1 TB for only 50 USD. So, the primary limiter of data collection is power, and with expanding options, including additional battery packs and even the potential for power or recharging from the Ocean itself (Copping et al. 2018; Whitt et al. 2020), the future of data collection looks encouraging, with a trend toward continuous recording. With extensive data collection, however, data management and storage become more challenging. Arguably, this is a good problem to have, i.e., too much data. With more temporal coverage, more subtle patterns of species' behavior and changes in noise can be discovered. The Ocean's stories can be told even better with extensive continuous data.

Overall, PAM has come a long way and is a powerful scientific research and conservation tool. It enables the continuous observation of underwater ecosystems while minimizing human impact. WOS collects critical data that informs conservation efforts while engaging the local community in protecting their marine environment.

7.4.2 Connecting the Community with the Ocean Through Science

Just over 50 years old, Cancun was built as a tourism hub. While successfully attracting visitors, this design left coastal areas inaccessible to residents. Physical barriers and social dynamics have created a disconnect between the community and the marine ecosystem they relied directly on. Similar cases are found in coastal communities in other developing countries, where tourism strategies often prioritize certain types of rapid economic growth over environmental and community well-being, without fully addressing the mutual reliance of economic development and environmental health. In an informal survey at a local university in Cancun, students between the ages of 17 and 24 reported not visiting the beach for months, some as long as 9 months. This shows how little direct presence the Ocean represents in their lives despite its proximity.

WOS uses PAM as a scientific tool to reconnect people with the Ocean. By recording and sharing soundscapes of the reef via workshops, conferences, or even social media, the community has a new way to regain access to these marine ecosystems. PAM has proven to be a potent tool for understanding marine ecosystems,

further underscoring the crucial role of the community in Ocean conservation.

7.5 Outreach Efforts

As a transdisciplinary group with expertise in both science and the arts, WOS recognizes the challenges of communicating scientific research to diverse audiences. A common one is that scientific knowledge often stays within academic circles due to complex communication, intimidating language, and inaccessible platforms. WOS has emphasized bridging the gap between science and community, making scientific information accessible and engaging to non-scientists while opening a multidirectional dialogue. Further, these approaches are adapted to multiple languages and learning styles. Through interactions grounded in active listening by all parties, WOS removes the stigma surrounding science, using the universal language of sound to foster deeper personal connections to the Ocean and each other.

WOS emphasizes Ocean Literacy, providing training sessions and workshops that engage participants in learning about soundscapes, Ocean monitoring and marine acoustics. These workshops build foundational knowledge that community members can apply by learning to analyze acoustic data through active listening skills, which are valuable in everyday life. For instance, as workshop participants listen and react to sounds, workshop facilitators identify sound sources, and the participants learn to identify the different types of sounds present in the recordings, such as environmental factors like waves and biological ones like crustaceans, fish or human-made noise such as boat motors. Participants also learn to identify their personal soundscape, consider how they feel about different sounds and how they might change their actions based on these realizations.

By involving the community in data analysis, WOS empowers local and other stakeholders to become active participants in marine conservation. At the same time, this citizen science approach helps solve the practical challenge of processing the vast amounts of acoustic data collected by PAM sensors while fostering a deeper connection to the environment. Participants with no science background can still learn to identify fish, shrimp, and boat motors, and flag sounds of interest for experts to go back and explore further. Through hands-on involvement, participants better understand how sound reflects the ecosystem's health, which can make them invested in protecting it.

WOS offers options for diverse age groups, from preschoolers to adults, adaptable to specific demographics. Since May 2021, WOS has facilitated 41 sessions across 25 events, totaling over 101.5 h and impacting 1500+ people through in-person and virtual events in Mexico, Spain, Maldives, and the USA (Fig. 7.4). Some of these initiatives are described below.

7.5.1 Senses Submerged

In collaboration with and funded by the Ocean Memory Project, a network of over 100 researchers from a broad spectrum of disciplines and cultural backgrounds, WOS created an experience where participants from USA and local Mexican residents were brought together to explore sensory immersion to develop a deeper understanding of what sensing can mean for Ocean organisms and Ocean memory. In the three-day diving workshop, participants engaged deeply with the soundscapes of the beach and the reef through mindfulness exercises (Figs. 7.5 and 7.6). The exercises guided the participants to actively feel the vibrations and rhythms of the underwater world. Vivid discussions took place after every dive, during which the group shared their experiences and built knowledge of the reef together.

The first workshop included 18 participants, equally split between men and women, aged 22–55. The group represented Mexico and the United States and included visual artists, biologists, engineers, photographers, psychologists, scuba divers, and community leaders. Most participants were based in the Mexican Caribbean, while others traveled from urban centers such as



Fig. 7.4 Public spaces increase exposure, allowing us to reach a broader audience. Puerto Morelos, Mex. (Photo: The Stills, 2023)



Fig. 7.5 Mindfulness listening exercises at sunrise in preparation for SCUBA immersions, Puerto Morelos, Mex. Activity in collaboration with Ocean Memory Project. (Photo: The Stills, 2022)



Fig. 7.6 Mindfulness listening exercises during scuba immersion in Puerto Morelos, Mex Reef. Activity in collaboration with Ocean Memory Project and King Scuba. (Photo: The Stills, 2022)

Mexico City, New York, and Philadelphia, enriching the workshop with diverse perspectives and expertise.

7.5.2 Preschool and Elementary School Training

WOS's Kids Training programs are designed to introduce children between 4 and 9 years old (PK-3) to soundscapes and marine acoustics engagingly and educationally. These highly interactive workshops reached an almost equal balance of boys and girls. The schools were located in diverse settings in Quintana Roo state, Mexico, from the rural community of Xcalak in the south to Cancun in the north. Activities included sound walks, painting, and hands-on exercises that taught kids about Ocean sounds and their role in monitoring marine life (Fig. 7.7). Children were especially intrigued by identifying the sources of sounds, often drawing connections to their parents' work, as many families in these regions have income that relies directly or indirectly on the reef, especially in towns and rural areas.

7.5.3 World Listening Day (WLD) and World Ocean Passive Acoustic Monitoring Day (WOPAMD)

WLD is an annual global event on July 18 that encourages people to explore and celebrate the world through sound, and WOPAMD is a newer annual celebration of PAM on June 8. As part of these events, WOS hosts special workshops and listening sessions. Through an initial "tune in", participants recognize and connect to their unique personal soundscape and later are invited to immerse themselves in the sounds of the reef, using acoustic recordings collected during our fieldwork (Fig. 7.8). These sessions aim to raise awareness about the importance of listening as a conservation tool and highlight how people can obtain data by listening to their soundscape.



Fig. 7.7 Local kids listening to their reef during the Anniversary of the MPA Parque Nacional Arrecifes de Xcalak, Mex. (Photo: The Stills, 2023)



Fig. 7.8 Students of Secundaria Técnica No. 7 in Puerto Morelos, Mexico, tuning in to their personal soundscape during an activity in collaboration with Pangea World Foundation. (Photo: The Stills, 2023)

Given the universal nature of sound, these sessions are highly adaptable and have been conducted in middle schools (ages 11–15), public squares, conferences, and even as downloadable scripts or audio files for people to experience independently.

7.5.4 The 30-Day Ocean Sound Challenge

The 30-Day Ocean Sound Challenge is not just a challenge; it is a journey of personal growth and learning. Designed to create a habit of pausing, listening, and recognizing the power of sound, participants improve their listening skills while tuning in to the Ocean. They learn to identify their personal soundscape and apply those tools to Ocean soundscapes and daily life. Each day, participants are provided with a different sound recording from our archive of the Mesoamerican Reef, along with prompts to reflect on what they hear and how it makes them feel. These recordings range from the natural sounds of marine life, such as fish grunts and dolphin clicks, to the disruptive noises of human activities, like boat motors. This journey is an opportunity to learn, grow, and develop a deeper connection to the Ocean, inspiring and motivating participants to engage more deeply with the auditory environment.

Over 4 weeks, the participants are introduced to a staged learning process, "The 5 I's" developed by Spence. The first week focuses on the concept of "isolate," which involves picking out the sounds and considering their properties. The second week focuses on the idea of "identify" i.e. identifying the sound sources. The third week focuses on "interpreting," considering what the sounds mean. The fourth week focuses on "integrating," putting it together into a collective soundscape. The final 2 days focus on "imagine," a more open concept considering soundscapes of the future and a broader view of soundscapes and our roles in them.

The challenge encourages participants to listen mindfully, deepen their understanding of Ocean soundscapes, and develop a personal connection to the marine environment. By the end of the 30 days, participants reported a greater appreciation for sound and the Ocean, which can be translated into a more substantial commitment to conservation efforts. See the resources section for information on the entire challenge, which is free on YouTube and SoundCloud, offering a convenient and accessible way to learn about marine soundscapes and contribute to conservation.

7.5.5 Marine Protected Area Training for Touristic Operators

We have collaborated with Cancun and Isla Mujeres's MPA by including a section on acoustic monitoring in their certification program for local tourism operators and service providers. In the course, they are taught the fundamentals of acoustic monitoring, the importance of underwater soundscapes, and how their work in tourism can positively or negatively impact the marine environment, such as through their guidance of proper tourist behavior on the reefs. This training empowers them with the knowledge and tools to understand the importance of marine soundscapes and their potential to impact marine conservation significantly. While we do not have exact demographic data, most operators are males between 20 and 55 years old. In Cancun, many operators come from different parts of Mexico, while in Isla Mujeres, they are often second or third generation residents from the Island. By educating local service providers, WOS ensures that awareness extends beyond the scientific community and into the daily operations of tourism and tourists.

7.5.6 Pilot Program Supporting Reef Restoration Using PAM in K. Rasfari Protected Area, Maldives

In the Maldives, the Rasfari Reef ecosystem experienced severe damage following the Navios Amaryllis grounding incident in 2021. To support

its restoration, a pilot program led by WOS was launched using Passive Acoustic Monitoring (PAM) to assess reef health and provide baseline data for ongoing recovery efforts. This initiative, carried out in collaboration with the Ministry of Homeland Security and Technology, was implemented under the broader framework of Digital Maldives for Adaptation, Decentralisation, and Diversification, a program promoting digital technologies to foster resilience in the face of climate change.

The pilot aimed to build local capacity in acoustic reef monitoring, involving 22 participants from government agencies, academia, and the private sector. Over a period of 4 weeks, participants engaged in a comprehensive 24-h training curriculum covering all aspects of PAM, including equipment deployment, data collection, spectrogram analysis using tools such as Raven software, and practical conservation applications (Fig. 7.9). Seventeen participants successfully completed the program: ten from the Environmental Protection Agency (EPA), two from the Maldives Marine Research Institute (MMRI), three students from the Maldives National University (MNU), and two marine biologists from civil society organizations.

As part of the outreach component, a public lecture was held at MNU, drawing nearly 70 attendees, including university students, staff, and a group of ten middle school students. Through simple active listening exercises, participants engaged with real underwater recordings from Rasfari Reef and successfully identified biological and anthropogenic sound sources such as fish calls and motorboats. This session not only introduced the fundamentals of Ocean soundscapes but also demonstrated the power of listening to build awareness and inspire a new generation of marine stewards in the Maldives.



Fig. 7.9 Pictured is a remote lecture on sound data analysis by WOS collaborator Dr. Aaron Rice. (Photo: Ahmed Haleem for D'MADD)

7.6 Evaluation Methods

The Ocean World of Sound (WOS) initiative employs a set of evaluation methods to assess the effectiveness of its outreach and citizen science efforts. These evaluations are designed to capture qualitative feedback, reflecting the deep emotional and experiential connections participants form with marine soundscapes. The evaluation process is centered on tracking the impact of WOS programs on participants' understanding of Ocean conservation, their active listening skills, and their personal connection to marine ecosystems.

7.6.1 Surveys

Surveys are a key tool in evaluating WOS's outreach efforts, particularly in gauging the impact of programs. Surveys conducted before and after participation help track changes in knowledge, awareness, and emotional engagement with Ocean soundscapes. For the 30-Day Challenge, 44 completed daily feedback forms provide valuable insights into how participants connected with the sounds of the Ocean. Many participants found that describing sounds with words was unexpectedly challenging, with one noting, "I learned that I want to understand better how to describe sounds." Another commented, "Describing sounds with words is not easy, but I am enjoying this exercise," highlighting how the challenge pushed participants to engage more deeply with the auditory environment.

These surveys revealed that as participants progressed through the challenge, they developed greater listening skills and were able to identify more sounds. One participant observed, "Two similar sounds can have a completely different way of being described, and it is hard to find the words to express the differences," showing an evolving sensitivity to the subtleties in marine soundscapes. The surveys also provided insights into participants' emotional connections to the Ocean, with one stating, "I learned that sounds coming from the water give me a sense of well-being." Another expressed, "sounds can alter my mood." We also asked a targeted question about this, "How do you feel after the experience?" and responses included "more calm and present" and "more relaxed." These reflections help WOS assess the extent to which participants felt a personal connection to marine conservation through sound.

7.6.2 Testimonials and Feedback

Testimonials and personal feedback provide valuable qualitative insights into WOS programs' emotional and experiential impact. After immersive listening sessions, participants are invited to share their reflections on how the experience affected them. These group-sharing sessions are designed to be open-ended, with no right or wrong answers. Some testimonials are also recorded in video, allowing the possibility of revisiting ideas to shape future workshops better.

One notable testimonial came from a boat captain who completed the MPA Training for Touristic Service Providers. After listening to a soundscape, he identified a specific fish species by sound because it was the same noise they make when caught. This example highlights the importance of recognizing artisanal fishing practices and Indigenous knowledge. It demonstrates how traditional expertise can complement scientific methods like PAM, which is still evolving and often reliant on lab-based reference recordings.

7.6.3 Creative Products

WOS workshops, particularly those targeting children, artists, and citizen scientists, incorporate creative outputs as an evaluation method. Participants are encouraged to create drawings, sound diaries, or written reflections based on their experiences with marine soundscapes. These creative products offer insights into how participants internalize and express their learning. For example, children draw pictures depicting their interpretations of marine soundscapes, including animals they "hear." In another example, citizen scientists maintain journals after ana-



Fig. 7.10 Creative products provide insight into how participants internalize and express what they've heard, in this case, the soundscape of the beach of Cancun. (Photo: The Stills, 2021)

lyzing acoustic data and reflecting on their observations and experiences. During the workshop, subjects and directions of creative outputs provide input to the workshop facilitators for possible areas for additional engagement, and further analysis of the products such as themes or patterns may provide us with additional insights as we compare across workshops and audiences over time (Fig. 7.10).

7.7 Aligning with Ocean Decade Goals

The WOS initiative aligns with the Ocean Decade Challenges for Collective Impact, notably *Challenge 2: Protect and restore ecosystems and biodiversity*. Using Passive Acoustic Monitoring (PAM), WOS provides critical data on biodiversity and human-induced stressors, such as noise pollution, to help resource managers restore ecosystems like the Mesoamerican Reef.

WOS also addresses *Challenge 9: Skills, knowledge, technology, and Participation for All* by involving local communities in acoustic monitoring through workshops and citizen science projects. This approach enhances Ocean Literacy and builds local capacity for conservation, empowering residents with the tools and knowledge to actively participate in protecting marine ecosystems. The model's scalability and PAM's cost-efficient technology ensure it can be adapted to other coastal communities globally.

Using sound to reconnect communities with their marine environment, WOS addresses *Challenge 10: Restore society's relationship with the Ocean*. Rapid tourism development has severed local ties to the sea in coastal areas like the Mexican Caribbean. By teaching active listening with marine soundscapes, WOS helps participants develop empathy toward marine life, fostering a deeper emotional and sensory connection with the Ocean. Such personal connection, enhanced through active listening practices, mir-

rors the psychological benefits described in health papers (Jones et al. 2019; Tustonja et al. 2024), where genuinely hearing fosters emotional safety and understanding. WOS's approach thus transforms how people perceive and relate to the Ocean, motivating them to take action to protect it.

Additionally, WOS contributes to *SDG 14. a*, which emphasizes increasing scientific knowledge, research capacity, and marine technology transfer to improve Ocean health, particularly in developing countries. WOS's efforts to democratize Ocean monitoring and conservation through community engagement directly support this goal by ensuring that local communities in areas like the MAR, especially in developing regions, are equipped with the technology and knowledge to participate in and benefit from marine conservation. Through emphasizing establishing partnerships across sectors and countries as well as locally to meet these aims, WOS also contributes to *SDG 17 Partnerships for the Goals*.

By developing a model that integrates scientific research, community engagement, and education, WOS has created a sustainable and scalable approach to Ocean conservation that can be applied to other coastal communities facing similar environmental and economic pressures. Working together to enhance Ocean Literacy throughout the decade and beyond, sound-based approaches can be expanded, and WOS is excited to form new collaborations. As we make Ocean soundscapes accessible and foster a sense of connection through sound, we help build a generation of Ocean stewards equipped with the knowledge and tools to safeguard the future of the Mesoamerican Reef and the global Ocean.

7.8 Conclusion

The Ocean's soundscape offers a unique and powerful tool to enhance Ocean Literacy, reconnect communities with marine ecosystems, and promote conservation efforts. By harnessing the transformative potential of sound, the WOS initiative has demonstrated the ability to engage diverse audiences, foster emotional and intellectual connections, and generate critical data for marine conservation.

Passive Acoustic Monitoring (PAM) emerges as an effective and accessible method for studying marine ecosystems, bridging scientific research and community engagement. By empowering local communities to actively participate in monitoring and conservation, PAM fosters stewardship and builds capacity for sustainable Ocean management.

Through innovative outreach programs and alignment with the Ocean Decade's goals, WOS provides a scalable model for enhancing Ocean Literacy and advancing conservation worldwide. Currently, the WOS has been contracted by the government of the Maldives to adapt the PAM community engagement model used in Mexico for Maldives as part of their coral reef restoration efforts. Additionally, efforts are underway to bring the model to Spain. Further, educational resources developed by WOS are freely available to educators globally, including guided listening exercises, the 30-Day Challenge, informative videos, and soundscape examples. WOS would welcome partnerships to help make these resources and methods more broadly accessible and implemented globally. As humanity's relationship with the Ocean evolves, sound-based approaches offer a pathway to inspire powerful and positive collective action, ensuring the protection of marine ecosystems for future generations.

7.8.1 Summary

Key concepts explored in this chapter include:

- The Ocean is a world of sound where sound travels faster and farther than in air, making it a vital tool for studying marine ecosystems.
- Ocean soundscapes are created by biological, physical, and anthropogenic sounds and serve

as indicators of marine ecosystem health and biodiversity.
- Sound has the transformative power to foster humans' emotional connections with the Ocean, enhance understanding of marine ecosystems, and promote active engagement in conservation efforts.
- Sounds are waves and the wave characteristics determine how they are perceived. The pitch of a sound is determined by its wave *frequency* (measured in hertz, which is cycles per second), with higher/faster frequency associated with higher pitch. Low frequency sounds are absorbed less rapidly in the Ocean than high frequency sounds, and can therefore travel longer distances.
- The loudness of a sound is determined by its wave *amplitude* with higher amplitude related to higher sound pressure, higher sound intensity, and higher perceived loudness. Sound intensities are often described in relative units of decibels (dB); the reference levels are different in air versus water so in-air versus in-water dB values should not be directly compared.
- The Ocean World of Sound (WOS) initiative works in the Mesoamerican Reef to support data collection, education, and community engagement through workshops, citizen science, and creative outreach programs.
- Passive Acoustic Monitoring (PAM) is a non-invasive, cost-efficient method for collecting long-term data on marine soundscapes, with scalability and adaptability for community involvement.
- PAM reconnects communities to their marine environments, addressing social and ecological disconnection caused by rapid coastal development.
- WOS education and engagement efforts include workshops, the 30-Day Ocean Sound Challenge, and training programs for diverse audiences to improve Ocean Literacy and conservation participation.
- The WOS initiative aligns with Ocean Decade goals, including ecosystem restoration, enhancing skills and technology transfer, and rebuilding society's relationship with the Ocean.

7.8.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Ocean World of Sound website: https://www.oceanworldofsound.org/
- Ocean World of Sound: MesoAmerican Reef: https://oceandecade.org/actions/ocean-world-of-sound-mesoamerican-reef/
- Ocean Decade Research Programme on the Maritime Acoustic Environment: https://oceandecade.org/actions/ocean-decade-research-programme-on-the-maritime-acoustic-environment-un-mae/
- Ocean World of Sound YouTube channel, including free training tools: https://www.youtube.com/@OceanWorldOfSound
- WOS Challenge on YouTube: https://www.youtube.com/playlist?list=PLaa-kQ8vQey3X7yv4a0N-NXKUDfo7WuPG
- WOS Challenge on SoundCloud: https://soundcloud.com/heatherspence/sets/ocean-world-of-sound-30-day-challenge-1
- Discovery of Sound in the Sea (DOSITS): https://www.dosits.org/
- World Forum for Acoustic Ecology: https://www.wfae.net/
- **Schafer, R. M.** (1993). *The soundscape: Our sonic environment and the tuning of the world*. Destiny Books. https://monoskop.org/images/d/d4/Schafer_R_Murray_The_Soundscape_Our_Sonic_Environment_and_the_Tuning_of_the_World_1994.pdf

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Raymundo Santisteban Avila is a Mexican visual storyteller, diver, and underwater researcher. Since 2020, he has coordinated Ocean World of Sound (WOS), focusing on advancing reef research and empowering community-led conservation efforts. A certified divemaster, freediver, and search-and-rescue specialist, Ray combines his background in art production and photography with a passion for marine conservation to connect people with the Ocean and promote mindful, sustainable practices.

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8

BlueMinds4Teachers: The Chronicle of an EU4Ocean Project Fostering Ocean Literacy in Education for Sustainable Development

Panayota Koulouri, Athanasios Mogias, Francesca Alvisi, Maria Cheimonopoulou, Melita Mokos, Evelyn Paredes Coral, and Silja Teege

Abstract

Education directed towards sustainability comes in response to the challenges of our increasingly interconnected planet while its future is at stake. Ocean Literacy (OL), via behavioral change initiatives and a systems approach, aims at connecting Ocean Science and Education for Sustainable Development (ESD). The objective of the BlueMinds4Teachers project was to strengthen the skills of teachers and other educators in OL issues through the collaboration of marine and freshwater scientists, experts from education and social sciences, teachers experienced in implementing blue projects, and young Ocean ambassadors. The objectives were: (a) to bring the inter- and multi-disciplinary approach of Ocean science issues to teachers and other educators enabling them to improve their knowledge on OL issues and integrate them into ESD; (b) to bridge skills and knowledge gaps by integrating science and pedagogy, improve social learning and critical thinking; (c) to design, develop, implement, and assess an interactive online training course to improve skills of teachers and other educators in promoting OL at schools and educa-

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tional communities; (d) to give the opportunity to meet, learn, discuss, and debate on rules and strategies of marine and maritime research, testing of already available teaching plans and modules, evaluation of possible additions, modifications, weaknesses, and strengths.

Keywords

Ocean Literacy (OL) · Teachers · Marine educators · Blue careers · Lesson plans · Pedagogical strategies

8.1 Introduction

Ocean Literacy (OL) is recognized as a baseline for Ocean conservation and sustainable management of freshwater and marine resources. The United Nations (UN) consider OL one of the crucial steps towards a sustainable future of the Ocean, and critical for the success of the UN Decade of Ocean Science for Sustainable Development (UNESCO-IOC 2021). Ocean Literacy is relevant for all of the Ocean Decade Challenges, which is specifically emphasized in "Challenge 9: Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of Ocean science and for all stakeholders", and "Challenge 10: Ensure that the multiple values and services of the Ocean for human well-being, culture and sustainable development are widely understood, and identify and overcome barriers to behavior change required for a step change in humanity's relationship with the Ocean" (UNESCO-IOC 2021).

Enhancing OL in formal education is the priority of the Ocean Decade (IOC-UNESCO 2022). Therefore, training of formal educators (including in-service and pre-service teachers), and non-formal educators (e.g., those working in aquaria and museums), together with the development of resources, is encouraged by the Ocean Decade (UNESCO-IOC 2021). In addition, education is identified as one of the key drivers for restoring society's relationship with the Ocean (Glithero et al. 2024).

The interdisciplinary and transdisciplinary approach that connects freshwater, marine, education, and social scientists is an acknowledged way of communicating complex Ocean issues. Moreover, the UNESCO-IOC (2024) recommends a transdisciplinary approach to education fostering an Ocean-literate workforce.

This chapter showcases an example of successful education practice, outlining the activities and outcomes of the BlueMinds4Teachers project, including the development of an online teachers' training course and a digital toolkit. The results of surveys carried out during and after the course in order to evaluate its short-term impact and overall performance are also presented. The project itself has been driven by scientists and educators whose work is associated with marine, freshwater, education, and social science. It was developed to provide opportunities and resources for formal and non-formal educators, consequently enhancing OL in the education community. In addition, it connected OL and the Blue Economy, emphasizing the role of the former in raising awareness in education on Blue Economy to attract youth to engage in Ocean-related careers, i.e. Blue Careers (European Commission 2021).

8.1.1 The Concept of OL in Education for Sustainable Development

The Ocean Decade focuses on generating knowledge and data to support sustainable development. However, its White Paper for Challenge 10, referring to "Restoring Society's Relationship with the Ocean", emphasizes the major societal transformations needed to create a sustainable

and equitable future (Glithero et al. 2024). More specifically, behavior changes in personal, emotional, and cultural connections with the Ocean are necessary beyond conventional scientific methods and proper science communication. Education for Sustainable Development (ESD), climate education, and global citizenship are becoming not only essential areas of pedagogical focus but also powerful instruments of social change. The concept of OL aims to connect Ocean science and ESD through behavioral change initiatives and adaptation of systems approach. Whereas education is an important driver, OL is an outcome, in a society that understands and values the Ocean's vital role in our lives and behaves in ways that ensure its health. Therefore, the concept of OL is central to operationalizing Challenge 10 and the United Nations Ocean Decade legacy.

Ocean Literacy is fundamental to many of the UN Sustainable Development Goals (SDGs), particularly to SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, SDG 6: Ensure availability and sustainable management of water and sanitation for all, SDG 13: Take urgent action to combat climate change and its impacts, and SDG 14: Conserve and sustainably use the Oceans, seas and marine resources for sustainable development (Mokos et al. 2019). Education for Sustainable Development, including Climate Literacy and OL, needs to be embedded in education as a cross-cutting issue across all educational levels.

Teachers' training and their professional development must be aligned with the aforementioned critical topics, ensuring that educators have access to free, high-quality, and up-to-date resources. BlueMinds4Teachers project is very relevant in the general context of ESD and, therefore, towards SDGs and Challenges of the United Nations Ocean Decade.

8.1.1.1 The Pedagogical Approach and the Social Aspects

Participatory methods in teaching and learning processes are the best for the educational objectives to be properly met and communicated to students, youth, and learners (e.g., Ballantine and McCourt 2007; Jacobs et al. 2016). These methods depend upon the active involvement of learners in educational activities. They have drawn their theoretical and methodological elements mainly from critical pedagogy and socio-cultural theories of learning. In addition, they focus not only on the outcome of the teaching procedure but also on the learning process; this way, learners are deeply and authentically involved in the educational process, starting from their own experiences (constructivist approach), influencing, shaping, and building learning in interaction with other learners and the local community.

Participatory teaching and learning methods cultivate socio-political skills and pedagogical values through an interdisciplinary and systemic approach of knowledge, hands-on science, project-based and inquiry-based learning, critical thinking, and democratic ethos. Therefore, they enable learners to improve their relationship with the Ocean, acquire the necessary competencies to participate in decision-making processes and play an active role in a modern democratic society.

8.1.1.2 Empowering the Connection Between Freshwater and Marine Ecosystems

Linking school learning and other educational activities to the real-life daily experiences of students and learners, regardless of where they live (coastal or inland), is a key element in their understanding that the Ocean influences and is influenced by freshwater and terrestrial environments (a conceptual OL principle). Freshwater, coastal, and marine ecosystems are inextricably linked (Lamberti et al. 2010). Streams and rivers

transport water, sediments, organic matter, and nutrients downstream to estuaries and coastal ecosystems, thus influencing their productivity. The maintenance of land elevation in deltas and coastal areas and the interception of coastal erosion are also important, especially under the prism of climate change. Nutrient transfers can occur in both directions, as nutrients return from the Ocean to freshwater and terrestrial environments through biogeochemical cycles (e.g., the life cycle of birds and anadromous fishes enriching food webs).

Several pressures that can affect the coastal and marine environments come from anthropogenic activities on land, i.e. agriculture, industrial activities, wastewater treatment, forestry, and hydroelectric energy production (European Environmental Agency 2024). Understanding the interconnection between freshwater and marine ecosystems is a prerequisite for a holistic and integrated approach to managing all water bodies, promoting sustainability in all aspects of the water cycle. To this end, educational projects empowering the connection between freshwater and marine ecosystems are important as only a few have been implemented in Europe, at least, according to the Network of European Blue Schools.

8.1.2 The Background of the Project

In 2023, "BlueMinds4Teachers: Fostering Ocean Literacy in Education for Sustainable Development" was selected as one of the three winning projects of the "Blue Challenge" proposed by the European Ocean Coalition (EU4Ocean), inspired by the European Union (EU) Year of Skills, to drive collective action on OL. The EU4Ocean, a bottom-up inclusive initiative promoting OL in the EU consists of three components: (i) the EU4Ocean Platform, which includes organizations and initiatives that collaborate and mobilize OL efforts on priority issues such as Climate and Ocean, Food from the Ocean, and Healthy and Clean Ocean; (ii) the Youth4Ocean Forum, a free platform for young people engaged in the protection of the Ocean and its sustainable management; (iii) the Network of European Blue Schools, which includes schools implementing educational projects addressing Ocean issues.

The one-year project BlueMinds4Teachers (October 2023–September 2024) aimed at strengthening the skills of educators in OL issues through the collaboration of (a) marine and freshwater scientists, (b) experts from education and social sciences, (c) teachers experienced in the development and implementation of blue projects at schools, and (d) young Ocean ambassadors (e.g., university students, early career Ocean professionals). Jointly interactive meetings and activities were planned to provide educators with the motivation, capability, and opportunity to increase their awareness on Ocean issues and integrate them into their educational initiatives. Synergies with other projects such as Offshore Renewable Energies partnership in the Pact of Skills—FLORES, BlueGeneration, Next BlueGeneration were also essential for the successful implementation of the project in order to update educators regarding OL initiatives in Europe related to Blue Economy and Blue Careers.

The rich experience and previous knowledge of all the involved institutions (i.e. National Research Council, Italy; Hellenic Centre for Marine Research, Greece; Democritus University of Thrace, Greece; University of Zadar, Croatia; the Hydrobiological Station of Pella, Greece), such as participation in the BlueSchoolsMed and BlueNIGHTS projects, the Mediterranean region Working Group of European Marine Science Educators Association and publishing research on OL (e.g., Cheimonopoulou et al. 2022; Koulouri et al. 2022; Mogias et al. 2015, 2019, 2021, 2022; Mokos et al. 2019), were shared to work in an interdisciplinary way. The exchange of good practices among the project's partners, educators, and young people, along with the establishment of a constructive dialogue, was the basis for a dedicated workshop held in Croatia in January 2024. The participants collaborated to finalize the preparation of the course.

8.1.3 The Objectives of the Project

The objectives of the project were to (a) bring the inter- and multi-disciplinary approach of Ocean science issues to formal and non-formal educators (including university students), improve their ability to address and integrate them into the school curricula and other educational activities; (b) create a permanent working group where scientists, educators, and youth can interact effectively to build a robust educational community and innovative educational materials and tools; (c) contribute to bridging skills and knowledge gaps in educators, by introducing pedagogical methods and scientific knowledge, empowering social learning and critical thinking); (d) design an interactive online training course that can be reproducible, exportable, scaled-up and adaptable to local and national needs in EU countries and beyond.

The BlueMinds4Teachers project allowed elementary and secondary education EU (and non-EU) teachers and educators in non-formal education settings (e.g., aquaria, museums, zoos, science centers) to develop their skills in OL issues and increase their confidence in teaching about the Ocean and its resources. The aim was to support international best practices for Ocean education by integrating them into broader climate and sustainability education through teachers' training as well as educator and professional development certification programs.

8.2 The BlueMinds4Teachers Online Course

8.2.1 Co-Design and Co-Development of the Course

There is a global need for training of teachers and other educators in OL and the availability of educational resources. To contribute to this need, the BlueMinds4Teachers working group co-designed and co-developed a free-access online training course, advocating the protection of the Ocean and sustainable management of its resources. As already mentioned, a two-day hybrid workshop was organized at the University of Zadar in Croatia. Open discussions during the workshop concerned the content of an online course, the choice of interactive elements, the evaluation of the course's impact, and the communication and dissemination strategies of the project at the EU level. Furthermore, the teachers specifically requested that the outcome of the project, the best practices, and the lesson plans for each OL principle should be included in a digital toolkit.

During the discussions, it was kept in mind that teachers of elementary education usually have adequate Pedagogical Content Knowledge (PCK) and are therefore aware of teaching and learning strategies but lack sufficient Content Knowledge (CK) on Ocean science issues. On the other hand, secondary school teachers and other educators, especially natural scientists, may have sufficient CK on relevant topics but lack PCK. Regarding the social perspective addressed in the course, all educators have an opportunity to integrate Blue Economy key concepts and Blue Careers into their classrooms and other educational activities.

Central to the course was to highlight the connection of the OL framework to EU priorities and Missions (e.g., EU Mission: Restore our Ocean and Waters), SDGs, Ocean Decade, school curricula, and the Network of the European Blue Schools. This was achieved by providing content knowledge on Ocean science issues along with pedagogical strategies useful for implementing blue projects (e.g., hands-on activities, project-based and inquiry-based learning, open schooling) enhancing social learning, critical thinking, and scientific approach. These outcomes and processes are also the gateway to the Network of the European Blue Schools, which educates students and makes them aware of, and passionate about, sustainable Ocean management.

Overall, the content of the course was organized into four sections: (a) introduction to the project and connection to the Ocean Decade, EU Missions, and SDGs; (b) OL principles and their implementation in everyday life and teaching; (c) introduction to Blue Economy and Blue Careers; (4) pedagogical approach to teaching OL. As a

followup, the course was communicated and disseminated through social media channels.

8.2.2 Implementation of the Course

The online course was delivered in three sessions during April 2024 offering the opportunity to educators, university students, and researchers to meet, learn, discuss, and debate on (a) OL framework and Ocean issues; (b) EU priorities concerning the protection and sustainable use of the Ocean; (c) scientific methods, rules and strategies of marine and maritime research; (d) modern participatory teaching and learning methodologies.

The first session of the online course was held on April ninth, 2024, reaching almost 90 participants. This session started with an introduction to the project and its objectives, background of marine and aquatic education, the OL framework and its evolution to a multi-perspective concept, links to Agenda 2030 SDGs, the Ocean Decade Challenges, the EU Missions and priorities for 2019–2024, the Network of the European Blue Schools and inspiring blue projects. This was followed by the presentations of the first five OL essential principles, their related fundamental concepts and links to the above issues and school curricula. The second session on April 16th was attended by almost 75 participants. This session included the presentation of the last two OL principles and related fundamental concepts, the Blue Economy key concepts, a case study on offshore renewables, and video testimonials of people with blue professions from FLORES, BlueGeneration and Next BlueGeneration projects. On April 23rd, the third session reached about 70 participants and modern participatory pedagogical strategies that can be implemented for OL activities were presented.

In total, 184 teachers and educators registered for the online course from 28 EU and non-EU countries (Fig. 8.1). Around 40% of the total registered people were elementary school teachers, 30% were secondary school teachers, and 30% were other educators.

All sessions were held during the afternoon hours to allow teachers and other educators to attend outside their working hours and were recorded after their consent had been given for further use. During all sessions, an interactive approach was encouraged by inviting participants to write their questions and/or comments in the chat, and these questions were discussed at the end of the sessions. By the end of the course, all relevant materials were shared with the participants (e.g., presentations, references, and guidelines for developing a lesson plan) and certificates of attendance were issued.

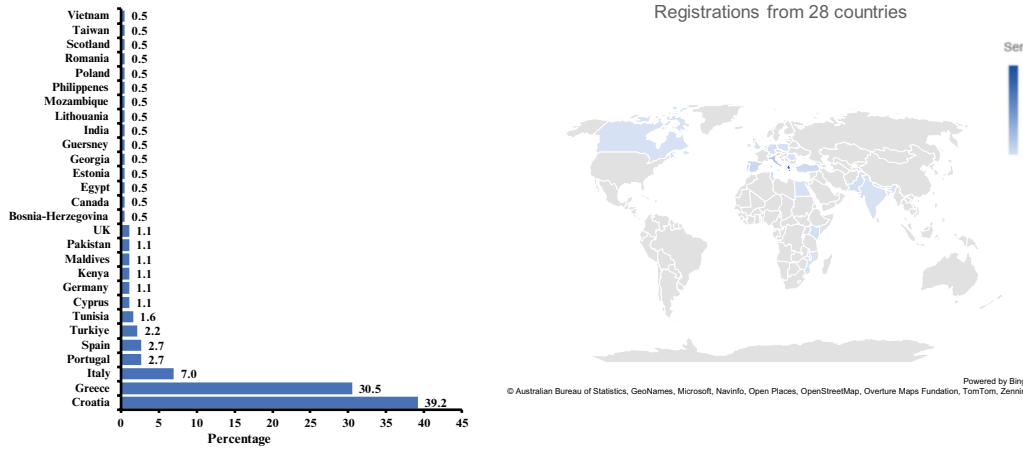


Fig. 8.1 Percentages of people registered for the BlueMinds4Teachers online course per country (map chart provided by Bing, color gradient is proportional to the number of registrations)

8.2.3 Mapping Participants' OL Knowledge and Attitudes—Surveys and Polls

Three surveys were performed during the entire course based on partners' previous experience, to get an insight into educators' understanding and connection to OL (Cheimonopoulou et al. 2022; Koulouri et al. 2022; Mogias et al. 2015, 2019; Mokos et al. 2019). The first one investigated their OL knowledge before and after the presentation of the OL principles, the second one focused on their knowledge and attitudes toward key concepts of the Blue Economy, and the last one inquired overall performance of the online course. In addition, to actively engage the participants during the course, a poll regarding the connection of a certain OL principle to curriculum topics was completed at the end of each OL principle presentation. All surveys and polls were delivered in Google Forms.

8.2.3.1 Survey 1: OL Knowledge

This survey was prepared to measure the short-term impact of the BlueMinds4Teachers course by assessing the participants' content knowledge regarding Ocean science issues before and after the online course. This pre- and post-survey included 18 questions concerning the 7 OL principles and the 45 fundamental concepts presented during the course along with some demographic information. Just before the beginning of the OL principles presentation, 76 attendees completed the online survey, of which approximately 92% were females, mainly from Croatia and Greece. Environmental education programs had been designed and implemented by approximately 67% of respondents, while marine education programs were carried out by 40% of them. Different age groups of participants were well represented, most holding a master's degree (Figs. 8.2a, b). Half of them were working in elementary schools, while both new professionals (1–5 years of service) and experienced ones (>20 years of service) were the majority (Figs. 8.2c, d). Apart from respondents with degrees in science (including marine science) and pedagogics, there were several other disciplines engaged (e.g., language, management of

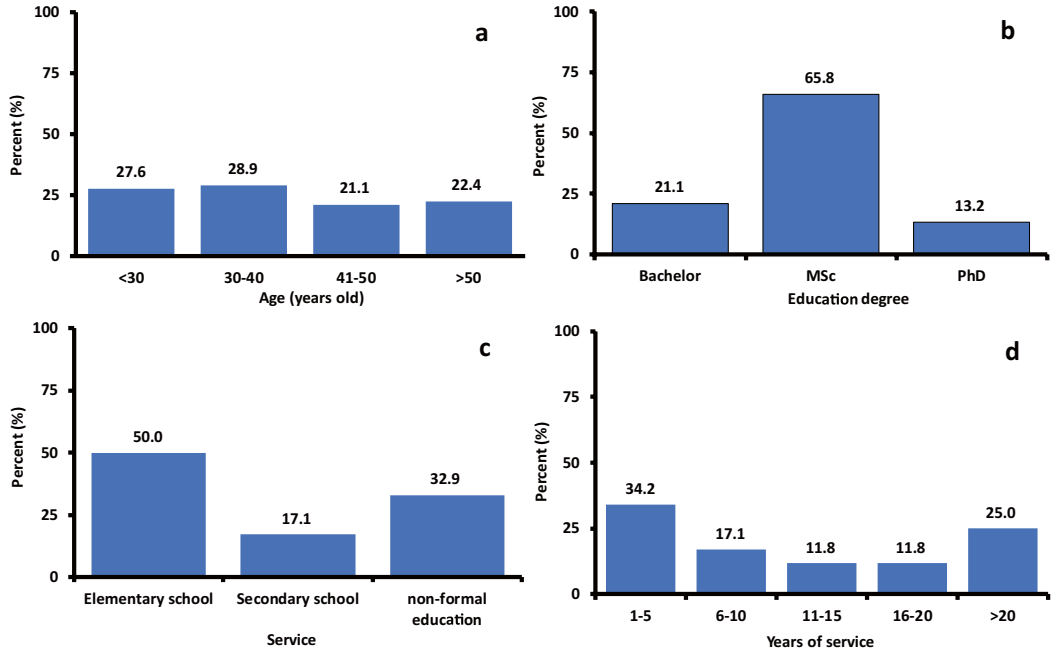


Fig. 8.2 a–d Demographics of the attendees participating in the OL content knowledge pre-test of the first survey

natural ecosystems, early childhood education, Information and Communication Technology).

After the presentation of OL principles, 47 attendees filled in the online survey, of which 98% were females. Environmental Education programs had been designed and implemented by approximately 77% of the respondents, while marine education programs were carried out by approximately 49%. Many respondents were over 50 years old, and most of them had a master's degree (Figs. 8.3a, b). Almost half of them were working in elementary schools, while relatively new professionals (1–5 years of service) and experienced ones (>20 years of service) were the majority (Figs. 8.3c, d). Most of the respondents had a degree already portrayed in the previously mentioned disciplines.

The survey results showed that the respondents possessed a relatively moderate to high level of knowledge on Ocean science issues. However, the online course further increased their content knowledge about OL principles and concepts. More specifically, concepts of Principle 3 "The Ocean is a major influence on weather and climate" and Principle 4 "The Ocean makes Earth habitable" were further clarified as well as Principle 2 "The Ocean and life in the Ocean shape the features of Earth" (Table 8.1). Nevertheless, further work is needed to evaluate the conceptual understanding of the general Ocean sciences content, focusing on the knowledge component and other OL dimensions (Mogias et al. 2015; Paredes Coral et al. 2022).

8.2.3.2 Survey 2: Knowledge and Attitudes Towards the Key Concepts in Blue Economy and Blue Careers

The next online survey was conducted after the end of the second session. Questions covered topics related to knowledge and attitudes toward the key concepts of the Blue Economy and Blue Careers. Of the approximately 75 attendees, 29 completed the survey, of which most were females (92.9%). Almost half of the respondents were over 50 years old with a master's degree (Figs. 8.4a, b), while most had been working as teachers/educators either for a few years (1–5) or for more than 20 years (Fig. 8.4d). Respondents from all teaching levels of service were well rep-

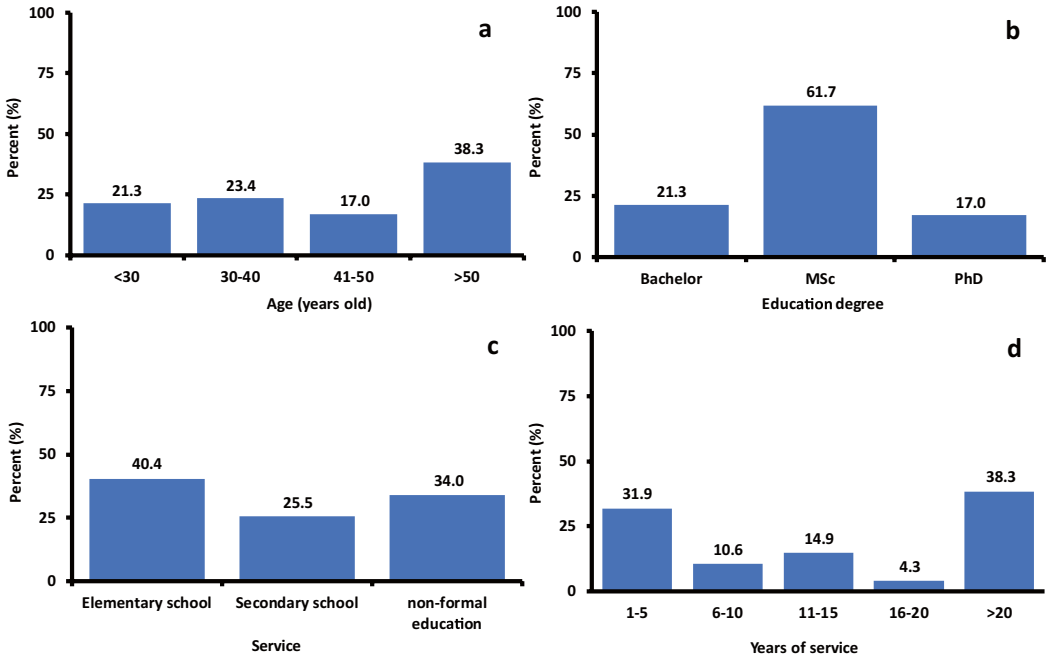


Fig. 8.3 a–d Demographics of the attendees participating in the OL content knowledge post-test of the first survey

Table 8.1 Short-term impact evaluation of the BlueMinds4Teachers online course on the participants regarding content knowledge on Ocean science topics; percentage (%) of correct answers received before (Pre-test) and after (Post-test) attending presentations related to OL principles and concepts (correct answers are indicated in bold)

Survey Statements		% correct answers		
		Pre-test	Post-test	p-level
1.1	The Mediterranean Sea is connected to **all the parts of the Ocean (OL-1)**	69.7	72.3	*Ns*
1.2	Most of the water on the Earth is **in the Ocean (OL-1)**	88.2	97.9	*Ns*
1.3	The form of the coastline is modified mainly by **seawater motions (OL-2)**	75.0	76.6	*Ns*
1.4	If you walk in the mountains and see a rock containing fish fossils, it means that **the rock with the fish fossils was formed a long time ago in a sea or lake (OL-2)**	82.9	95.7	*
1.5	The first living organisms on Earth lived **in the Ocean (OL-2)**	84.2	97.9	*
1.6	Most of the rainwater falling on land originally came from **the tropical Ocean (OL-3)**	35.5	53.2	*Ns*
1.7	Scientists think that climate change will cause **sea level rise (OL-3)**	93.4	95.7	*Ns*
1.8	The climate of a coastal area would experience **hotter summers and colder winters** if there was no sea **(OL-3)**	60.5	74.5	*Ns*
1.9	**Marine photosynthetic organisms** are the main source of the oxygen that living beings breathe **(OL-4)**	75.0	89.4	*Ns*
1.10	The marine environment is home to different animals **depending on the sea depth (OL-5)**	82.9	93.6	*Ns*
1.11	The deep Ocean that is always in the dark has **many different species of organisms (OL-5)**	75.0	78.7	*Ns*
1.12	The Ocean is home to **organisms of many different species (OL-5)**	98.7	95.7	*Ns*
1.13	Most of the world's goods are transported **by ships (OL-6)**	98.7	95.7	*Ns*
1.14	The Ocean influences the life of people **living everywhere around the world (OL-6)**	94.7	95.7	*Ns*
1.15	What I throw in the sink influences **freshwater and marine organisms as well as humans (OL-6)**	84.2	93.6	*Ns*
1.16	**Fish** is the resource that is most at risk of being exhausted in the Ocean **(OL-6)**	73.7	80.9	*Ns*
1.17	**The deep Ocean** is the least explored environment **(OL-7)**	90.8	95.7	*Ns*
1.18	We need to study the Ocean so that **we will be able to sustainably use its resources (OL-7)**	86.8	89.4	*Ns*

Ns: Non-significant
*: Significant in ≤0.05 p level

resented (Fig. 8.4c). The correct responses refer to the most relevant factors for the formation of an Ocean-literate person in Blue Economy, namely knowledge, attitudes, behaviors, and self-interest (Table 8.2). The three requirements for a sustainable Blue Economy, namely social equity, environmental sustainability, and economic viability were also given as answers. The perceptions of the attendees concerning OL initiatives and skills that support and empower Blue Economy sectors and Blue Careers were very positive (Table 8.3). These results suggest that promoting cross-institutional and interdisciplinary cooperation among research institutions, marine education networks, and Blue Economy sectors is crucial to sustaining this international movement of OL and represents an urgent challenge (Paredes Coral et al. 2021).

8.2.3.3 Survey 3: The Online Course Performance

A final survey was prepared to assess the overall performance of the course and to help BlueMinds4Teachers consortium improve the online course and its content. This survey was administered after the end of the third session. Of the approximately 70 attendees, 42 responded to the survey, of which most were females (92.9%). Almost 80% of the respondents had implemented Environmental Education programs, while 60% carried out marine education programs. More than half of them worked at the elementary

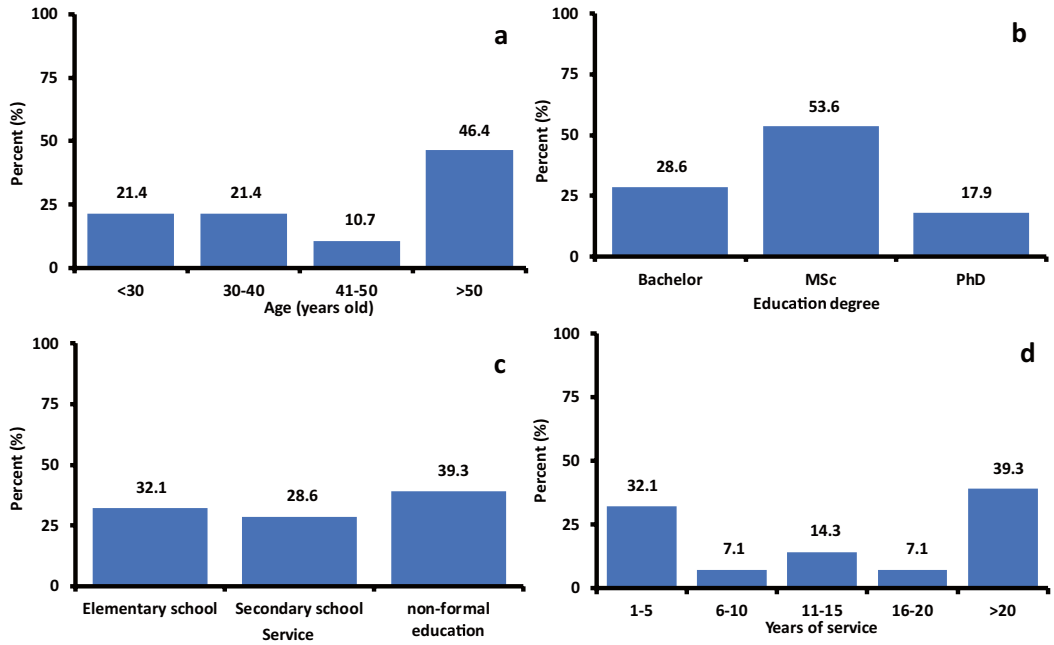


Fig. 8.4 a–d Demographics of the attendees participating in the second survey regarding the Blue Economy key concepts and Blue Careers

Table 8.2 Percentage (%) of correct answers received after attending presentations related to Blue Economy key concepts (correct answers are indicated in bold)

	Issues regarding an Ocean-literate person in the Blue Economy	% correct answers
2.1	The 3 requirements for a Sustainable Blue Economy are **(i) socially equitable, (ii) environmentally sustainable, and (iii) economically viable**	53.6
2.2	**Wave energy** is an emergent sector in the European Blue Economy	39.3
2.3	Social sciences can contribute to a more Sustainable Blue Economy **by understanding the way maritime workers connect with the Ocean**	32.1
2.4	According to the latest research, the most relevant factors to shape an Ocean-literate person in the Blue Economy is **(i) knowledge, (ii) attitudes, (iii) behaviors, and (iv) personal interest**	64.3

Table 8.3 Perceptions relevant to forming an Ocean-literate person in Blue Economy and Blue Careers (3.1–3.4), and evaluation of the session (3.5); Likert scale statements, with values ranging from 1 (totally disagree) to 5 (totally agree) (SD: standard deviation) received after attending the second session

	Attitude statements	mean	SD
3.1	Ocean Literacy can support the blue economy by empowering maritime workers to make informed and responsible decisions	4.29	1.243
3.2	Blue careers can become more attractive thanks to Ocean Literacy initiatives	4.36	1.254
3.3	Ocean Literacy skills are needed to achieve a more Sustainable Blue Economy	4.29	1.243
3.4	Ocean Literacy skills are transferable across sectors	4.11	1.197
	Evaluation of the second session	Mean	SD
3.5	In what degree did the course module meet the proposed objectives?	4.46	0.637

school while they were between 30 and 40 or more than 50 years old with a master's degree (Figs. 8.5a, b, c). Most of them had been working as teachers/educators for a few years or more than 20 years (Fig. 8.5d). In addition, more than 60% of the respondents were either specialist teachers or non-formal educators, i.e. teaching a particular subject such as biology, mathematics, physics, chemistry, geology, geography, Information and Communication Technology (ICT), but also language, history, foreign languages, arts, music, sports.

According to the results of this survey (Table 8.4), all different approaches, i.e. the teaching and learning methods, the OL framework, the Blue Economy, and the Blue Careers concepts seem equally necessary for the respondents to develop blue projects in their classroom and other educational activities. They also stated that they increased their knowledge about the topics covered in all three sessions. Furthermore, they declared that they can design and implement Ocean-related projects in their classrooms or non-formal education settings using modern participatory methods, applying inter- and/or multi-disciplinary approaches while collaborating with experts, stakeholders, and the local community. Overall, participants stated that they feel more confident about developing a blue project.

8.2.4 Polls: Connecting OL Principles to School Curricula

Further to the above-administered surveys, polls were also communicated to the participants asking them to propose topics, in the form of keywords, they considered relevant to the curricula they work on and to the OL principles and concepts. In total, 138 different topics were given for the 7 OL principles (Fig. 8.6). Most of the topics related to OL Principle 1 (33 topics in total) were relevant to common curriculum themes such as the water cycle, water properties, plate tectonics, sea level change, and climate change (Fig. 8.6a). The most popular keywords for OL Principle 2 (24 topics) were: biogeochemical cycles, plate tectonics, water cycle, rock cycle, elements circulation, and carbon cycle (Fig. 8.6b). For OL Principle 3 (25 topics), climate-related topics, i.e.

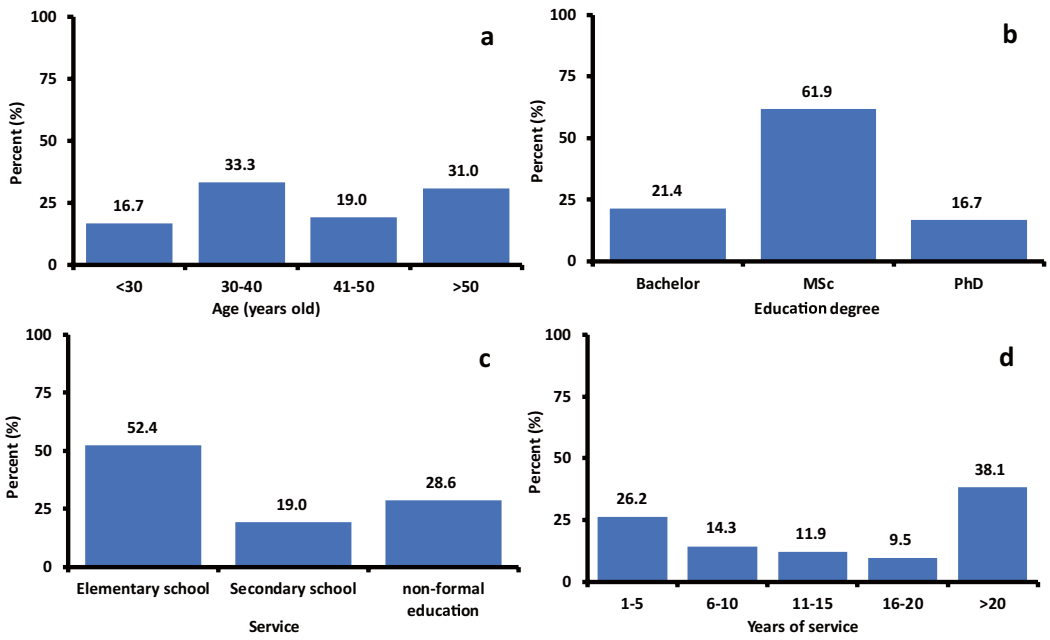


Fig. 8.5 a–d Demographics of the attendees participating in the third survey regarding the overall performance of the online course

Table 8.4 Likert scale statements (SD: standard deviation) with values ranging from 1 (totally disagree) to 5 (totally agree) of the performance survey

	To what extent did…	mean	SD
4.1	…The first session regarding Ocean Literacy Principles meet your educational needs?	3.95	0.795
4.2	…The second session regarding the social sciences approach (Blue Economy & Blue Careers) meets your educational needs?	3.88	0.968
4.3	…The third session regarding the pedagogical strategies that can be used in the classroom meet your educational needs?	4.21	0.813
4.4	…You increase your knowledge about sea-related issues?	3.98	0.950
4.5	…You increase your knowledge in order to integrate Blue Economy concepts into your classroom	4.05	0.825
4.6	...You increase your knowledge about the pedagogical strategies that can be used when designing and implementing an environmental education program?	4.12	0.861
4.7	…You develop responsible attitudes towards sea-related issues?	4.10	0.850
4.8	…You develop critical thinking towards sea-related issues?	4.14	0.814
	To what extent do you feel that…	Mean	SD
4.9	…this seminar convinced you to design and implement Ocean-related issues in your classroom?	4.05	0.825
4.10	…this seminar convinced you to use modern participatory methods when designing and implementing Ocean-related issues in your classroom?	4.29	0.742
4.11	…you can apply interdisciplinary and/or multidisciplinary approaches when designing and implementing Ocean-related issues in your classroom?	4.21	0.871
4.12	…you should collaborate with experts and/or stakeholders and/or the local community when designing and implementing Ocean-related issues in your classroom?	4.24	0.790
	Evaluation of the BlueMinds4Teachers course	Mean	SD
4.13	In what degree do you feel more self-confident about developing a blue project after this course?	4.24	0.821



Fig. 8.6 a–h Word clouds per OL principle revealing the topics the attendees consider relevant to the school curricula (a–g) and modern participatory teaching and learning methods that can be applied to implement blue projects (h)

climate change, carbon cycle, greenhouse effect, and water cycle, were the most frequent (Fig. 8.6c).

Photosynthesis, water cycle, and oxygen seem to be the most important topics (27 topics) for OL Principle 4 (Fig. 8.6d). For OL Principle 5 (19 topics), biodiversity, marine ecosystems, and food chains/webs were the most frequent answers (Fig. 8.6e). For OL Principle 6 (22 topics), alien species, human impact, overfishing, marine pol-

lution, coastal hazards, and marine biodiversity were the most popular keywords (Fig. 8.6f). The most popular answer for OL Principle 7 (19 topics) was sea exploration, while mapping, mathematical models, biodiversity monitoring, deep sea animals, and technology were also mentioned (Fig. 8.6g).

Several of the above-mentioned topics referred to more than three principles, such as photosynthesis, climate, Ocean acidification, water cycle, carbon, marine ecosystems, and marine resources, highlighting the interconnection among the OL principles. The most popular topics such as water cycle, water properties, biogeochemical cycles, plate tectonics, climate, climate change, photosynthesis, biodiversity, marine and Ocean ecosystems, food chains and webs, human impact, overfishing, marine pollution, sea exploration were expected to be recorded as relevant to OL principles and concepts as they are included into school curricula of different countries (Mokos et al. 2021). However, the total number of topics mentioned (138) was unexpectedly high, given that Ocean issues are generally missing from national curricula and school textbooks (Ezgeta-Balić and Balić 2024; Mogias et al. 2021, 2022).

Another poll was also administered during the third session so that participants could propose modern participatory teaching and learning strategies to develop and implement blue projects with their audiences in classrooms, aquaria, museums, and other education settings. Field study, debate, project method, case study, role-playing, brainstorming, and problem-solving, were mostly recorded (Fig. 8.6h).

8.2.5 The Digital Toolkit

Apart from the online course, one of the main outcomes of this project is a ready-to-use and open-access "digital toolkit". More specifically, it includes (a) the introduction to the BlueMinds4Teachers project; (b) audio-visual material from the webinars, one for each OL principle, illustrating fundamental concepts, relevant references, and links to the EU priorities and international initiatives; (c) audio-visual material from the webinars focusing on Blue Economy key concepts and Blue Careers, while proposing ways for educators to integrate them into their classrooms and other educational activities; (d) audio-visual material from the webinar focusing on the pedagogical strategies that can be applied for OL activities; (e) lesson plans proposed and developed by the project partners. Lesson plans were specifically requested by educators to help them develop new pedagogical paths in their classrooms and non-formal educational settings. They were produced based on OL content; therefore, seven lesson plans following each of the seven principles, containing examples of educational activities, were produced. All webinars were accompanied by PowerPoint presentations and references.

The BlueMinds4Teachers "digital toolkit" is accessible for free use through the European Marine Science Educators Association website under OL resources.

8.3 Conclusion

Based on the main tools used in this project, i.e. the online course, the surveys and polls, and the digital toolkit, lessons learnt and recommendations to ensure broad participation and engagement by teachers and other educators are: (1) course scheduling—for the sessions it is essential to choose the day and time of the week following their suggestions; (2) locally relevant examples—information provided must be linked to the real world and adaptable to different working and geographical environments to ensure their attention and understanding; (3) interactive elements—it is essential to create elements of interaction before, during, and after the course, to allow researchers to answer questions, to allow participants to make a constructive contribution to the course itself (active learners), and in general to keep their attention and motivation; (4) outputs—ready-to-use and open-access educational resources with basic guidelines (e.g., best-practices lesson plans) provided by marine and freshwater researchers as well as education and

social sciences experts are essential to promote further development and implementation of OL and to support the Network of European Blue Schools; (5) impact evaluation—it is fundamental to provide assessment tools to improve the quality of the proposed training courses and resources; (6) certification—accreditation certificate of participation is important for the role of teachers and other educators in supporting young learners toward Ocean issues and their professional development; and (7) sustainability—training modules should be implemented on a regular basis, while user-friendly materials should be translated in different languages.

Although there are many open-access resources related to OL issues, the OL framework is still largely unknown to teachers, marine educators, young people, and the general public. Therefore, in addition to Ocean science knowledge, and teaching and learning methods provided to teachers and other educators, there is a need for dissemination and communication of these topics. The concepts of the Blue Economy and Blue Careers should also be included.

The partners of the project disseminated and communicated its objectives, activities and outcomes by participating in several EU events during 2024 (e.g., European Ocean Days in Brussels, Ocean Decade Conference in Barcelona, European Science Education Research Association-ESERA mini-Conference in Valencia, European Marine Science Educators Association-EMSEA Conference in Zadar) to different communities (e.g., researchers, educators, other stakeholders, policymakers) in order to share information and encourage uptake of best practices. In addition, the community created by teachers, marine educators, early career Ocean professionals, other stakeholders and partners within the framework of the project will keep on updating news, events, new materials and tools, and projects through the social media channels and online contacts of the BlueMinds4Teachers team. This way future collaborations (e.g. BlueLightS), in-depth Ocean understanding and motivation of community action can be achieved as suggested by UNESCO-IOC (2021).

The BlueMinds4Teachers project, with more than 70 participants in each online session from many different EU and non-EU countries (e.g., Croatia, Greece, Italy, Portugal, Spain, Türkiye, Tunisia, Cyprus, Germany, Kenya, Maldives, UK), can be considered as a success story mostly due to bridging knowledge systems and practising interdisciplinary and transdisciplinary science as recommended for the Ocean Decade (UNESCO-IOC 2021). Natural and social scientists, educators, science communicators, policymakers—across generations, genders, and geographies—can collaborate on similar projects to increase the capacity and confidence of teachers and other educators (including scientists). This way the latter can develop impactful Ocean-related projects in classrooms, aquaria, museums, research centres, etc. Projects should also be adapted to locally relevant and national environments in culturally appropriate ways. Furthermore, sharing educational resources such as the digital toolkit co-developed within the framework of this project, is an excellent way of providing support to educators to develop the skills and resources necessary to include the Ocean across multiple platforms, languages, and places. This way, teachers and marine educators can raise levels of OL knowledge and emphasize the marine citizenship and identity of their young learners who, as future citizens and consumers, will inevitably influence the marine environment.

The promotion of a sustainable Blue Economy in education can also contribute to the development of the next generation of blue skills and provide opportunities for attractive, sustainable maritime careers supporting the European Green Deal initiatives (e.g., the Farm to Fork Strategy, the Sustainable Blue Economy Strategy, the EU Offshore Renewable Energy strategy, the Biodiversity Strategy and the Circular Economy Action Plan). Finally, Ocean and OL play a vital role in the entire UN sustainability agenda through education by setting specific learning objectives (cognitive, socio-emotional, and behavioral) for each different SDG in order to achieve "a sustainable, peaceful, prosperous and equitable life on earth for everyone now and in the future" (UNESCO 2017).

8.3.1 Summary

Key concepts explored in this chapter include:

- Training of formal and non-formal educators, along with the development of resources, in order to strengthen skills in OL issues is a priority of the Ocean Decade and one of the proper ways to achieve the UN sustainability agenda.
- Bridging knowledge systems and practising interdisciplinary and transdisciplinary science as recommended for the Ocean Decade is an acknowledged way of communicating complex Ocean issues not only to teachers and other educators but also to children, youth, policymakers and the general public.
- As the OL framework is still largely unknown to teachers, marine educators, young people, and the general public, there is a need for dissemination and communication of Ocean topics, including the concepts of the sustainable Blue Economy to attract youth and engage them in Ocean-related careers supporting the European Green Deal initiatives.

8.3.2 Recommended Resources

The following resources provide further insights and support on this topic:

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- The Blue Education Platform. (n.d.). BlueLightS. https://blue-lights.eu/
- EMSEA. (n.d.). Ocean Literacy Resources. BlueMinds4Teachers Digital Toolkit. https://www.emseanet.eu/
- European Commission. (n.d.). Network of European Blue Schools. Maritime Forum. https://maritime-forum.ec.europa.eu/theme/Ocean-literacy-and-blue-skills/Ocean-literacy/network-european-blue-schools_en
- Forward Looking at the Offshore Renewables. (n.d.). FLORES. https://oreskills.eu/
- Island Liechtenstein Norway Grants. (n.d.). Blue Generation Project. https://www.blue-generation.org/index.php/en/
- Navigating Opportunities: Careers in the Blue Economy. (n.d.). Next BlueGeneration. https://nextbluegeneration.eu/
- The Mediterranean quest "TO "FIND THE BLUE". (n.d.). BLUE SCHOOLS MED. https://www.blueschoolsmed.eu/

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IOC-UNESCO (2022) A new blue curriculum—A toolkit for policy makers. IOC Manuals and Guides, 90

Jacobs GM, Power MA, Wann IL (2016) The teacher's sourcebook for cooperative learning: Practical techniques, basic principles and frequently asked questions. Simon and Schuster

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UNESCO-IOC (2024) Sea beyond. Venice Declaration for Ocean Literacy in action. How to engage society to regenerate the most valuable ecosystem on our Planet. https://Oceanliteracy.unesco.org/wp-content/uploads/2024/06/ENG_Venice-Declaration-for-Ocean-Literacy-in-Action.pdf

Author Contributions

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9 Heritage for an Oceanic Culture: The Essential Role of the Past in Ocean Literacy

Arturo Rey da Silva and Georgia Holly

Abstract

Understanding humanity's historical relationship with the Ocean is essential for comprehending contemporary interactions and the Ocean's significance globally. Ocean Literacy, a multidimensional effort to enhance public engagement with the Ocean, is deeply rooted in this human-nature relationship. Heritage, which reflects these connections, enriches Ocean Literacy with diverse perspectives, preserving traditional practices, beliefs, and knowledge linked to the sea. In June 2024, the integration of cultural heritage as a critical element for fostering a deeper connection between humans and the Ocean was recognised in the Venice Declaration for Ocean Literacy in Action. This chapter examines how heritage shapes Ocean culture and promotes Ocean Literacy for marine conservation and sustainable livelihoods by integrating traditional knowledge, reviewing preservation frameworks, and outlining strategies for effective communication and interdisciplinary collaboration in conservation efforts.

Keywords

Ocean Literacy (OL) · Cultural heritage · Marine conservation · Traditional ecological knowledge · Maritime practices · Sustainable livelihoods · Human-Ocean relationship · Community engagement · Heritage preservation · Ocean heritage · Communication

9.1 Introduction

Ocean culture encompasses the rich tapestry of human connections to the sea, woven through centuries of exploration, trade, resource exploitation, mythology, and migrations. This cultural legacy is not just a relic of the past but a living, breathing entity that continues to influence contemporary coastal communities and marine conservation efforts. Exploring the past reveals the deep-rooted practices that have profoundly influenced the ecological and social fabric of our coastline. As recognised by the recently adopted 'Venice Declaration for Ocean Literacy in Action', the integration of cultural heritage as a critical element for fostering a deeper connection between humans and the Ocean is pivotal for nurturing a sense of stewardship and responsibility toward our Oceans today (UNESCO 2024). Heritage, which reflects these connections, enriches Ocean Literacy with diverse perspec-

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tives, traditional practices, beliefs, and knowledge linked to the sea (Fig. 9.1).

Ocean Literacy, a multidimensional effort aimed at fostering public engagement with the Ocean, is fundamentally tied to the interconnected relationship between humans and nature, and the profound effects of human activities on marine ecosystems. Emerging in the early 2000s, Ocean Literacy has since become a cornerstone of global sustainability efforts, playing a key role in the United Nations 2030 Sustainable Development Agenda, its Sustainable Development Goals (SDGs), and the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). Cultural and heritage aspects have remained underrepresented in these initiatives, even as new literature highlights the necessity to expand social sciences perspectives, to integrate history and culture, to enhance attitudinal and behavioural components (McKinley et al. 2023; Schwerdtner Manez et al. 2023) or to develop 'actions utilising marine heritage' to broaden Ocean Literacy's reach (Cretella et al. 2023; Mokos et al. 2021). This brings a call to settle the 'human dimension dilemma' in marine conservation (Ramadhan et al. 2022; Stel 2021) and a critical turn to what Mentz named 'Blue Cultural Studies' (2009) or 'Blue Humanities' in an attempt to embrace 'scholarly and artistic discourses that foregrounds human relationships with water in all its forms' (Mentz 2022, p. 950). The essential shift in societal behaviour toward the Ocean is deeply influenced by cultural patterns, historical values, and socio-economic contexts. In essence, Ocean Literacy cannot be successful unless heritage—the influence of the past on the present—is incorporated into its development and design. In this sense, heritage bridges past and present, fostering cultural continuity and identity. As it has been already recognised by Payne and Marrero, 'It is difficult to ensure all voices are heard and included in mapping the way forward in the field and that Ocean



Fig. 9.1 Understanding human relation with the Ocean is the primary goal of Ocean Literacy. Heritage is an intrinsic element to today's uses, values and local knowledge. In the image, fishers from the Island of Mozambique deploy their nets at low tide. Photo by Arturo Rey da Silva

literacy initiatives are culturally relevant and locally applicable' (Payne and Marrero 2021). Incorporating cultural significance—the recognition and integration of the historical, social, and intangible values associated with human connections to the Ocean—is one of the priorities to ensure major success of Ocean Literacy. This involves acknowledging the role of maritime traditions, indigenous knowledge, and cultural heritage in shaping our understanding of the Ocean, fostering stewardship across diverse communities, and deepening insights into the socio-environmental dynamics of marine ecosystems while improving access to related datasets and themes. By doing so, it tackles two of the field's major challenges in the twenty-first century: comprehending complex human-Ocean interactions and ensuring broader accessibility to valuable data (Fauville 2018).

This chapter explores heritage's role in shaping oceanic culture and promoting Ocean Literacy for marine conservation and sustainable livelihoods. It is addressed to academics, practitioners, policymakers, educators, conservationists, community stakeholders, and Ocean advocates involved in Ocean Literacy, marine heritage, environmental sustainability, and policy development, aiming to foster interdisciplinary collaboration, integrate cultural perspectives into marine governance, and to promote the preservation of traditional knowledge and practices within the broader goals of the Ocean Decade. The chapter presents a series of initiatives that illustrate the practical applications of heritage in Ocean Literacy. These include examples from the Rising from the Depth network, and the paradigm shift it created in marine heritage challenge-led research in East Africa; the Cultural Heritage Framework Programme, an Ocean Decade Endorsed Programme; and *SeaVoice* as a novel means of communicating Ocean identities through the diversity of Ocean voices.

9.2 Marine Cultural Heritage. Importance of the Past in our Present Ocean

Throughout history, Oceans have been instrumental in shaping human civilizations, serving as vast highways for exploration, trade, and cultural exchange, fostering interconnected societies across the globe. In the Mediterranean, ancient cultures such as the Phoenicians, Egyptians, Greeks, and Romans used maritime routes for commerce and expansion, spreading knowledge, technology, and cultural practices. Similarly, the Indian Ocean facilitated trade and cultural interactions between East Africa, the Middle East, South Asia, and Southeast Asia, exchanging goods like spices and textiles while fostering religious and technological diffusion. In the Pacific, Polynesian navigators mastered celestial navigation to traverse vast distances, creating interconnected island communities and shared cultural heritage. Along the Atlantic, the Vikings and later European transatlantic expeditions profoundly influenced societies in the Americas, Africa, and Europe during the Age of Exploration. Even in the Arctic, Indigenous peoples have sustained a millennia-long marine presence, relying on intricate ecological knowledge to thrive in extreme environments. These global examples underscore the Ocean's historical role as catalyst for human development and cultural exchange. The cumulative impacts of these activities, from ancient trade to indigenous practices, provide crucial insights into contemporary marine environments and stress the importance of integrating traditional knowledge into modern Ocean governance and conservation efforts.

The Ocean has profoundly shaped human settlement and coastal community development. The abundance of marine resources, such as fish and shellfish, supported early populations and fuelled thriving coastal economies. Maritime industries like fishing, shipbuilding, and salt pro-

duction became vital to many societies. Cultural heritage, reflected in maritime traditions, archaeological sites, folklore, and art, underscores the deep connection between humans and the sea. Today, these connections continue to influence contemporary societies and underscore the Ocean's enduring importance in human civilization.

Underwater archaeology, as the discipline that investigates material traces of this heritage found in aquatic contexts, started its journey in the 1950's, with the invention of the self-contained underwater breathing apparatus or SCUBA which allowed archaeologists to develop methods to study archaeological sites underwater with the same 'standards than those deemed acceptable on land' Bass 2012, p. 7). The 'nascent discipline' soon became internationally recognised (Frost and Croome 1972) and movements towards the preservation of submerged sites ended with its consideration within national legislations and the adoption of the UNESCO Convention on the Protection of the Underwater Cultural Heritage in 2001. This Convention recognizes underwater heritage as 'an integral part of the cultural heritage of humanity' and establishes a legal framework to protect submerged sites from looting, exploitation, and destruction in all maritime zones. It prioritizes in situ preservation, promotes international collaboration, and sets standards for responsible archaeological practices (UNESCO 2001).

During the 1980s and especially in the 1990s new theoretical approaches introduced the concept of maritime cultural landscape (Westerdahl 1992) that expanded the interconnectedness of the material culture with the larger social and environmental context, transforming the field of research from the simple material remains of a shipwreck into a web of interconnected evidence that provide us a window to understand socioeconomic and environmental transformation throughout time. The epistemological framework of the discipline is recently exploring the application of flat ontologies (Rich and Campbell 2023), in which humans and non-human things are studied and understood equally, providing for a framework considering the relationships between all things that make the Ocean, its nature, societies and time in the Anthropocene. Public engagement, and citizen science, have also been part of key management strategies to better know and preserve this heritage throughout the development of the discipline (Scott-Ireton et al. 2023). understanding that educating and involving the public is a significant step towards ensuring preservation, enjoyment, and knowledge creation.

As we see, today, the concept of marine cultural heritage is a broad and multifaceted notion. This heritage manifests in numerous forms, ranging from tangible elements such as archaeological remnants including shipwrecks, submerged settlements, harbours, and coastal landscapes, to more intangible aspects like indigenous languages, musical traditions, and customary fishing practices (Henderson et al. 2021). It also includes less perceptible elements, such as cultural cosmologies, inherited thought processes, and ingrained spatial-temporal behaviours and worldviews. Holly et al. (2022) highlight the importance of this heritage in understanding past societies and ensuring its protection as part of Ocean conservation efforts, particularly in the conservation of complex coastal ecosystems as evidenced by the project Rising from the Depths.

9.3 One Ocean with Many Names. Heritage Ensures Diversity

'One Planet, One Ocean', is the moto of the Ocean Decade, however a shift towards heritage approaches will evidence the existence of a plurality of perceptions and ways to see and understand the Ocean. There are many ways to acquire knowledge from its study, through modern scientific ontologies or years-old knowledge systems. It is clear that 'The Earth has one Ocean with many features' (Ocean Literacy Principle 1), many voices and expressions that can only be understood through unveiling their *languages* in terms of culture and heritage (Rozwadowski 2020; Schwerdtner Manez et al. 2023).

There has been a significant paradigm shift in the way heritage professionals approach the past in marine environments, as evidenced by the scholarly debate that challenges the perception that natural and cultural heritage are separate and isolated legacies and highlights the interconnectedness between the past, present, and future. Western-centric views on heritage, normally based on monuments, shipwrecks and archaeological structures 'has made anthropocentric experiences of heritage all but invisible, despite its emphasis on visuality and the claims to benefit humanity' (Rico 2024, pp. 138–139). Given that Ocean Literacy can enable society to tackle environmental issues stemming from human activities, it is crucial to incorporate Ocean-related knowledge into educational programmes (Ghilardi-Lopes et al. 2019). This integration should encompass both intangible as well as tangible heritage, such as traditional knowledge and insights gained from historical experiences.

Let's take for instance the way we refer when speaking or writing about the Ocean in sciences but also in policies, international debates, and Ocean governance frameworks. We normally used a set of 'official' languages such as English, French or Spanish, missing out many languages, concepts and ways of expressing the human-Ocean relation of thousands of coastal and Ocean communities. There are many ways of expressing the values and historical connection with the Ocean that cannot be expressed in the common languages used in global sciences, communication or heritage scholarly. Many of these languages are disappearing, loosing with them important repositories of knowledge. Heritage helps to connect local meaning to global understanding and can be used as tool to convey values between different languages.

At the same time, the way the past is treated in several coastal communities does not replicate western views on linear temporal dimensions, Cartesian divisions or patriarchal ways of protecting heritage (Vargas-Downing 2024, pp. 133–135). Different languages represent different knowledge systems, different approaches to governance as well as the way they represent the legacy and heritage of a *longue durée* of human knowledge of the Ocean, essential for today's Ocean Literacy. How many ontological worlds, ways of understanding and living the Ocean, are we missing if we only use one set of languages to describe it, study it and communicate it? Can we truly cultivate an Ocean-literate society without embedding cultural diversity and heritage legacy as core elements in its design and across all its dimensions? This recognition of cultural heritage as a multivocal and multifaceted resource aligns with its role in sustainable development and contribution to global challenges and is what motivated the Rising from the Depths project.

9.4 Marine Cultural Heritage for Sustainable Development

Cultural heritage plays a pivotal role in sustainable development by serving as a foundation for economic growth, social cohesion, and environmental stewardship (Bandarin et al. 2011). Recognising the need to move marine heritage studies towards achieving outcomes that benefit the society and contribute to sustainable development, the Rising from the Depths (RftD) network sought to explore how heritage contributes to the global challenges of coastal communities in East Africa, specifically in Kenya, Tanzania, Mozambique, and Madagascar (Henderson et al. 2021), by inserting challenge-led approaches into academic research. This region, though rich in cultural and natural heritage, is economically vulnerable and faces significant threats due to environmental changes and human activities like offshore oil and gas exploration, port construction, and unsustainable fishing practices (Breen and Rhodes 2010). The network's primary goal was to demonstrate how, by co-creating projects between researchers and coastal communities, heritage can aid communities by understanding identity, promoting place-making, and sourcing alternative sources of income. Through co-creation, the network developed multiple understandings of marine cultural heritage from the point of view of coastal communities and devel-

oped research which incorporated these community-developed definitions. It also aimed to enhance the impact of overseas aid in the marine sector by promoting the integration of cultural heritage into development for ethical, inclusive, and sustainable outcomes.

The RftD network, funded by The Global Challenges Research Fund of UK Research and Innovation between 2017 and 2021, was based on an interdisciplinary challenge-led research model that encouraged equal collaboration between researchers from the UK and the Global South. It emphasized the co-creation and co-production of marine heritage programmes in partnership with local communities and stakeholders. Key research themes included integrating terrestrial and marine studies to explore human-sea relationships, maritime mobility's impact on identities, environmental legacies of marine resource exploitation, and examining marine heritage's legal and economic value in development projects, while promoting a rights-based approach to heritage management.

The RftD's challenge-led research shifted from heritage-centred to heritage-driven methodologies, focusing on societal, environmental, and economic challenges. It funded 27 projects in East Africa, and organized workshops, policy meetings, and training programmes with local authorities, institutions, and UNESCO (Fig. 9.2). This interdisciplinary approach enhanced local capacity, increased public awareness, improved policy recommendations, and supported sustainable heritage-based tourism initiatives through active community and stakeholder collaboration. The network engaged policymakers to recognize marine cultural heritage as a key resource for

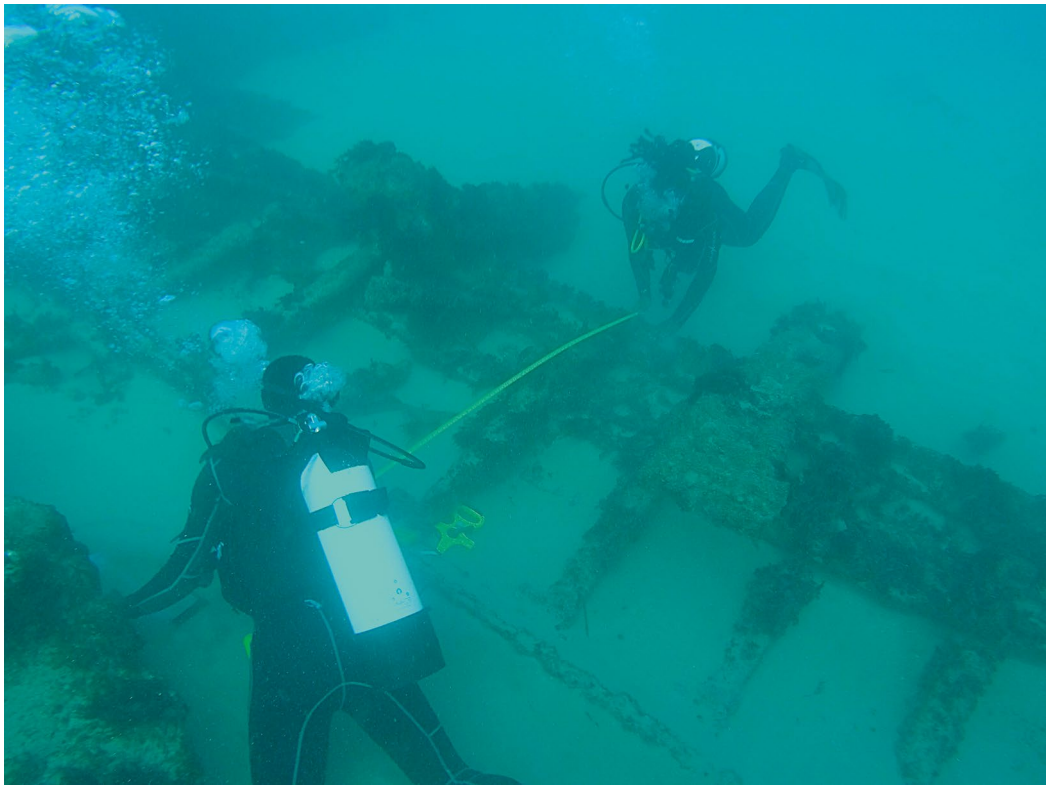


Fig. 9.2 In May 2022, the Rising from the Depths Network, in collaboration with UNESCO's East Africa Regional Office in Nairobi, organized a capacity-building workshop on Marine Cultural Heritage for young African professionals. This workshop, part of a broader initiative to enhance skills and knowledge in this field, brought together professionals, local managers, researchers, and decision-makers. Held in Mombasa, the event also featured a special outreach programme with local communities during the World Ocean Day. Photo by Arturo Rey da Silva

addressing development challenges and advocated for ratifying international instruments like the UNESCO 2001 Convention, ratified only by Madagascar in the region.

For example, in Kenya, the *MUCH to Discover in Mida Creek* project showcased marine cultural heritage as a resource for community empowerment. Led by the Bidii na Kazi women's group, the project established sustainable livelihoods, including mangrove reforestation, butterfly farming, and beekeeping, which collectively helped restore over 300,000 mangroves. These efforts not only mitigated the effects of climate change but also utilised heritage to create alternative income sources for women and strengthen local biodiversity. By combining participatory research with educational outreach to 30 schools, the project deepened awareness of cultural and environmental interconnectedness, providing a blueprint for heritage-based community development (Bita and Forsythe 2023).

In Tanzania, the *Bahari Yetu, Urithi Wetu* (Our Ocean, Our Heritage) project focused on preserving and celebrating the maritime traditions of Bagamoyo. Local fishers and boatbuilders collaborated with researchers to document traditional techniques, creating a valuable record of artisanal practices through exhibitions, academic publications, and a documentary. By fostering pride in these cultural assets and facilitating the transfer of knowledge to younger generations, the project not only preserved intangible heritage but also contributed to sustainable fisheries management (Fig. 9.3). This initiative exemplified how heritage-driven engagement can strengthen community identity and resilience while promoting sustainable resource use (Cooper et al. 2022).



Fig. 9.3 The Bahrai Yetu, Urithi Wetu, RftD project directed by Dr. Jon Cooper, University of Exter, Dr. Elgidius Ichumbaki, University of Dar es Salaam, and Dr. Lucy Blue, University of Southampton, confronted the endangerment of traditional boatbuilding and maritime practices in Bagamoyo (Tanzania) due to urban expansion, tourism, and overfishing. It documented threatened maritime heritage, promoted traditional boatbuilding for tourism, and created a community heritage hub. Community engagement, training, and collaboration with academic and government partners will produce a coastal heritage strategy for sustainable development and preservation of maritime traditions. Photo by Arturo Rey da Silva

Further south, the *Making Maritime Museums Matter* project in Mozambique revitalized interest in maritime heritage by developing interactive museum exhibits and educational programmes that linked heritage to marine conservation and sustainable tourism. These efforts attracted visitors, boosted local economies, and fostered a deeper understanding of Mozambique's maritime history. Meanwhile, in Madagascar, the *Using Fishers' Traditional Maritime Knowledge* initiative integrated local knowledge into modern fisheries management. This project demonstrates how traditional ecological knowledge (TEK) complements scientific data, enhances conservation, and promotes sustainable practices like seasonal restrictions and rotational harvesting. When TEK is considered and integrated into management strategies, communities achieved better fish stock recovery, biodiversity conservation, and compliance with regulations, while fostering ownership and trust in management decisions. The authors argue that blending TEK with science creates adaptive, culturally appropriate fisheries management that balances ecological goals with local livelihoods and heritage (Henderson 2024; Holly et al. 2022).

The network played a crucial role in enhancing Ocean Literacy by focusing on four key areas: research and documentation, community engagement and capacity building, policy and advocacy, and sustainable development projects. The interdisciplinary research conducted integrates fields such as archaeology, anthropology, marine biology, education, and climate science and aimed to understand traditional maritime practices, document coastal heritage sites, and provide valuable insights into how cultural assets can be utilized for future development initiatives. Educational initiatives, including the creation of education curricula and workshops in local languages, were designed with community members to celebrate their maritime culture and its potential role in fostering sustainable development.

The lessons learned from the analysis of the 27 innovative projects highlight that effective governance of marine heritage requires more than just conventional practices like research, education, management, and policymaking. One thing that remained evident was the influence of the *power relations* and discourses that shape how different groups define and engage with heritage. The historical context and political dynamics surrounding heritage often dictate which narratives are prioritized and which are neglected. Additionally, the way the *heritage practice* is carried out—how various stakeholders describe, value, and define heritage—greatly affects the approach to conservation and study. These practices are further shaped by the *policies* that provide the regulatory framework for how heritage is managed and protected. Finally, it is essential to recognize the central role of the *people* in heritage preservation, as marine heritage ultimately reflects what communities choose to value and pass down to future generations and can often conflict with development initiatives (Henderson 2024).

Heritage-conservation conflicts often arise when efforts to preserve cultural heritage intersect with marine conservation priorities. The challenge of balancing the preservation of submerged archaeological sites with the protection of fragile marine ecosystems have been evidenced on several occasions by the network projects. For instance, shipwrecks and ancient coastal settlements, while being vital historical records, sometimes serve as artificial reefs that support diverse marine life as it is evidenced in the case of Mozambique Island. Interventions to excavate or preserve these sites can disturb these ecosystems, creating tension between heritage preservation and biodiversity conservation. Yet, if managed properly, these diverse ecosystems can support heritage, biodiversity, and coastal communities (Paxton et al. 2024). Similarly, traditional fishing practices, which are integral to cultural identity in regions like East Africa and Southeast Asia, may conflict with modern conservation regulations aimed at mitigating overfishing or habitat destruction. In Tanzania's Bagamoyo region, as illustrated, urban expansion and overfishing have endangered traditional boatbuilding practices, necessitating a delicate balance between conserving this cultural heritage and addressing environmental concern.

RftD underscores the significance of heritage as a measurable and actionable indicator for assessing Ocean sustainability. It provides evidence that heritage is not solely a reflection of the past but a critical driver influencing contemporary practices in Ocean use and conservation. Practically, this involves integrating heritage into sustainability indices and frameworks. For example, RftD proposes the inclusion of maritime cultural heritage metrics—such as the mapping of heritage sites, evaluation of traditional knowledge systems, and quantification of heritage-based economic activities (e.g., sustainable tourism or traditional fisheries)—into broader assessments of Ocean health and governance. These practical tools bridge cultural and ecological indicators, allowing policymakers and researchers to assess the multifaceted relationship between people and the Ocean.

This approach represents a paradigm shift in marine heritage studies, fostering interdisciplinary collaboration between maritime archaeology, social sciences, environmental studies, and marine sciences. The Cultural Heritage Framework Programme builds on this foundation by operationalizing this shift and scaling it to align with the priorities of the Ocean Decade.

9.5 The Cultural Heritage Framework Programme

The Ocean Decade presents a unique opportunity to evidence the importance of marine cultural heritage in fostering a deeper societal connection to marine environments, ultimately contributing to the achievement of the SDGs (McKinley et al. 2023). In 2019, marine heritage professionals established the Ocean Decade Heritage network (ODHN) to promote the recognition and preservation of cultural heritage within the Ocean Decade and the SDGs, providing a collaborative platform to highlight heritage's role in sustainable Ocean governance (Trakadas et al. 2019), and addressing threats from climate change and human activities (Jarvis et al. 2023).

In 2022, ODHN launched the Cultural Heritage Framework Programme (CHFP) as an initiative designed to ensure and exemplify the integration of cultural heritage into the wider marine sciences and Ocean Decade Challenges (Henderson et al. 2024). The CHFP, is the only Ocean Decade Endorsed Programme which deals with cultural heritage. It highlights heritage as the essential contribution to designing better strategies to face current global challenges. The framework encourages interdisciplinary collaboration, de-codes language between natural and cultural heritage sciences, and facilitates a network of heritage-led projects for sustainable development (Henderson et al. 2024). Communication is a fundamental aspect of the CHFP, and so the network works to make cultural heritage in the Ocean Decade more accessible to marine scientists, and the public. This integration ultimately supports holistic approaches to managing marine resources and preserving cultural legacies for future generations by advocating for the creation of a specific target regarding heritage within Ocean related SDGs in the post-2030 Agenda.

Financed by the Lloyd's Register, CHFP recognizes the crucial role of heritage in shaping identities, fostering community resilience, and promoting sustainable practices and aims to ensure that cultural considerations are not sidelined in favour of purely economic or ecological objectives. This is particularly relevant in coastal and marine contexts, where cultural heritage is often intertwined with local livelihoods and environmental stewardship (Lee 2019).

Ocean Literacy is an essential component of the CHFP as it aims to foster a deeper awareness of the Ocean's role in cultural heritage and the interconnectedness of marine ecosystems and human societies, with an aim to enhance public engagement and promote sustainable practices (Ferreira et al. 2021). For instance, initiatives that connect Ocean Literacy with cultural heritage, which before CHFP were largely absent from the Ocean Decade, can empower both local populations to recognize the value of their maritime traditions and practices, thereby fostering a sense of stewardship for marine environments, and educate policy-makers on the benefit of engaging

with a diverse array of cultural heritage for the benefit of both people, and the planet.

One such initiative that exemplifies this integration and empowering of local values and traditions is *SeaVoice*, which originates from the need to communicate better the importance of marine heritage to bigger audiences. At time of writing, it is one of CHFP's 20 endorsed cultural heritage actions within the Ocean Decade.

9.6 *SeaVoice*, Humanizing Ocean Communication

SeaVoice is a digital and in-print storytelling platform that humanises and diversifies Ocean communication by amplifying a wide range of voices and perspectives across Ocean heritage, conservation, and sciences. Launched in 2023, *SeaVoice* provides an accessible space for Ocean scientists, advocates, artists, community members, policymakers, and more to share their perspectives on an equal footing. In addition to its digital content, *SeaVoice* publishes a magazine to further amplify these voices and foster meaningful connections between people and the Ocean. As part of this, *SeaVoice* retains a policy of open access to all online articles, and free paper-copies of the *SeaVoice* Annual, an annual book in which the *SeaVoice* stories of the year are published, sent to all authors and contributors.

Communication of Ocean values, experiences, and knowledge, especially from coastal and indigenous communities, has often been categorized under recreation or cultural tourism. This occurs because many marine management models prioritize ecosystem services, categorizing environmental resources by their potential for resource extraction and exploitation. This transactional framework links environmental value to financial benefits, such as tourism and fishing, overlooking the complex relationship between people and their environment, particularly in non-Western contexts where livelihoods, cultural practices, and heritage are deeply intertwined with nature. Although aspects such as tourism and fishing are often an important aspect of community's day-to-day life, measuring these aspects as the only cultural heritage resource of community's vastly underestimates the heritage value of socio-ecological landscapes (Pascua et al. 2017). Addressing this issue requires incorporating a diverse range of heritage values into science, policy, and management, and this requires an accessible platform for publication for the underrepresented voices who hold such heritage. To facilitate this discussion, *SeaVoice* was created as a platform for sharing stories, experiences, and understandings of the Ocean, in which multiple heritage and science-based values can be presented and shared to a public audience. Importantly, coastal community voices are represented alongside those of policy-makers and academics, so as to provide a balanced and broad representation of Ocean narratives.

SeaVoice integrates human-Ocean interconnections into sustainable development discussions, highlighting often-overlooked histories and voices within western-centric marine conservation. In doing so, *SeaVoice* has addressed distinct issues being faced by certain communities, scientists, policymakers, and advocates, as well as highlighting specific commonalities between these parties, throughout the global north and south, and across vocational demographics.

By engaging with disparate groups on an equal platform, this approach amplifies narratives from individuals deeply connected to water bodies, such as community members, artists, and Ocean advocates, which typically lack a platform. Presented alongside scientists and policymakers, these stories foster open dialogue and informed discussion. This integration aims to avoid audience segmentation, encouraging readers to engage with a broader range of perspectives. By sharing these narratives, *SeaVoice* seeks to deepen the human-environment connection and inspire actions to protect vital resources (see Fig. 9.4).

What sets *SeaVoice* apart is its commitment to bridging the gap between scientific knowledge and cultural experience. Through a blend of articles, stories, and interviews, it captures the complex dynamics between the Ocean and humanity. The magazine delves into the historical, emotional, and even spiritual relationships people



Fig. 9.4 The SeaVoice Annual is a curated selection of stories from 2023 and 2024 that highlights humanity's deep connection with blue spaces. Featuring 20 compelling articles and awe-inspiring photography, the publication celebrates our marine heritage with topics ranging from shipwrecks and sharks to science, surfing, and sailing. Made with an ethically sourced seaweed cover, the first Annual includes a foreword by Ocean advocates Sylvia Earle and Dona Bertarelli, with stories from 16 countries offering diverse perspectives on our relationship with water. Photo courtesy of Adam Radage

have with water, while also addressing pressing environmental issues such as rising sea levels, Ocean acidification, and the impact on coastal communities.

SeaVoice's core mission revolves around the potency of narrative. The magazine humanises the Ocean climate crisis by emphasising personal accounts. In its inaugural issue, Volume 01: Osmosis, *SeaVoice* shared stories of deep-rooted, often generational, links between people and the Ocean. These narratives span diverse cultures and regions, from researchers connecting with the Ocean through the blue health benefits of surfing, to indigenous communities in the Philippines striving to safeguard their ancestral waters. By highlighting these varied perspectives, *SeaVoice* not only highlights the significance of environmental custodianship but also illustrates that climate change is a worldwide concern affecting all of humanity. Subsequent volumes address different themes, including: the collective duty of coastal populations in Ocean conservation (Volume 02: Community), the shifting landscape of Ocean advocacy through the tales of young campaigners (Volume 03: Gen Sea), an exploration of blue technology's transformative impact on Ocean protection and restoration (Volume 04: Blue Tech); and an exploration of how different cultures, disciplines, and communities understand and experience the Ocean through our five senses (Volume 05: Sense); the leadership, labour, and lived experiences of women in Ocean spaces (Volume 06: Water Women); and the cultural, historical, and biocultural dimensions of human–Ocean relationships (Volume 07: Heritage) (Holly et al. 2024). Future volumes will continue to explore diverse human connections to the Ocean by uniting Ocean stakeholders through common themes, such as the role of literature and art on Ocean culture, and the global relevance of local perspectives on Ocean heritage.

SeaVoice's mission is grounded in justice and equity. Acknowledging the disproportionate impact of climate change on marginalized groups, especially Indigenous communities, the maga-

zine highlights the voices of those most affected. Coastal communities, often the first to face rising sea levels and extreme weather, have their stories shared through *SeaVoice*'s journalism. By combining these narratives with scientific data and activism, *SeaVoice* strives to foster a just and sustainable human-sea relationship.

As an initiative by the Cultural Heritage Framework Programme, *SeaVoice* invites readers to learn about Ocean challenges and become part of the solution. Combining storytelling, science, and advocacy, *SeaVoice* encourages critical thinking about our relationship with water and environmental preservation, offering hope amidst climate change. By humanizing Ocean conservation, *SeaVoice* integrates cultural and natural heritage perspectives of the Ocean and exemplifies the use of Ocean Literacy methods to spark conversations, inspire collective responsibility, and drive inclusive change for the future of our planet.

9.7 Discussion: The Role of Heritage in Ocean Literacy

The relevance of heritage into Ocean Literacy frameworks, albeit largely absent for a long time (Rozwadowski 2020), has been recently recognised in the 2024 Venice Declaration and is included, although indirectly, within the Ocean Literacy UNESCO Principles, particularly within Principle 6 'The Ocean and humans are inextricably interconnected'. Despite this recognition, heritage does not have yet a central position in creating 'an oceanic culture'. Although increasing efforts have been made since the beginning of the Ocean Decade to align UNESCO thematic areas (culture, sciences, social sciences, communication and education) to support a sustainable Ocean, the monolithic structure of UNESCO's programmes and their statutory nature makes breaking bureaucratic and epistemological barriers challenging. Culture works indeed as a booster for intersectoral synergies at UN level, leveraging connection between agencies and programmes. It is, however, through the work of advocates from Ocean sciences, social sciences, education, and particularly the disciplines of marine archaeology and marine ecology where we can see a slow but steady change in the approach to the way the Ocean is understood and communicated. This change is exemplified by challenging academic and western understandings of the Ocean, as illustrated by the RftD projects, by advocating for changes in policy, such as the work conducted by the CHFP, or by humanizing and diversifying communication, as exemplified by *SeaVoice*.

Through the examples and initiatives presented in this chapter, it becomes clear that heritage has been always an inseparable part of Ocean Literacy, even if its potential has not been fully explored and utilised. It offers a holistic view of the Ocean-human relationship by:

(a) **Representing unwritten communication channels.** Maritime traditions, folklore, and traditional ecological knowledge embody deep, culturally embedded ways of interacting with the marine environment. For example, coastal communities have passed down sustainable fishing practices, navigation techniques, and rituals connected to the sea for centuries. These practices not only represent historical survival strategies but also communicate essential ecological information about local marine ecosystems. Without these cultural values and unwritten knowledge systems, Ocean Literacy would lack the contextual understanding needed to fully grasp how people have engaged with the sea over time. For instance, indigenous Polynesian navigation systems, which rely on reading the stars, Ocean currents, and bird migrations, offer a unique way of understanding and interacting with the marine environment that goes beyond scientific data alone (Salmond 2021).

(b) **Highlighting Ocean connectivity and identity.** Oceanic cultures are deeply intertwined with marine ecosystems, and many coastal communities identify with the sea as an integral part of their identity and livelihood. This identity-building aspect is crucial for fostering a sense of responsibility and stewardship toward the Ocean. Take, for example, the Maasai in East Africa, who,

despite being traditionally perceived as land-based pastoralists, have deep cultural ties to the Indian Ocean. They maintain historical connections to the coast through trading and spiritual practices, reflecting a broader cultural identification with the Ocean that many might overlook without acknowledging the role of heritage. By understanding how cultural identity is built through these historical and present-day connections to the Ocean, Ocean Literacy efforts can inspire a deeper emotional and personal connection to marine conservation. Ultimately, heritage and culture represent the personal and emotional dimensions of Ocean identity formed by generations of passed down belief systems and practices, which are essential to understand if we are to cultivate truly sustainable behaviours toward marine ecosystems.

(c) **More Informed Datasets**. Traditional ecological knowledge offers practical insights into how communities have managed marine resources over time. This knowledge is particularly valuable in addressing contemporary issues such as climate change, biodiversity loss, and overfishing. For example, the traditional marine tenure systems in the Pacific, known as tabu, have been used for centuries to regulate fishing and protect marine ecosystems by designating certain areas as off-limits for specific periods. These practices not only conserve biodiversity but also ensure the long-term sustainability of fish stocks. By engaging with this cumulative knowledge, as shown in projects from the Rising from the Depths network, Ocean Literacy can evolve to include both scientific and cultural wisdom, making conservation efforts more effective and tailored to the local context.

Heritage is a core component of Ocean Literacy, adding cultural depth to make it more inclusive, comprehensive, and impactful. Without heritage, Ocean Literacy efforts would be limited to scientific knowledge and pedagogical rigour, missing out on the rich, diverse ways in which humans have understood and interacted with the Ocean throughout history.

9.8 Future Directions

The ongoing transformation in Ocean management, research, communication, and education prompts reflection on the evolving human-marine relationship, which takes complex and diverse forms in the present. Integrating heritage into Ocean Literacy offers clear benefits but presents challenges. These include the need for inclusive and accessible funding to foster cross-sector dialogue, more opportunities for indigenous representation to accurately reflect diverse cultural perspectives, and further research on cultural heritage value to develop holistic socio-environmental indicators for environmental management.

Future efforts to integrate heritage into Ocean Literacy should prioritize expanding community-based programs, enhancing international collaboration, recognition of local languages, and developing innovative educational tools. Synergies and interdisciplinarity within Ocean Literacy are already paving the way for new methods of communicating the Ocean's values, ranging from scientific papers to personal insights from individuals and coastal communities. The diversity of voices and the creation of platforms for them to be heard is a trend that must be accelerated as a global Ocean community.

9.9 Conclusion

Highlighted by the Ocean Decade, SDGs, and particularly the 2024 Venice Declaration, Ocean Literacy emphasizes restoring humanity's connection to the Ocean through cultural heritage, human rights, and traditional knowledge systems. Marine cultural heritage, both tangible and intangible, is central to fostering a deeper human-Ocean relationship globally.

This chapter has explored various interdisciplinary and collaborative approaches that underline the importance of human-centred approaches to Ocean management, highlighting that the preservation of heritage is as vital as conserving marine ecosystems. A multifaceted approach is crucial for advancing Ocean Literacy and preserving heritage, with specific recommendations

for policymakers, educators, and stakeholders. Policymakers should integrate heritage into national and international Ocean governance, aligning its protection with marine conservation. Coastal and indigenous communities must be empowered to manage their marine heritage, with policies incorporating their traditional knowledge into conservation and development. Partnerships among marine scientists, archaeologists, and sociocultural experts should be promoted to create holistic Ocean policies addressing both environmental and cultural dimensions. Stakeholders, including NGOs, the private sector, and local communities, are encouraged to support citizen science initiatives and sustainable livelihoods that align with heritage values, contributing to both economic opportunities and conservation efforts (Kennedy et al. 2024).

Recognizing the deep connections between humanity and the Ocean, integrating heritage into Ocean Literacy offers a powerful pathway to inspire collective action, ensuring that cultural traditions and ecological stewardship shape a thriving future for all.

9.9.1 Summary

Key concepts explored in this chapter include:

- Humanity's historical relationship with the Ocean is essential to understanding contemporary marine interactions and fostering a sustainable future.
- Ocean Literacy encompasses not only scientific research but also cultural, historical, and traditional knowledge. It aims to improve societal awareness of the Ocean's significance to humans, and human's significance to the Ocean.
- Interdisciplinary approaches, combining marine science, archaeology, and local community engagement, are crucial for effective Ocean management and conservation, but also for effective Ocean education and communication.
- As evidenced by the projects in Rising from the Depths, heritage is key to inspiring stewardship of marine ecosystems by linking historical connections with modern conservation strategies and promoting community-driven initiatives.
- *SeaVoice* aims to humanize and diversify Ocean communication by blending science, heritage, and personal stories, thus fostering intersectional dialogue and public engagement in Ocean conservation.

9.9.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Cultural Heritage Framework Programme—https://Oceandecadechfp.org/
- *SeaVoice*—https://www.*SeaVoice*.online/
- Ocean Decade Heritage Network—https://www.Oceandecadeheritage.org/
- Rising from the Depths—https://rising-fromthedepths.com/

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Peace Boat: Navigating Ocean Literacy Through Global Voyages

10

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Abstract

This chapter examines youth empowerment and capacity-building programmes through the concrete examples of the *Ocean and Climate Youth Ambassador* and *Youth for SDGs* Programmes onboard Peace Boat's global voyages. It situates these initiatives within the context of the UN Decade of Ocean Science and the Sustainable Development Goals (SDGs), highlighting the interconnections between SDG 14 and other SDGs. The chapter demonstrates how educational programmes onboard a ship can serve as effective platforms for advancing Ocean Literacy, with time at sea offering opportunities for workshops, lectures, and deeper engagement with the Ocean, and port visits enabling hands-on learning experiences. It also explores how Peace Boat's longstanding experience in peace education has informed the development of programmes that emphasise the link between humanity and the Ocean and aim to foster behavioural change and action in participants. Particular focus is given to the inclusion of youth from Small Island Developing States (SIDS), whose first-hand experiences of the Ocean and climate crises strengthen calls for urgent action. By fostering cross-regional exchanges among youth, Peace Boat promotes solidarity, leadership development, and collective advocacy on a global scale.

Keywords

Ocean Literacy (OL) · UN Ocean Decade · Youth empowerment · Small Island Developing States (SIDS) · Peace education · Sustainable Development Goals (SDGs) · Maritime innovation · Peer-learning · Decarbonization · Citizen science · Environmental stewardship · Nature-based solutions

10.1 Introduction

Amid the escalating impacts of climate change and Ocean degradation, fostering Ocean Literacy has become more critical than ever. As defined by the UNESCO Intergovernmental Oceanographic Commission (IOC), Ocean Literacy refers to an understanding of the Ocean's influence on people and the reciprocal

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Fig. 10.1 Peace Boat Global Voyages, Sailing for Sustainability

impact that humans have on the Ocean (UNESCO IOC 2021). This knowledge is a vital tool for empowering individuals and communities to engage in informed, sustainable Ocean stewardship (Fig. 10.1).

Peace Boat's *Ocean and Climate Youth Ambassador Programme* and *Youth for SDGs for the United Nations Ocean Decade* serve as exemplary models of Ocean Literacy in practice, effectively bridging the global and local dimensions of Ocean governance, advocacy, and sustainability.

This chapter examines these two programmes within the broader context of the United Nations (UN) Sustainable Development Goals (SDGs) for 2016–2030 and the UN Decade of Ocean Science for Sustainable Development (2021–2030), as well as their links to peace education. Through their innovative approaches, these initiatives demonstrate how youth engagement can advance Ocean Literacy, amplify the voices of those most affected by climate change and Ocean degradation, and foster international collaboration towards achieving sustainable Ocean governance.

10.2 Peace Boat—Sailing for Change

Founded in 1983, Peace Boat is a Japan-based international NGO with Special Consultative Status with the United Nations Economic and Social Council (ECOSOC). The organization promotes peace, human rights, sustainable development and respect for the environment. Peace Boat US, its non-profit international office located at the United Nations Plaza in New York, works towards advancing education for the UN Sustainable Development Goals (SDGs), with a particular focus on the UN Decade of Ocean Science for Sustainable Development and experiential Ocean Literacy programs.

Peace Boat organizes global voyages for peace and sustainability onboard a passenger ship that sails around the world with the UN SDGs logo on its hull. Guided by the SDGs, Peace Boat's voyages, both onboard and in the ports it visits, empower participants, enhance local capacity for sustainability, and promote people-to-people cooperation across borders. These voyages, managed under a social business model, blend sustainable tourism, lifelong learning and friendship-building with educational programs, collaborative projects and advocacy, primarily funded by voyage participation fees.

Peace Boat has organized over a hundred voyages, including three global and one regional voyage annually, visiting around 100 ports each year. Each voyage, departing from and returning to Japan, hosts approximately 1500 participants, who spend three months traveling the world. Participants come from all walks of life, with the youngest participants in the Montessori education programs and hundreds of lifelong learners of all ages.

10.3 Peace Boat's Model for Learning

Peace Boat's global voyages offer opportunities for participants to engage with the world's natural and cultural richness, including visits to UNESCO World Heritage Sites. The ship serves as a mobile classroom, using travel as an educational experience. Participants are invited to critically engage with contemporary global challenges and deepen their understanding of the interconnected world in which we live.

The first Peace Boat voyage took place in 1983, organized by a group of university students as a creative response to government censorship concerning Japan's wartime military aggression in the Asia-Pacific. To promote historical understanding and reconciliation, the students chartered a ship to visit neighboring countries, fostering direct dialogue with those who had been directly impacted. This foundation in experiential learning and intercultural exchange remains central to Peace Boat's pedagogical model. Today, with over 20 port visits per voyage, participants engage directly with diverse communities, enhancing their understanding of global issues through lived experiences and dialogue. Each port visit is complemented by thematic study programs that address topics such as peacebuilding, human rights, and environmental sustainability.

Peace Boat's educational philosophy is detailed in *Navigating Disarmament: The Peace Boat Model* by Sumiko Hatakeyama and Akira Kawasaki (2020), which outlines three key pedagogical pillars:

1. Developing empathy through understanding the humanitarian aspects of global issues
2. Recognizing the threats and systemic challenges facing the world today
3. Learning practical strategies for constructive action and advocacy

One prominent example of this approach is the "Global Voyage for a Nuclear-Free World: Peace Boat Hibakusha Project." Since its inception, this project has brought over 120 Hibakusha (survivors of the atomic bombings of Hiroshima and Nagasaki) onboard Peace Boat's ship to share their personal stories and advocate for the abolition of nuclear weapons. These testimonies highlight the "humanitarian impacts" of nuclear weapons, allowing participants to learn directly from those who experienced the bombings first-hand. This narrative-driven learning model, where first-hand accounts play a central role, is a cornerstone of Peace Boat's educational approach, aiming to inspire behavioral change and motivate learners to take action.

Following the adoption of the 2030 Agenda for Sustainable Development by the United Nations in 2015, Peace Boat has aligned its programs with the SDGs which shape both the content and methodology of the programs. Among the 17 Goals, SDG 4, "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", most directly reflects Peace Boat's educational mission. Target 4.7, is particularly relevant:

> By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development (United Nations 2021, para. 4.7).

Fostering a culture of peace is Peace Boat's mission. The United Nations defines a culture of peace as "a set of values, attitudes, modes of behavior, and ways of life that reject violence and prevent conflicts by addressing their root causes, with a view to solving problems through dialogue and negotiation among individuals, groups, and

nations" (United Nations General Assembly [UNGA] 1997, 1999). Achieving this through peace education is at the core of its activities, using the ship as a space for dialogue and first-hand testimonies.

In addition to the general educational programming offered to approximately 1000 participants on each three-month voyage, Peace Boat also hosts specialized, intensive programs focused on specific thematic issues. These include dialogue for youth from conflict regions, disarmament education in collaboration with the International Campaign to Abolish Nuclear Weapons (ICAN), and focused programming on the SDGs. These initiatives reflect Peace Boat's commitment to providing thematic depth and cultivating global citizenship through experiential learning.

10.3.1 Peace Education and Ocean Literacy

Peace Boat defines peace as 'positive peace,' a concept advanced by Johan Galtung (1964) which refers to the presence of justice, equality, and the absence of structural violence, alongside the creation of conditions for harmony, cooperation, and flourishing societies. This approach includes the promotion of sustainable environmental practices that ensure the well-being of all living beings. By recognizing the intrinsic connections between peace, sustainability, and the natural environment, Peace Boat's model aligns with this holistic vision.

During three-month global voyages aboard a passenger ship, the Ocean is an integral part of daily life. From sunrise to sunset, the Ocean is a constant presence, both physically and metaphorically, serving as the backdrop for experiential learning. The ship's numerous visits to coastal communities further enhance this immersion, making the voyages a unique platform for advancing Ocean Literacy. Ocean Literacy has become a central theme in Peace Boat's educational programming. By fostering awareness of the interdependence between humans and the Ocean, Peace Boat seeks to cultivate a sense of responsibility and agency among participants, encouraging them to engage in marine conservation and adopt sustainable practices. The focus is on helping learners understand why this issue matters.

During Peace Boat's visit to New York City for UN World Oceans Day, Oceanographer Sylvia Earle stated that the greatest challenge facing the Ocean is "exactly what Peace Boat is addressing—people don't know why they should care. They don't have it in their minds and hearts a real understanding of why the Ocean matters and why it is urgent right now in the early twenty-first century to make decisions that will solve the problems. Making peace with nature, making peace with the Ocean is a priority" (Earle 2018).

In line with Peace Boat's broader educational philosophy, focused on empathy, awareness of global threats, and actionable change (Hatakeyama and Kawasaki 2020), its approach to Ocean Literacy similarly prioritizes behavioral transformation. This aligns with UNESCO's framing of Ocean Literacy during the UN Decade of Ocean Science for Sustainable Development, which stresses not only knowledge acquisition but also the cultivation of the values, attitudes, and behaviors necessary for Ocean stewardship:

> Ocean Literacy is not just a measure of what people know, but also a reflection of the values, attitudes, and behaviors towards the Ocean and its tangible and intangible resources. Striving for greater Ocean Literacy can promote the vital behavioral change that drives the Ocean Decade. It will ensure that citizens feel compelled and empowered to promote and undertake actions to address the most pressing threats to Ocean health (UNESCO-IOC 2021, p. 4).

In recent years, Peace Boat has developed two flagship programs focused explicitly on SDG 14: the Ocean and Climate Youth Ambassador Programme and the Youth for SDGs for the UN Ocean Decade. Both initiatives contribute to advancing Ocean Literacy among youth from diverse regions, fostering international collaboration, and inspiring concrete action for the Ocean in alignment with the goals of the UN Ocean Decade, in particular related to Challenge 10,

"Restore humanity's relationship with the Ocean" and "Meaningful society-Ocean connections are strengthened, driving increased motivation, capability and opportunity for people, across all sectors of society, to make decisions, act and behave in ways that ensure a healthy Ocean."

10.4 Ocean and Climate Youth Ambassador Programme

Peace Boat firmly believes in the transformative power of personal narratives and testimonies as catalysts for social and political change. Throughout its history, the organization has used its ship as a platform to amplify the voices of those directly affected by conflict, environmental degradation, and systemic injustice. From its earliest voyages addressing the legacy of Japanese military aggression in the Asia-Pacific region, Peace Boat has placed first-hand testimony at the heart of its educational philosophy, emphasizing the importance of listening to and learning from those at the center of global challenges (Hatakeyama and Kawasaki 2020).

During its global voyages, Peace Boat visits numerous Small Island Developing States (SIDS) across the Indian, Caribbean, and Pacific Oceans. Through study and exchange programs conducted at ports of call, participants engage directly with local communities to learn about the real-time impacts of climate change and Ocean degradation. These encounters offer powerful experiential learning opportunities, often sparking onboard initiatives and collaborative actions with local partners (Fig. 10.2).

Building on the success of its Hibakusha Project, through which Peace Boat amplified the voices of atomic bomb survivors and contributed to the momentum that led to the adoption of the Treaty on the Prohibition of Nuclear Weapons in 2017 (International Campaign to Abolish Nuclear Weapons [ICAN] 2017), the organization launched the Ocean and Climate Youth Ambassador Programme in the same year. The initiative was inspired by the effectiveness of testimonial-based advocacy and aims to elevate



Fig. 10.2 Peace Boat participants calling for climate action during a visit to Male in the Maldives in 2015

the voices of youth from SIDS and other frontline regions most affected by the Ocean and climate crises. Officially launched during the first United Nations Ocean Conference in June 2017, in collaboration with the Alliance of Small Island States (AOSIS), the programme brought together youth leaders to travel aboard Peace Boat's ship through Europe and to New York. Participants engaged in capacity building while delivering their messages to civil society actors, media, and policymakers encountered during the voyage.

The programme was submitted as one of Peace Boat's Voluntary Commitments to SDG 14: Life Below Water (Peace Boat 2017b). It played a role in advancing the momentum from the UN Ocean Conference, hosted by Fiji and Sweden, toward COP23, where Fiji held the presidency. The programme reinforced the connection between Ocean health and climate change as outlined in Fiji's Vision for COP23 (COP23 Presidency 2017). The programme was recognized by the COP23 Presidency Secretariat as an endorsed event of COP23 (Fig. 10.3). It was one of the winners of the first edition of the Educators' Challenge Awards given by the Global Challenges Foundation.

10.4.1 Youth for SDGs for the United Nations Ocean Decade

Peace Boat's global voyages have served as the foundation for Peace Boat US "Youth for the SDGs" scholarship programmes since the adoption of the United Nations 2030 Agenda for Sustainable Development. These voyages provide a dynamic platform for capacity building, where participants engage in onboard seminars and workshops led by a diverse group of educators, including academics, activists, civil society leaders, and artists. At ports of call, participants join experiential learning and field-based programmes, deepening their understanding of the Sustainable Development Goals (SDGs) through direct interaction with local communities.

In 2023, Peace Boat US launched the Youth for the SDGs for the UN Ocean Decade programme, an initiative with a strong focus on



Fig. 10.3 Peace Boat's ship sailed with the flag of COP23 during the first Ocean and Climate Youth Ambassador Programme as it sailed from Barcelona, Spain through Europe and to New York, United States

citizen science and Ocean education, aligned with the objectives of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). The programme's core aim is to build capacity and generate knowledge (UNESCO IOC 2021), particularly among youth leaders who are already contributing to SDG 14 (Life Below Water) in their home communities. Through this initiative, selected youth receive scholarships to participate in Peace Boat's global voyages, gaining hands-on experience in advocacy, education, and collaborative action for Ocean sustainability.

On World Oceans Day, June 8, 2023, the "Youth for the SDGs" programme was formally recognized as a Contribution to the UN Ocean Decade by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. This endorsement affirmed the programme's alignment with the Ocean Decade's mission to transform Ocean science into actionable knowledge for sustainable development.

The initiative builds upon Peace Boat's longstanding expertise in experiential education and capacity building, now sharpened with a thematic focus on SDG 14 and the cross-cutting priorities of the Ocean Decade. During the inaugural voyage of the MV *Pacific World* in 2023, two regionally focused programmes were held under the Youth for the SDGs framework: one in the Arctic region and the other in Latin America. These programs enabled youth participants to engage in intercultural learning, collaborative scientific inquiry, and policy-oriented discussions, fostering a generation of leaders equipped to address Ocean and climate challenges on a global scale. The Youth for the SDGs for the UN Ocean Decade initiative has continued to grow through 2024 and into 2025, reflecting Peace Boat's ongoing commitment to empowering young people through education, advocacy, and international collaboration in pursuit of sustainable Ocean governance (Fig. 10.4).



Fig. 10.4 Citizen science and water testing during the Youth for SDGs program for the UN Ocean Decade as part of the Arctic Voyage in Longyearbyen, Norway

10.4.2 The Role of SIDS Youth in Ocean Action

The impacts of climate change and Ocean degradation are most acutely felt by Small Island Developing States (SIDS), often called Large Ocean States. Located in some of the world's most climate-vulnerable regions, these nations face rising sea levels, stronger storms, and other environmental threats that endanger ecosystems and coastal communities. Despite these challenges, SIDS have emerged as leaders in global climate and Ocean advocacy. While SIDS are among the most affected by climate threats, they also embody deep intergenerational knowledge about sustainable living and resource stewardship. Their strong cultural, economic, and spiritual ties to the Ocean highlight the urgency of addressing overfishing, marine pollution, and coral reef degradation.

Recognizing their crucial role, Peace Boat integrates youth from SIDS into its global sustainability initiatives, focusing on Ocean Literacy, environmental education, and policy advocacy. These efforts amplify their voices, equipping them to contribute meaningfully to local adaptation strategies and international policy discussions.

The Ocean and Climate Youth Ambassador Programme was created to empower young people from SIDS as leaders in marine and climate action. The initiative includes youth from all three major SIDS regions—the Caribbean, Pacific, and Indian Ocean—highlighting diverse ecological and socio-political contexts. This diversity fosters solidarity, peer learning, and access to a global network of mentors and experts, enhancing participants' influence in environmental policy-making.

Peace Boat US's Youth for the SDGs programme prioritizes youth from SIDS by offering scholarships, training, and leadership development, ensuring equitable access to global platforms for learning and advocacy. It empowers youth from Ocean-dependent regions to shape the future of climate and Ocean governance. Inclusion and diversity are central to the programme's approach. It emphasizes the importance of Global South youth, especially from SIDS, in creating equitable environmental solutions. Cross-cultural engagement between youth from the Global North and South promotes collaborative action toward achieving the Sustainable Development Goals (SDGs). Furthermore, targeted scholarships for international forums and conferences allow young SIDS leaders to connect globally, share strategies, and co-create initiatives that transcend borders. These exchanges catalyze innovation and action, empowering youth to lead regionally and contribute to the global movement for Ocean protection and climate justice.

10.5 Global Education and Experiential Learning in Ports of Call

Peace Boat places significant emphasis on experiential learning, a central element of its educational model. With voyages visiting approximately 100 ports annually, Peace Boat leverages these diverse locations to engage with local stakeholders and learn about regional realities. Activities in ports are integral to the programme, providing participants with context-specific, hands-on learning experiences. From the Arctic to the coral reefs of Latin America, each visit offers insights into community challenges, potential solutions, and cross-cultural exchange.

Port-based activities align closely with SDG 14 and Ocean Literacy, particularly the ten challenges outlined for the UN Decade of Ocean Science. Peace Boat's educational initiatives address a wide range of topics, fostering a deeper understanding of marine environments, climate change, and sustainable development.

10.5.1 Marine Life

Traveling by ship enables participants to observe marine ecosystems and species *in situ*, thereby deepening their understanding of global Ocean issues. In the Arctic, youth observed whales and puffins near Akureyri and Reykjavik

and visited the University Centre in Svalbard (UNIS) for discussions with marine biologists on the impacts of climate change. In the Antarctic, participants studied penguin colonies, whales, and seabirds—illustrating the vital connections between biodiversity, climate regulation, and ecosystem health. In Guatemala, collaboration with the Sustainable Ocean Alliance provided youth with the opportunity to participate in sea turtle monitoring activities, reinforcing the relationship between coastal health and marine conservation (Fig. 10.5). These direct, experiential encounters with marine life in their native habitats enhance participants' ability to understand and internalize Ocean Literacy Principle 5—"The Ocean supports a great diversity of life and ecosystems"—as well as the importance of Ocean Decade Challenge 2: "Protect and restore ecosystems and biodiversity."

10.5.2 Marine Plastic Pollution

Addressing Ocean Decade Challenge 1, *"Understand and Beat Ocean Pollution,"* Peace Boat integrates marine plastic pollution into its programming through clean-up initiatives, citizen science, and public education. In London, participants collaborated with UOCEAN on an electric boat waterway clean-up and conducted water quality testing, contributing data to the Ocean Data and Information System (ODIS), see Fig. 10.6). In Barcelona, youth investigated the prevalence and impact of microplastic pollution (Fig. 10.7), while in Valparaíso, Chile, and Lisbon, Portugal, large-scale beach clean-ups combined with citizen science efforts raised public awareness about Ocean stewardship.

These hands-on activities allow youth to deepen their understanding of marine pollution sources and dynamics—for example, by not only



Fig. 10.5 Turtle Conservation and Monitoring program in Puerto Quetzal, Guatemala with local communities



Fig. 10.6 Cleaning the Paddington River in London, United Kingdom, with UOCEAN



Fig. 10.7 Coral restoration study programme with reef to reef in Portabelo, Panama

engaging in beach clean-ups but also participating in a river clean-up to trace pollution to its terrestrial origins. Such experiential learning reinforces Ocean Literacy Principle 6: *"The Ocean and humans are inextricably interconnected,"* particularly in terms of how *"Human development and activity leads to pollution (point source, non-point source, and noise pollution)"* (UNESCO-IOC 2021). Moreover, these experiences foster behavioural change, encouraging participants to reflect on their own plastic consumption and empowering them to initiate similar environmental actions within their home communities after the voyage.

10.5.3 Coral Reef Conservation

Peace Boat's experiential curriculum also includes coral reef conservation, particularly in

areas where reef systems are under threat, again related to Challenge 2, of the UN Ocean Decade. In Tenacatita, Mexico, youth participated in a project aimed at raising public awareness about coral degradation caused by urbanization, poor waste management, and climate change. This activity helped youth understand both the scientific and sociopolitical aspects of reef preservation. In Panama, participants visited the Reef2Reef coral restoration project, gaining firsthand insight into marine habitat rehabilitation efforts. Additionally, Peace Boat US co-hosted the Annual Blue Economy Forum in Mexico with Restore Coral and local NGOs. The forum brought together experts and stakeholders to discuss marine protected areas, coral restoration, and regional responses to climate change under the UN Ocean Decade framework.

10.5.4 Blue Carbon Ecosystems

Blue carbon ecosystems, such as mangrove forests and seagrass meadows, are another central focus of Peace Boat's environmental education, directly supporting Ocean Decade Challenge 2 (*Protect and restore ecosystems and biodiversity*) and Challenge 5 (*Unlock Ocean-based solutions to climate change*) (UNESCO-IOC 2020). In Guatemala, youth explored mangrove ecosystems and participated in sea turtle monitoring programmes, gaining a deeper understanding of the ecological significance of mangroves as both biodiversity hotspots and carbon sinks. In Panama, Peace Boat facilitated exchanges between youth participants and the Kuna and Embera Quera Indigenous communities—longstanding partners in Ocean Literacy. These intercultural dialogues emphasized the cultural and environmental importance of mangrove ecosystems, and participants contributed to local conservation efforts by donating educational books on marine conservation to community libraries. In Chile, participants engaged in reforestation efforts at the Botanical Gardens of Viña del Mar. Working alongside local environmental groups, they removed invasive species and planted native trees, contributing to the restoration of coastal ecosystems and the strengthening of climate resilience.

Viewing these blue carbon systems firsthand is a key element of Peace Boat's experiential learning approach, enabling participants to move beyond abstract theory toward a more embodied understanding of ecological interdependence. Small, hands-on actions—such as planting mangroves or removing invasive species—also foster behavioural change by empowering youth to adopt and advocate for sustainable practices in their own communities (Fig. 10.8).

In Iceland, youth participants visited geothermal plants and wind farms to study the country's leadership in renewable energy transitions aimed at reducing greenhouse gas (GHG) emissions. In Denmark, as part of the Ocean and Climate Youth Ambassador Programme, participants visited an offshore wind farm to explore both the benefits and the challenges associated with scaling low-carbon wind energy. In Panama, Peace Boat co-hosted a seminar with the National Secretariat of Energy to examine SDG 7: Affordable and Clean Energy, offering youth insights into national energy strategies and the broader connections between energy policy, climate mitigation, and social equity. In Tromsø, Norway, youth took part in a forum at the Arctic Economic Council and joined a kelp study programme, which emphasized the potential of nature-based solutions—such as kelp forests—for carbon sequestration.

In Manzanillo, Mexico, Peace Boat's Blue Economy Forum featured discussions on port decarbonization and clean energy innovations for the maritime sector, positioning youth participants at the forefront of efforts to transition toward sustainable energy systems. Experiencing real-world alternatives to fossil fuel-based energy—ranging from geothermal and wind power to marine-based solutions—helps participants recognize the feasibility of energy transition strategies. By witnessing operational renewable energy projects in diverse geographic and political contexts, youth are empowered to advocate for similar solutions in their own countries and communities. These experiences also deepen their understanding of the interconnected relationship between climate change and the



Fig. 10.8 Youth for the SDGs scholars participate in reforestation of the mangrove ecosystems with our partners in Kompot, Cambodia

Ocean, reinforcing the urgency of integrated and forward-looking energy and climate action (Figs. 10.9 and 10.10).

10.5.5 Amplifying Calls for Ocean and Climate Action

In addition to serving as learning and capacity-building opportunities, port visits provide a platform for youth participants to share their experiences and amplify the voices of their home communities. This was particularly significant for youth from Small Island Developing States (SIDS). In several ports, advocacy took the form of public sessions where participants spoke about the unique challenges and resilience of their islands. For example, in Lisbon, a public session was held at the Pavilion of Knowledge, hosted by Ciência Viva, an organization promoting Ocean Literacy in Portugal and another aimed primarily at youth with Christiana Figueres in London organized by Ocean Generation (Fig. 10.11a, b).

Beyond public engagements, youth participants were also given the opportunity to meet directly with policymakers. In Malta, youth met with His Excellency George Vella, President of Malta, at the Grand Master's Palace in Valletta and had discussions with the Minister of Education and the Minister of the Environment. In Barcelona, participants met with Josep Rull, Minister of Territory and Sustainability of the Catalan Government. Similarly, in Valparaíso, Chile, youth representatives were welcomed by government officials at an onboard event.

Engagements like this provide valuable opportunities for young people to share firsthand testimonies and lived experiences directly with decision makers—particularly in high-income countries. By centering the voices of youth from



Fig. 10.9 Ocean and Climate Youth Ambassadors visiting a windfarms in Copenhagen, Denmark



Fig. 10.10 Studying kelp in Tromso, Norway during the Arctic Voyage for the UN Ocean Decade

vulnerable regions, the programme helped humanize the global climate and Ocean crises, highlighting the urgent need for inclusive, youth-led action.

10.5.6 Events in Ports Onboard the Ship for Blue Innovation and the Blue Economy

While in port, Peace Boat's ship serves as a venue for convening local stakeholders, fostering exchange and collaboration. A notable example was the official United Nations World Oceans Day reception, held onboard while docked in Manhattan, bringing together ambassadors, UN officials, civil society representatives, and programme participants. Youth shared perspectives from their island communities and experiences gained through the programme.

Peace Boat US has also hosted a series of Blue Innovation Receptions onboard, focusing on innovative solutions for Ocean sustainability through the lens of the Blue Economy. In collaboration with local governments, industry partners, and UN agencies, these events have addressed topics such as the BBNJ Treaty and the development of a sustainable, inclusive blue economy. Receptions have been held in ports including Honolulu (USA), Manzanillo (Mexico),



Fig. 10.11 a, b A public event at the Pavilion of Knowledge with Ciência Viva in Lisbon, Portugal and London with Christiana Figueres

Valparaíso (Chile), New York (USA), Miami (USA), and Cape Town (South Africa) (Fig. 10.12).

10.6 Global Education for Sustainability: Guest Educators

While at sea, Peace Boat serves as a mobile classroom, equipped with lecture halls and seminar rooms where guest educators deliver lectures, workshops, and seminars. These sessions foster global awareness and youth leadership, equipping participants with knowledge of pressing issues and the skills to advocate for sustainable change.

Guest educators have included Christiana Figueres, former Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC), who spoke on international climate governance and the Paris Agreement (UNFCCC 2015), and Adriana Valenzuela, then UNFCCC Focal Point for Climate Education and Youth, who addressed strategies for integrating youth into global decision-making. Peace Boat's educational approach also emphasizes the connection between cultural knowledge and environmental stewardship. Myriam Angueira highlighted the power of storytelling to inspire action, Binka Le Breton explored Indigenous knowledge and biodiversity protection, and Brandon Levy from the Sustainable Ocean Alliance led discussions on marine conservation and Ocean sustainability.

Throughout the voyage, youth engage with experts on climate, conservation, and development, fostering intellectual growth and a sense of agency. Peace Boat is also working with partners to co-develop a shared Ocean Literacy curriculum aligned with the UN Ocean Decade (UNESCO-IOC 2021). Introducing key themes onboard allows for deeper engagement during port programmes, as participants arrive with essential context. The ship also provides a safe and inclusive environment for dialogue, collaboration, and intercultural exchange (Fig. 10.13).

10.7 Ocean Literacy within the Wider 2030 Agenda for Sustainable Development

Peace Boat's youth programmes highlight the interconnections between SDG 14—Life Below Water and the broader 2030 Agenda, particularly SDG 13—Climate Action. As outlined in Ocean Literacy Principle 6, "The Ocean is a major influence on weather and climate." This connection is reinforced by SDG 14's call to address Ocean acidification, a direct impact of global warming. The Ocean and Climate Youth Ambassador and Youth for the SDGs Programmes center the Ocean-climate nexus, equipping youth to address intertwined challenges of climate disruption and marine ecosystem decline.



Fig. 10.12 Blue Economy Forum to support the BBNJ Treaty and UN Ocean Decade programs onboard the Peace Boat in Valparaiso, Chile



Fig. 10.13 Workshop on the SDGs with Adriana Valenzuela, then UNFCCC focal point for climate education and youth onboard Peace Boat's ship

Aligned with SDG 4—Quality Education, Peace Boat adopts an experiential and inclusive model that fosters leadership, critical thinking, and global engagement through field visits and collaboration with local and international stakeholders.

In support of SDG 5—Gender Equality, programmes address the gendered impacts of Ocean degradation and promote the leadership of young women in climate and Ocean governance.

SDG 7—Affordable and Clean Energy is addressed through site visits to geothermal and wind energy facilities in Iceland and Denmark, exposing youth to real-world clean energy solutions.

Contributions to SDG 15—Life on Land include reforestation and ecosystem restoration projects, such as native species planting in Chile, which emphasize land-Ocean interdependence.

Under SDG 12—Responsible Consumption and Production, participants engage in beach clean-ups and citizen science to understand marine pollution and advocate for circular economy practices.

Peace Boat supports SDG 10—Reduced Inequalities through scholarships and accessible programming for youth from underrepresented regions, especially Small Island Developing States (SIDS).

Its peace education model, a foundation for Ocean Literacy, aligns with SDG 16—Peace, Justice and Strong Institutions by exploring how militarism contributes to Ocean degradation and climate impacts. This was powerfully illustrated in events in Lisbon, London, and New York, where Marshall Islands youth advocate Selina Leem performed "Just a Blue Passport" (Leem 2017), linking nuclear testing legacies to ongoing climate threats in her homeland.

Finally, SDG 17—Partnerships for the Goals underpins Peace Boat's methodology, which relies on collaboration with governments, UN bodies, academia, and civil society to deliver impactful programmes and mobilize resources including for scholarships.

Through this integrated approach, Peace Boat demonstrates how Ocean Literacy serves as both a thematic anchor and strategic entry point for advancing the SDGs—fostering youth leadership, environmental justice, and sustainable futures.

10.7.1 Global Education and Peer Learning: Bringing Youth Together

A central strength of Peace Boat's initiatives, such as the Ocean and Climate Youth Ambassador Programme and Youth for SDGs, lies in their commitment to global education and peer learning. By bringing together young people from diverse cultural and geographic backgrounds, these programs foster mutual learning, cross-cultural dialogue, and collaborative problem-solving. Participants share lived experiences and local innovations, deepening their understanding of global challenges and the diverse strategies used to address them.

For youth from SIDS, these exchanges are particularly impactful. Many are already engaged in local environmental initiatives but often face constraints in scaling their efforts due to limited resources and networks. Participation in global programs provides access to new tools, expertise, and support systems, strengthening their local actions and positioning them to contribute more effectively to international policy-making and advocacy.

Peer learning also cultivates solidarity across regions. Recognizing that climate change and Ocean degradation are collective challenges reinforces a sense of shared responsibility and motivates joint action. Youth realize they are part of a larger global movement—one that transcends national boundaries and unites diverse communities in pursuit of sustainable development.

A signature component of the Youth for SDGs programme is the opportunity for participants to host workshops and deliver ship-wide presentations. In the ship's main lecture halls, youth showcase their leadership in Ocean conservation and sustainable development, highlighting the initiatives they are leading in their home countries. These presentations not only foster peer-to-

peer education but also amplify youth voices within the broader discourse on sustainability and climate.

10.7.2 Citizen Science and Youth Education

As part of its commitment to the UN Ocean Decade's Objective 1, "Identify Critical Ocean Knowledge" (United Nations 2021), Peace Boat integrates citizen science into its Youth for SDGs programme in collaboration with EarthEcho International (Kennedy et al. 2024). Participants engage in hands-on activities such as using water testing kits onboard the ship and in ports of call to measure critical water quality indicators, including pH levels, temperature, turbidity, and oxygen concentration. By participating in these activities, youth contribute to building global public awareness and involvement in the protection of water resources through consistent, basic monitoring practices across diverse marine environments.

The data collected by participants feeds into a growing global database that will support Ocean science throughout the UN Ocean Decade and beyond. This practical engagement empowers youth to better understand the health of aquatic ecosystems and reinforces the importance of evidence-based environmental stewardship.

A key outcome of this initiative has been the collaboration between EarthEcho International, Peace Boat US, and The International Oceanographic Data and Information Exchange (IODE), leading to the development of an inclusive Ocean Data and Information System (ODIS). ODIS enables digital stakeholders to reliably share and discover critical Ocean data globally, democratizing access to essential information.

Through these efforts, the Youth for SDGs programme not only raises awareness but also strengthens informed decision-making at both community and global levels. Participants become active contributors to the sustainable management of the planet's most vital resource—the Ocean (Fig 10.14a, b).

10.7.3 Communication and Media Literacy

As youth travel onboard, events are organized in collaboration with local stakeholders and communities, where participants share their personal experiences of the impacts of climate and Ocean change. These activities, combined with the testimonies of the youth ambassadors, are often featured in local and national media at each port of call, amplifying their voices and driving broader public engagement.

Media and communication literacy is a key component of Peace Boat's onboard capacity-building programs. Effective communication bridges the gap between knowledge acquisition and public awareness. Each program engages a professional filmmaker to document the voyage, expanding the reach of Ocean Literacy beyond the immediate group of participants and equipping youth to share their stories with the world.

One powerful example is the short documentary *Against the Tide: A Journey for Climate Hope* by filmmaker Luis Barreto (Peace Boat (2017a), which follows seven young leaders from Peace Boat's inaugural Ocean and Climate Youth Ambassadors Programme. *Against the Tide* was first screened at the Fiji Pavilion at the 2017 United Nations Climate Change Conference (COP23) in Bonn, Germany, and has since been shown at major international conferences and film festivals, including the UN Ocean Decade Conference in Barcelona and COP29 in Baku in 2024, earning several awards. Barreto also documented the first Youth for SDGs voyage to the Arctic, producing the short documentary *HOPE*. This film shares the stories of youth participants from the Cook Islands, Panama, Hawai'i, and Palau, highlighting their shared struggles and hopes for a sustainable future.

Throughout both the Ocean and Climate Youth Ambassadors Programme and the Youth for SDGs program, photographers, filmmakers, and journalists have joined as guest educators, offering workshops and lectures on media communication and literacy. These initiatives not only



Fig. 10.14 a, b Citizen Science water testing in Puerto Quetzal, Guatemala, with kits in collaboration with EarthEcho International

enhance participants' storytelling skills but also ensure that their messages continue to resonate globally through major UN-related events and civil society forums.

10.7.4 Global Engagement After the Programmes: Participation in International Fora

Peace Boat is a strong advocate for the inclusion of youth in global decision-making, particularly concerning the future of our planet. To advance this goal, we actively involve young leaders from the *Youth for the SDGs* and *Ocean and Climate Youth Ambassadors* programmes in prominent international fora. Each iteration of the *Ocean and Climate Youth Ambassador Programme* to date has culminated in New York, where participants had the opportunity to speak at the United Nations Headquarters during important events such as UN World Oceans Day and the UN High-level Political Forum on Sustainable Development.

Our core objective is to amplify the voices of youth from the frontlines of the Ocean and climate crises, especially from Small Island Developing States (SIDS). Through Observer Status with the United Nations Framework Convention on Climate Change (UNFCCC) and Special Consultative Status with the UN Economic and Social Council (ECOSOC), Peace Boat facilitates youth participation in these critical UN spaces by providing the necessary accreditation. This enables us to foster more inclusive civil society participation and ensure youth perspectives are heard in high-level global discussions.

We have organized side events on youth empowerment with our youth alumni as speakers at the UN Climate Change Conferences (COPs), the UN Ocean Conferences, the UN Water Conference, the Summit of the Future, the UN Ocean Decade Conference, Climate Week NYC, the BBNJ Treaty Conferences, the High-level Political Forum on Sustainable Development (HLPF), and the ECOSOC Youth Forums.

Furthermore, alumni from these programmes have gained valuable experience through internships at Peace Boat US, located near the UN Headquarters in New York. These internships deepen their engagement with UN processes and help them continue their advocacy work on the global stage.

10.8 Reflections from Programme Alumni

Jevanic Henry from St Lucia joined Peace Boat in 2019. He served as an AOSIS Fellow, the UN General Secretary Youth Advisor on Climate Change and is currently an UNFCCC Fellow.



Peace Boat's Ocean and Climate Youth Ambassador Program epitomises what it means to connect actions from local to global and vice versa. A transformative learning experience grounded in the practical realities of SIDS, both regarding challenges and opportunities in relation to climate and Oceans issues. This program was the first major capacity building program which introduced and bolstered my understanding of the Ocean-climate nexus. The opportunity to learn, share and create new ideas together with other youth leaders from SIDS coupled with engaging with citizens from developed nations with varying levels of climate change knowledge, was a unique component that brought added value to the comprehensive experience. In my advocacy and climate actions, I am now able to relate more effectively to citizens in varying contexts, on advancing climate and Ocean solutions.

Beyond the program, the sustained engagement of Peace Boat with the alumni community, allowing us to continue amplifying our voices and actions in key global UN and civil society spaces has been invaluable. The opportunities to build solid connections with diverse stakeholders in the Ocean and climate space have catalysed positive results in my community in advancing a climate solution-oriented era.

Nathalia Lawen from Seychelles joined the Ocean and Climate Youth Ambassador Programme in 2019 supported by the Seychelles Ministry for Climate Change. She then joined the Peace Boat delegation at COP26 in Glasgow, COP27 in Sharm el-Sheik, Egypt, and the UN Ocean Decade Conference in Barcelona in 2024. She is an Economist at the Central Bank of Seychelles.



If I could choose two words to describe my participation in the Ocean and Climate Youth Ambassador Programme, it would be "life changing". The very core aim of the programme was to include youth from Small Island Developing States, and that is exactly how I felt—included. Islands are separated from the mainland by the Ocean, and sometimes it can really feel like the wider world is out of reach. At times it may be hard to have other people understand the realities of your home country given its uniqueness in every way possible. Being on the programme, I learnt that I wasn't alone and that the challenges Seychelles face are not that different. Listening to my peers on the programme speak about how natural disasters hinder availability for resources in Montserrat, how strong waves also wash away roads in Trinidad and how climate change has also changed the rainfall patterns in Fiji felt oddly comforting (to know we shared similar experiences and hopeful that perhaps better solutions could come about). Oftentimes, the intensity of our (islanders') experiences are not well understood because it can feel unfamiliar to many who live in more temperate zones. I am grateful that the programme allowed me to share my experience, but also to hear from my peers' experiences. The programme ended in 2019—but our friendship remains till today.

The programme has definitely widened my network and has allowed me to work with other NGOs, meet other youth external from the Ocean and Climate Youth Ambassador Programme and has allowed my voice to reach a wider audience. The experience of speaking and presenting on the international stage has built my confidence and presentation skills. It has also opened my mind to innovative ways of reducing my own carbon footprint. I have been blessed to be able to observe negotiations at the UNFCCC COP, which was particularly beneficial for me as this helped me immensely in an IPCC simulation module I took at University. I managed to contact an IPCC focal point from a SIDS because of a connection forged at COP. The experience I have received so far has truly been invaluable.

Khadija Stewart from Trinidad and Tobago joined the Ocean and Climate Youth Ambassador Programme in 2019. She has been involved with Peace Boat's activities since then, speaking on several panels at numerous conferences including COP28, UN Ocean Conference, Our Ocean Conferences and SIDS4. In 2023, she joined the Youth for SDGs Programme.



Participating in the Peace Boat Ocean and Climate Youth Ambassador Programme and the Youth for SDGs programme was a transformative milestone in my life. I came on board as a shy, soft-spoken graduate from the Caribbean, unsure of how or where my voice fit into the global climate conversation. What I found was a powerful space of learning, cultural exchange and community that helped me discover not only my voice, but the confidence to use it meaningfully. Engaging with other young people from small island developing states helped me realise how deeply connected we are through our shared histories, challenges, and hopes. While our island realities differ, there is a common resilience and wisdom that united us. The programme equipped me with tangible tools to engage with policymakers, speak on public platforms, and most importantly, believe in the power of youth-led advocacy. Coming from a context where young people are often seen but not heard, that validation was life-changing.

But what set Peace Boat apart was that the journey did not end when the ship docked. My engagement with Peace Boat has extended well beyond the initial programme. Through continued access to international spaces via accreditation, ongoing collaboration with Peace Boat's partners, and opportunities to share my stories on global platforms, I have been able to build a dynamic and evolving career in Ocean and climate advocacy. These experiences have deeply shaped my leadership style and strengthened my resolve to uplift the voices of Caribbean youth. There was something truly healing about being at sea. That experience created a spiritual connection with the Ocean that I never anticipated. As someone from a region where the Ocean is both a source of history and trauma, this voyage allowed me to reframe that relationship through a lens of hope and stewardship. It felt like a personal reckoning and a call to action all at once.

Antoni D. Soalablai is from Palau and joined the Youth for SDGs programme in the Arctic in June 2023. She has spoken in Peace Boat organized side events at COP28 in Dubai and COP29 in Baku and now works at the Office of Climate Change, at the Office of the President in Palau.



Participating in the Youth for SDGs Programme was a truly transformative experience as a young Ocean advocate. It wasn't just about learning about the Ocean, but about understanding its interconnectedness with everything else on the planet. It created a space where I felt empowered to ask questions, challenge my own assumptions, and explore new perspectives (while exploring the world)! This experience showed me a deeper understanding of the challenges our Oceans face and instilled in me a sense of urgency and responsibility to act. It was a turning point for me, and solidified my commitment to advocating for the Ocean and its vital role in our collective future. The Youth for the SDGs Programme fundamentally shifted my understanding of the SDGs. I wasn't just memorizing goals, but experiencing them firsthand. From lectures with leading experts to hands-on excursions studying sea kelp in freezing waters and whale watching in the Arctic, I gained a deep appreciation for the interconnectedness of these goals. These experiences became a powerful tool for me, shaping my approach to education and advocacy. Back in Palau, I integrated these learnings into the Palau Pledge Dive Camps. Inspired by our EarthEcho water testing on the Peace Boat, I implemented the same citizen science initiative for our students. Now, they have the opportunity to analyze the water quality of their own Ocean, gaining a direct understanding of its health. I believe this hands-on experience empowers them to be active stewards of the environment, and it has been rewarding to see them continue to utilize the testing kits, carrying on the spirit of the Youth for SDGs Programme forward.

Kneyone Murray from Trinidad and Tobago joined the Youth for SDGs Program in 2024 in Central America. His scholarship was funded by the Blue Planet Alliance where he now works as Caribbean Director.



Immersing myself in the United Nations Youth for SDGs program aboard Peace Boat's 114th Global Voyage was more than just a journey, it was a soul-shifting experience that ignited something deep within me. Sailing through Latin America, from Panama to Guatemala and Mexico, I was introduced to grassroots environmental efforts that reminded me of the raw, urgent beauty of our planet and the interconnectedness of our global community. One of the most humbling moments was in Guatemala, where we waded through mangroves alongside a local sea turtle conservation team, catching these ancient, majestic creatures by hand. Feeling their strength and grace reminded me that this world is not ours to dominate but to protect. I also had the incredible honor of speaking at the Blue Economy Forum in Manzanillo, Mexico, sharing the voice of youth in the transition to clean energy and the blue economy. There, we released baby turtles into the Pacific, visited the Crocodile Center, and wrapped up with a 10-minute beach cleanup that proved how small actions create real ripples. But the impact didn't stop there. Since returning, I've poured myself into this work so much so, sometimes even funding workshops from my own salary when support wasn't available. From Artivism sessions and renewable energy LEGO builds to local beach cleanups and climate storytelling with kids, the spirit of the voyage continues to shape everything I do. This experience sparked a fire in me that couldn't be ignored. It pushed me to team up with friends and community leaders to bring these messages to youth across the Caribbean. And now, I find myself serving as the Caribbean Director for Blue Planet Alliance, one of the very organizations that believed in me and helped make this voyage a reality. It's a full-circle moment I could've never imagined, and it's all thanks to the UN Youth for SDGs program. That journey wasn't just about seeing the world, it was about becoming part of the force reshaping it. I'm endlessly grateful, despite all the politics and challenges, because I know firsthand the kind of hope and action this program can inspire. This isn't the end. It's just the beginning.

Elsei Telei, Researcher at the Palau International Coral Reef Center



I joined the Ocean and Climate Youth Ambassador Program very early on in my career, but I will always remember it as an incredible foray into the world of climate advocacy. I sharpened skills such as planning and execution of confident public speaking and group facilitation, particularly for a bilingual audience; I had incredible opportunities such as seeing the Lagoa do Fogo in the Azores Islands with my own eyes, meeting Ocean pioneer Sylvia Earle, and delivering a speech at the The Explorers Club in New York City; but most of all, I made deep connections with like-minded individuals from other small islands such as my own. I would never have met them otherwise and for me, that human connection is the strength of this program. Nothing bonds a group quite like being out in the vast expanse of the Ocean, and while I have had the opportunity to join several other research cruises since, I will forever cherish my time out at sea with the Ocean and Climate Youth Ambassadors. Ultimately, I believe the core of any work, even in the marine science field where I work now, is people, and the skills, experiences, and connections I gained from the Peace Boat gave me the confidence to build a career in the Ocean space.

Salomé Zajbert joined the Youth for SDGs program in Central America in June 2023. She has spoken in Peace Boat organized side events at COP28, High-Level-Political Forum, and the 2024 UN Ocean Decade Conference. She is the ShaRED Sea Program Coordinator at EcoPeace Middle East and/or Grant Manager at Seanovation & Ardag Aquaculture and Biotechnology Center.



Seeing the direct connections between scientific knowledge and real life projects like enhancing fair coastal development and better sharing the maritime space, was my favorite part of the Youth for SDGs programme. It made me realize that bridging science, coastal communities, conservation organizations, governments and companies' interests is possible when everyone is eager to do their bit, giving me tremendous hope for the future.

The programme also enabled me to understand global Ocean-related debates and how to better incorporate them into my local work. For instance, the stakes of increasing the surface of true marine protected areas, developing a respectful blue economy at the service of the Ocean and transforming the ports industry—all of these very relevant to my work in the Gulf of Aqaba-Eilat.

Ever since I came back from Peace Boat, I started to pay attention that in our own EcoPeace's ShaRED Sea Ocean Literacy programme there would be more content on the importance of youth in advancing environmental and peace processes as well as providing a meaningful space for youth-led activities. I regularly give a lecture on this topic to make our youth and young professional participants realize their impressive potential and showcase how their personal commitment is part of a broader movement.

Thanks to the Youth for the SDGs programme, I also deepened my understanding on the activities linked to the blue economy, a world I barely knew while now, a part of my work consists on raising funds for Seanovation & Ardag aquaculture and biotechnology center in Eilat, paving the way to innovative solutions that are crucial to preserve the Ocean ecosystem and ensuring our food security. I am extremely grateful for the technical knowledge and the opportunities received and I hope to welcome the Youth for the SDGs programme participants in the Red Sea in the near future!

10.9 The Future of Peace Boat's Ocean Literacy Initiatives: Ecoship

Peace Boat is building Ecoship as the platform for future global voyages. Peace Boat's Ecoship will serve as a transformative platform for promoting Ocean Literacy, enhancing educational programs, and fostering collaboration on environmental advocacy. Inspired by nature, the Ecoship integrates renewable energy technologies such as wind power, solar panels, and hybrid propulsion systems, to achieve a 40% reduction in CO2 emissions. This cutting-edge vessel exemplifies Peace Boat's commitment to climate action and sustainable development, serving as a hub for experiential education, scientific marine research, and innovative projects that address pressing Oceanic challenges (Fig. 10.15).



Fig. 10.15 Peace Boat's Ecoship will be a transformational program for decarbonization of the maritime industry and voyages for sustainable development

Aligned with the objectives of the UN Decade of Ocean Science for Sustainable Development, the Ecoship will support Peace Boat's continued educational programs throughout the decade, visiting over 100 ports of call annually. As the decade progresses, these programs will transition onto the Ecoship, a 60,000-ton, 2000-passenger capacity vessel equipped with 6000 m^2 of solar panels and eight retractable sails. The Ecoship will serve as a flagship for the UN SDGs, peace, and sustainability, providing a dynamic educational environment that fosters collaboration and learning among diverse communities. Acting as a floating classroom and laboratory, it will offer unparalleled opportunities for experiential education and international cooperation.

With guidance from distinguished environmental and maritime experts on the advisory panel including Dr. Sylvia Earle, Amory Lovins, Fabien Cousteau, Wanjira Mathai and Christiana Figueres, Peace Boat aims to leverage the Ecoship to achieve the 2030 Agenda for Sustainable Development and contribute significantly to the implementation of the UN Ocean Decade programs on a global scale.

10.10 Conclusion: Youth as Catalysts for Change

Peace Boat's Ocean Literacy initiatives provide a holistic approach to addressing critical environmental challenges, particularly those related to Ocean conservation and climate change. By involving youth, especially from Small Island Developing States (SIDS), these programs promote global awareness and aim to equip participants with the knowledge and skills necessary to engage in local and global efforts toward sustainability. The combination of experiential learning, peer exchange, and citizen science through the Ocean and Climate Youth Ambassador Programme and the Youth for SDGs programme allows participants to engage directly with pressing environmental issues and contribute to meaningful solutions.

Drawing on Peace Boat's experience in peace education, these initiatives highlight the interconnectedness of global challenges and stress the importance of cross-disciplinary approaches in addressing them. Peace education, in this context, encourages a more nuanced understanding of environmental issues, considering their social, political, and economic dimensions, and stresses the need for integrated solutions and makes action and behavioural change the key purpose of the programmes.

Through collaboration with international organizations, local communities, and youth networks, Peace Boat has succeeded in amplifying the voices of young leaders, particularly from vulnerable regions like SIDS, in global decision-making processes. By facilitating their participation in forums such as the UN Climate Change Conferences, the UN Ocean Conferences, and the High-level Political Forums on Sustainable Development, Peace Boat has provided a platform for these youth to contribute to international discussions on climate and Ocean action.

Overall, Peace Boat's Ocean Literacy initiatives highlight the importance of youth involvement in global sustainability efforts. By fostering cross-cultural exchange and collaboration, these programs contribute to a broader understanding of environmental challenges and support the development of a generation of youth who are equipped to advocate for sustainable solutions. This engagement is crucial for advancing the goals of the 2030 Agenda for Sustainable Development and for addressing the interconnected issues of Ocean health, climate change, and social equity.

10.10.1 Summary

- Peacebuilding and sustainability are interconnected. Peace Boat's mission demonstrates how peace education and Ocean sustainability efforts can be mutually reinforcing through global dialogue, cooperation, and a shared focus on behavioral change and action.
- Experiential learning at sea enhances Ocean Literacy. Peace Boat's voyages serve as mobile classrooms, providing participants with hands-on, interdisciplinary education.

The time spent at sea fosters a deeper appreciation of the Ocean, and the various ports visited offer opportunities for learning and engagement with local environmental challenges.

- The inclusion of Small Island Developing States (SIDS) youth in Ocean Literacy programmes is vital. The programmes contribute to capacity building and provide a platform for the youth to use the skills they have developed in their own communities to advocate for global sustainability.
- Bringing youth from different regions, particularly from SIDS, together fosters learning through shared experiences and challenges. These programmes encourage cross-cultural exchange, enabling youth from diverse backgrounds to collaborate, learn from one another, and gain new perspectives on global environmental issues. This exchange fosters solidarity among youth leaders and encourages collective action on shared challenges.
- The first-hand experiences of youth from communities on the frontlines of the Ocean and climate crises can serve as a call to action. Peace Boat's programmes amplify the voices of young leaders from SIDS, raising awareness of the humanitarian impact of these crises and driving collective efforts toward global solutions.
- Ocean advocacy aligns with the UN Ocean Decade. Peace Boat's initiatives are aligned with the objectives of the UN Ocean Decade, promoting awareness, fostering partnerships, and mobilizing action across sectors and borders to support Ocean conservation and sustainable management.
- Sustainable maritime innovation supports climate goals: Technological innovation, such as the Ecoship project, demonstrates how sustainable maritime practices can contribute to climate mitigation and Ocean protection, reinforcing the importance of green technologies in global sustainability. This approach highlights the potential for maritime industries to lead the way in sustainable development.
- Global networks foster collective responsibility: Peace Boat's international cross-sector partnerships emphasize shared global responsibility for Ocean conservation, highlighting the Ocean as a common heritage of humanity that requires collective action. By building a global community of youth leaders, these networks foster a sense of interconnectedness and shared responsibility for the future of the planet.
- Ocean Literacy is deeply connected to the SDGs: Peace Boat's programs integrate Ocean Literacy with a broad range of SDGs, including SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 15 (Life on Land), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 17 (Partnerships for the Goals). This interconnected approach illustrates how Ocean Literacy contributes to achieving a range of sustainable development objectives, from education to climate action and gender equality.
- Media and communication literacy are key to raising awareness: Through the use of documentary films and media workshops, Peace Boat equips youth with the skills necessary to communicate their environmental advocacy effectively. These activities enhance the visibility of youth-led Ocean and climate initiatives.
- Citizen science fosters youth engagement in environmental monitoring: Programmess like the Youth for SDGs incorporate citizen science, allowing participants to collect data on water quality and contribute to global databases. This educates youth about Ocean health and empowers them to take actionable steps toward protecting marine environments through science-based advocacy.

10.10.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Peace Boat: https://peaceboat.org/english/
- Peace Boat US: https://peaceboat-us.org/
- Ecoship: https://ecoship-pb.com/about-ecoship/
- Against The Tide: A Journey of Climate Hope: https://vimeo.com/246790944
- Peace Boat Ocean and Climate Youth Ambassador Programme (A Short Film): https://vimeo.com/289616328
- Peace Boat's Ocean and Climate Youth Ambassador Programme and Alumni Accelerator: https://sdgs.un.org/partnerships/peace-boats-Ocean-and-climate-youth-ambassador-programme-and-alumni-accelerator
- Youth for SDGs scholarship programme: https://peaceboat-us.org/programs/youth-for-the-sdgs/
- UNESCO IOC Ocean Literacy: https://www.ioc.unesco.org/en/Ocean-literacy

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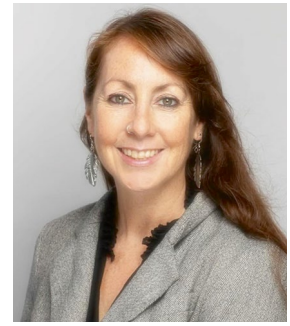
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Karen Hallows is International Coordinator of Peace Boat. Karen has twenty years of experience with Peace Boat's NGO activities promoting peace, human rights, and environmental sustainability through advocacy and education. Karen founded and coordinates the Ocean and Climate Youth Ambassador Programme, bringing young leaders from Small Island Developing States (SIDS) onboard Peace Boat's ship to build capacity and share their frontline experiences. She leads Peace Boat's engagement in the UN Climate Change Conferences (COPs), with a focus on youth. Karen also works on the intersections of peace and demilitarisation with climate justice.



Emilie McGlone is Director of Peace Boat US. Emilie joined Peace Boat in 2004 and currently serves as the UN liaison and Director of Peace Boat US in New York, a nonprofit promoting peace, sustainability, and environmental awareness through global educational voyages. She develops youth-focused programs to engage with global issues onboard. In 2015, Emilie founded the "Youth for the SDGs" scholarship programme which later became part of the UN Ocean Decade and was officially endorsed by IOC UNESCO in 2023 as a 'Contribution' to the Decade. The program continues to empower and educate global youth leaders working towards Ocean and climate action, with efforts ongoing through 2030.



Allison Boehm International Coordinator at Peace Boat US, has worked for over two decades on issues of peace, gender equality, women's rights, disarmament and sustainable development. Allison began working with Peace Boat in Tokyo in 2002 and joined five global voyages before moving to New York in 2006, as the first Peace Boat US staff member. Allison works with Peace Boat US on all United Nations advocacy and educational programs with extensive experience in disarmament, peace and security issues. Allison holds a Master's degree in International Affairs from Columbia University's School of International and Public Affairs (SIPA).



Sara Hollingshead is a Peace Boat US Intern and recent graduate from the University of Michigan who received her Bachelor's in International Studies. She is passionate about sustainable peace initiatives, nuclear disarmament, and fostering cross-cultural understanding to build stronger global connections. She is a strong supporter of SDG #4: Quality Education and #16: Peace, Justice, and Strong Institutions, highlighting education as key to addressing inequality and mobilizing communities, and strong institutions as vital for sustainable peace. She's based in Ann Arbor, Michigan.



José Maidana is a Peace Boat US Intern, social entrepreneur, human rights activist, and conservation advocate passionate about protecting environmental and cultural heritage sites. He focuses on public policy analysis and climate health interventions in the Global South, guided by SDGs #10 & #11 on Reduced Inequalities and Sustainable Cities and Communities. His work involves research and intersectional conservation initiatives on five continents, from UNESCO Heritage Sites strategies to Indigenous Peoples' Rights activism and cultural diplomacy. He is based in Portland, Oregon.

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11 Fostering Ocean Literacy and Youth Empowerment Through Education: A Case Study in São Vicente, Cabo Verde

Yolanda Sánchez Álvarez, Nathalie Almeida, and Esther García-González

Abstract

This study analyses an educational sequence designed to enhance Ocean Literacy and leadership in 8–12-year-old students from a school in São Vicente, Cabo Verde. The sequence consisted of four interactive sessions delivered over 1 week, culminating in a final session that engaged parents, teachers, other students, and participants from the Edinburgh Ocean Leaders Program. This process ultimately led to forming a group of young marine ambassadors.

The sequence was developed by the local NGO Biosfera 1 with the support of an external marine education specialist. It was co-designed and tailored to align with the local context. The methodology incorporated science education tools and interactive strategies to increase Ocean knowledge, foster self-confidence, and develop leadership and communication skills. Each session was iteratively refined based on daily observations and participant feedback to address emerging needs and adapt to the students' progress.

Findings, based on the qualitative analysis of student feedback, game responses, participation levels, and video interviews show that the students' confidence, group identity, and ability to communicate new knowledge about Ocean conservation improved. These results underscore the importance of integrating leadership and empowerment strategies within Ocean Literacy programs and offer replicable practices for broader application in similar contexts.

Keywords

Community engagement · Leadership marine conservation · Marine education · Ocean Literacy (OL) · Science education · Self-confidence

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11.1 Introduction

Humans depend heavily on marine ecosystems for goods and services, yet most of these ecosystems have directly or indirectly experienced significant anthropogenic impacts due to local and global activities (Halpern et al. 2008). Overfishing, marine pollution, and climate change exemplify how human activities harm

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Ocean health daily, stressing the critical need to recognize that Ocean threats are a direct consequence of human behavior (Glithero et al. 2024).

In response to these pressing issues, the United Nations (UN) designated the years 2021 to 2030 as "the Decade of Ocean Science for Sustainable Development." It seeks to stimulate Ocean science across multidisciplinary areas and contributes to achieving the Sustainable Development Goals by 2030. Establishing Marine Protected Areas (MPAs) as conservation tools is one of the strategies proposed to address the environmental challenges affecting coastlines. However, the success of these tools depends on efforts to rebuild society's relationship with the Ocean through multiple dimensions, including engagement and education activities. These activities have shown favorable ecosystem changes linked to sustainable behaviors at the individual level (Ruckelshaus et al. 2013). Thus, enhancing knowledge and fostering concern through education are critical strategies for advancing long-term sustainable coastal management (Bennett and Dearden 2014).

Establishing a community capable of making responsible marine conservation decisions requires developing knowledge, attitudes, and skills at the individual level (Greely and Lodge 2009; McKinley and Fletcher 2012). Central to this process is the design of education programs that consider contextual factors, incorporate participants' local knowledge and prior understanding, and enable connections between information and decision-making (McDonnell 2001). A profound understanding of the Ocean's role and function is essential for promoting a healthy and sustainable marine environment (Mogias et al. 2019), as outlined in the Ocean Decade Vision 2030 White Papers: Challenge 10 (Glithero et al. 2024).

Within the framework of the UN's Decade of Ocean Science, Ocean Literacy (OL) plays a pivotal role in fostering informed and responsible behaviors among citizens and stakeholders toward the Ocean and its resources (Ashley et al. 2019).

However, achieving sustainable Ocean-related attitudes through education requires addressing various challenges. Traditional approaches tended to prioritize scientific knowledge over other skills, creating a need for interdisciplinary, participatory, and action-oriented education models (Tsevreni 2011). The concept of OL has evolved, and its understanding has broadened, now including ten core dimensions (McKinley et al. 2023). Authors in the field of environmental education have also highlighted the importance of personal growth predictors, such as environmental sensitivity, empowerment, and responsibility toward nature as central to fostering environmentally responsible behaviors (D'Amato and Krasny 2011; Hungerford and Volk 1990).

Empowerment and leadership have frequently been identified as goals of community-based marine conservation initiatives, but their determinants and implications remain underexplored (Petriello et al. 2021). Leadership, as described by Popper et al. (2004), combines self-confidence, a proactive mindset, and prosocial relational skills.

There is growing momentum to involve youth in marine environmental decision-making, reflecting broader trends toward public participation and accountability in environmental governance (Devenport et al. 2021). Youth are increasingly aware of and concerned about the consequences of climate and Ocean change. While they will continue to bear the burden of these challenges, they also have the potential to influence the trajectory of future decisions. As a result, many marine conservation initiatives have prioritized youth inclusion and representation at international conventions, where they actively contribute to global marine conservation efforts (Chen et al. 2019). Furthermore, numerous agencies and organizations are addressing these conservation and sustainability challenges by focusing on youth education to foster the next generation of conservation leaders (Ernst et al. 2017).

Bringing together the concepts of community empowerment and youth engagement, Kelly et al. (2022) proposed five practical strategies for engaging and empowering youth with climate and Ocean science to support long-term sustainability. These strategies include incorporating different voices, fostering active science learning through dialogue, encouraging connections with nature, building critical thinking skills, and promoting co-creation.

Building on these strategies, an educational sequence was designed to empower students by fostering self-confidence and enhancing their knowledge of marine science. This sequence aims to serve as a replicable model for integrating empowerment in OL programs to advance marine conservation efforts.

11.2 Context: Cabo Verde and the NGO Biosfera 1

Cabo Verde is a Small Island Developing State (SIDS) recognized internationally as a global hotspot for marine biodiversity. Its extensive Exclusive Economic Zone (EEZ) hosts a remarkable diversity of emblematic and unique marine species in the North Atlantic. Over 90% of Cabo Verde's population resides in coastal areas where socioeconomic activities such as fishing, tourism, and industry are intricately linked to the marine environment. Consequently, a thriving marine environment is critical for the nation's sustainable development.

Well-managed MPAs present an opportunity to promote marine conservation while fostering sustainable development. However, effective implementation requires co-design with local populations, as evidenced by findings from semi-structured interviews conducted by Sena et al. (2023). Their research stresses the crucial role of non-governmental organizations (NGOs) and local leaders in disseminating knowledge and fostering a critical and informed perspective among community members regarding the future implementation of MPAs in Cabo Verde. Studies analyzing the connection between communities in Cabo Verde and the Ocean show the concerns of the population regarding limited OL programs, not allowing the community to engage in the ecosystem's protection. Integrating women and students in future strategies and policies to improve environmental protection is therefore essential (Ferreira et al. 2021).

Biosfera 1, an NGO based in São Vicente, Cabo Verde, is dedicated to the conservation and protection of marine and terrestrial biodiversity across the archipelago, with a particular focus on uninhabited islands such as Santa Luzia, Branco, and Raso. Its efforts are centered on preserving endangered species and promoting sustainable practices within local communities. Alongside its conservation work, Biosfera 1 actively engages in community outreach, educating local populations about the importance of biodiversity and encouraging their participation in managing marine protected areas.

11.3 Escola da Salamansa Pilot Marine Conservation Educational Sequence

In 2022, Biosfera 1 designed, implemented and evaluated a pilot educational sequence at a school called *Escola da Salamansa* in São Vicente. This initiative aimed to enhance students' knowledge of marine conservation and develop leadership skills, providing a basis for fostering local empowerment and environmental stewardship.

11.3.1 Methodology

The pilot sequence was implemented at a local school and targeted a mixed-age group of students aged 8–12. It consisted of four three-hour sessions, with up to 30 students per session. The sessions were conducted during multiple visits by educators from Biosfera 1, ensuring continuous engagement and a structured learning process.

The sequence (see Sect. 11.4) was designed to build on students' prior knowledge, which was assessed at the start of each session through interactive questions. These initial discussions not only helped gauge their understanding but also revealed their interests. This allowed the educators to adapt activities to align with the students' preferences and learning needs.

A range of tools and strategies were used during the sessions to foster empowerment and leadership skills. These included well-structured presentations, participatory activities, interactive dialogues, educational games, and problem-solving exercises. Each session emphasized co-

constructing new knowledge in collaboration with the students, ensuring the learning process was both contextualized and engaging.

The culminating activity of the sequence consisted of students presenting their newly acquired knowledge to an audience comprising their peers, families, and a panel of marine conservation experts (the Edinburgh Ocean Leaders). This activity boosted the students' self-confidence and strengthened their roles as young marine ambassadors within their community.

11.3.1.1 Educational Strategies to Promote Empowerment Through Self-Confidence

The following educational strategies to promote empowerment were employed:

1. Give students the floor: An essential approach is to encourage students to participate, supporting the guidance of activities and leading the group. This not only validates their voice but also increases their sense of belonging and engagement in the activity.
2. Make time for trust-building in a pleasant atmosphere: The students are given space and time to feel comfortable with the new educators.
3. Invite participation: Actively encourage the students to take part in discussions and express their thoughts. It helps them develop critical thinking skills while learning to listen to and respect each other.
4. Avoid providing direct answers and instead promote critical thinking: Educators should refrain from giving direct answers. Instead, guiding students to explore solutions independently promotes deeper learning and enhances joint problem-solving skills.
5. Optimise classroom layout: The physical arrangement of the classroom plays a crucial role in shaping the learning environment. Open and participatory spaces where teachers and students are on the same level promote equality and collaboration. In addition, encouraging students to decorate the classroom with their creations from activities fosters a sense of ownership of the space. This practice allows them to express their creativity and helps them feel more connected to their learning environment.
6. Reinforce learning: Developing different approaches to obtain key information helps strengthen learning. Essential concepts are hence internalized through continuous exposure.
7. Use delayed correction: Immediate correction can sometimes stifle creativity and critical thinking. Instead, it is more beneficial to engage in discussions about different proposals before making corrections. This method allows students to reflect on their mistakes and learn from them organically.
8. Educators as guides: Educators should be guides rather than authoritarian figures. As guides, educators facilitate learning in a supportive and non-intrusive manner, helping students navigate their educational journey independently. They can collect students' feedback and ideas related to methodologies and activities so as to improve them and incorporate learnings into future sessions.
9. Support communication: Facilitating communication between students is crucial for collaborative learning. Educators should support dialogue by not interrupting and allowing students to freely express their thoughts.

11.3.1.2 Educational Strategies to Promote Knowledge Increase in Ocean Science

The following educational strategies to promote knowledge increase were employed:

1. Contextualize information: It is essential to address topics that are directly connected to the students' immediate surroundings, making what they learn feel relevant and grounded in their reality and environment.
2. Build on existing knowledge: Students do not come to the learning process with a blank slate. It is crucial to acknowledge and build on their prior knowledge, ensuring activities are aligned with their current level of understanding.
3. Considering interests: To foster meaningful learning, it is vital to identify students' interests and use them as examples or starting points to explore other topics.

4. Encourage peer discussions to highlight new knowledge: When students recognize they are acquiring unique information compared to their peers, this knowledge becomes more valuable to them, increasing their engagement and sense of ownership.
5. Fostering questions over answers: Encouraging students to ask questions rather than simply receiving answers helps them actively seek out the information needed to progress in an activity. Working with their prior and preconceived ideas is key to creating a strong foundation for learning.

The sequence of activities was co-designed by the NGO Biosfera1 and an external education expert, ensuring a balance between expertise in marine conservation, science education, and local knowledge in education and OL. This collaborative approach enabled the activities to be flexible and adaptive, incorporating insights from each session to refine subsequent sessions. Adjustments were made based on observations of students' engagement and learning progress, ensuring the sequence remained responsive to their needs and interests.

Each activity was designed setting explicit goals to enhance self-confidence and knowledge acquisition. These goals were embedded into the structure and content of the activities, making sure the learning process was intentional and measurable. Activities combined theoretical elements, practical tasks, and reflective exercises to create a holistic learning experience.

11.4 Marine Conservation Program Activities

The 4-day Marine Conservation program consisted of the following activities.

11.4.1 Day 1

- **Activity 1:** ***"We are Ambassadors!"*** In this activity, the students were told a group of foreign visitors, interested in the Ocean, would soon visit their school. Since the visitors would not have the opportunity to experience the Ocean firsthand, the students' mission was to act as "marine ambassadors" and introduce their island to the guests. The students chose a group name and put their proposals in a cardboard box. To foster connection and build trust within the group, the students introduced themselves mentioning their name, as well as a "superpower" of a marine animal they admired, (for instance, the protective shell of turtles). They were also asked to find additional marine "superpowers" to share with the rest of the students the next day.
  - **Knowledge goal:** Understand different characteristics of Ocean inhabitants while reviewing prior knowledge of the students regarding common biodiversity.
  - **Leadership goal:** Empower the group by giving them a mission and responsibility.

- **Activity 2:** ***"Where are we?"*** The students were given a blank map of São Vicente and the *Desertas* Reserve (Fig. 11.1A). They were asked to label the islands and villages they recognized and to put sticky notes with the names of marine animals on the map in accordance with their habitats (Fig. 11.1D). The educators reviewed the activity to ensure the species were correctly represented and the locations were accurate while guiding the students toward giving the correct answers. They did not directly provide the students with the answers. The activity included placing humans on the map to emphasize their role as co-inhabitants of the island and the impact they have. This activity aims to promote student participation and increases their confidence in sharing ideas, even if they are not correct (Figs. 11.1B and C).
  - **Knowledge goal:** Assess prior knowledge and interests before providing any information; increase the students' knowledge of the island's geography and biodiversity.
  - **Leadership goal:** Give the students time to share their knowledge and discuss names of the island and the animals that live on it in groups.

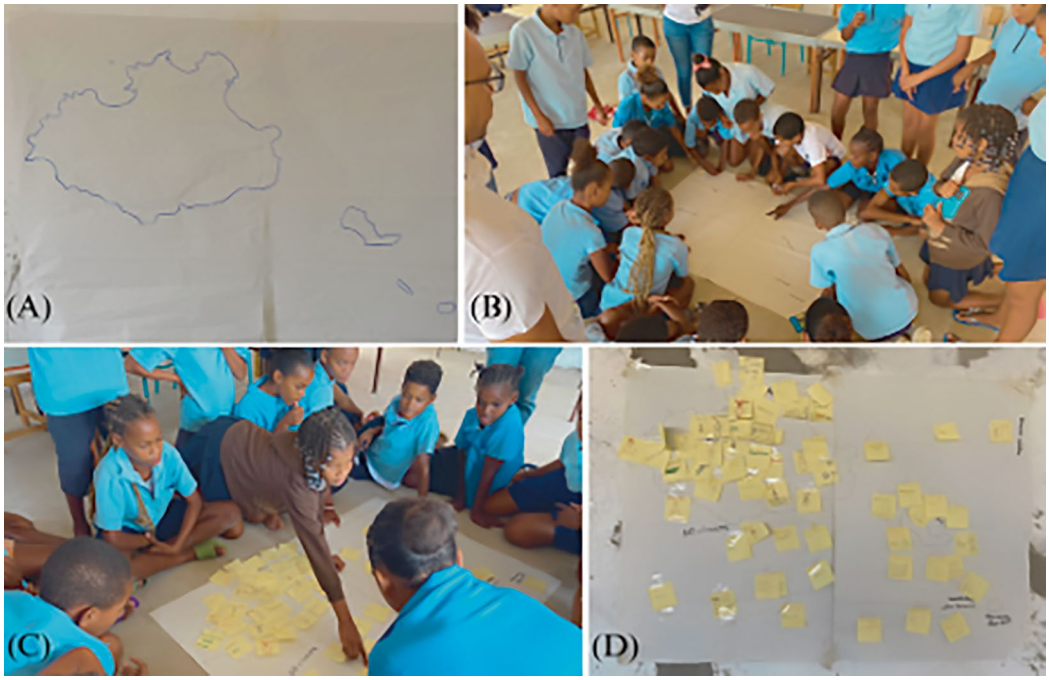


Fig. 11.1 (A) Blank map of the island; (B) and (C) Students discussing and putting sticky notes with the names of marine animals on the map;(D) Final map of the island including the sticky notes the students have added

11.4.2 Day 2

- **Activity 1:** ***"Who lives on the island?"*** Building on the previous day's work, the students used their map to explore four key groups, sharks, turtles, birds, and humans. Divided into teams, each group receives a set of information about their assigned topic and decides together which information to use to create an informative poster, highlighting essential aspects such as food sources, habitats, characteristics, and connections with other species (Fig. 11.2). After presenting their posters, the students engaged in a discussion on which group to prioritize for conservation, its importance, reasons for why this group should survive, potential threats, and solutions. Some of the ideas to discuss included (a) If one group of animals had to be saved, which would it be?; (b) Why are they important?; (c) Why should my animal survive and not the others?; (d) Do they think we should include threats to the species?; and (e) solutions to address these threats.
  - **Knowledge goal:** Increase the students' knowledge of marine ecosystem inhabitants including the characteristics of the main groups of animals: kinds, feeds, reproduction places, etc.; make the students understand humans are co-habitants together with other living beings on the island.
  - **Leadership goal:** Empower the students through obtaining and analyzing information, and being critical about what to include in their poster (Figs. 11.2A, B and C).

- **Activity *2*:** ***"What did we learn?"*** The students were asked to write their thoughts about the next questions on a small piece of paper and were asked to share it with the rest of the participants: (a) What is the most important thing you learned today?; and (b) Share interesting facts you learned today.



Fig. 11.2 (A) Poster template for students, (B) Students designing and creating their posters, and (C) Students presenting their posters

- **Knowledge goal:** Get back to the information shared and learned during the activity and listen to other group learnings.
- **Leadership goal:** Share ideas with the group and participate in the discussion, using the knowledge acquired to increase critical thinking skills.

11.4.3 Day 3

- **Activity 1:** ***Threats and solutions*****.** The students were shown images of various threats and were asked to evaluate their impact on their animal group. They received detailed information on these threats, as well as potential solutions. In the same groups created for the days before, the students used printed photos and new information to create new posters focusing on threats and solutions. Each group presented their posters and shared their insights from the recent sessions. Following the presentations, the students engaged in discussions on the topics including (a) What are the dangers for these species?; (b) Who is responsible for these dangers?; (c) How can I help?; (d) What are Marine Protected Areas (MPAs)?; and (e) How does having a marine-protected area help me? Topics related to marine protected areas are integrated at the end of the activity to broaden the students' understanding of the

positive impact they could have on the marine ecosystem.
  - **Knowledge goal:** Increase understanding of threats and solutions that marine biodiversity faces on the island, explaining humans play a key role in these threats, and providing possible solutions.
  - **Leadership goal:** Repeat the methodology for the activity to increase confidence creating their new posters, focussing more on the content than on the process (Fig. 11.3A).

- **Activity 2:** ***The roulette quiz.*** The students were asked to develop questions related to the posters they previously designed. Each student prepared three questions. After the educators reviewed the questions, the students selected three representative questions from each group to be added to a blank roulette quiz created by the educators (Fig. 11.4A). Each group wrote their questions on triangles to be attached to the roulette. Once completed, the students played the roulette game.
  - **Knowledge goal:** Review the students' main learnings, creating questions related and use them in a game to check the knowledge retained.
  - **Leadership goal:** Recognize knowledge increase regarding marine topics, and share it with other students to empower them in their self-confidence as new ambassadors (Fig 11.4B).

- **Activity 3:** ***Our group.*** In the last three sessions, possible names for the group were put in a box in the classroom. In this activity, the names were shared, and the whole group voted for the name (Fig. 11.4C).
  - **Knowledge goal:** There is no knowledge goal in this activity.
  - **Leadership goal:** Increase the students' sense of belonging to a group, preparing them to be future ambassadors in marine topics for their community.



Fig. 11.3 (A) Final posters for presentations

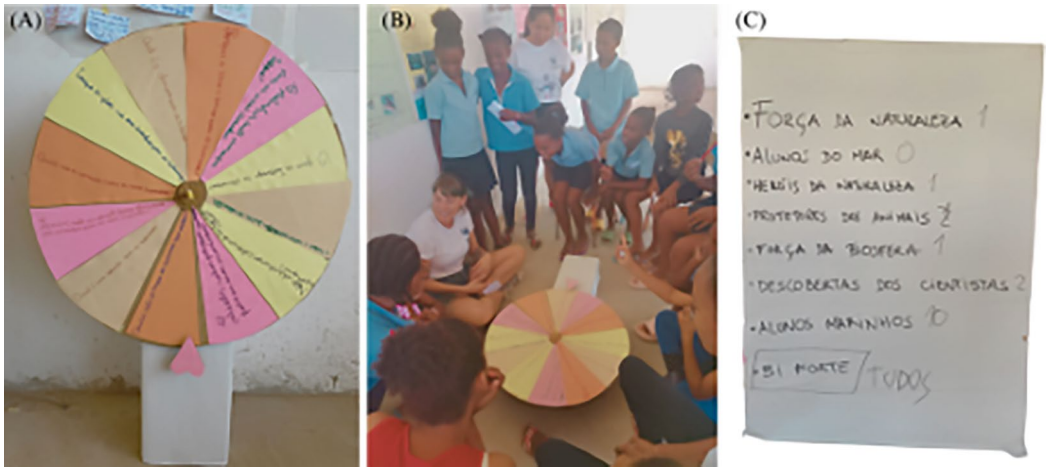


Fig. 11.4 (A) Final Roulette designed with student's questions, (B) Roulette game with students, (C) list of names proposed for the group and votes

11.4.4 Day 4

The students' parents, schoolteachers, and the international group "Edinburgh Ocean Leaders" were invited to this session. Before the activity, a discussion was held with the Edinburgh Ocean Leaders about their interaction with the students. Educator coordinators of the activity shared the main teaching tools implemented during the activities. The aim was to encourage the Edinburgh Ocean Leaders to integrate these tools into the session. As a result, the Edinburgh Ocean Leaders group engaged with the students sitting on the floor, facilitating a bidirectional and horizontal exchange of information, listening to the students' questions and asking questions in return.

The students, supported by the educators and all the materials they designed during the activities, shared their knowledge with the visitors, promoting a better understanding of the marine ecosystem and mechanisms for its conservation. The activity consisted of four stages:

1. **Introduction:** The students introduced themselves individually and collectively as the *Biforte* group, mentioning their names and the superpowers they associated with marine animals. The guests were also invited to introduce themselves using superpowers from marine animals they felt connected to.
2. **"What have we done?":** The group presented the materials as outcomes of all the sessions they participated in. They showed the island map with their contributions, the "learning wall" of each day, focusing primarily on sharing the posters and the information compiled in them.
3. **Quiz:** the guests were invited to participate in a quiz after reviewing the posters to test their knowledge about the marine ecosystem on the island.
4. **Conclusion:** The guests were asked to leave, and a final conversation with the students took place to discuss their feelings about the activity. After sharing anecdotes about the adults needing their help for some quiz questions, the students were awarded special certificates for their participation in the educational sequence, as well as a photo of the *BiForte* group.
   - **Knowledge goal:** Answer the guest's questions looking for the answers in the materials designed during previous sessions; ask the Edinburgh Ocean Leaders about the topics they were interested in.
   - **Leadership goal:** Help young learners take the lead in an educational activity designed for adults, analyzing their leadership skills through interacting with the guests (Figs. 11.5A, B and C).



Fig. 11.5 (A) and (B) Students presenting their posters to adults, (C) Students and adults playing the Quiz Roulette

11.5 Evaluation Metrics for Effectiveness of the Sequence

To assess the effectiveness of the sequence, a set of tailored evaluation metrics was established to reflect the multifaceted impact. Each metric was linked to specific activities and outcomes, ensuring a comprehensive assessment of the sequence's impact.

11.5.1 Knowledge Increase in Marine Ecosystems

The students' knowledge growth regarding marine ecosystems and conservation was assessed using both direct and indirect methods. Observations focused on how the students' understanding of marine ecosystems evolved over time. This included their ability to identify marine species, express the importance of biodiversity, and connect marine conservation concepts to their local environment. Visual and verbal demonstrations of this knowledge, such as explaining ecological relationships, or creating educational materials, were recorded and analyzed.

- **Assessment strategies:** The students were asked to present specific facts about marine ecosystems, such as identifying local marine species, describing ecological relationships, and explaining the importance of marine biodiversity and its threats. Assessment was carried out through group presentations, interactive quizzes, and creative outputs like posters and maps.

- **Indicators of success:** The students showed increased understanding, were able to apply learned concepts to new contexts, and used conservation-related terminology in discussions and activities.

11.5.2 Self-Confidence and Development of Leadership Skills

The evaluation of the students' self-confidence and leadership skills was closely intertwined, as both dimensions were essential for fostering active participation and collaborative dynamics within the sequence. Self-confidence was assessed through the students' willingness to contribute to discussions, express their opinions, and present ideas to various audiences, including peers, families, and external stakeholders. Leadership skills were evaluated based on the student's ability to take the initiative, guide peers, and manage group tasks effectively.

- **Assessment strategies:** The educators closely observed the students during group activities, monitoring their comfort levels in speaking up during discussions, engaging in debates, and assuming leadership roles. Particular attention was paid to behaviors such as volunteering to lead collaborative tasks, organizing materials, and facilitating equal participation among team members. These observations were complemented by video recordings of presentations and reflective notes from educators.
- **Indicators of success:** There was increased student participation, reduced hesitation to express ideas, and greater enthusiasm during presentations. Evidence of leadership included students confidently stepping up to coordinate tasks, resolving conflicts within groups, and guiding discussions effectively. Collaborative outputs, such as posters, maps, and multimedia presentations, further showcased the students' ability to work as a team and apply problem-solving skills in real-world scenarios.

11.5.3 Group Identity and Teamwork

The development of group identity and a sense of belonging was evaluated through both observable behaviors and creative outputs. Indicators of a growing group identity and sense of belonging included how the students referred to their team, their willingness to support one another, and the use of inclusive language when discussing their group's achievements. These aspects were analyzed through behavioral observations and the narratives the students shared about their experiences.

- **Assessment strategies:** The students were encouraged to create and adopt a group name and logo, which served as tangible representations of their collective identity. The educators observed student interactions, looking for inclusivity, mutual support, and pride in group accomplishments.
- **Indicators of success:** Successful group identity was evident when the students consistently referred to their group name, worked collaboratively without prompting, and expressed pride in their team's achievements. This sense of belonging was also assessed through reflective discussions in which the students expressed what it meant to be part of the group and their role in achieving shared goals.

Each of these metrics was supported by a combination of observational data, student artifacts, and reflective practices, providing a robust framework for analyzing the impact of the sequence on the participants. This multi-dimensional evaluation approach ensured outcomes were registered, highlighting the overall impact of the sequence with regard to fostering knowledge, confidence, leadership, and community building.

11.6 Data Collection and Analysis

The data collection methodology was designed to ensure an inclusive and participatory environment, allowing all students to express themselves and feel comfortable sharing their thoughts. Emphasis

was placed on providing enough time for the students to speak, reflect on their ideas, and engage in discussions with their peers in a safe space without being afraid of making mistakes. This approach fostered an open atmosphere for learning and reflection, which was key to writing both individual and collective learning outcomes.

11.6.1 Observation as a Primary Tool

Observation was a central component of data collection. The research team carefully monitored student participation, behaviors, and engagement during activities. Observational data were analyzed according to predefined categories, focusing on the students' knowledge acquisition, leadership development, self-confidence, and group dynamics. These observations provided real-time insights into the students' progress and allowed the team to adapt the sequence accordingly to support ongoing learning.

11.6.2 Supporting Data and Student Artifacts

Additional data were collected through student-created materials such as maps about marine biodiversity of the island, posters about specific groups of inhabitants of the region, and a roulette game with questions based on the posters' information. These artifacts were systematically reviewed to assess to what extent the students were able to apply marine conservation concepts and communicate their understanding creatively. The artifacts also provided valuable evidence of student engagement and group coordination to share learned information with the rest of the group.

11.6.3 Explicit Learning Through "What Did I Learn Today?"

At the end of each session, the students completed a reflective activity called "What did I learn today?" documenting their learning experiences. They shared these reflections on paper and in video interviews. This activity showed the students' knowledge development and ability to express and apply what they had learned. It was crucial for writing the explicit learning outcomes of the sequence and understanding how the students framed and communicated their new knowledge.

11.7 Data Analysis and Reflection

The data collected from observations, student artifacts, and reflections were analyzed through daily team discussions. The team of researchers reviewed the materials to evaluate student progress in real-time, identify emerging trends, and make adjustments for the following sessions. This iterative process allowed for continuous improvement of the educational sequence, and ensured it was responsive to the students' evolving needs.

The final session, in which the students assumed the role of educators for their peers, parents, and the Edinburgh Ocean Leaders, provided a unique opportunity to observe the students' leadership skills in action and to assess their ability to apply knowledge in real-world contexts while take on leadership responsibilities.

11.7.1 Results: Knowledge Increase of the Marine Ecosystem

11.7.1.1 Observed Data

The participants improved their understanding of marine biodiversity and the environmental threats these ecosystems face. Key areas of knowledge acquisition were observed and analyzed throughout the sessions:

- Biodiversity: During the first session, in which the students had to identify animals inhabiting the island's ecosystem, their proposals were repetitive and included non-local species like polar bears and penguins. However, all the students were able to identify turtles, and knew where to place them. During the three sessions, they learned about local species, their charac-

teristics, habits, threats, etc., and were able to talk about them. In the activity focused on proposing superpowers for marine animals, many students repeated what their peers had mentioned. On the second day, the session began by encouraging the students to come up with new superpowers. Several students showed the necessary confidence to share a superpower that had not been mentioned previously. One student even brought a book about marine animals and wanted to share a unique characteristic of penguins as a superpower that had not been discussed in the class before. This awakened many students' interests.

- Geographical knowledge: During the map activity, the students worked together to identify places on the island, and, through peer-to-peer discussions, they expanded their knowledge of marine geography, including regions such as Ilhéu Branco and the Atlantic Ocean, or villages on their island they initially did not know where to place.
- Environmental threats and solutions: Before the activities, the most common threat mentioned was beach pollution, focusing on the threat to human health. After carrying out the activities, the students were able to identify several threats to marine life, such as habitat destruction and overfishing, showing increased awareness of the challenges. They were also able to propose solutions to mitigate threats, such as avoiding littering and protecting areas during the breeding season.
- Commitment to conservation: At the beginning of the sequence, most students found it difficult to connect their responsibility to Ocean conservation, as they did not feel connected the problem. By the end of the sequence, they were able to reflect on the role of humans in protecting the marine environment, expressing personal commitments to improving their behavior, particularly regarding waste disposal.

11.7.1.2 Explicit Learning

The "What did I learn today?" activity helped the researchers identify knowledge increase. Results were organised (Table 11.1) into three different levels of depth of information:

- General information: the students mention general ideas of the session.
- Activity headlines: they mention the main ideas worked on during the sessions.
- Specific information: they mention specific ideas of the new information the sequence aims to share with them.

An increase in the number of specific responses was detected on days 2 and 3, showing student progress in acquiring knowledge related to the Ocean and sharing it during the sessions.

On the last day, the students were asked to record a video summarising their learnings from the day. Four videos, one per group, were recorded (Table 11.2) to encourage all the students to participate both in front of the camera and in sharing information. General trends observed in the videos were classified.

11.7.1.3 Evaluation Through the Roulette Game

The roulette quiz was based on questions the students formulated. It allowed assessing the shared information the students considered essential, and the degree of critical thinking applied in selecting content. The questions created (Table 11.3) varied in depth, but were all related to the information acquired during the process of developing posters for presentations. An initial trial of the roulette quiz was conducted internally with the students. The groups whose questions were selected randomly were particularly enthusiastic, as they knew the answers. This motivated the rest of the students, as they hoped their questions would be next.

The Roulette quiz was implemented on the last day when external participants attended the session. All the participants were divided into groups, ensuring a balanced distribution of students (acting as group leaders), teachers, external students, parents, and the Edinburgh Ocean Leaders. The students' enthusiasm when answering the questions was evident, as they realized they possessed specific knowledge the adults in their group did not.

Table 11.1 What did I learn today?

What did I learn today?	Day 1	Day 2	Day 3
General information	I learned a lot (3x) I learned many things about nature. Today I learned about the force of nature (2x)	Many facts about humans I learned about animal feeding. I learned many important things about the sea, sharks, seabirds, humans, and turtles.	
Activity headlines	I learned about living beings and that animals are the same. I learned that humans and marine animals must work together. I learned that we have to treat animals the same way we treat humans. I learned to defend animals. I learned that we are the same as animals. I learned that people should treat animals well. I learned about the home of all animals. I learned about the powers of animals. I learned to put animals in their homes.	I learned where seabirds are found (3x). Shark food, turtle food, types of turtles, and types of sharks I learned the species of sharks and where they live I learned the species of seabirds, where they live, characteristics of seabirds, feeding of seabirds I learned about humans, a little bit of everything, turtles, shrimps, sharks, fish, seabirds, and squid. I learned what animals eat, where they live, types of animals and their characteristics. I learned about the humans on earth. I learned about seabird feeding (2x)	I learned about threats and solutions for humans. I learned many things like sharks, turtles, seabirds, and humans, and their characteristics. I learned the solutions and threats for all animals. I learned about the threats and solutions(X5). I learned about the threats and solutions for animals and humans. I learned about the threats of the animals I studied.
Specific information	The tourists are very interested in getting to know our Ocean. The marine animals. The consequences for the island of São Vicente. I learned where Ilhéu Branco is (2x). I learned about the islands of Cabo Verde. I learned where the Atlantic Ocean is.	I learned how to help turtles, and stop eating turtles, not to throw garbage in the sea because it kills the animals. I learned about the species of seabirds. Birds eat fish and squid. I learned a lot about humans. I really enjoyed learning about humans and they eat everything because they are omnivores I learned about shark feeding. They eat turtles, seals, fish and shrimp. I learned what turtles and sharks eat. Turtles eat algae. Sharks eat seals. I learned about the names of turtles, such as the green turtle.	I learned that we should not throw trash into the sea or on the ground. I learned about the threats, the solutions for all animals. There are abandoned pets and there is by-catch. I learned about animals, their threats, and that we should not throw trash into the sea. I learned about threats. It's dangerous to throw trash on the beach because fish can eat it, and we eat the fish. I learned not to throw trash into the sea. I learned solutions, that we shouldn't throw trash on the beach or in the sea. For example: Plastic bags. I learned what sharks eat. I've already learned about turtle food. I learned that turtles live in the sea and come to land to reproduce.

Table 11.2 Videos

Video 1	Six students from the "Humans" group participated. Three of them spoke about specific learnings related to human threats and solutions within the marine ecosystem.
Video 2	Five students from the "sharks" group participated. Three students shared general comments on the poster titles, and two students provided specific examples related to different categories of information.
Video 3	Six students from the "turtles" group participated. Three students referenced general poster titles, and the other three shared more detailed information regarding what they learned.
Video 4	Two students from the "seabirds" group participated. Both offered highly specific information about the posters. One student shared examples of food sources and threats to seabirds, while the other discussed various seabird species found on the island.

Table 11.3 Questions

Why are cats a threat to sea turtles?
What are the threats to humans?
What are the solutions to reduce threats to seabirds?
What solutions exist for shark threats?
What types of humans exist?
What are the main threats to seabirds?
Why shouldn't we leave trash in the sea?
What do sea turtles eat?
Why are straws bad for turtles?
Why is trash dangerous for humans?
What do sharks eat?

11.7.2 Self-Confidence in Communication and Knowledge Transfer as a Key Leadership Skill

A key outcome of the sequence was for the students to be able to confidently communicate and transfer knowledge to others. This was evident in their interactions with peers and their presentations to the external group, which included adults.

11.7.2.1 Public Speaking

At the beginning of the sequence, the students were shy and lacked confidence during group presentations to their peers. They often read directly from the posters or recited memorized text. Their body language and voice projection indicated discomfort, as many struggled with eye contact and appeared nervous.

However, as the days progressed, a marked improvement in public speaking was observed. The students began to present their ideas more confidently, using the posters as supplementary resources rather than depending on them entirely. By the time of the final presentations, several students spoke without referring to the posters, and some even volunteered to present the information individually on video.

11.7.2.2 Knowledge Transfer

The students actively shared the knowledge acquired with both their classmates and the visiting adults. They used educational tools such as posters and videos to communicate their marine conservation ideas effectively. They explained environmental threats and solutions in an accessible and engaging manner to their audience.

For instance, during the final presentations to the external group, the students asked the adults to come and look at their posters, so they could explain what they had worked on during the sequence.

11.7.2.3 Challenges and Progress in Video Presentations

Recording videos posed a significant challenge to the students' self-confidence, as it introduced a higher level of performance pressure. Additionally, they were asked not to use the informative posters they had created for this activity. Initially, many students felt comfortable standing in front of their posters, but froze in front of the camera without them, not knowing what to say. However, the recording process was carefully structured to give them the necessary time and space to build up confidence.

Over time, the students began to play, joke, and laugh with each other in front of the camera. Some of them gradually started recalling specific content from their posters and expressed themselves more confidently. While a certain degree of shyness was expected, the students' progress

was remarkable. By the end of the activity, they engaged freely with the content and spoke about it with great ease in comparison to the early stages of the sequence.

After filming their initial videos, a few students revisited their posters to broaden their understanding of the material. They then requested to be re-recorded, showing increased confidence in presenting the information.

11.7.2.4 Interaction with Adults

The arrival of parents, teachers, and the Edinburgh Ocean Leaders initially made the students feel nervous. However, the positive group dynamic quickly took over, turning the interaction between students and adults into a valuable learning experience.

The Edinburgh Ocean Leaders played a key role in supporting the students. Before the activity, they participated in a preparatory session in which they were introduced to the sequence methodology. They discussed strategies to foster the students' self-confidence and leadership.

The Edinburgh Ocean Leaders showed empathy and created a supportive atmosphere. Their engagement not only encouraged the students to share their knowledge with enthusiasm, but also empowered them as future leaders. This was likely to be a significant moment in the students' educational journey.

During the session with adults, the students showed leadership and initiative. After the initial group presentations, each student group gathered around their respective posters while the adults moved from poster to poster asking questions. The students conveyed great enthusiasm, approaching adults and guiding them through their posters. They eagerly divided the information, and each group participant explained different aspects of the content. This process highlighted both high levels of self-confidence and leadership.

A few students took the initiative to lead the presentation of materials, such as the island map, and actively discussed the lessons learned in the workshop. This proactive engagement demonstrated their ability to take ownership of their learning, highlighting substantial progress in both leadership and communication skills.

11.7.3 Teamwork and Group Identity Development

The sequence emphasized the development of teamwork and a strong sense of group identity as a leadership skill. These interconnected skills were fostered through collaborative activities and decision-making processes encouraging students to work together effectively and build a shared purpose.

11.7.3.1 Collaborative Knowledge Generation and Decision-Making

Teamwork occurred during the activities that required collective decision-making, such as the map and the poster design tasks. For the map activity, the students engaged in reflective discussions to agree on where to place the names of various parts of the island. This collaboration showed their ability to have productive dialogues and reach consensus. Similarly, the poster creation process allowed the students to analyze, prioritize, and organize key information. By the third day, their familiarity with the materials and tasks enabled them to complete their posters more efficiently, integrating both textual and visual elements to offer clear explanations. These activities showed their ability to synthesize knowledge and adapt it based on previous experiences, highlighting their increasing confidence and teamwork skills.

11.7.3.2 Creating Group Identity and a Sense of Belonging

A defining moment in the sequence was choosing a group name. The name decided on was "BiForte," which symbolizes unity and shared purpose. The students were asked to come up with suggestions for names and had to put them in a box. The final vote was scheduled for the day before the concluding activity. Unbeknownst to the educators, the students decided to unanimously vote for the same name, surprising Biosfera 1's team and showing an exceptional level of group cohesion. The chosen name, together with a custom logo designed by one of the students, was presented during the visit of the

external participants. This further reinforced their sense of identity and collective achievement.

As the week progressed, the students fully embraced their identity as "marine ambassadors." This newfound role inspired them to confidently advocate for environmental awareness and marine conservation solutions. Excitement and pride were palpable when the students received their certificates. They felt recognized as individuals who were now part of a meaningful collective effort.

11.8 Discussion

The results reveal the potential of this educational sequence to promote students' marine knowledge, self-confidence, and group identity, three critical elements in enhancing OL and leadership. The findings also stress the importance of designing educational programs that extend beyond mere knowledge acquisition, as pointed out by (Ferreira et al. 2021). Such programs play a crucial role in fostering leadership skills, which are essential for strengthening OL and ensuring the protection and conservation of marine biodiversity, as proposed in regions like Cabo Verde.

It is important to recognize that enhancing the students' self-confidence was a gradual process that required careful preparation. Providing students with time and space to think critically, construct arguments, and determine how to share their ideas with peers was essential. The progress observed throughout the sessions underscores the importance of patience and a supportive environment, allowing for continuous refinement and adaptation of the sequence based on the students' reactions and feedback. Giving the students time to process information, practice presentation skills, and become familiar with the workshop methodology proved to be a key factor in their success in public speaking, group collaboration, and video recording. This approach aligns with Kelly et al. (2022) who point to the importance of involving young people in the design and co-creation of learning opportunities.

A key indicator of success in this sequence was the students' ability to confidently engage with visitors during the final activity. They effectively shared their newly acquired knowledge, using materials they had created throughout the sequence to facilitate knowledge exchange. Their engagement with the activities was also clear in their enthusiasm for collaborative designs, presentations, games, and shared learning experiences.

Developing group identity, symbolized by the creation of a group name and logo, further sharpened their leadership skills as marine ambassadors advocating for Ocean conservation. Enabling young people to take responsible action on environmental issues should be a primary concern of education (Schreiner and Sjøberg 2005). In this context, OL programs have the opportunity to empower young people in Ocean science by providing them with opportunities to assume leadership roles. Adults and adult-led organizations have the responsibility to engage with and empower young people in Ocean conservation efforts (Kelly et al. 2022).

Additionally, fostering an environment in which the students could participate without fear of judgment or negative feedback was essential. This safe space encouraged them to take risks, make mistakes, and learn through trial and error. It not only increased their confidence, but also indicated a greater willingness to actively contribute to collaborative marine conservation efforts. Working with communities to develop mechanisms supporting engagement is fundamental to achieving the UN's Decade of Ocean Science's goal of transforming society's relationship with the Ocean (McRuer et al. 2024). Student-centered projects adopting this view are of paramount importance as an initial step toward attaining shared Ocean conservation goals.

Finally, these results align with the findings of Kelly et al. (2022) who emphasize the need for assessment in various interactive and experiential activities that could enhance OL strategies. While this study focused on self-confidence, future research could further explore additional factors of behavioral models, such as self-efficacy and its role in promoting effective OL, as highlighted by Stoll-Kleemann (2019). Furthermore, OL research should integrate a vast range of disciplines and gain insights from other fields to broaden the scope of knowledge (McRuer et al. 2024).

11.8.1 Recommendations for Future Implementations

To strengthen future implementation, three key areas are recommended for continued development and refinement:

1. Development of leadership skills: While the acquisition of Ocean knowledge is explicitly assessed in each session, helping students recognize both their own learning and that of their peers, future iterations should place a stronger emphasis on the explicit evaluation of leadership skill development. This would allow students to identify their progress in these areas better. One way to achieve this is by incorporating structured activities in which students collectively analyze and reflect on their leadership skills with their peers.
2. Long-term engagement: to maximize the impact of the sequence, it is essential to maintain continuous engagement with the group through a structured series of activities rather than through isolated events. These activities should balance two key objectives: building OL and fostering leadership skills. Future programs could explore diverse Ocean-related topics that align with students' interests, incorporating workshops, interactive discussions, and hands-on learning experiences. A sustained approach would ensure students remain actively involved and empowered in their roles as Ocean ambassadors. In the case of *BiForte*, the NGO Biosfera1 has continued its efforts by implementing additional activities with the group.
3. Sustaining group identity: The strong sense of identity created during the sequence should be maintained. Organizing activities where the group has to lead the exchange of information with the community through games, sharing posters, making field trips, etc., would be an excellent opportunity to strengthen the unity of the group and make them more visible in their communities as the ambassadors they are. Providing physical symbols of group membership, such as custom T-shirts, or other items featuring the group logo, would help reinforce their connection to the group and remind them of their role in Ocean conservation beyond the sequence implemented.

11.9 Conclusion

The sequence's success was not solely based on content delivery, but also on the holistic development of students as leaders. This approach to educational sequence design, which integrates leadership development, collaborative work, and self-expression, can serve as a model for future Ocean Literacy programs, or any initiative aimed at empowering youth and adults.

Involving students in every step of the design process, from choosing content to presenting it to an audience, ensures they feel empowered in the outcome, thereby enhancing their commitment to both their personal growth and to the overarching goals of the sequence.

The methodologies discussed in this study require investing considerable time in various stages: design, implementation, evaluation, and improvement. The design phase involves understanding the context, integrating perspectives of both local and external experts, and considering the participants' prior knowledge and interests. Implementation requires flexibility to adapt to emerging insights during the process, giving the participants time and space to comprehend the proposals and engage in a comfortable manner. Evaluation is innovative, avoiding traditional testing methods, while improvement emerges from merging the learning outcomes with the educators' goals. All these stages require time, which, in project settings, is synonymous with budget.

When designing conservation proposals that integrate community engagement, education, and leadership, it is essential to account for the necessary budget to include educational experts who can analyze the context, invest time in understanding the community's knowledge, interests, and expectations, find the best educational and engagement tools for the audience, co-design the methodology with the local group, and continuously test and refine the proposal. For many years, marine conservation initiatives have emphasized community leadership, and more

recently, the concept of Ocean Literacy has become a key component. Although these elements are now widely integrated into long-term conservation proposal designs, there is limited evidence of the methodologies for their implementation and the tangible impact.

Research is vital to show how programs which include science education tools to promote leadership in Ocean Literacy are time-consuming and require financial investment to create meaningful changes. Furthermore, it is crucial to continue examining the impact of integrating these concepts into marine conservation strategies. It is not enough to include educational ideas on conservation proposals; when it comes to developing Ocean Literacy and empowerment skills, well-designed, contextualized, and high-quality educational strategies are necessary.

11.9.1 Summary

Key concepts explored in this chapter include:

- Localized, community-based education can foster Ocean Literacy and youth empowerment by connecting learning directly to the lived experiences and needs of participants.
- Program activities that integrate observation, discussion, fieldwork, and creative expression strengthen understanding of Ocean issues and reinforce personal and collective responsibility.
- Collaboration between NGOs, educators, and local stakeholders enhances the sustainability and cultural relevance of Ocean Literacy initiatives.
- Integrating leadership development into Ocean learning activities builds participants' confidence and capacity to act as Ocean ambassadors within their communities.
- Sustained engagement through structured activities promotes deeper learning, long-term commitment, and stronger group identity.
- The BiForte initiative provides a replicable model for linking Ocean science education with civic participation in Small Island Developing States (SIDS).

11.9.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Biosfera Cabo Verde: https://biosfera1.com
- SciDev.Net (UK) Ocean Science for development in SIDS: Facts and figures: https://unesdoc.unesco.org/ark:/48223/pf0000229514
- UNESCO. (2019). *Mid-term review of the UNESCO SIDS Action Plan 2016–2021.* https://unesdoc.unesco.org/ark:/48223/pf0000367367
- UNESCO-IOC. (2021). *Ocean Literacy for All: A Toolkit.* Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000260721

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12 From Ocean Literacy to the Sustainable Blue Economy: Empowering Youth Through SOI Foundation's Blue Futures Pathways Global Initiative

Kiersten L. Runte, Anna S. R. Naylor, and Tara J. Mascarenhas

Abstract

This chapter explores the growing importance of the Sustainable Blue Economy (SBE) in addressing global challenges related to climate change, resource use, innovation and economic development, with a focus on empowering youth in Canada through water-related career navigation. The Blue Futures Pathways (BFP) program, led by the Students on Ice Foundation, connects young people, particularly those from Indigenous, underrepresented, and remote communities, with education, mentorship, and career opportunities across the Ocean, freshwater, wastewater, and cryosphere sectors. Through national and international partnerships, experiential learning, and youth-led initiatives, BFP is helping shape a more inclusive, resilient, and innovative water workforce. This chapter highlights personal stories from BFP participants that demonstrate the transformative impact of access, representation, and community-driven programming. As BFP expands its reach, it continues to contribute meaningfully to water-related education, climate resilience, and inclusive youth leadership across Canada and within the broader context of the United Nations Decade of Ocean Science for Sustainable Development.

Keywords

Sustainable Blue Economy (SBE) · Workforce development · Youth engagement · Ocean Literacy (OL) · United Nations Decade of Ocean Science for Sustainable Development (Ocean Decade) · UN Ocean Decade Action · Canada · Arctic · Underrepresented · Indigenous · First Nations · Inuit · Métis · Equity · Diversity · Inclusion · Ocean · Fresh water · Wastewater · Ice · Cryosphere · Innovation · Global initiatives · NGO

12.1 Introduction

By 2050, the global population is projected to exceed 9.8 billion, driving increased demand for food, energy, jobs, raw materials, and economic growth (United Nations 2024; OECD 2025). The Ocean holds immense potential to meet these needs, but it faces many challenges from overexploitation, pollution, biodiversity loss, and climate change (Haas et al. 2022; Rossi 2022). The

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path to sustainable Ocean growth depends on empowering the next generation with the skills, opportunities, and resources they need to lead. This includes fostering inclusive policies, supporting innovative, community-driven solutions, and ensuring long-term economic investment.

Non-Governmental Organizations (NGOs) play an essential role in advancing the goals of the United Nations Decade of Ocean Science for Sustainable Development (the Ocean Decade) by linking science, policy, and society. As highlighted in the United Nations Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Oceanographic Commission (IOC) *Ocean Decade Manual for Non-Governmental Organizations*, "NGOs have significantly expanded their role in Ocean science and effective governance, championing marine and coastal ecosystem-based management, local stewardship and Ocean Literacy initiatives, and decision-making processes at all levels of society" (Kennedy et al. 2024, p. 3). Their collective engagement exemplifies how civil society can transform global goals into local solutions, embodying the collaborative spirit of the Ocean Decade. Through their community-based networks and ability to engage across disciplines and scales, "NGOs act as vital intermediaries, bridging the gap between scientific research and community engagement" and help translate Ocean knowledge "into actionable strategies, ensuring local communities, policymakers, and other stakeholders to comprehend the importance of sustainable Ocean practices" (p. 25). NGOs also "bridge knowledge gaps across age groups" (p. 26). Their participation strengthens advocacy, education, and innovation, providing real pathways for civil society, particularly youth, educators, and Indigenous partners, to contribute to sustainable Ocean management.

The Organisation for Economic Co-operation and Development (OECD) anticipates that advances in these emerging sectors could result in a doubling of the Ocean industry's contribution to Gross Value Added to USD 3 trillion by 2030, and an additional 40 million full-time equivalent jobs (OECD 2025). The relevance of the Ocean, freshwater and cryosphere to Canada, and particularly to Indigenous peoples, cannot be over-emphasized. Canada has the longest coastline in the world, 70% of which is exclusively in Indigenous communities (Government of Canada SC 2024). Inuit Nunangat, the Inuit homeland north of the tree line, comprises four regions: Nunavut, Inuvialuit (northern parts of Northwest Territories and Yukon), Nunavik (northern Québec), and Nunatsiavut (northern Labrador). This region covers 40% of Canada's territory and is home to over 200,000 inhabitants. In addition, Canada possesses 20% of the world's total freshwater resources and produces the most renewable freshwater per person each year globally (Environment and Climate Change Canada 2025).

The Nova Scotia-based Centre for Ocean Ventures and Entrepreneurship (COVE) Workforce Initiative identified significant barriers to entry and engagement in Canada's marine sector (Scully 2016). Key takeaways were that youth, parents, teachers and experienced workers in analogous industries shared dated notions of traditional marine industries (i.e. limited to navy and commercial fishing). These industries were characterized as involving dirty, cold, dangerous, and labour-intensive work, and rarely included creative or cognitive pathways. Furthermore, a persistent 'prestige' bias that privileges academic over vocational pathways was observed in youth as early as grade six. A long history of boom and bust within some of these industries had reinforced the belief that Ocean careers are unstable, unpredictable, and likely to disappear again. These negative perceptions impair the ability to recruit young diverse workers, and particularly a broad range of talent, to the marine industry, and

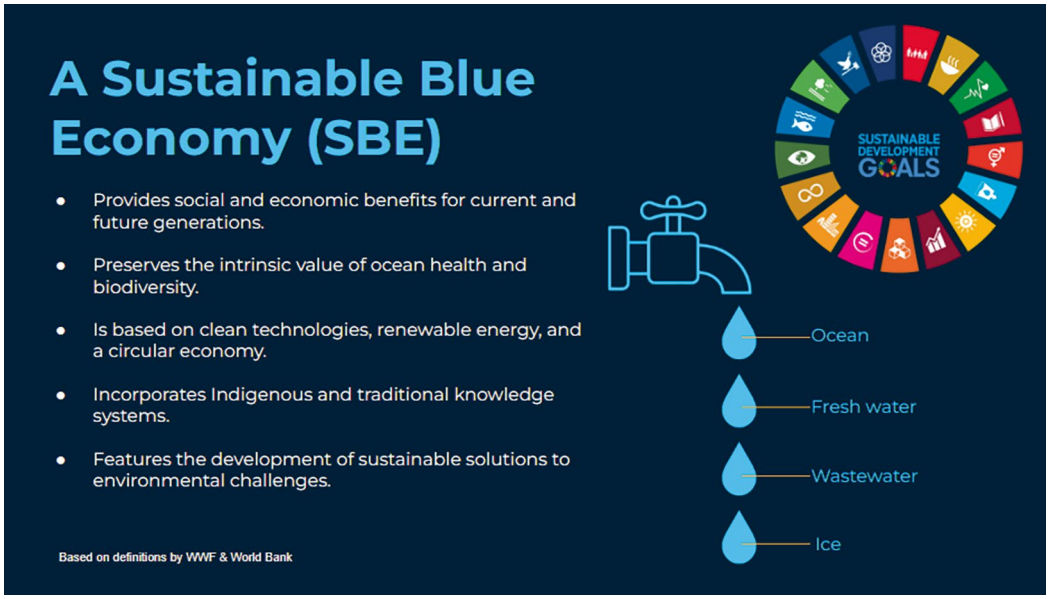


Fig. 12.1 The Students On Ice Foundation definition of the Sustainable Blue Economy, expanding on definitions from organizations like the World Wildlife Fund and the World Bank

research has shown that parents, teachers and other relevant role models actively coach youth away from these pathways (Scully 2016).

To change such perceptions and open doors, youth need programs that show the full potential of Ocean and water-related careers, where they see themselves represented and able to make a meaningful impact in the sector. The Students on Ice (SOI) Foundation's Blue Futures Pathways (BFP) program is doing exactly that; connecting young people with educational resources, professional development opportunities, mentorship, internship and work placements across the Sustainable Blue Economy (SBE). Expanding on the definitions set forth by the World Wildlife Fund, the United Nations and the World Bank, the SOI Foundation defines the SBE as including all work related to the Ocean, fresh water, wastewater, and the cryosphere, with social responsibility and circular economy components that ensure water is used sustainably over generations (see Fig. 12.1). In this chapter, we highlight how the SOI Foundation is supporting youth to explore, grow, and lead in this space, and how programs like Blue Futures Pathways are essential to building a more inclusive, innovative and thriving water-related workforce.

12.2 The Students on Ice Foundation

The polar regions are among the most important and vulnerable places on Earth, driving and regulating critical global climate systems, from land to sea. Often referred to as the greatest classrooms on Earth, they are homelands, frontiers, laboratories, and living classrooms, offering powerful opportunities for learning and connection. Warming nearly four times faster than the global average (Rantanen et al. 2022), the Arctic and Antarctic are at the frontlines of climate change. In response, SOI is dedicated to helping equip youth with the knowledge, leadership skills, and global perspective needed to address the most pressing challenges of our time.

The SOI Foundation began with a bold vision: to inspire a better future by connecting youth to the polar regions and each other through transformative educational experiences. Since the first expedition to Antarctica in 2000, SOI has led over 55 expeditions to the Arctic, Antarctic, and regions in between, creating life-changing opportunities for youth from across Canada and around the world (see Figs. 12.2 and 12.3). At the heart



Fig. 12.2 Youth and educators on a zodiac in Kangerlussuaq Fjord, Greenland. Photo licensed by the Students on Ice Foundation

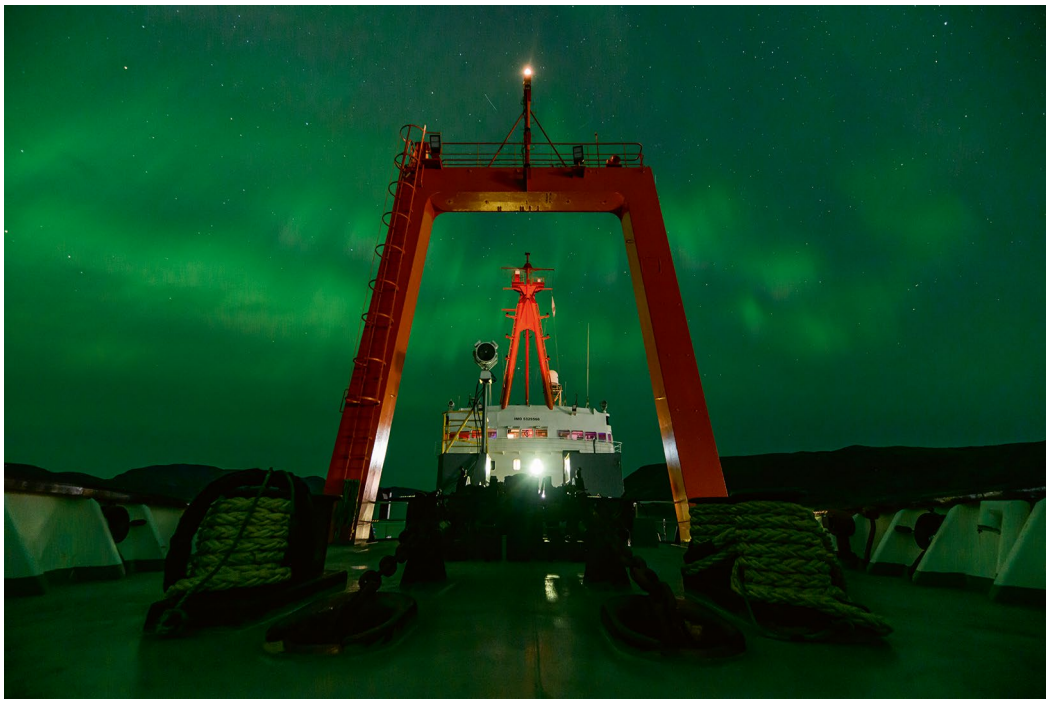


Fig. 12.3 The MV Polar Prince icebreaker sailing through the Arctic underneath the Northern Lights. Photos licensed by the Students on Ice Foundation

of SOI's mission is the goal to foster globally minded leaders by immersing youth in experiential learning environments and collaborative, cross-cultural journeys. These expeditions, set in some of the most ecologically and culturally significant regions on Earth, are the foundation of the organization's identity and impact.

Over time, SOI has grown beyond expeditions to offer a range of programs that deepen its impact on youth, communities, and the polar regions. Guided by core values of sustainability, equity, and leadership, the Foundation's work continues to evolve in response to the rapidly changing climate, social and geopolitical context. "Young people are ready to lead." states Geoff Green, SOI Founder and President, "The next generation holds the solutions to the challenges we face. Our role is to keep opening doors for learning, for leadership, and for impact. We have a responsibility to give them the tools, the opportunities, and the support to help them build a better future for their communities and for the planet."

SOI's programs centre on climate action, a healthy Ocean and community well-being, grounded in hands-on, interdisciplinary and inclusive learning. Students and educators bring diverse perspectives, creating a space for mutual respect and shared understanding. Students develop a holistic understanding of a place or a topic by learning from multiple perspectives. For example, pairing glaciology lessons with Inuit knowledge on how melting ice affects traditional hunting. Through connection to the land, water, and one another, the Students on Ice Foundation continues to empower youth with the tools, experiences, and relationships needed to forge a more just, resilient, and sustainable future.

12.3 Blue Futures Pathways

Expanding on the SOI Foundation's flagship expedition program, it became clear that there was a need to provide long-term educational and career support for young people creating change in Canada's water sectors. In 2019, SOI led a landscape analysis in partnership with COVE, to understand how youth were currently being supported in their educational and career pathways, and the input required from educators and employers. What emerged from the research was that, despite significant efforts to support youth engagement, initiatives were largely fragmented, and often region- and sector-specific. This presented a clear opening for a more integrated and inclusive approach: one that could engage youth from across Canada and encompass the full breadth of opportunity in the SBE. In particular, a need to elevate non-traditional career pathways and ensure that underrepresented youth could see themselves reflected was of key importance.

In response to this gap, the Blue Futures Pathways (BFP) program was launched in 2020. From flexible internships and mentorship to education, funding, certifications and leadership opportunities, BFP helps young people (ages 15–35) gain confidence, develop skills, and take the next step in their career journey. In line with SOI's mandate, BFP places particular emphasis on underrepresented and Indigenous youth, and activities that support those in remote and rural areas across Canada. Through a bilingual and at times trilingual, equity-focused approach, BFP connects youth and early career individuals with the tools, networks, and the guidance they need to explore water literacy, the Sustainable Blue Economy and water-related career pathways.

BFP implicitly includes Ocean Literacy or indeed water literacy, and all BFP activities contribute directly to advancing it. Through hands-on learning, career exploration, skills development, and knowledge-sharing, BFP supports young people in building meaningful connections to Ocean and water systems, understanding their role in Ocean sustainability, and envisioning themselves as part of a Sustainable Blue Economy. These are all core components of Ocean and water literacy as without this, it is not possible to engage fully in a career in the Sustainable Blue Economy.

Since 2020 and with support from almost 60 Partners, BFP has facilitated over 600 internships, supported 400+ youth through mentorship, trained over 2300 youth in the SBE and engaged over 29,000 youth through relevant resources on



Fig. 12.4 Youth participant lowers a remotely operated vehicle into the water on the 2024 Blue Futures Pathways expedition in Newfoundland and Labrador. Photos licensed by the Students on Ice Foundation

the BFP's Portal for Opportunities, Resources and Talent (PORT). Although BFP was initially established as a national initiative, its official endorsement as an Action of the United Nations Decade of Ocean Science for Sustainable Development has led to it becoming a global initiative. Through more than 80 outreach events across Canada and internationally, the program continues to expand its reach and impact. In 2024, BFP also became the host of ECOP Canada, the Canadian node of the global UN Early Career Ocean Professionals (ECOP) program. These types of partnerships demonstrate the impact of BFP and a growing network of early career professionals, who are shaping a more resilient and sustainable future for our waters.

BFP programming is also rooted in experiential, place-based, and problem-based learning. To this end, the BFP team developed and led expeditions in 2023 and 2024. The BFP Expeditions brought together a diverse cohort of youth and educators to explore water literacy and the interconnected nature of Canada's SBE. Through hands-on learning in science, Ocean technology, navigation, artistic expression, communications and storytelling, participants had the opportunity to earn certifications in drone operations and vessel safety, tackled real-world challenges and explore innovative solutions (see Fig. 12.4). Learning came from diverse professionals; from scientists to artists and Indigenous Elders to industry leaders, who shared personal stories about their own career journeys. These moments sparked curiosity, built confidence, and reinforced the belief that there is no single path to making a meaningful impact in water sectors. Every participant left with a stronger understanding of the many possibilities that exist and the value of their voice within them. BFP is more than a program; it is a platform for youth to lead, to learn, and to build a better future for their communities through the protection of water, which connects us all.

12.4 Finding a Future Blue Pathway: Perspectives on Navigating a Career with BFP

The BFP program was created to help young people from all walks of life see themselves in water-related careers, whether in the Ocean, freshwater, wastewater, or ice sectors. The following stories highlight just how unique and transformative each journey can be and underline how none of these paths have been linear. These youth and educators found their way into the SBE through community connection, storytelling, hands-on learning, and the courage to pursue what felt possible. Together, these journeys show that when we lead with inclusion, equity, and curiosity, we shape a future where everyone can thrive.



Fig. 12.5 Kathleen Matari speaks on a panel at IMPAC5, Vancouver, January 2023. Photos licensed by the Students On Ice Foundation

> BFP helped me see that what I contribute has value. We've created a strong exchange of learning, and I feel fortunate to be part of something that encourages youth to explore careers in water-related sectors.
> —*Kathleen Matari, BFP Educator.*

12.4.1 Kathleen's Story: Learning Through Teaching

Kathleen's journey with SOI started when she joined an expedition in 2017, sharing her knowledge of the Arctic Ocean and its fundamental importance to the Indigenous communities, such as her own Northern Inuvialuit community. Her contribution to BFP was through two distinct and impactful roles as a content provider and an educator. As a contributor, she actively helped develop classroom resources by researching and creating curriculum, reviewing content for accuracy and cultural relevance, and collaborating closely with the BFP team throughout the entire process from initial concept to final publication. Seeing her work integrated into educational tools used in classrooms across Canada represented a meaningful step toward advancing equitable and inclusive education for youth.

Her second experience working in partnership with BFP, visiting classrooms across the North was equally enriching. Kathleen was welcomed into schools where she not only taught but also learned from the predominantly Inuit students. She gained insights into their geographic homes, cultural values, and academic priorities, forming connections that went both ways.

Kathleen appreciated how BFP facilitated professional networking across regions. Although she primarily worked virtually, the 2023 IMPAC5 (International Marine Protected Areas Conference) in Vancouver, Canada brought everyone together in person and enabled Kathleen to share her work on a global stage (see Fig. 12.5). She has since stayed connected with fellow educators and contributors and continues to serve as a key contact in the Northwest Territories.

12.4.2 Safe's Story: Exploring Interconnection and Community

For Safe, a young student from New Brunswick, Canada, the 2024 BFP expedition revealed the deep interconnection between humans, wildlife, the Ocean, land, and air (see Fig. 12.6). He found witnessing the links between these systems and understanding how human impacts on the Ocean ripple outward eye-opening. Through the program, he was exposed to a wide range of perspectives, from youth and education across generations, including Indigenous knowledge systems which helped him think more holistically and critically about sustainability.



Fig. 12.6 Youth participant, Safe in Newfoundland and Labrador on the 2024 Blue Futures Pathways Expedition. Photos licensed by the Students on Ice Foundation

One of the most impactful moments for Safe was visiting the Torngat Mountains National Park. Surrounded by untouched landscapes, the group fished using traditional methods and learned about sustainable harvesting. Watching knowledge transfer happen between youth and across generations, left a lasting impression.

> Seeing different perspectives had power and strength. It inspired me to reflect on what I knew, what I have yet to learn, and how we can approach global challenges more thoughtfully. Ocean-related jobs will continue to grow, and curiosity is key. Be open-minded, challenge yourself, and explore widely. That's how we find our place in this sector.
> —*Safe AbuJayyab, BFP 2024 Youth Participant.*

Safe valued the strong social and professional networks fostered through BFP. He made friends from every corner of the country and now knows he can reach out to them when visiting different cities. Professionally, the experience introduced him to people working in research, conservation, policy, art, communications, and more. These connections have already helped with job referrals, references, and invitations to events.

For Safe, the program created space for honest conversations and cultural exchange. Sharing circles, Indigenous games, community, visits, dog-sledding, and scientific learning all contributed to helping him build a deeper understanding of himself and others.

12.4.3 Kiersten's Story: Building Community and Breaking Barriers

Kiersten's experience with BFP opened their eyes to what was possible in the Ocean sector. Coming from a non-coastal province, access to marine education was limited. Although they had already moved to the coast to study marine science, their understanding of the field remained narrow and academic. BFP created space to look beyond the classroom and connect with others who were equally inspired to make a difference.

During their final undergraduate year, feeling uncertain about their future, Kiersten attended a connector event hosted by SOI. They nervously spoke to the BFP Program Manager, Anna Naylor, and signed up as an intern during the first year of the program. That year's program included modules on the SBE, workshops on networking and resumes, and one-on-one mentorship. They remember, more than anything, finally feeling like their interests and goals were being seen and heard, and like they were welcomed into a supportive network of marine enthusiasts. From that experience came their first position in the Ocean sector where they discovered a natural passion for science communication and storytelling.

BFP's support gave them the confidence to return to graduate school, something they once thought inaccessible due to the challenges of living with a disability. When BFP launched its first dedicated expedition, Kiersten reached out to ask if there might be a last-minute spot and a few days later, got a call to say there was! The ship was set to depart in days, but the BFP team rallied behind

them, coordinating travel and making it happen. That experience, filled with multi-generational learning and cross-cultural exchange, cemented their belief in the power of building community.

> BFP taught me the power of showing up for your community, listening deeply, and paying it forward. Real change begins when we learn from others and keep opening doors for those who follow. BFP led me down new paths, connected me with like-minded people doing meaningful work, and brought together our shared commitment to a better future across all water sectors.
> —*Kiersten Runte, 2023 BFP Expedition Alumni.*

As someone living with a disability, Kiersten is familiar with the lack of accessibility and systemic inequities in many spaces, across academia and within the Ocean industry. BFP created a rare and meaningful space where they never felt overlooked. It was a model for what inclusive programming can look like when it centres care, intention, and lived experience (see Fig. 12.7).

12.4.4 Lindsay's Story: A First-Person Account of Rising Above Your Fears and Feeling at Home on the Water

The following testimonial is a moving, first person account about transitioning from a fear of water to a love of the Ocean (see Fig. 12.8). The text has been edited for length and clarity but remains in the author's own voice.

> My name is Lindsay. I am an Indigenous mother to three beautiful children. I am from Sitansisk First Nation, however I grew up in a small town in New Brunswick, Canada, daughter of a military man and an elementary school teacher.
> I am honoured to have been asked to write about my journey with Students on Ice. My time spent on the Ocean had a significant impact on my life, and it shaped my entire future. Blue Futures Pathways opened a door for me. I was terrified of open water. I never thought I would be on the Ocean, other than a quick ferry ride. I was stuck in a rut within my life, I found myself not being fulfilled anymore. I was diagnosed with debilitating health issues and I began to think I couldn't do anything. My body



Fig. 12.7 Kiersten (middle) on the 2023 Blue Futures Pathways (BFP) expedition in Rigolet, Newfoundland and Labrador, Canada alongside BFP alumni Alexandra (left) and Ellie (right). Photos licensed by the Students On Ice Foundation



Fig. 12.8 Lindsay Davidson, BFP Intern on the 2022 Ocean Conservation Expedition, New Brunswick, Canada. Photos licensed by the Students on Ice Foundation. Photos licensed by the Students on Ice Foundation

was constantly sore and I fell into a terrible mindset, and gave up on a lot of things that made me happy.

One day on Facebook, I saw that there was a trip for two Indigenous youth, to go with Students on Ice. I applied and succeeded. I boarded the ship on September 14th, 2022, together with another youth. We had to get into the zodiac to make our way over to the Polar Prince ship. I was terrified! However, I did it, and an amazing journey began.

On the ship, Blue Futures Pathways opened my eyes. We got to see so many things that never crossed my mind—the number of creatures within the Ocean, the importance of conservation. We got to go lobster fishing and identify different parts of the lobster. We learned about microplastics and the damage they cause. We were shown multiple types of Ocean drifters, which measure water salinity, depth, temperature and current. The data from the drifters is automatically uploaded and studied for different reasons.

While all this learning was taking place, I couldn't fathom the thought of leaving the water as I had fallen in love with multiple aspects of being out on the Ocean. I then began digging into what could be next for me. I wasn't a fan of going back to school for a prolonged period. I was also a stay-at-home mom, with little help near me and I knew that prolonged years of school would not work. Then my relationship came to an end and so I branched out and moved back to my hometown and essentially started over.

In May 2023 I saw a job posting as an Aboriginal Fisheries Strategy (AFS) crew member with Sitansisk Fisheries. I took a chance, applied and I was hired. A few days into my job, I found myself back in my happy place. I was on the boats doing work with the University of New Brunswick. We were out on the Wolastoq River, finding fish to see if mussel larvae were using the gills as hosts. We were using rods and reels, beach seines and fyke nets to collect our data.

Within months of working for fisheries, a new position opened as a Resource Management Officer Technician. I applied and got transferred in 2023. Within this role, our job duties were essentially to be the eyes and ears for the Department of Fisheries and Oceans (DFO). I found myself loving the job but lacking the authority to protect our waters properly. Therefore, I decided that I wanted to become a conservation officer with DFO.

At this point I had tons of knowledge, thanks to all the courses put on by our coordinator. I had acquired certificates in electrofishing, wilderness first aid, Small Vessel Operator Proficiency, marine duties, fish Identification, pleasure craft operations, soil and water sampling, intermediate canoeing and VHF Radio to name a few.

In late July 2025, after multiple exams and an extensive interview, I got the email that I had passed and was to become a DFO conservation officer. I applaud myself for the hard work I've put into establishing a career within the fisheries sector, and every single day, I thank Blue Futures Pathways for shaping my future. I am thankful to SOI for opening a door for me. This opportunity was more than a quick trip for me, I am now on an adventure of a lifetime. I love myself, I have courage, and I've overcome obstacles I didn't believe were possible.

I want to finish by telling our Indigenous youth, get out there. Even if you don't believe you can. We need knowledgeable people on our waters. Those with dedication to keeping our water as healthy as it can be, and to restore damage already done. It is so important to conquer the things you don't believe you can. It is not only important for our environment, but for your personal growth, and mental health. I truly found myself with Blue Futures Pathways. Wəliwən kəmac! (Thank you very much in Wolastoqey language).

—Lindsay Davidson, BFP Intern on the 2022 SOI Ocean Conservation Expedition.

12.5 Conclusion and Future Steps

As Blue Futures Pathways moves through Phase III, the program continues to expand in key sectors within the Sustainable Blue Economy including the Ocean, fresh water, wastewater and ice. These systems are deeply interconnected and critical to climate resilience, community well-being, economic growth, water literacy, and provide equitable, innovative opportunities in

underrepresented, remote areas across Canada and beyond. Through our strategic partnerships with educators and employers, we continue to engage youth and ECOPs with diverse career possibilities tied to many different sectors, from water quality to sustainable tourism, community infrastructure to Ocean technology, and environmental engineering to conservation.

In the Arctic and in the Great Lakes, BFP is strengthening long-term partnerships to ensure that programming remains community-led, culturally grounded, and locally relevant. Through these collaborations, BFP supports youth across Northern and Indigenous communities in accessing opportunities that reflect both traditional knowledge systems and multi-generational perspectives.

Building off the open-access learning modules that are available through the PORT, BFP is also pioneering education through the creation of university-level micro-credential courses tailored to the SBE in collaboration with the University of British Columbia, Canada. These credit programs will help those seeking to gain recognized skills and education, and represent a significant step toward more accessible, inclusive, and practical career pathways.

A key expansion of the BFP program is the inclusion of the ECOP Canada node under the SOI/BFP umbrella. Within ECOP Canada, the ECOP Ambassador Program was designed to help ECOPs across Canada evolve their own initiatives, develop professional skills, and attend global conferences sharing their voices on national and international stages. This work is essential to strengthening youth leadership and representation across the water sectors and supports the achievement of the UN Sustainable Development Goals.

Through these initiatives, and guided by a strong commitment to equity, diversity, inclusion, and sustainability, BFP continues to build capacity for a thriving, resilient water sector from coast-to-coast-to-coast. From online resources and mentorship to employment support, skills training, and certifications, BFP remains a hub for connection and opportunity. For those looking to explore, grow, or contribute to the future of water, the BFP PORT offers a gateway to tools, training, and opportunities for youth, educators, and employers.

At a time when the world faces urgent challenges related to climate change, biodiversity loss, and the sustainability of water systems, the voices and experiences of youth are guiding new and necessary directions. BFP has shown that when young people are given access, support, and the chance to lead, they not only find meaningful careers, but they also contribute to a more inclusive, innovative, and resilient water sector. Their journeys serve as a reminder that a thriving blue future is built not just through technology or policy, but through lived experience, community knowledge, and the shared courage to envision a sustainable future for all.

12.5.1 Summary

Key concepts explored in this chapter:

- The Ocean and water sectors are critical to meeting global needs for food, energy, and jobs, but face major sustainability challenges.
- Canada's unique geography and Indigenous communities make it a key player in the Sustainable Blue Economy (SBE).
- Youth face barriers to entering marine and water-related careers due to outdated perceptions, lack of knowledge and limited access to opportunities available.
- The Students on Ice Foundation's Blue Futures Pathways (BFP) program addresses these gaps by connecting youth aged 15–35, educators and employers to education, mentorship, skills training, funding, and career opportunities across the SBE.
- BFP emphasizes inclusion, Indigenous leadership, experiential learning, and diverse career pathways beyond traditional and academic roles.

- Personal stories from BFP participants highlight how access, support, and representation can transform career pathways and lives.
- As BFP grows, it continues to focus on innovation, Arctic, fresh water, wastewater, and global collaborations through its range of partnerships, Canada's Ocean Supercluster, ECOP Canada and the UN Ocean Decade.
- The program is building a more inclusive, resilient, and youth-led water sector across Canada and beyond, helping amplify innovation through Ocean and water literacy, access to technology, and training and funding to make it happen.

12.5.2 Recommended Resources

The following resources provide further insights and support on this topic:

- The Students on Ice Foundation: www.soi-foundation.org.
- The Blue Futures Pathways Portal for Opportunities, Resources and Talent (PORT); www.bluefuturespathways.org.
- Blue Futures Pathways Landscape Analysis: https://storymaps.arcgis.com/stories/e6841451929246cc9a1039872a7770bc.

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Author Contributions

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[2]Anna Naylor: Co-conceptualization; Writing—Review and Editing.

[3]*Tara Mascarenhas Co-conceptualization; Writing—Review and Editing.

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Kiersten L. Runte provides a creative lens to SOI's Blue Future Pathways (BFP) team, bringing a passion for science communication and storytelling. With over 5 years' experience working in Canada's Ocean innovation and research space, they've fostered skills in project management, graphic design, photography, videography, technical writing, workshop development, science education and outreach. Kiersten's background in marine mammal acoustics led them to investigate a mystery beaked whale signal as part of their MSc research, where a passion for creating marine educational programming for youth and communicating science to non-science audiences was kindled. They completed the Dalhousie University's Indigenous studies certificate program, located on the unceded territory of Mi'kma'ki people. They are also an alum of BFP's first cohort of interns and hopped aboard the first dedicated BFP expedition back in 2023.



Anna S. R. Naylor has over 10 years of experience working and connecting youth within the Sustainable Blue Economy and brings this passion to the SOI Foundation. After graduating from her Master's in Marine Management, Anna co-founded OCEANS-NS, a registered not-for-profit organization in Nova Scotia, Canada, that sought to enhance and strengthen Ocean education in Nova Scotia. From there, Anna continued to develop her skills and bring experience in project management, program development, and youth engagement for her position as Program Manager for Blue Futures Pathways. Anna focuses on providing internships, mentorships, career opportunities/training and developing initiatives that support Canadian youth to chart their career within the Sustainable Blue Economy. Anna was one of the first Canadians to receive a Sustainable Blue Economy Professional designation (SBEP) in 2025.



Tara J. Mascarenhas joined the SOI Foundation in 2016 as the Program Team Lead for the Canada C3 expedition that travelled the length of Canada's coastline from the Great Lakes to Victoria via the Northwest Passage. Inspired by its legacy, she spearheaded Blue Futures Pathways. As Director of Programs, in 2023 and 2024 Tara led two expeditions from the Arctic to Newfoundland, providing young adults with opportunities to test their skills on the land and water. Tara was one of the first Canadians to receive a Sustainable Blue Economy Professional designation (SBEP) and in 2024 was honoured as one of a hundred Canadians selected by Governor General Mary Simon to receive a King Charles III Coronation Medal in recognition of her work supporting youth in environmental careers. Tara has a background in education, capacity development and international humanitarian aid, and a BA Honours degree from the University of Leeds, UK. She is currently studying for a bilingual, Executive Master's in Business Administration at McGill-HÉC Montréal, Canada.

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13 Co-designing Ocean Science with Small Island Developing States' Local Stakeholders: A Tool for Ocean Literacy

Naya Sena and Mitsutaku Makino

Abstract

The United Nations Decade of Ocean Science, under the motto "The Science We Need for the Ocean We Want," provides an international framework for addressing Ocean challenges through science-based solutions, co-design methodologies, multistakeholder collaboration, and the advancement of Ocean Literacy. Such a framework is particularly relevant to Small Island Developing States (SIDS), which face unique socio-ecological vulnerabilities and are highly dependent on Ocean resources. This chapter presents research conducted in Cabo Verde, a small island state in the eastern Atlantic, aimed at assessing local stakeholders' perceptions of Ocean-related challenges and identifying scientific priorities aligned with national and community needs.

The study identifies the most pressing Ocean Decade Challenges for Cabo Verde by analyzing twenty-seven interviews with local stakeholders. The interviewed stakeholders had a direct connection to the Ocean, either through their work or expertise, and represented diverse backgrounds, bringing a wide range of perspectives to the co-design process. Findings revealed a set of "Local Ocean Decade Challenges," that contextualize the global priorities to Cabo Verde's specific circumstances and highlight the value of integrating local knowledge into the global Ocean Decade framework. The study emphasizes the importance of co-design and multistakeholder engagement in Ocean science and underscores the role of Ocean Literacy in strengthening community participation and fostering sustainable Ocean relationships in SIDS contexts.

Keywords

Co-designing · Decade challenges · Multistakeholder collaboration · Local knowledge · Ocean Literacy (OL) · Ocean science · Small Island Developing States (SIDS) · Stakeholders engagement · Stakeholders perceptions · Sustainable development

13.1 Introduction

This chapter presents a study that was part of a doctoral research project on coastal sustainable and resource management in Cabo Verde, a small African archipelago classified as a Small Island Developing State (SIDS). The study demonstrates a method of co-designing Ocean

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science with the local stakeholders to identify national science priorities and promote Ocean Literacy.

The Introduction provides an overview of important concepts related to the United Nations Decade of Ocean Science for Sustainable Development framework developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Oceanographic Commission (IOC) and outlines the main environmental and socio-ecological characteristics of Cabo Verde. The methods used for interview analysis as well as the main findings are presented in subsequent sections. The chapter concludes by discussing the importance of adapting international frameworks to local realities, the value of engaging SIDS local stakeholders in Ocean science, and how such engagement fosters greater human-Ocean connections. A selection of recommended literature is provided at the end of the chapter to guide readers interested in learning more about co-design methodologies and their links to Ocean Literacy.

13.1.1 Overview of the Ocean Decade and Ocean Literacy

Proclaimed by the United Nations, the Decade of Ocean Science for Sustainable Development 2021–2030, also known as UNDOS or Ocean Decade, is a global framework and initiative to promote the sustainable use and conservation of the world's Oceans. Under the motto "The science we need for the Ocean we want," the Decade's mission is to foster transformative Ocean science and innovative solutions for sustainable development, connecting people and the Ocean.

The Ocean Decade can be considered an extension of the United Nations Sustainable Development Goals (SDGs), which focus on SDG 14, "Life Below Water," as a tool for development, sustainability, inclusivity, and equity. The main objectives are to identify the required knowledge for sustainable development, to generate comprehensive knowledge and understanding of the Ocean, and to increase the use of Ocean knowledge.

To do so, the Ocean Decade advocates inter- and transdisciplinary research, co-designing methods, multistakeholder engagement, and generating knowledge to support policymaking and develop effective management strategies. Such a task is not easy to achieve and the 10 Ocean Decade Challenges address the most critical issues facing the Ocean, from pollution and biodiversity loss to climate change and Ocean economy development: Challenge 1—Understand and beat marine pollution, Challenge 2—Protect and restore ecosystems and biodiversity, Challenge 3—Sustainably feed the global population, Challenge 4—Develop a sustainable and equitable Ocean economy, Challenge 5—Unlock Ocean-based solutions to climate change, Challenge 6—Increase community resilience to Ocean hazards, Challenge 7—Expand the Global Ocean Observing System, Challenge 8—Create a digital representation of the Ocean, Challenge 9—Skills, knowledge and technology for all, and finally Challenge 10—Change humanity's relationship with the Ocean (UNESCO-IOC 2021a).

The ten Decade Challenges cover a diverse range of topics, and Challenge 10 highlights the importance of Ocean Literacy in achieving the Ocean Decade goals. Understanding the Ocean's influence on people and people's influence on the Ocean fosters a deeper connection between society and the Ocean, promoting informed decision-making and inspiring positive action toward the sustainable use of marine resources.

Ocean Literacy can take many forms, including creating national strategies to shape education policies and training teachers in schools and other educational settings like universities and aquariums. It also involves programs for students at all levels, from early childhood to higher edu-

cation, and those with special needs. Another key aspect is the knowledge exchange between scientists and the public, including local communities, governments, and businesses. Training programs focused on the blue economy and Ocean sustainability for government, business, and media leaders are also important. Additionally, youth empowerment and public awareness campaigns play a big role in promoting Ocean Literacy (McKinley et al. 2023).

Ocean Literacy is particularly important in communities where the Ocean is often the most valuable resource. The Small Island Developing States (SIDS) are a group of 57 countries and territories due to their small size, and vulnerable socio-ecological systems, tend to share similar sustainable development challenges. They host high levels of biodiversity and endemism, present high risks to natural disasters and climate change effects, have limited resources, and their economies are small. Tourism, fisheries, and agriculture are the most predominant economic activities in SIDS.

The SIDS are often called Large Ocean States, not only due to the larger Ocean areas than land areas but also due to the Ocean's importance in all socio-ecological aspects of SIDS communities. Therefore, initiatives like the Ocean Decade contribute to scientific production and serve as a platform to educate and change attitudes toward the Ocean.

13.1.2 The Study Site, Cabo Verde

Composed of ten islands and numerous islets of volcanic origin, the archipelago of Cabo Verde is located around 500 km off the coast of mainland West Africa. With a population of 593,149 people, the islands exhibit a diverse range of topographical characteristics, from mountainous terrain on the western islands to coastal plains on the eastern islands.

Geographically located within the Sahelian belt and the northeastern trade wins, the country has a notably arid climate and frequent droughts, which subsequently impact the country's agriculture and social dynamics (Neto et al. 2020).

Cabo Verde is part of the Macaronesia, a biogeographical region in the North Atlantic Ocean, that includes five other archipelagos: Azores, Madeira, Selvagens, and the Canary Islands. Apart from many historical connections, the archipelagos share common geological processes and host a mixture of European, African, and American flora and fauna. (Florencio et al. 2021). Such particularity means that these islands have exclusive characteristics and face unique challenges.

Cabo Verde has a complex history shaped by colonization, the transatlantic slave trade, periodic droughts, and the struggle for independence. The Portuguese arrived in 1462 and established their colonial domain for almost five centuries, using the islands' geographical location for the transatlantic slave trade. (Schneider and Ferguson 2020). The archipelago gained its independence on July fifth, 1975, and gradually transitioned to a democracy, adopting a new constitution and holding the first multi-party elections in 1991 (Pereira et al. 2019). Cabo Verde has a semi-presidential representative democratic system, with regular elections and stable democratic governments from different parties.

Classified as a Small Island Developing State (SIDS), Cabo Verde presents many of the characteristics typical of these territories: small size, geographic isolation, environmental vulnerability, high levels of biodiversity and endemism, scarcity of resources, fragile economy, high immigration rates and reliance on imports. (Scandurra et al. 2018).

Two Cabo Verde islands, Fogo and Maio, were classified as UNESCO Biosphere Reserves in 2020, confirming the country's relevance to global biodiversity. The 956 km of coastline hosts most of the country's settlements, but it also hosts one of the world's most important nesting sites for the loggerhead sea turtle (*Caretta caretta*) (Martins et al. 2022), the cliffs serve as nesting grounds for endemic and endangered species of seabirds and its waters are full of biodiversity (Semedo et al. 2021). Consequently, coastlines and marine areas deemed important for biodiversity and habitat preservation are integrated into the National Network of Protected Areas.

Interestingly, most of the 47 protected areas are also home to rural and coastal communities that have their own cultural traditions, aspirations, and ways of life that should be considered, respected, and preserved as much as possible.

The country's economic scenario is concerning with an unemployment rate of 13.57%, a poverty rate of 35.5%, a minimum wage of 128 USD, and heavy dependence on imports. (Furtado 2018). Cabo Verde is characterized by its high emigration rates, with more than 700,000 Cabo Verdeans living abroad, which is higher than the resident population. The largest communities of Cabo Verdean emigrants can be found in the United States of America, Portugal, and France (Monteiro et al. 2020).

Factors like lasting periods of drought, limited sources of fresh water, and reduced arable land mean that agriculture is mostly rainfed and farmers often practice subsistence farming. The most traditional crops include maize, beans, cassava, and sweet potato, while the common livestock are chickens, goats, and pigs. The high uncertainty of the agriculture sector forces most farmers to alternate to fishing activities, so most farmers are fishers, and most fishers are also farmers. In years of drought, food security is seriously compromised and the country's dependence on imported goods intensifies (Tavares 2020).

Coastal and marine resources are essential parts of Cabo Verde's socioeconomic structure. The country has 700,000 km^2 of Economic Exclusive Zone which is more than a hundred times its land area, of 4033 km^2 (Monteiro et al. 2020).

Tourism contributes 25% to the country's Gross Domestic Product (GDP), employs 45% of the country's workforce, and is the sector receiving the most investments, both national and international. The industry is predominantly beach and maritime-sports tourism, with a recent strong increase in eco-tourism and community-based tourism.

Fishing is a crucial sector in Cabo Verde's socio-economic panorama. Fish is one of the main components of locals' diet and is present in several traditional celebrations and cultural habits. Coastal communities rely on fisheries as a source of nutrition and livelihood. The fishing industry contributes to 74.2% of Cabo Verde's exports, supporting the country's economic diversification and growth (Furtado 2018).

These unique characteristics make Cabo Verde's socioecological context even more vulnerable, evidencing its developmental challenges and accentuating the need for sustainable public policies and practices.

13.1.3 Ocean Literacy in Cabo Verde

Cabo Verde's commitment to the environment and sustainable practices has been registered through the policies and strategies implemented over time since its Independence. In 1980 the International Union for Conservation of Nature (IUCN) launched the World Conservation Strategy (WCS). Cabo Verde has incorporated the WCS principles into its environmental policies, particularly in protecting its marine biodiversity and promoting sustainable development in small island ecosystems.

In 1994, the archipelago ratified the Convention on Biological Diversity (CBD), and the following year, in 1995, it ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD) (Da Rosa 2013).

In light of these commitments, Cabo Verde created different National Strategies and Action Plans to conserve its unique biodiversity, particularly in marine ecosystems and protected areas, and to promote sustainable development.

Cabo Verde's commitment extended to the United Nations Decade of Ocean Science (UNDOS) launched globally in January 2021. A year later, on June eighth, the Ocean Decade National Committee of Cabo Verde was officially coinciding with World Oceans Day. As of 2022, Cabo Verde was the only SIDS with a National Decade Committee. Since then, Cabo Verde has carried out different projects and programs to promote the Ocean Decade and Ocean Literacy (OL).

Cabo Verde is home to the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), a Graduate School Program endorsed by the Ocean Decade that focuses on training Ocean scientists to address the Climate Change challenges of the region.

The Early Career Ocean Professionals (ECOPs), an Ocean Decade-endorsed global network program, is currently being implemented in Cabo Verde. The program focuses on capacity building, Ocean Literacy, and youth engagement in Ocean science.

Additionally, different Ocean Literacy initiatives have been carried out that align closely with the framework outlined in UNESCO IOC's *Ocean Decade Manual for Non-Governmental Organizations*. The Manual emphasizes that sustainable Ocean management depends on the active participation of diverse actors, disciplines, and perspectives, and that NGOs play a vital role in bridging science, policy, and society, bringing together stakeholder groups and building strong networks across sectors, particularly within the framework of the Ocean Decade (Kennedy et al. 2024).

This vision is reflected in Cabo Verde's ongoing efforts: the *Blue School* program—originally from Portugal and extended to Cabo Verde in 2019—integrates Ocean Literacy into school curricula; the project *Nôs Txon, Nôs Mar* (*Our Land, Our Sea*), launched in 2021 by the NGO *Associação para a Defesa do Ambiente e Desenvolvimento* (Association for the Defense of the Environment and Development), focuses on community-based Ocean Literacy through educational campaigns, beach cleanups, and capacity-building workshops with local fishermen; and the *Ocean Literacy for All Cabo Verde Initiative*, a partnership between the Ministry of Education and UNESCO-IOC, promotes public education on climate change impacts, sustainable use of marine resources, and marine pollution. Collectively, these initiatives embody the collaborative and inclusive spirit of the Ocean Decade by linking science, education, and community engagement to foster a more Ocean-literate society.

Finally, it is important to mention the work that local NGOs carry out on the different islands and the crucial contribution they give to Ocean Literacy in Cabo Verde, organizing workshops, capacity-building sessions, awareness campaigns, and citizen science initiatives. The very much underfunded local NGOs are the bridge between government policies and local communities, facilitating the communication between science and local knowledge and promoting the balance between ecological needs and socio-economic development (Sena et al. 2023).

Considering their unique vulnerabilities and developmental challenges, the Ocean Decade and its focus on developing Ocean Literacy are essential for SIDS to achieve sustainable development. Furthermore, SIDS coastal communities often live, use, and depend on the same natural resources that are to be preserved and protected. So, it is essential to assess locals' perceptions and to actively engage them in Ocean science production through co-design methods (Sena et al. 2023). It is crucial to generate a better understanding and knowledge of the Ocean in SIDS communities, and, on the same note, scientists must expand their collaborations and find partnerships in these communities and their knowledge. Building a stronger relationship between people and the Ocean.

Therefore, this chapter presents a study in which local stakeholders from Cabo Verde were interviewed online (during the COVID-19 pandemic in 2021) as part of a doctoral research project. The study analyzed stakeholders' perceptions (The Ocean We Want) to determine the most urgent scientific priorities and the Local Decade Challenges for Cabo Verde (The Science We Need).

Specifically, this study aims (1) to present the Local Decade Challenges for Cabo Verde, (2) to discuss the importance of co-designing and multi-stakeholder engagement in Ocean science and Ocean Literacy, and (3) to highlight the importance of adapting international frameworks to local contexts.

13.2 Methods

13.2.1 Data Collection: Semi-Structured Interviews

Due to the constraints posed by the COVID-19 pandemic, the interviews were conducted online using the video meeting application Zoom. The interview method used is semi-structured interviews, where predetermined questions are combined with open-ended prompts. This allows the interviewers to explore more topics according to the participant's response. Twenty-seven semi-structured interviews were carried out between July and August 2021, targeting local stakeholders working with the Ocean.

All permissions and information regarding the study purposes were shared with the interviewees through email and an online Informed Consent Form. The questions were based on the literature review and aimed to understand the local stakeholders' perspectives on the sustainability of coastal and marine resources in Cabo Verde.

As shown in Fig. 13.1, the local stakeholders had different areas of action. They included researchers, academics, NGO leaders, ecotourism operators, government officials, and environmental activists.

Unfortunately, it was not possible to include fishers and other community-level stakeholders. At the time, the COVID-19 pandemic was still active, and social isolation measures were still in place in Cabo Verde. This meant that only those with a personal computer and internet access at home could participate in the interviews. In the case of coastal communities, this would only be possible using community centers, which were closed at the time.

A mix of the Purposive Sampling method, which involves selecting participants based on specific criteria, and the Snowball Sampling method, where initial participants who meet the predefined criteria help identify and recruit additional participants, was applied. This resulted in 67% of male and 33% of female interviewees.

13.2.2 Data Analysis

The interviews were conducted over Zoom, which was not only a practical solution during the pandemic but also a great way to engage with local stakeholders remotely. To ensure all the information was saved and could be carefully reviewed later, each interview was recorded using both Zoom's cloud storage and an external audio device. The interviews were in Cabo Verdean Creole and Portuguese and were later transcribed and translated into English.

The interviews were analyzed using Content Analysis. This method helps researchers make sense of interviews or other types of communication by looking for patterns, themes, or ideas.

To organize the information, the 10 Ocean Decade Challenges were used as the main categories (or "codes"). These codes helped label different parts of the interview content. For each main code, subcategories were created to better capture the specific challenges that apply to Cabo Verde.



Fig. 13.1 Areas of action of interviewed local stakeholders

Two tools were used to help with this process: NVivo, software designed for analyzing qualitative data, and Microsoft Excel to organize and explore the information from the interviews.

13.3 Results

The results from the interviews' coding are expressed in Fig. 13.2. On the vertical axis, the 10 UNDOS Challenges are listed. The horizontal axis expresses the number of times the local stakeholders referenced each Ocean Decade Challenge (ODC).

The top three Ocean Decade Challenges most referenced were Challenge 4—Sustainable Ocean Economy (n = 38 references), Challenge 2—Protect and Restore Ecosystems (n = 37 references), and Challenge 10—Behavior Change (n = 31 references).

The 10 Ocean Decade Challenges were used as the initial codes, and a subcode or subcategory was identified and registered in an Excel sheet, as shown in Fig. 13.3. This resulted in the identification of specific Ocean Decade challenges for Cabo Verde, which will hereinafter be referenced as Local Decade Challenges (LDC).

13.4 Discussion

13.4.1 The Decade Challenges in Cabo Verde

The top three most referenced Decade Challenges (DC) for Cabo Verde were Challenge 4—Sustainable Ocean Economy (n = 38 references), Challenge 2—Protect and Restore Ecosystems (n = 37 references), and Challenge 10—Behavior Change (n = 31 references).

The DC 4 refers to a sustainable Ocean economy and recognizes the importance of fostering a healthy and productive Ocean that can support economic growth and livelihoods while also preserving the environment.

The economic characteristics of SIDS are shaped by isolation, unique geographical and environmental conditions. In general, SIDS economies are small, depending on a limited number of sectors like tourism, fisheries and agriculture, and are highly vulnerable to external shocks such as natural disasters and climate change effects. Therefore, marine resources are a central part of SIDS' economies and societies, underscoring the importance of a sustainable Ocean economy, that promotes sustainable prac-

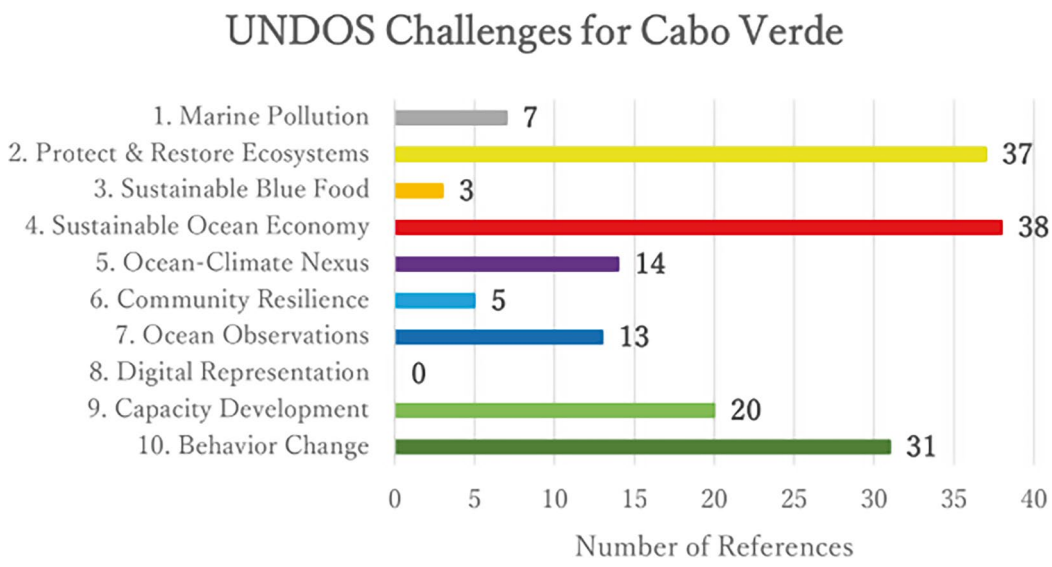


Fig. 13.2 Most referenced UNDOS Challenges for Cabo Verde according to local stakeholders

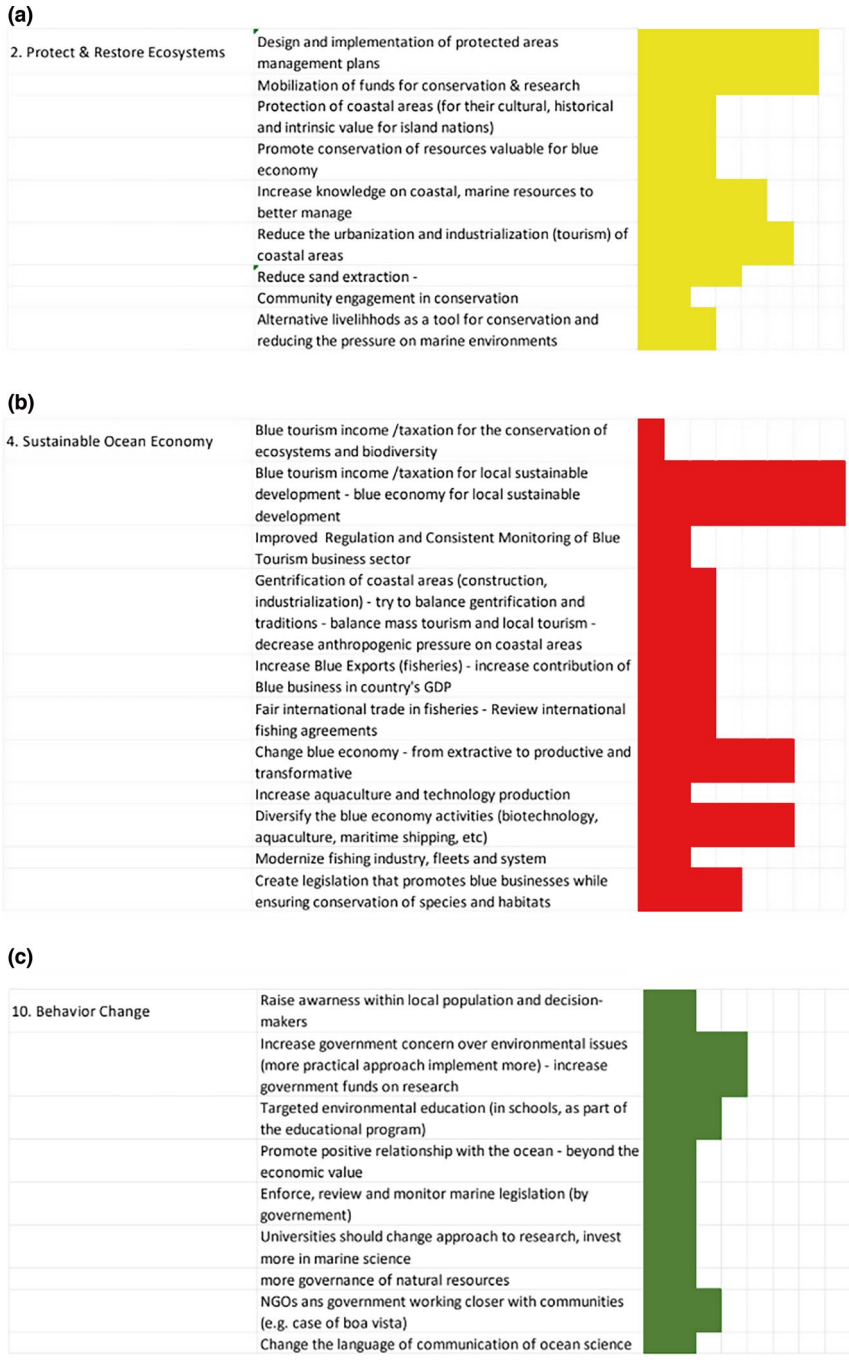


Fig. 13.3 Top three identified and detailed Local Ocean Decade Challenges for Cabo Verde, according to local stakeholders

tices to ensure the economic growth while minimizing the negative impacts on marine environment and ecosystems.

The local stakeholders interviewed helped identify some of the Local Decade Challenges (LDC) 4, indicating the most relevant challenges

for Cabo Verde regarding a sustainable Ocean economy. The most mentioned LDC 4 was "Using blue tourism income for local sustainable development", which translates to the necessity of steering most or part of blue tourism profits to the socio-economic development of local communities, and the support of community-based tourism projects.

Like in most SIDS, Cabo Verde coastal communities are usually poor in income, livelihoods, and infrastructures and it seems that the current tourist tax system is not impacting directly the socio-economic development of local communities. Many coastal communities lack fishing infrastructures (i.e., fishing docks and fish processing facilities), equipped schools, and health centers, and face many challenges related to sanitation and urbanization (Sena et al. 2023).

Other important LDC 4 topics were to "Prioritize blue economy productive and transformative activities" and the "Diversification of blue economy activities". In the case of Cabo Verde, most coastal communities' livelihoods are fisheries, beach sand mining and agriculture, and relying heavily on extractive activities not only jeopardizes the resources sustainability but it can make the economy vulnerable to fluctuations in commodity prices. Thus, promoting productive and transformative activities contributes to economic diversification, reducing dependence on a single sector and enhancing overall resilience. On the same note, a diverse economy offers different job opportunities and sources of income, improving employment rates, promoting economic self-sufficiency, and reducing the vulnerability of local economies to global market trends and fluctuations. An interviewed NGO member said: "We have training programs in the communities that give them the technical and economic support to create their own companies. Not only related to fishing but also related to enhancement and processing of the fishing products and diversification of activities."

The Ocean is structural in any SIDS economy and Cabo Verde is no different. According to local stakeholders, when applied to the Cabo Verde context, a sustainable Ocean economy is one that promotes the socio-economic development of local communities, fairly distributes the revenues amongst all stakeholders, and ensures the long-term sustainability of the resources.

Next, Decade Challenge 2 refers to protecting and restoring marine ecosystems and was the second most referenced by local stakeholders. It calls for a better understanding of the effects that multiple stressors have on marine ecosystems, and for the development of solutions to monitor, protect, manage, and restore ecosystems and their biodiversity. The local stakeholders identified "Designing and implementation of protected areas management plans" and "Reduction of sand extraction" as some of the most relevant Local Decade Challenges 2 for Cabo Verde.

Cabo Verde has a total of 47 nominated Protected Areas, but 45% of these areas are not fully implemented, meaning that there is no management and monitoring plan enforced in these areas. This is critical because Cabo Verde, like most SIDS, hosts a unique diversity of species and habitats, that require proper protection and conservation plans and are valuable tourist attractions. Two of Cabo Verde islands, Fogo and Maio islands, are UNESCO World Biosphere Reserves which further adds to the country's responsibility on the matter. Additionally, most of the protected areas are also home to many local communities, so it is vital to ensure the sustainable use of natural resources and the enforcement of regulations.

The Local Decade Challenge 2 "Reduction of sand extraction" is very particular to the Cabo Verde context. Beach sand extraction or mining has huge impacts on coastal ecosystems, causing habitat destruction, coastal erosion, water quality degradation, loss of marine biodiversity, and saline intrusion. In Cabo Verde, beach sand mining is a consequence of extreme poverty, lack of job opportunities, and social inequalities. Most sand miners are women and children in vulnerable socio-economic situations and the income generated from this activity is very low, but often is the only alternative livelihood during periods of drought and low fish catch. This is particularly frequent in rural coastal communities where tourism activities are not so significant. Additionally, there are many health and safety risks associated with beach sand mining, as most miners don't

know how to swim and must carry heavy loads on their head and back.

Saline intrusion is another negative impact of beach sand mining, as it contaminates underground freshwater and degrades agriculture soil.

Beach sand mining is not a challenge unique to Cabo Verde, but the local nuances should be well understood and the communities directly affected by these challenges should be engaged in the co-designing of solutions.

Finally, Decade Challenge 10 on behavior change aims to change humanity's relationship with the Ocean, by ensuring that the multiple values and services of the Ocean for human well-being, culture, and sustainable development are widely understood.

Behavior change cannot be achieved without knowledge, connection, and literacy. All stakeholders have to understand the positive and negative impacts of the Ocean's sustainability.

Interestingly, the identified Local Decade Challenge 10 demands behavior change from different groups of stakeholders, from government to local communities. The most cited LDC 10 was the "Increase government concern over environmental issues" demanding more environment-oriented public policies and strategies, and the fostering of sustainable projects and practices.

The academia is called to "Change the approach to research and invest more in marine science." Non-governmental organizations and authorities are urged to "Work closer with the communities." Scientists are challenged to "Change the language of communication of Ocean science" to simplify and amplify scientific information.

An environmental activist interviewed said, "We need to invest in education. We need people to be more aware of their roles in protecting our Ocean. We have always seen the Ocean as an immense thing, where we can take what we want because it never ends, but it ends..."

All stakeholders must understand the impacts that humans and the Ocean have on each other to change behavior. So, awareness campaigns are a great tool to disseminate information. It is also important that environmental education becomes a transversal topic in the school curriculum. It is vital to update and enforce marine legislation and it is required that academia and government work together to develop adequate educational plans and tools. This is integral to Ocean Literacy.

The Small Islands Developing States are often referred to as the Large Ocean States, in reference to the Ocean's important significance in these territories. The Ocean is more than a socio-economic resource, the Ocean is culture, traditions, and home to SIDS communities. However, SIDS faces unique challenges in the protection and conservation of the Ocean, so international frameworks like the Decade of Ocean Science have to be put under the local communities' lens.

The Ocean is one and global, so any inclusive framework must call for a universal-synchronized effort for sustainable use of the Ocean. It is also true that any inclusive framework should consider the specificity of each region and territory. And that was the main motivation of this study: to ask the local stakeholders what is "The Science We Need", for "the Ocean that Cabo Verde Wants".

13.4.2 Co-designing as a Tool of Ocean Literacy: The Case of Small Island Developing States

The Decade of Ocean Science calls for every stakeholder to be involved in taking action, in the generation of knowledge, and in promoting change of behaviors. Looking at the Ocean Decade motto, "The Science We Need, for the Ocean We Want", the "We" intends to gather scientists, communities, governments, the private sector, and all other stakeholders to think and work together for a sustainable Ocean.

Consequently, co-designing Ocean science is one of the fundamentals of the Decade, in which all stakeholders collaboratively plan, develop, and implement Ocean research and solutions. Instead of scientists working in isolation, co-design emphasizes partnership and shared decision-making between all stakeholders. This helps to better identify research questions and priorities that are aligned with the needs and concerns of local communities, industries, and policymakers. It promotes cooperation and synergies between different areas, respects cultural con-

texts, avoids potential negative impacts on communities, and brings long-term resilience and sustainability.

However, co-designing Ocean science is not only an essential tool for inclusive and community-driven research but also a key driver of Ocean Literacy, another fundamental of the Ocean Decade framework. Through co-design, local communities gain scientific knowledge and a deeper understanding of Ocean systems, while also contributing their expertise to research and policymaking. For example, in the presented study local stakeholders' ideas and expertise served as a platform to identify the Ocean Decade Challenges for Cabo Verde, generating scientific knowledge and contributing to a contextualized understanding of the Ocean-related issues in the country.

Ocean Literacy promotes a better understanding of the Ocean's influence on people and people's influence on the Ocean, bridging the gap between scientific knowledge and societal action. Co-designing Ocean science enhances Ocean Literacy by increasing local communities' scientific understanding of the Ocean. At the same time, greater Ocean Literacy empowers communities to engage more actively in co-design initiatives, creating a reinforcing cycle of knowledge and action.

Furthermore, the co-designing approach promotes Ocean Literacy by integrating local and traditional knowledge in Ocean science and exposing the connection between people and the Ocean. People directly affected by Ocean issues, like fishers, coastal residents, or tourism operators have unique perspectives and valuable knowledge because of their experiences, traditions, and culture. By involving them in co-designing methods, their perceptions and concerns are understood and, consequently, the resulting research can be more relevant, practical, and effective. For example, suppose scientists are researching coastal erosion in Cabo Verde. In this case, it is important to work together with beach sand miners, to understand the challenges and problems they face. By co-designing with beach sand miners, scientists can co-create realistic strategies that conserve the coastal areas of Cabo Verde, while fostering alternative livelihoods for sand miners. This collaborative approach ensures that the knowledge generated is scientifically credible, relevant, and actionable, it promotes the empowerment of local communities, and it increases people's understanding of the Ocean.

In SIDS co-designing Ocean science gains even more relevance as local communities have a high dependence on Ocean resources. The Ocean is livelihood, food, and nutrition. The most prominent economic activities in SIDS, tourism and fisheries, depend on a healthy and productive Ocean. In Cabo Verde, for example, tourism employs more than a third of the working population, being the biggest contributor to the country's Gross Domestic Product. Fish and seafood are often the most consumed animal protein, as it is accessible and affordable. The Ocean and the coastlines are the playgrounds for kids and adults and, in many cases, are the only leisure sites for underprivileged communities. The Ocean is also part of the history, traditions, and folklore of SIDS communities and it shapes most of the socio-cultural aspects. This proximity between people and the Ocean in the SIDS context, confirms Ocean Literacy Principle 6 which states that "the Ocean and humans are inextricably interconnected." Consequently, this reinforces the importance of actively engaging SIDS communities in the co-designing methods and integrating their traditional knowledge in Ocean science.

Recognizing the role of co-designing in advancing Ocean Literacy, the Ocean Decade has identified four Priority Areas to implement Ocean Literacy initiatives (UNESCO-IOC 2021b): policy, formal education, corporate action, and increased community engagement. In this study, the co-designing approach promoted community engagement in Ocean science and policy making. When local stakeholders and communities actively participate in Ocean science production, their understanding of the Ocean increases and their sense of ownership is improved, as their ideas and perspectives are integral parts of policies and plans put in place. The collaborative, inclusive, and participatory characteristics of co-designing foster better and closer relationships between people and the Ocean, contributing to Ocean Literacy.

13.5 Conclusion

The Decade of Ocean Science emphasizes the need for collaborative action and knowledge generation, urging all stakeholders, scientists, communities, governments, and the private sector, to work together for a sustainable Ocean. The concept of co-designing Ocean science, a fundamental principle of the Decade, involves joint planning, development, and implementation of research and solutions by all stakeholders and can be an important tool for Ocean Literacy. This approach integrates local and traditional knowledge, allowing those directly affected, like fishers or tourism operators, to contribute their unique perspectives and ensure that research is relevant, practical, and effective.

For example, in Cabo Verde, co-designing with beach sand miners can lead to strategies that balance coastal conservation with alternative livelihoods, fostering sustainable management of Ocean resources. The approach ensures a balance between ecological and socio-economic aspects, promoting dialogue across disciplines and interests.

In Small Island Developing States (SIDS), co-designing Ocean science is especially significant due to the communities' dependence on and close relationship with the Ocean. A healthy and productive Ocean is one of the pillars of sustainable development in these territories. Therefore, the inclusion of local and traditional knowledge, through co-designing methods, ensures that the knowledge generated is scientifically credible, relevant, and actionable, leading to informed and sustainable management of Ocean resources.

The co-designing approach promotes community engagement, empowering local stakeholders to actively participate in Ocean science, thus enhancing their understanding and sense of ownership. This collaborative approach fosters stronger connections between people and the Ocean, contributing to long-term sustainability and promoting Ocean Literacy.

13.5.1 Summary

Key concepts explored in this chapter include:

- The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) provides a framework for transforming Ocean science through co-design, multistakeholder engagement, and Ocean Literacy, particularly relevant for Small Island Developing States (SIDS).
- Cabo Verde, as a SIDS, faces unique socio-ecological vulnerabilities and relies heavily on Ocean resources, underscoring the need for localized approaches to global Ocean Decade Challenges.
- Twenty-seven interviews with Cabo Verdean stakeholders identified national priorities and "Local Ocean Decade Challenges" that contextualize global goals to specific community needs.
- The top three priorities were:
  - Developing a sustainable Ocean economy that equitably distributes blue-tourism and fisheries benefits.
  - Protecting and restoring ecosystems through management plans and reducing destructive practices such as beach-sand extraction.
  - Fostering behavior change across government, academia, NGOs, and communities to strengthen environmental concern and stewardship.
- Co-designing Ocean science enhances inclusivity by integrating local and traditional knowledge, ensuring that research questions, methods, and outcomes align with community realities.
- This participatory approach promotes Ocean Literacy by building understanding of the mutual influence between people and the Ocean and by empowering communities and local NGOs to take part in decision-making and policy processes.
- In SIDS contexts, where economies and cultures are tightly interlinked with the Ocean, co-design serves as both a scientific and educational tool for sustainable development.
- The Cabo Verde case demonstrates how collaborative frameworks within the Ocean Decade can translate global aspirations into locally relevant action and foster long-term, sustainable relationships between people and the Ocean.

13.5.2 Recommended Resources

The following resources provide further insights and support on this topic:

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[1]*Naya Sena: Co-conceptualization; Writing—Original Draft, Review, and Editing; Methodology—Design, Data Collection, Data Visualization, and Analysis; and Grant Writing and Funding Acquisition.

[2]Mitsutaku Makino: Co-conceptualization; Project Administration—Supervision and Coordination; Methodology—Design, Data Collection, Data Visualization, and Analysis; and Grant Writing and Funding Acquisition.

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14 Integrating National Resources to Build a Benchmark Nation for Ocean Literacy

Chia-Dai Yen and Li-Ying Lin

Abstract

The Asian region's diverse cultures, languages, and ethnicities reflect varying levels of progress in Ocean Literacy. In 2018, Taiwan established the Ocean Affairs Council (OAC) to oversee marine conservation, safety, and professional development. The 2020 *National Ocean Policy White Paper* emphasized the importance of cultivating marine professionals and enhancing nationwide Ocean Literacy. By 2024, the OAC had positioned Taiwan as a benchmark nation for Ocean Literacy and advanced the development of marine industry professionals by aligning initiatives with international standards, promoting global exchanges, and implementing nationwide policies.

The project focuses on two main objectives: building a benchmark nation for Ocean Literacy and upgrading marine industry professionals. It leverages technology to establish the Ocean Literacy Digital Academy and the Marine Professionals Digital Academy, introduces learning passports, and develops competency models. Partnerships with academic and international organizations address educational gaps, while leadership training and global collaboration strengthen Taiwan's Ocean Literacy goals, enhancing both industry competitiveness and social impact. Running from 2025 to 2028, the project continues to advance Ocean Literacy in Asia through cooperation with the Asian Marine Educators Association (AMEA) and alignment with the United Nations (UN) Sustainable Development Goals (SDGs). This chapter presents the OLBN project's objectives and strategies, inviting Ocean Literacy partners to establish collaborative mechanisms and jointly promote international cooperation.

Keywords

Asian Marine Educators Association (AMEA) · Ocean Literacy (OL) · Ocean Literacy Policy · Regional cooperation · Sustainable Development Goals (SDGs)

14.1 Interdisciplinary Approach to Ocean Literacy

Ocean Literacy is defined as an understanding of the Ocean's influence on you and your influence on the Ocean. Even though the subject (you/your) is interpreted differently by various scholars—whether as a person/that person (Koutsopoulos

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and Stel 2021), human/their (Rock et al. 2020), or us/our (Apostoloumi et al. 2021)—the definition of Ocean Literacy consistently evolves from a cognitive understanding of the Ocean to fostering positive impacts through attitudes and skills. This definition encompasses Ocean-related knowledge, a positive attitude toward the Ocean, and the skills necessary to support sustainable Ocean development. Individuals with Ocean Literacy should be able to protect and sustainably use Ocean resources in a responsible manner. They also understand fundamental Ocean concepts, such as how marine ecosystems operate, the Ocean's impact on the climate, Ocean resource management, and the effects of human activities on the marine environment. With this understanding, they can make informed decisions to promote sustainable Ocean development (Mokos et al. 2020).

Since marine education spans diverse fields, including both natural sciences and social sciences (Schaffner et al. 2016), adopting an interdisciplinary approach to Ocean Literacy has become particularly important. Therefore, collaboration among different fields and roles is needed (Barracosa et al. 2019). At the first UN Ocean Conference in 2017, the importance of Ocean Literacy began to be recognized in discussions about Ocean issues. This focus continued at the second UN Ocean Conference in 2022 and subsequent Ocean Decade Conference in 2024, where Ocean Literacy gained increasing attention from global marine scientists and policymakers. However, in many Asian countries, academic achievement is still the main focus at all educational stages. The Ocean is not treated as an academic subject. It is often included as a topic within these disciplines, and many countries still fail to recognize the importance of the Ocean. Therefore, there is significant room for improvement in advancing Ocean Literacy across Asia.

14.2 The Establishment of the Ocean Literacy Community Network

The development of Ocean Literacy in Asia has been greatly influenced by the United States, particularly through the initiative that began at the 2015 National Marine Educators Association (NMEA) Conference in Rhode Island. Four founding members jointly launched the Asia Marine Educators Association (AMEA), an initiative facilitated through collaboration between the College of Exploration and the Consortium for Ocean Science Exploration and Engagement (COSEE) during the first meeting.

In October 2015, the first workshop was held at Tokyo University of Marine Science and Technology, where the AMEA headquarters office was established. The inaugural AMEA conference took place in September 2016 at National Taiwan Ocean University in Keelung, Taiwan, under the theme "Marine Professionals and Ocean Literacy." Representatives from 10 countries, including Japan, South Korea, Hong Kong, China, Indonesia, Malaysia, Bangladesh, the Philippines, and Taiwan attended, along with over 200 marine education professionals, officials, scholars, and students. They discussed the themes of "Ocean Literacy," "Development of the Marine Education Community," and "International Marine Education Community." Committees from the Philippines, Indonesia, Hong Kong, South Korea, and Taiwan were established (Fig. 14.1).

The second conference, themed "Coordination, Collaboration, Cooperation (3Cs) Towards a Strong Marine Education," was held in September 2017 in Bataan, Philippines. It attracted 24 marine education experts and scholars from 13 countries and over 200 teachers and students. The third AMEA conference was held in Qingdao, Shandong, China, in 2017, focusing on marine education philosophy and action in Asia. Discussions covered the foundational theories of marine education, summaries and exploration of various levels and types of marine education activities, marine education curriculum and actions, Ocean Literacy cultivation and evaluation, international comparisons of marine education, and the integration of marine education with marine history and culture. Ten countries and over 200 marine educators participated.

The conference also announced AMEA's 2019–2021 strategic development goals, which included enhancing Ocean Literacy in Asia, strengthening marine education cooperation



Fig. 14.1 2016 The first AMEA conference held in Keelung, Taiwan

among Asian countries, encouraging youth participation, and fostering sustainable AMEA development. Plans for future collaborations with the International Pacific Marine Educators Network (IPMEN) were also outlined.

The fourth AMEA conference, held in Seoul, South Korea, in 2022, expanded the committee to 21 members and established the first Youth Committee with 14 advisory members. Sixteen young members from various countries presented the 2022–2024 AMEA strategic goals and action plans. In 2025, AMEA collaborated with the Ocean Policy Research Institute (OPRI) and ECOP to host its 10th Anniversary Conference at its headquarters in Tokyo, Japan. The event featured keynote speeches from distinguished guests, including Dr. Yutaka Michida, Chairperson of UNESCO-IOC. The symposium was held at both OPRI and the Tokyo University of Marine Science and Technology, followed by an outdoor experiential activity in Itoigawa. During the event, the "Tokyo-Itoigawa Declaration" was released, emphasizing the integration of Ocean Literacy with outdoor activities and regional revitalization to establish meaningful values in the relationship between people and the environment. It also underscored the vital importance of promoting Ocean Literacy across Asia through international cooperation.

Since 2023, AMEA has actively participated in United Nations (UN) Ocean Decade activities. In 2024, AMEA collaborated with RELATO (Latin American Education Network for the Ocean), the Lusophone Ocean Decade Hub, to organize a satellite event during the Ocean Decade Conference in Barcelona, Spain. As of 2024, AMEA has over 200 members across Asian countries, including Japan, South Korea, China, Indonesia, Bangladesh, the Philippines, Malaysia, Thailand, Australia, Hong Kong, Taiwan, India, and Nepal, along with international partner members from the United Kingdom, United States, Sweden, the Netherlands, Canada, Italy, and others, all working to promote Ocean Literacy (Fig. 14.2).

Behind each AMEA partner is a network of local Ocean Literacy collaborators, forming a strong system of communication and cooperation through community connections. In addition to marine scientists and education scholars, AMEA and its partner members include government decision-makers, field teachers, media partners, and others, all working towards the common goal of promoting Ocean Literacy.



Fig. 14.2 AMEA's Ocean Literacy forum in 2024 at the Ocean Decade Conference, Barcelona, Spain

14.3 Asia Needs a Comprehensive, Integrated Plan to Adopt a Multi-pronged Approach

Since 2015, through the initiatives of many marine education partners, the promotion of Ocean Literacy in Asia has gradually gained attention. However, due to the region's diverse cultures, languages, geographies, political systems, economics, and societies, cooperation and sustained effort are even more essential for promoting Ocean Literacy in Asia. Over the past decade, despite limited resources and complex political environments, AMEA has continued to grow, strengthening the confidence of its members in regional and international cooperation. It plays an important role in addressing changes in the marine environment, protecting marine ecosystems, and promoting sustainable development. Various parties, including governments, international organizations, academic institutions, and non-governmental organizations (NGOs), have collaborated to promote Ocean education and the spread of Ocean Literacy.

Many Asian countries have participated in the UN Ocean Decade's Action Plan, demonstrating their commitment to raising public awareness of Ocean issues. This global initiative has prompted governments to take concrete actions to promote Ocean Literacy education and to strengthen international cooperation and knowledge sharing. Therefore, collaboration through organizations such as AMEA and IPMEN has become increasingly important for promoting Ocean Literacy, connecting resources among Asian countries, and facilitating educational exchanges through workshops, conferences, and publications.

In addition, promoting Ocean Literacy requires support from formal curricula. Many countries in Asia are implementing marine education programs. For example, Bangladesh announced in 2024 that it would incorporate Ocean Literacy into its national curriculum, and Taiwan has also embedded Ocean Literacy in its national development policies. Countries like Taiwan, China, and Japan are integrating Ocean Literacy into students' daily learning through initiatives like "blue schools," cultivating a sense of responsibility for the Ocean among the

younger generation. They are also providing professional training for educators to help teachers acquire the skills needed for Ocean Literacy education, thereby encouraging more schools and communities to participate in marine education activities.

However, even though countries have been actively promoting Ocean Literacy over the past decade, some countries in Asia still face challenges such as limited educational resources, insufficient teacher training, and a general lack of public awareness. Effectively integrating Ocean Literacy into the education system and ensuring that resources are accessible to all sectors of society remain urgent issues to address. As global attention to marine conservation and sustainable development continues to grow, further promoting Ocean Literacy in Asia, and gradually making it a core element in educational policies and public culture, is essential. There is a pressing need to establish stronger regional cooperation platforms and encourage more countries to join global Ocean Literacy initiatives, which will be a key direction for the future development of Ocean Literacy in Asia.

14.4 From Ocean Literacy to the Vision of Ocean Nations

The Ocean is a globally shared environment. Ocean Literacy not only establishes awareness of the Ocean among students and the public but also, more importantly, encourages positive behaviors toward the Ocean. These positive behaviors arise not only from everyday life but also from a more advanced phase of developing professional competencies that help build Ocean Literacy in connection with the environment and others, as well as support the transformation of marine-related industries. These two categories are referred to as marine general education and marine professional education (Cruz and Pauly 1998).

Taiwan is an island nation, with 21 of its 22 counties and cities bordering the sea, maintaining a close relationship with the Ocean. Developing Ocean Literacy and cultivating marine professionals are crucial foundations for national development. However, due to geopolitical and economic factors, marine professional education has been systematically nurtured since 1935, while marine general education has only gained attention since 2005. Therefore, overall progress remains in the early stages. Nevertheless, with global climate change and industrial internationalization, the government has gradually begun to recognize the importance of the Ocean. In 2005 and 2015, the Ministry of Education released two versions of the *Marine Education Policy White Paper*. In 2018, the Ocean Affairs Council (OAC) was established. In 2019, it enacted the Basic Ocean Law, and in 2020, it released the *National Ocean Policy White Paper*.

To comprehensively promote the Ocean Literacy policy, the OAC proposed the Ocean Literacy Benchmark Nation and Marine Industry Professionals Upgrade Project in 2024. The goal of the project is to establish Taiwan as a benchmark nation for Ocean Literacy and to share successful experiences that can assist other Asian countries in promoting Ocean Literacy, linking national marine development, and collectively addressing global Ocean challenges.

The main concept of this program is based on Ocean Literacy, aiming to enhance the Ocean Literacy of the entire population. The second phase focuses on gradually fostering positive awareness of the Ocean among the public and increasing interest in marine career development. The third phase involves nurturing national marine professionals. The ultimate goal is to implement the objectives of the national Ocean policy and establish the vision of an Ocean Nation, as illustrated in Fig. 14.3.

Based on the framework for the development of Ocean Literacy and national Ocean policy, the Ocean Literacy Benchmark Nation and Marine Industry Professionals Upgrade Project consists of five phases: (1) basic competency training for Ocean Literacy leadership professionals, (2) linking international Ocean Literacy leaders and professionals, (3) expanding the social influence of Ocean Literacy leaders, (4) establishing a training system for industry professionals, and

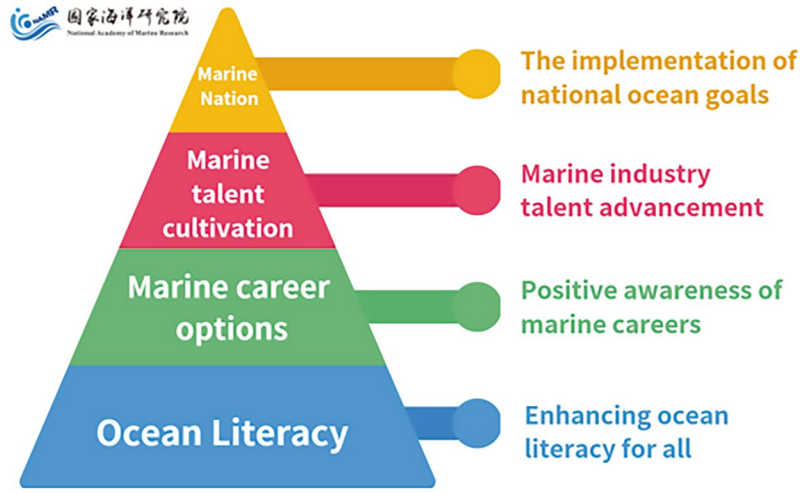


Fig. 14.3 Framework for Ocean Literacy to National Ocean Policy Development

(5) fostering the competitiveness of industry professionals. This is an integrated plan aimed at establishing an Ocean Literacy benchmark nation and advancing the development of national marine industry professionals. It includes a total of 13 sub-projects, such as the establishment of a shared Ocean Literacy information platform for Asia and a marine professionals resource integration platform. The project is scheduled for implementation from January 2025 through December 2028, with a total budget of approximately $13.2 million USD. The OAC will oversee the project, with the National Academy of Marine Research (NAMR) executing it collaboratively.

In the aspect of the Ocean Literacy Benchmark Nation (OLBN) project, research support activities include (1–2) constructing a competency model for Ocean Literacy leaders, (1–6) organizing academic seminars on Ocean Literacy, and (1–7) developing curriculum lesson plans for the Ocean Science Sequence (OSS 9–12). In the category of social influence, activities include (1–3) conducting Ocean Literacy leadership training, (1–4) organizing international workshops for Ocean Literacy leaders, (1–5) providing subsidies for Ocean Literacy leaders to promote Ocean Literacy, and (1–8) holding an Ocean Literacy knowledge contest. Seven sub-projects will integrate resources through the Ocean Literacy Information Platform, aligning with the current central and local government systems for promoting marine education in Taiwan. This aims to establish a model for promoting Ocean Literacy and further facilitate international exchanges and the cultivation of international capabilities among Ocean Literacy leaders and students. However, due to uncertainties in the international cooperation context, in 2025 the Ocean Affairs Council (OAC) adjusted subproject 1–7, *Development of Ocean Science Sequence (OSS 9–12) Curriculum Lesson Plans*, reallocating the related budget to support teachers in promoting Ocean Literacy and to encourage the formation and participation of Ocean Literacy teacher learning communities. Subproject (1–8), holding an Ocean Literacy knowledge contest, was also revised into an Ocean Literacy Creative Teaching Competition, with regional preliminary rounds held in northern, central, southern, and eastern Taiwan, followed by a national final competition.

Regarding the upgrade of marine industry professionals, research support activities include (2–4) conducting a national survey on the supply and demand of marine industry professionals and (2–5) publishing an annual report on supply and demand trends. In the category of social influence, activities include (2–2) developing a com-

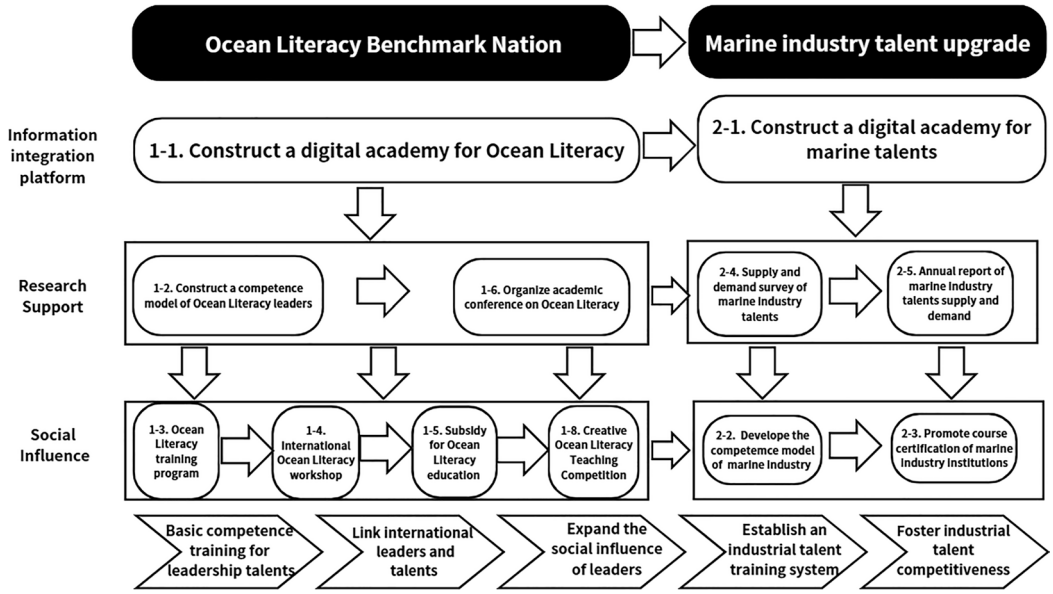


Fig. 14.4 The Ocean Literacy Benchmark Nation (OLBN) Project Framework (revised 2025)

petency model for the marine industry and (2–3) promoting a certification system for marine industry professionals. These four projects will integrate resources through the (2–1) Marine Industry Digital Academy, compiling a professional database and a digital résumé system to enhance the professional capabilities of marine industry professionals and promote innovation and development in the marine industry sector (Fig. 14.4).

14.5 The Ocean Literacy Benchmark Nation (OLBN) Project

The Ocean Literacy Benchmark Nation and Marine Industry Professionals Upgrade Project is an integrated plan that begins with students and the general public and extends to the development of marine industry professionals. It comprises a total of 12 sub-projects, collaboratively promoted by the central and local governments, addressing policy implementation comprehensively. It is hoped that this initiative will serve as a reference for other countries when formulating their own Ocean Literacy policies. The following section provides a detailed explanation of the seven sub-projects related to OLBN.

To construct the OLBN project, seven subprojects have been launched: *Building an Ocean Literacy Digital Academy*, *Constructing a Competency model for Ocean Literacy Leaders*, *Implementing an Ocean Literacy Leader Training Program, Organizing International Workshops for Ocean Literacy Leaders*, *Subsidizing Ocean Literacy Education Promotion Activities*, *Holding Academic Seminars on Ocean Literacy*, and *Creative Ocean Literacy Teaching Competition*. These initiatives aim to achieve the goal of establishing an Ocean Literacy Benchmark Nation.

Among them, *Ocean Literacy leadership* is a significant indicator of the United Nations Decade of Ocean Science for Sustainable Development and a central component of Ocean Literacy policy worldwide. It includes encouraging youth to engage in promoting Ocean Literacy and cultivating Ocean leaders, both of which are vital elements of marine education policy development in many countries.

Taiwan, located at the center of Asia, has a well-established marine education promotion system, clear Ocean Literacy policy goals, and a strong foundation in international basic education, giving it great potential to serve as a training base for Ocean Literacy leaders. Furthermore, the *Ocean Science Sequence (OSS)* teaching materials, developed in collaboration between the University of California, Berkeley (UC Berkeley) and the National Oceanic and Atmospheric Administration (NOAA). Currently, NAMR and UC Berkeley are collaborating to promote these materials in Taiwan and internationally. In addition to the OSS materials, Taiwan boasts diverse and rich resources in marine culture, marine society, marine recreation, and marine technology, making it well suited to developing Ocean Literacy applications that align with the unique characteristics of different countries (Fig. 14.5).

International Ocean Literacy leaders are individuals with exceptional expertise and influence across various fields, including science, education, policy-making, and environmental protection, dedicated to advancing society's understanding, protection, and sustainable use of the Ocean. These leaders should possess a deep global perspective, recognizing the interconnectedness of Ocean issues across regions and the need for global cooperation to effectively address these challenges. They also need to excel in fostering cross-cultural and multinational collaboration, promoting information sharing, scientific cooperation, and policy dialogue among different countries.

Many of these leaders participate in or lead international marine organizations, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Oceanographic Commission (IOC), NMEA, the European Marine Science Educators Association (EMSEA), AMEA, and IPMEN, where they are able to advocate for policies and contribute to global marine governance. They are also instrumental in advancing marine education globally, raising public awareness through educational initiatives and outreach. Through their research and scientific contributions, these leaders publish significant papers and engage in international programs that enhance knowledge in areas such as marine science, culture, law, and technology. Additionally, their policy influence helps shape and promote sustainable international Ocean policies, supporting the broader goals of global Ocean stewardship and sustainable development.



Fig. 14.5 The Minister of the Ocean Affairs Council (OAC) visited a school participating in the OSS course

The presence of international Ocean Literacy leaders is crucial for addressing global Ocean issues, as these challenges often transcend national boundaries and require international cooperation and coordination to achieve sustainable Ocean management and protection. For Taiwan, cultivating international Ocean Literacy leaders is of significant importance. First, Taiwan is located in East Asia, surrounded by key marine areas such as the East China Sea, South China Sea, and the Pacific Ocean, and plays a vital role in regional Ocean affairs. Developing international Ocean Literacy leaders can strengthen Taiwan's collaboration with neighboring countries and regions in marine science, environmental protection, and resource management, enabling joint efforts to tackle regional Ocean challenges.

Second, Taiwan possesses rich marine ecological resources but also faces issues such as marine pollution and resource overexploitation. Cultivating international Ocean Literacy leaders allows Taiwan to share its experiences globally and participate in international marine conservation initiatives to ensure the sustainability of the marine environment. In terms of research and development, Taiwan has outstanding marine research institutions and a strong community of scientists. Fostering international Ocean Literacy leaders will enhance Taiwan's reputation within the international scientific community, promote research collaborations with other nations and regions, and advance marine science research.

Additionally, Taiwan needs to balance the development of its marine economy with sustainable resource use. International Ocean Literacy leaders can actively contribute to policy formulation and implementation, providing expert advice to achieve more sustainable marine development for Taiwan. Finally, by cultivating international Ocean Literacy leaders, Taiwan has the opportunity to project a more proactive image in global Ocean affairs, thereby expanding its influence and visibility in the international community.

Therefore, the entire OLBN program focuses on cultivating youth leaders. This is achieved through various sub-projects, including the establishment of an Ocean Literacy Information Integration System, the creation of a training mechanism for youth leaders in Ocean Literacy, the promotion of international exchanges among youth leaders, support for youth initiatives in Ocean education, the development of Ocean Literacy teaching materials, the organization of academic seminars on Ocean Literacy, and the implementation of Ocean Literacy knowledge competitions. The central government will take the lead in promoting these initiatives, collaborating with local governments and educational institutions to establish a nationwide Ocean Literacy policy that engages all citizens. Below is an introduction to the seven sub-projects of OLBN.

14.5.1 Sub-project 1–1: Establishing the Ocean Literacy Digital Academy

The project aims to establish the Ocean Literacy Digital Academy, which will consolidate Ocean Literacy-related information and build a professionals training system. The main users of the Ocean Literacy Digital Academy include students and the general public learning about Ocean Literacy, as well as formal and informal educators engaged in Ocean Literacy education.

The system functions include:

1. Ocean Literacy Information Integration Platform: Consolidates domestic and international Ocean Literacy information and provides a registration system for Ocean Literacy activities.
2. Ocean Literacy Learning Passport Platform: Includes a professional development system for teachers in Ocean Literacy, the digital learning passport for students to record their learning journey and plan their learning path through the system, and a human resources database for Ocean Literacy both domestically and internationally.
3. Ocean Literacy Community Interaction Platform: Facilitates interaction among members of domestic and international Ocean Literacy communities and includes a community audio-visual communication system.

The Digital Academy will be available in multiple languages through an AI-supported system,

integrating other components of this project, including Ocean Literacy leadership training courses, international Ocean Literacy workshops, and Ocean Literacy promotional activities. Additionally, this project's component 1–1: Establishing the Ocean Literacy Digital Academy is planned to integrate hardware infrastructure and system development with component 2–1: Establishing the Ocean Professionals Digital Academy, collectively creating a comprehensive information platform for Ocean Literacy education and the cultivation of Ocean professionals in Asia, tailored to different user needs.

14.5.2 Sub-project 1–2: Constructing the Ocean Literacy Leadership Competency Model

Due to the current lack of a complete training system for global Ocean Literacy leaders, this project will use the *Analysis, Design, Development, Implementation, and Evaluation* (ADDIE) model to establish a competence model for Ocean Literacy leadership. This model will provide the foundational structure for nurturing Ocean Literacy leaders in Taiwan and across Asia.

The first year will focus on building the competency framework, while years two through four will involve evaluating training effectiveness and developing course modules. It is expected that, through the formation of an international research team and research outputs, a competency framework will be established, consisting of one set of 16 courses totaling 32 hours. By the end of 2028, the goal is to have at least three countries adopt training models derived from the Ocean Literacy Leadership Competency Model, thereby establishing an international cooperation mechanism for Ocean Literacy.

14.5.3 Sub-project 1–3: Implementing the Ocean Literacy Leadership Training Program

This sub-project leverages Taiwan's nearly 10-year well-established marine education promotion system to organize two National Ocean Literacy teaching workshops, each attended by over 200 teachers from all 22 counties and cities across Taiwan. Each workshop spans 2 days and includes lectures, small-group teaching demonstrations, and teaching presentations, training over 400 teachers as seed instructors for promoting Ocean Literacy.

Additionally, each county and city assigns experienced senior Ocean Literacy teachers as mentors to assist less-experienced teachers in lesson preparation. The program is complemented by teacher-led Ocean Literacy and community support initiatives, which include open classroom observations and the facilitation of teacher learning communities, establishing a comprehensive mechanism for promoting Ocean Literacy nationwide.

14.5.4 Sub-project 1–4: Organizing International Ocean Literacy Leaders Workshop

This sub-project aims to organize international workshops for Ocean Literacy leaders, providing a platform for knowledge exchange, collaboration, and capacity building among participants from different countries. The workshops will focus on best practices in Ocean Literacy education, effective teaching methodologies, and the sharing of successful case studies.

By inviting experts and educators from around the world, the workshops will foster an environment of learning, innovation, and cross-cultural collaboration, empowering participants to become effective Ocean Literacy advocates within their respective regions. The expected outcomes include the development of a collaborative network of Ocean Literacy leaders and the creation of shared educational resources that can be utilized in a variety of teaching and learning contexts. In June 2025, the OAC collaborated with the National Marine Educators Association (NMEA) in the United States to hold an International Ocean Literacy Leadership Workshop. Taiwanese Ocean Literacy teachers were subsidized to attend the NMEA conference



Fig. 14.6 The Ocean Literacy Leadership Workshop at the 2025 NMEA Conference

in the U.S., fostering the development of an international perspective among Taiwan's Ocean Literacy leaders (Fig. 14.6).

14.5.5 Sub-project 1–5: Subsidizing Ocean Literacy Promotion Activities

This subproject focuses on providing subsidies to support various Ocean Literacy promotion activities. The aim is to enhance public awareness and understanding of Ocean issues through community engagement and educational initiatives. The funded activities may include workshops, seminars, educational field trips, and interactive exhibits that encourage participation from students, teachers, and the general public. By facilitating these events, the project seeks to inspire a sense of stewardship for the Ocean and to promote sustainable practices within local communities. The ultimate goal is to foster a culture of Ocean Literacy that empowers individuals to take action in protecting marine environments. This subsidy program is open to applications from Ocean Literacy leaders. Upon approval after review, each project may receive a maximum subsidy of $15,000 USD. Additionally, there are subsidy programs for Ocean Literacy communities, aiming to implement the national Ocean Literacy policy and achieve the goal of fostering Ocean Literacy among all citizens.

14.5.6 Sub-project 1–6: Organizing Academic Conference on Ocean Literacy

This sub-project aims to host academic conferences focused on Ocean Literacy, bringing together researchers, educators, and practitioners to share knowledge, research findings, and best practices in marine education. The conference will provide a platform for discussions on a variety of topics related to Ocean Literacy, including scientific research, policy development, and community engagement strategies.

The objectives of the conference include:

1. Promoting collaboration among scholars and practitioners in the field of Ocean Literacy.
2. Sharing innovative teaching methods and educational resources to enhance Ocean Literacy programs.
3. Facilitating the exchange of ideas and experiences to improve marine education initiatives.

4. Identifying research gaps and future directions for Ocean Literacy studies.

These conferences will also encourage participation from international experts in marine science and education, fostering a global perspective on Ocean Literacy. Through presentations, panel discussions, and interactive workshops, participants will gain insights into effective strategies for promoting Ocean Literacy within their respective communities and educational institutions.

Overall, the project seeks to strengthen the academic foundation of Ocean Literacy initiatives and support the development of informed and engaged Ocean stewards. Therefore, hosting an international Ocean Literacy academic conference in Taiwan will help advance awareness, education, and action toward marine sustainability.

14.5.7 Sub-project 1–7: Development and Promotion of Ocean Literacy Teaching Materials

The Ocean Literacy framework serves as a common international framework for Ocean Literacy, under which many teaching materials and lesson plans have been developed. Among these, the *Ocean Science Sequence (OSS)* teaching materials developed by UC Berkeley and NOAA previously described. These materials are centered on the seven principles of Ocean Literacy and a comprehensive scope and sequence, involving more than 70 marine scientists and educators from across the United States in their development.

The *OSS 3–5* (beginner/elementary) and *OSS 6–8* (intermediate/middle school) materials, developed in 2010 and 2015, respectively. They are currently licensed for regional promotion in South Korea and Taiwan, where they have received significant positive feedback in classroom teaching. In June 2023, NAMR officially obtained educational licensing from UC Berkeley for the use of the *OSS* lesson plans in Taiwan, including translation and publication, seed teacher training, and in-school implementation, while assisting local governments in promoting Ocean Literacy education in schools.

However, the final stage of the Ocean Literacy scope and sequence, the *OSS 9–12* (advanced/high school to adult education) materials, still need to be developed. This gap exists primarily because of the global demand for this advanced stage of Ocean Literacy, which bridges general and professional education. Since 2020, the UN has commissioned the Prada Group to promote the *Sea Beyond* project, which collects global Ocean Literacy teaching modules and promotes Ocean Literacy education worldwide.

Although many Ocean education materials and lesson plans have been collected in recent years, there remains a need for systematic Ocean Literacy teaching modules tailored to the learning characteristics of the Asia-Pacific region, particularly for high school and university levels. Current examples of high school Ocean education include those from South Africa, New South Wales, Queensland, the Cambridge curriculum in Singapore, as well as North American programs in Florida, New England, and British Columbia. However, there is still no standardized lesson plan used across Asia or globally.

The *OSS 9–12* project aims to promote Ocean Literacy education in schools and community education institutions using the *Ocean Science Sequence (OSS)* materials. It also seeks to build Taiwan as a model country for Ocean Literacy, establishing a demonstration and training base for *OSS* promotion in Asia. The project goals include collaborating with the United States to develop an internationally recognized set of *OSS 9–12* (advanced/high school to adult education) materials, consisting of four volumes, three units, and 60 lesson plans, and granting free licenses to the UN and at least three additional countries. Additionally, the project will continue to promote the *OSS 3–5* (beginner/elementary) and *OSS 6–8* (intermediate/middle school) materials in Taiwan.

As mentioned previously, due to the instability of international cooperation and related political factors, this sub-project was removed in the 2025 revised version. Although this sub-project was removed from the OLBN program, the international demand for OSS 9–12 Ocean Literacy materials still exists. In the future, as Ocean Literacy continues to develop, it is hoped that

more countries or international organizations can collaborate to support the research and development of the Ocean Science Sequence 9–12 materials. Additionally, K–2 level materials remain a relatively underserved area at this stage.

14.5.8 Sub-project 1–8: Creative Ocean Literacy Teaching Competition

The Ocean Literacy Creative Teaching Competition is centered around three core principles: (1) Promoting OSS Innovation: Teachers are encouraged to transform and extend existing OSS materials, develop innovative teaching tools, and validate their effectiveness through classroom practice. (2) Integrating Ocean Literacy Across Disciplines: OSS materials are combined with various learning areas from the curriculum to create interdisciplinary courses, deepening and expanding Ocean Literacy education. (3) Localizing Ocean Literacy Teaching: Teachers are encouraged to apply OSS materials and methods to local marine issues and challenges, utilizing local resources to enable students to learn in authentic contexts and cultivate understanding and responsibility for their living environment.

Through the competition, teachers can enhance their professional expertise, while students gain hands-on and inquiry-based learning experiences to understand marine science principles and apply their knowledge in everyday life. This approach not only strengthens knowledge application but also advances the dual goals of literacy education and sustainable development.

The inaugural competition was divided into four regions (North, Central, South, East) and open to teams of students and teachers from elementary, junior high, and high schools across Taiwan. Using OSS G3–5 (elementary) and G6–8 (middle school) materials as the foundation, participants engaged in curriculum design, teaching tool development, or classroom implementation. Teams could select a unit from the OSS materials and transform it into a teaching plan that incorporates experiments, inquiry, or local resources, making lessons more relevant to students' lives and enhancing learning outcomes and educational value.

14.6 Conclusion

The Ocean Literacy Benchmark Nation (OLBN) project has become a core component of Taiwan's marine education and professional development initiatives. This project integrates resources from both central and local governments, aiming to enhance Ocean Literacy among students and the general public while fostering the development of professionals in the marine industry. In most countries, marine education is promoted through Ocean-related government agencies. While these agencies have expertise in marine science, maritime, marine conservation, and Ocean related issues, they often lack the authority to implement a comprehensive educational framework. On the other hand, the education sector has the capacity and authority to disseminate education widely but lacks specialized knowledge and resources in marine topics. Taiwan is one of the few countries with a dedicated central-level Ocean-related agency. Although the Ocean Affairs Council (OAC) has only 7 years of experience since its organizational reform in 2018, the Minister's emphasis on Ocean Literacy has led to its inclusion as a key policy direction in the 2025 National Ocean Policy White Paper. By integrating resources from both the Ministry of Education and the OAC, Taiwan has established a collaborative model for promoting Ocean Literacy, serving as an important exemplar in the field.

Through seven sub-projects, this initiative actively promotes Ocean Literacy education both domestically and internationally. The program encompasses eight key areas such as the establishment of a digital Ocean Literacy academy, leadership competency models, training programs, international workshops, and the promotion of academic research and educational competitions in Ocean Literacy. These measures will help position Taiwan as a leader in Ocean Literacy in Asia and advance global cooperation in marine education and environmental protection.

One of the main focuses of the program is to cultivate Ocean Literacy leaders, who will not only play a significant role in the United Nations Ocean Decade Action Plan but also enhance Taiwan's status in global Ocean collaboration, environmental protection, and international image building. With its rich marine culture and research resources, Taiwan seeks to promote Ocean Literacy applications that meet the needs of various countries through these sub-projects, thereby further influencing the development of global Ocean policy.

During the establishment of the Digital Academy, the Ocean Literacy Competency Model will be further refined and gradually expanded to Southeast Asia and other Asian countries in conjunction with leadership training programs. This international promotion plan will not only strengthen regional cooperation but also elevate Taiwan's status and influence in the fields of international marine science and policy.

Overall, the OLBN project will not only contribute to Taiwan's sustainable development but also promote global Ocean Literacy education, foster the development of international marine leaders, and provide policy-making reference models for other countries. These efforts will ensure that Taiwan continues to play a leading role in addressing future marine challenges.

14.6.1 Summary

Key concepts explored in this chapter include:

- Taiwan's Ocean Affairs Council (OAC) serves as the central coordinating body linking education, industry, and policy to strengthen Ocean Literacy nationwide.
- The Ocean Literacy Benchmark Nation (OLBN) project aligns Ocean education, leadership training, and industry development to position Taiwan as a model for Asia and beyond.
- The Interdisciplinary Marine Education initiative bridges the natural and social sciences, emphasizing collaboration among academia, government, and civil society to advance Ocean Literacy.
- The creation of the *Ocean Literacy Digital Academy* and *Marine Professionals Digital Academy* demonstrates how technology can facilitate inclusive, multilingual access to Ocean education and professional training.
- The construction of an *Ocean Literacy Leadership Competency Model* and implementation of training programs cultivate youth and professional leaders to support the United Nations Ocean Decade goals.
- Partnerships with academic and international institutions strengthen global cooperation, curriculum exchange, and the dissemination of educational resources such as the *Ocean Science Sequence (OSS)* teaching materials.
- Subsidized community initiatives, contests, and workshops enhance public participation and awareness, building a shared culture of Ocean responsibility and sustainability.
- By advancing the OLBN project, Taiwan aims to contribute to international Ocean policy dialogue, workforce development, and the sustainable growth of the marine industry across Asia and the Pacific.

14.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Ocean Affairs Council (OAC)—Taiwan: Comprehensive information on Taiwan's national Ocean policies, Ocean Literacy initiatives, and the *Ocean Literacy Benchmark Nation* (OLBN) project: https://www.oac.gov.tw.
- National Academy of Marine Research (NAMR): https://www.namr.gov.tw.
- Asian Marine Educators Association (AMEA):
  - AMEA Official Website: https://sites.google.com/view/asia-marine-ed/.
  - AMEA Facebook: https://www.facebook.com/groups/AMEA2015.
  - AMEA Youth Committee Instagram: https://www.instagram.com/amea_youth_committee.
  - AMEA LinkedIn: linkedin.com/company/asia-marine-educators-association-amea.
- Ocean Science Sequence (OSS)
  - Ocean Science Sequence for Grades 3–5: https://mare.lawrencehallofscience.org/

wp-content/uploads/sites/2/2022/09/OSS_3-5_Sampler_Web_2015.pdf.
  - Ocean Science Sequence for Grades 6–8: https://mare.lawrencehallofscience.org/wp-content/uploads/sites/2/2023/03/OSS_6-8_Sampler_2015_web.pdf.
- United Nations Decade of Ocean Science for Sustainable Development (2021–2030): https://www.unesco.org/en/decades/Ocean-decade.
- The PRADA Group Sea Beyond Project: https://www.pradagroup.com/en/sustainability/cultural-csr/sea-beyond.html.

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15 The Evolution of a National Ocean Literacy Network: Challenges and Achievements of the Irish Ocean Literacy Network (IOLN) from 2016 to 2026

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Abstract

Since its establishment in 2016, individuals and organisations have been brought together by the Irish Ocean Literacy Network (IOLN) to work towards the IOLN vision of achieving an Ocean-literate society across the island of Ireland. Over the last 10 years, the Network has been transformed from an informal organisation into a Company Limited by Guarantee (CLG). A range of funding sources, including seed funding from national state bodies, in-kind and financial member contributions, and EC Horizon funding as part of the Prep4Blue

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consortium, has also been engaged. In 2021, an external review of the Network was conducted, and feedback on its structure and actions was provided by 24 members. In response to this review, along with input from the steering committee, a new strategy, vision, mission, and governance structure for the Network was established by the IOLN Board of Directors and Secretariat. This newly formalised Network aims to develop an all-island community of practice, focusing on local initiatives that respond to a range of drivers, such as climate change, population growth, loss of habitat and biodiversity, sea-level rise, blue growth initiatives, and collaborative actions to influence marine policies. This chapter outlines the evolution of the IOLN and highlights a range of challenges and solutions which have been part of its journey.

Keywords

National network · Knowledge transfer · Community of practice · Ocean Literacy (OL) · Ocean-literate society · Co-development · Strategic actions

15.1 Introduction

In 2016, a movement was set in motion within the coastal communities of the island of Ireland. The Irish Ocean Literacy Network (IOLN) was founded, emerging not from government mandates or corporate interests, but from the collective passion of individuals who recognised that the Ocean is more than a body of water with boundaries. What began as an informal gathering of like-minded people has grown into an all-island Network, bridging the Republic of Ireland and Northern Ireland in a shared mission to ignite awareness, foster knowledge, and inspire positive actions toward the marine environment.

This chapter will chronicle the evolution of the IOLN over its first 10 years, from its conception in 2016 through to 2026, and will explore how the establishment of a national Ocean Literacy network can support the UN Decade of Ocean Science for Sustainable Development (2021–2030), especially its Challenge 10: Restoring Society's Relationship with the Ocean (Glithero et al. 2024). The strategies and actions that proved successful, the member contributions that advanced its progress, and the challenges faced will be highlighted.

The narrative is based on key milestones selected by 11 members, including those who have served as members, secretariat, steering committee members, directors, and staff. It aims to provide useful insights for others seeking to establish national-scale Ocean Literacy networks, support the Ocean Decade through Ocean Literacy initiatives, or increase awareness of the complex relationships between human societies and the Ocean, alongside the opportunities and challenges they present.

As an island, the combined area of the Republic of Ireland and Northern Ireland is surrounded by the Irish Sea, the Celtic Sea, and the vast Atlantic Ocean, a maritime expanse that shapes the weather, economy, and very identity of the people. The Republic of Ireland alone possesses a marine territory of approximately 880,000 km^2, nearly 10 times the size of its terrestrial area. Its coastline, extending over 3000 km, reflects the essence of its island nature, with 40% of the population residing within 5 km of the Ocean (CSO 2016). Yet, despite this proximity and a rich maritime heritage, an unsettling reality remains: the connection of its people to the Ocean has diminished.

Historically, a focus on terrestrial resources for survival, economic growth, and development has contributed to what might be described as a "marine deficit" among the general population—a societal drift away from maritime awareness.

Two recent online Ocean Literacy Surveys, one conducted in the Republic of Ireland, by Fair Seas (n = 1293) and one in Northern Ireland by the Department of Agriculture, Environment and Rural Affairs (n = 1081) revealed that even among active participants, knowledge of Ocean-related topics across various domains remains limited (DAERA 2022; McKinley 2023). This trend is not confined to Ireland alone: while preparing to launch the Mission to Restore our Ocean and Waters by 2030 (hereunder Mission Ocean), Pascal Lamy, chair of the Mission Board, identified a similar challenge across Europe: "the gap between the importance of Oceans and waters on one side, and the very little knowledge and emotional connection that many people have with this, on the other" (EU Science & Innovation 2020).

Increasing global Ocean Literacy is therefore fundamental to achieving the goals of the Ocean Decade. The Challenge 10 White Paper emphasises that Ocean Literacy is "central to operationalising Challenge 10 and to the Ocean Decade's legacy. Ocean Literacy is an outcome – a society that understands, values, and cares for the Ocean" (Glithero et al. 2024). Several of the Challenge's Strategic Ambitions highlight the role of Ocean Literacy, calling for actions to research and measure it, employing it as a policy tool, and mapping global initiatives. To support these objectives specifically, the development of the IOLN can be seen as a case study in how establishing a national-scale Ocean Literacy network can help overcome challenges to achieving Challenge 10's goals.

Despite society's diminished connection to the Ocean and limited funding for social science initiatives, the IOLN has demonstrated remarkable resilience throughout its 10-year journey. The Network has overcome numerous challenges, achieving steady progress and advancing its mission even in the face of adversity. Now, as part of the Ocean Decade, the IOLN stands well-positioned to make meaningful contributions to enhancing Ocean Literacy and supporting sustainable marine initiatives.

15.1.1 Prehistory: 2012–2016

The foundations of the IOLN were laid prior to 2016 through a combination of national and European policies and project and funding initiatives, notably the Sea for Society project and the Irish Government's Harnessing Our Ocean Wealth—An Integrated Marine Plan for Ireland (HOOW).

The EU-funded Sea for Society project (2012–2015), involving 20 partners across 12 European countries, and aimed to raise awareness and identify key challenges in daily interactions with the Ocean. Through extensive consultations with over 500 stakeholders and citizens across 9 European countries, the project advocated for a collective vision of sustainable blue environments, ultimately shaping a vision for a future Blue Society.

A 'Blue Society' encapsulated a vision for a society in which people benefit from the Ocean's vast potential while preserving its environmental integrity. Central to this vision is a governance system that recognizes the Ocean as a global common, requiring collective management across sectors and borders. Key components identified for achieving this include education, effective policy enforcement, science-informed action, and the development of cross-sector partnerships (McHugh et al. 2016).

In Ireland, stakeholder engagement was conducted through workshops that brought the concept of Ocean Literacy onto the marine agenda. A total of four consultations took place in 2013, two with marine stakeholders and two with youth/general citizens. These events facilitated practical discussions regarding the establishment of an Irish Ocean Literacy forum, comprising stakeholders from education, research, industry, and government. The proposed forum aimed to create a cohesive education and information pro-

gram spanning students from primary level (5–12 years of age) to third level (over 18 years). Other events focused on knowledge sharing through science talks and explored the use of collective intelligence methodologies to ensure the project's legacy beyond its end date in 2015.

In 2012, the Inter-Departmental Marine Coordination Group (MCG) published Harnessing Our Ocean Wealth—An Integrated Marine Plan for Ireland (HOOW) on behalf of the Irish Government. This plan articulated the Government's vision, high-level goals, and key 'enabling' actions necessary to create an appropriate policy, governance, and business environment to unlock Ireland's marine potential (Inter-Departmental Marine Coordination Group 2012). The vision stated that "Our Ocean wealth will be a key element of our economic recovery and sustainable growth, generating benefits for all our citizens, supported by coherent policy, planning and regulation, and managed in an integrated manner."

The plan outlined three goals:

1. Thriving Marine Economy
2. Healthy Ecosystems
3. Engaging with the Sea

The third goal 'Engaging with the Sea', aimed to build on Ireland's maritime heritage, strengthen marine identity, increase awareness of the Ocean's value, opportunities, and societal benefits, and promote engagement and participation by all.

Harnessing Our Ocean Wealth (HOOW) ran from 2012 to 2018, with annual progress reports highlighting the achievement of goals through a set of eight enablers. One of these was 'Capacity, Education, Training, and Awareness.' This enabler reported a significant increase in actions over the 6 years of reporting, with the number of actions and projects expanding from five pages of deliverables in 2012 to over 20 pages in 2018 (Inter-Departmental Marine Coordination Group 2012, 2018).

These separate but parallel policy actions and funding provisions created an environment that fostered both the motivation and the government support necessary to collaborate towards a Blue Society on the island of Ireland. This adds a dimension to one of the Strategic Ambitions of Ocean Decade Challenge 10—to undertake "research on Ocean Literacy as a policy tool" (Glithero et al. 2024). This research may encompass not only understanding the importance of Ocean Literacy for effective policy making but also how Ocean Literacy itself relies on sound policy to become established and flourish.

As part of the Sea for Society project, organisations, and individuals from sectors including the blue economy, marine research, marine recreation, and advocacy, participated in a series of workshops in 2013 that identified barriers to sustainable marine ecosystems. Many of these organisations became key players in the inaugural meeting of the IOLN which was held in 2016. Those present were committed to establishing a network that emphasised the importance of a Blue Society and Ocean Literacy for Ireland and sought to advance the vision and mission outlined in Harnessing Our Ocean Wealth (HOOW). Following the final stakeholder meeting of the Sea for Society project in Ireland in 2015, the Marine Institute, the state agency responsible for Marine Research, Technology Development, and Innovation in Ireland, agreed to provide 2 years of seed funding for an IOLN secretariat, which was to be run by the Northern Ireland-based company, Blue Inspiration, from 2016 to 2018. With this support, the Irish Ocean Literacy Network (IOLN) or hereafter referred to as the Network, was ready to be set up.

15.1.2 2016–2018: The Beginning

The first meeting of the IOLN was held in October 2016 at the Titanic Museum in Belfast, Northern Ireland. During this meeting, 27 attendees representing 18 organisations deliberated on the mission of the IOLN and agreed as a group that the Network should function as a coordinating umbrella organisation rather than replicating the efforts of network members. The IOLN was envisioned as an influential body, guiding marine initiatives instead of lobbying for specific causes. The group was also mindful of the cross-border nature of the Network, which spans both the

Republic of Ireland and Northern Ireland (a part of the United Kingdom). It was determined that this aspect should be considered in the Network's actions and tasks from the outset. The whole-island approach to marine issues resonated with those in attendance and was already being pursued by other NGOs and researchers.

The Network members were inspired by existing networks, such as the National Marine Educators Association (NMEA) in the USA and the European Marine Science Educators Association (EMSEA). The definition of Ocean Literacy established by the NMEA and the seven Ocean Literacy principles (Payne and Marrero 2022) were incorporated into the Network's communications and mission. However, it was quickly noted during member meetings and discussions that an all-island marine science educator's association would not adequately meet all of the members' needs. It was essential for the Network to remain relevant to other marine organisations and stakeholders outside the education sector. For example, at the first meeting of the Network of the 18 organisations represented, only 50% were actively involved in formal and informal marine education.

This approach aligns with contemporary developments in Ocean Literacy, which view it holistically, encompassing not only scientific knowledge but also embodied, traditional, practice-based, spiritual, and other forms of Ocean knowledge (Worm et al. 2021). It also resonates with Challenge 10's emphasis on integrating (Western) scientific knowledge with other knowledge systems, such as Indigenous knowledge, and promoting Indigenous-led Ocean science to achieve its aims (Glithero et al. 2024).

From 2016–2018, the Network began to take shape, steadily growing to 40 members. The first steering committee was set up and met online, while a members meeting was held in person each year. Some of the initial actions taken by the IOLN focused on communication—both to increase awareness of the IOLN itself and to amplify its message. The Network's website (see Sec. 16.7.2., Recommended Resources), along with social media pages on Facebook, X, LinkedIn, and Instagram, provided an excellent platform for engaging with members and sharing news and information. Details and outcomes of events were shared with the Network, and member information was exchanged to facilitate collaborations and knowledge sharing among members and civil society. After the initial two-year period, the Marine Institute confirmed continued funding for a secretariat, with Galway Atlantaquaria—Ireland's largest native species aquarium—taking over the role for the next three years.

The IOLN's digital presence and online activities were critical in establishing primary awareness of the Network beyond its own membership. At the EMSEA conference in 2018, Francesca Santoro, then Head of Ocean Literacy and Ocean Communication Activities at UNESCO-IOC, highlighted the Irish Ocean Literacy Network as a leading example of national efforts to enhance Ocean Literacy. She noted that Ireland was one of only three European countries to have established a dedicated network for this purpose.

This recognition of the IOLN, along with mentions during other presentations at the Marine Knowledge Expert Group Meeting in Brussels (January 2018) and the Group of Experts on Capacity Development's First Session at UNESCO Headquarters in Paris (March 2018), brought significant international attention to the Network. These acknowledgments not only validated the Network's efforts but also showcased its work on a global stage.

15.1.3 2018–2022: Developing the Network's Capacity

The Network now had a firm foundation as it approached the start of the Ocean Decade. Its next step was to grow its reach and impact. Between 2018 and 2021, the IOLN continued to receive funding for a secretariat from a small number of national organisations. In addition to this financial backing, the secretariat, steering committee, and members involved in campaigns and events contributed many hours of in-kind support. This support helped facilitate the delivery of national events, the development of the

IOLN website and social media channels, and the launch of the first members' campaign. A series of videos featuring members were created and loaded onto the IOLN Website, and a selection of marine education resources was shared with the national broadcaster, RTE Junior, for World Ocean Day in 2020. Members also participated in European and international events, such as the Atlantic Ocean and North Sea Ocean Literacy Festival.

IOLN Regional Meetings adopted a new format that included expert keynote speakers, member presentations, panel discussions, and dedicated networking time. Topics covered during these meetings included microplastics and marine litter, the Ocean and human health, innovation and the Ocean, net-to-plate sustainable seafood, sustainable island economies (in collaboration with the Virtual Island Summit), and communities of practice—learning from and creating Ocean and catchment communities. Each meeting left time for members to network and present information on their own initiatives and work (Fig. 15.1).

During this time, membership expanded to over 100 individuals, groups, and organisations, representing a wide range of stakeholders. This was aided by the work of the secretariat, network members, and a significant increase in website views and social media engagement. The IOLN also participated in European and international initiatives, including EU4Ocean and UNESCO's 'Ocean Literacy with All' UN Decade Programme.

One of IOLN's most notable impacts at this time was the delivery of its first major campaign, 'We Are Islanders.' This all-island social media campaign was launched in 2019. The theme was selected following a consultation held with 19 network members. The campaign was designed in a co-creation workshop open to all IOLN members. To participate in 'We Are Islanders,' individuals were invited to share their personal connections with the Ocean through short videos posted on social media, using the common hashtag #WeAreIslanders. This campaign highlighted the shared island perspective across the border, emphasising that everyone on the island of Ireland is an islander and underscoring the importance of appreciating the Ocean that surrounds us.



Fig. 15.1 Keynote speakers Dr. Easkey Britton (on the right), surfer and former post doc fellow at NUI Galway, and filmmaker Ken O'Sullivan of SeaFever Productions (on the left). Themes such as the Ocean and Human Health are the focus of IOLN members' meetings. (Photo: Garry Kendellen)

The campaign was launched on World Ocean Day 2019 and was met with enthusiastic participation by Network members. Giant #WeAreIslanders portrait frame boards were used to capture people's passion for the Ocean, resulting in over 100 photographs that communicated a positive message about Ocean wealth, maritime heritage, and personal stories of life on the island of Ireland. Although the campaign was interrupted by the COVID-19 pandemic, the hashtag #WeAreIslanders continued to be used to



Fig. 15.2 The We Are Islanders Campaign at the 2019 World Ocean Day Celebrations saw participation from IOLN members. (Photo: Nóirín Burke)

connect news and social media posts about IOLN members' activities throughout 2020, during which the hashtag #WeAreIslanders trended online during World Ocean Day that year (Fig. 15.2).

However, as 2021 approached, the current funding stream was nearing its end. Due to the Network's informal structure, funding could not be sought directly within the Networks own name. As a result, funding applications had to be submitted by the secretariat, Galway Atlantaquaria, on behalf of the Network.

Activities within the Network, which had already slowed due to the COVID-19 pandemic, faced additional challenges when financial support ended in June of that year. Despite these setbacks, the Network remained operational, with the secretariat and steering committee members staying active and contributing through in-kind support.

To determine the future of the Network at this point, a strategic review was commissioned by the secretariat and steering committee and conducted by an external facilitator. A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was completed first with members of the IOLN steering committee, followed by the deployment of an online survey to all members aimed at garnering feedback and ideas for the future from the membership. Twenty-four members took part in the online survey, which consisted of 34 questions. Survey participants, while a small percentage of the overall membership (24%) consisted of representatives from seven stakeholder groups. These included education, small medium enterprises, environmental groups, semi state bodies, non-governmental organisations, community groups and local authorities. To gain deeper insights one on one telephone interviews were conducted with 12 of the survey participants, including individuals from the IOLN steering group and general membership. The focus of the interviews was decided after the first tranche of surveys were completed. They were structured to cover experience of IOLN; priorities for the coming years; governance & structure; and funding. The process revealed that the IOLN had been successful in building a large network of diverse marine and maritime stakeholders, meeting the needs of its members, and establishing a strong reputation in Ireland and internationally since its establishment in 2016. However, participants felt that its infor-

mal organisational structure and governance model were no longer suitable for sustaining the growth of the Network, with 91% of interviewees noting that the Governance and Structure both need significant improvement.

The reliance on in-kind contributions and the lack of a formal business and legal structure for the IOLN were creating barriers to Network and its growth. The main recommendations from this major review were that the IOLN undertake the process of becoming a formal social enterprise, as this would ensure a more sustainable business model, and that it develop a strategy. These changes aimed at positioning the IOLN as a recognised actor in national and international initiatives focused on climate and the Ocean, such as the Ocean Decade. The review highlighted the importance of delivering benefits to all stakeholders, noting that this would retain stakeholder engagement and strengthen the Network. While the steering group welcomed and supported the review recommendations, this transformation would have required intense focus and dedicated time from the IOLN Secretariat, which did not seem possible as the end of 2021 approached when the Network was no longer funded.

15.1.4 2022–2024: Network Professionalisation and Deepening Capacity

In 2021, the Horizon Europe project 'Preparing the Research and Innovation Core for Mission Oceans, Seas, & Waters' (PREP4BLUE) saw the involvement of IOLN. PREP4BLUE was the first project funded within the framework of the EU's Mission Ocean, aimed at 'protecting and restoring the health of our Ocean and waters through research and innovation, citizen engagement, and blue investments by 2030'. Galway Atlantaquaria was invited to join the project, on behalf of the Irish Ocean Literacy Network, which would run for 3 years from 2022 to 2025.

The IOLN is one of three national Ocean Literacy networks involved in the citizen engagement work of PREP4BLUE, and through this project, the financial support needed to complete the recommendations of its strategic review was provided to the IOLN.

15.2 Formalising the Network with the Support of the IOLN Members

One of the major milestones was the formalisation of the IOLN into a structured entity. This transition involved meticulous planning, consensus-building, and the establishment of a clear membership framework that would enable more effective and sustainable operations. The work of the secretariat, support of members and the voluntary commitment from Board members were crucial in this transformation, showcasing the IOLN's commitment to a shared vision.

The IOLN was established as a Company Limited by Guarantee (CLG), a registered non-profit company, in November 2023 after approximately 2 years of planning and organisation. This transition helped the Network become more professional and active. As part of the CLG process, a governance structure was established, along with a constitution and strategy. The Network transitioned from a Steering Committee to a Board of Directors and created an Advisory Panel to support and guide its work (Fig. 15.3). Terms of Reference were produced for each role, and a new membership structure was developed.

By formalising its structure, the Network has opened itself up to a wider array of funding opportunities from national and international sources. Having a legal structure also makes it a more desirable partner for industry and sponsorship. The IOLN can now compete for funding independently and has recently been successful in becoming a partner on another winning Horizon Europe project (GuardIAS). The GuardIAS project is an ambitious initiative aimed at transforming aquatic environment governance and management in Europe. Along with membership fees and ongoing sponsorship from the Marine Institute, this financial backing not only validates IOLN efforts but also provides the necessary resources to expand its initiatives. This milestone marks a new era for the IOLN and will



Fig. 15.3 A meeting of the IOLN Board of Directors and Secretariat. (Photo: ERINN Innovation)

enable its enhanced impact and sustainability into the future.

15.3 Producing the IOLN Strategy

In December 2023, a new strategy for the IOLN (2024–2030) was launched, accompanied by a new vision and mission for the Network (see Fig. 15.4).

A more contemporary model of the definition of Ocean Literacy, as produced by McKinley et al. (2023), was incorporated into the Network's approach. This strategy represented a pivotal milestone that defined five objectives and set the direction for future endeavours (see Fig. 15.5). It was developed through expert input from the Board of Directors and member consultations at the annual meeting in November 2023, which was attended by 40 members. Members who were unable to attend were provided with a draft strategy via direct email and asked to share feedback and comments which would be incorporated with members feedback from the general meeting.

The timeline of the Strategy, leading to 2030, was chosen to align with IOLN's development goals, as well as with the Ocean Decade and Mission Ocean's timelines, to develop synergies between Irish and global Ocean-related frameworks and efforts aimed at establishing Ocean-literate societies. This alignment was also instrumental in providing a clear focus. Ocean Literacy (OL) is a broad and multifaceted concept, and there is a temptation to pursue numerous initiatives simultaneously. However, with limited resources, it is crucial to be realistic about achievable outcomes. This strategy has assisted in prioritising efforts, ensuring concentration on the most impactful areas. By doing so, resources have been allocated more efficiently and effectively.

Furthermore, the strategy has fostered a more realistic understanding of what can be achieved within the given time and resources. This realism has been essential for setting achievable goals and managing expectations, both internally and with members. It has facilitated a focus on delivering tangible results and providing valuable benefits to members. By aligning activities with strategic goals, it has ensured that the work remains meaningful, and that continuous value is added for members and the broader community.

One of these activities was the formation of dedicated working groups focused on subjects



Fig. 15.4 The Irish Ocean Literacy Vision and Mission (2023–2030)



Fig. 15.5 Five strategic objectives of the IOLN strategy (2023–2030)

recognised as instrumental for achieving the IOLN's strategic objectives, such as education, capacity building and training, understanding regional activism, and all-island Ocean Literacy campaigns. These groups allow specific aspects of the mission to be addressed in a structured and organised manner.

By dividing tasks among specialised teams, the diverse expertise of members can be leveraged, fostering a collaborative environment where each group can focus on targeted objectives. The activities of all working groups will contribute to defining and implementing the IOLN's work plan year after year, playing an instrumental role in enabling the Network to achieve more tangible outcomes in support of Ocean Literacy across the island of Ireland.

15.4 Celebrating Local Initiative and Advocates

Initially, the new IOLN network served as a platform for networking among those active in the marine sphere on the island of Ireland. The IOLN provided several added benefits, as previous networking opportunities tended to focus on public consultations regarding marine legislation, regulation, or specific impacts on the marine environment. While networking opportunities were available, they often took place within a context of tension or conflict, with members typically aligning with one side of an argument or point of view. The IOLN benefited from a core focus on raising awareness of the Ocean and the activities related to it. As a result, a more open forum was created to highlight the actions of individual players in the marine sphere, whether from research, regulatory, conservation, or industry perspectives.

At first, the IOLN focused on all-Ireland meetings, which were essential but may have lacked sufficient emphasis on local issues and activities. With the introduction of the IOLN's new regional meeting format, national stakeholders can still provide input while focusing more on regional actions. This allows local participants to engage in discussions that address the issues they are most invested in, without the need to travel across the country.

Regional meetings have also been opened to non-members to facilitate connections between IOLN members and other stakeholders, allowing discussions on how the Network can support their work and foster connections among them. Attendees consistently acknowledged the value of these events, recognising the opportunities they provided to meet new collaborators and learn from the experiences of their peers. These meetings created a space for open discussions about shared challenges and for brainstorming innovative ideas to drive change.



Fig. 15.6 IOLN members participating in a regional meeting in Belfast in Northern Ireland in 2023. (Photo: Nóirín Burke)

In this context, the series of regional members' meetings that the IOLN initiated in 2023 holds particular significance. The concept behind these events was to move meetings to various locations throughout the year, ensuring that all four provinces on the island of Ireland—Connacht, Munster, Leinster, and Ulster (which includes Northern Ireland)—were reached. Consequently, the regional members' meetings provided a unique opportunity to gain experience about the local challenges and opportunities faced by Ocean Literacy champions in their areas, while also offering a chance to outline the IOLN's governance structure to individuals and organisations who were new to the Network (Fig. 15.6).

A particularly good example of the IOLN regional members meeting occurred in June 2024 in Aughleam, a small village located at the end of a remote peninsula in one of the Irish-speaking areas (or 'Gaeltacht') of County Mayo, on the North-West coast of Ireland. Despite the challenges posed by its location, Aughleam is characterised by a thriving community deeply connected to the Ocean. Thus, the meeting held there provided a unique opportunity for the IOLN to learn how the Network, and Ocean Literacy in general, can better include and support coastal communities in the near future. More than one of the 41 attendees provided verbal feedback, expressing that they felt the IOLN could serve as 'a neutral convening entity to bring together different stakeholders and provide the holistic view that is missing to create a coordinated approach to marine management.'

15.5 Working Together to Increase our Impact

The new IOLN Campaigns Working Group will build on the previous IOLN #WeAreIslanders initiative to encourage all aspects of society across the island of Ireland. Future campaigns are expected to be better funded as the network can now apply for grants and funding to assist initiatives, and to focus on comprehensive issues affecting our Ocean, such as climate change. Figure 15.7 depicts the evolution of the IOLN from 2012–post 2024.

Another aspect of collaboration has been the IOLN's involvement in several international initiatives. At the European level, it is part of the



Fig. 15.7 Irish Ocean Literacy Network evolution

EU4Ocean Coalition and signed the 'Charter for Blue Education in Europe' in 2022 (Maritime Forum 2022). It is also engaged in the UNESCO global program and Ocean Decade Action 'Ocean Literacy With All,' as well as in the All-Atlantic Blue Schools Network. In 2024, the IOLN was part of the expert group that drafted the Venice Declaration (UNESCO 2024). Since 2022, the Network has strategically aligned itself with international policy frameworks such as the Ocean Decade and the EU's Mission Ocean.

Throughout 2023 and 2024, IOLN's workshop and outreach projects have been guided by the Ocean Decade's Challenges 9 (Skills, knowledge, technology, and participatory decision-making for all) and 10 (Restoring society's relationship with the Ocean). This alignment has contributed to increasing IOLN's impact on the international stage. For instance, after inviting the Challenge 9 White Paper Committee to participate in a co-design event that IOLN members helped organise at the UN Ocean Decade Conference in Barcelona in 2024, IOLN was invited to submit the results and recommendations from the workshop to the Committee. Some of these recommendations (Whyte et al. 2024) were subsequently integrated directly into the UNESCO policy whitepaper for Challenge 9 and will now be used to shape the priorities and work program of the Ocean Decade through to 2030.

15.6 2025 to the Future

The formal structure, strategy, and stable funding model have helped the Network go from strength to strength over the last two years. The work carried out by the new full-time Executive Officer, Catherine McCann, along with Project Officer Grace Windsor, has provided substantial operational and strategic support for the Network's growth and development. This organizational consolidation reflects best practice in NGO capacity-building, as outlined in Empowering NGOs (Kennedy and Mascarenhas 2025), which emphasises the importance of governance clarity, professional staffing, and diversified funding models in enabling long-term impact and resilience.

The IOLN will continue to actively support skills development and professional learning through a programme of meetings, workshops, and webinars delivered for and by its members. These sessions will address both technical and transferable skills, including Ocean Literacy practice, science communication, advocacy and

campaigning, funding readiness, evaluation and impact, and collaborative project development. Many of these activities are delivered through expert-led training and peer-to-peer exchange, allowing members to learn directly from practitioners with applied experience. This approach aligns with the UNESCO IOC Ocean Decade Manual for NGO's (Kennedy et al. 2024), which highlights the critical role of NGOs in strengthening Ocean Literacy, building community capacity, and translating scientific knowledge into accessible, action-oriented formats. Support received through initiatives such as The Wheel's Training Links (funded through the Department of Further and Higher Education, Research, Innovation and Science) has further enabled the Network to strengthen this offer and build organisational and individual capacity across its membership.

Our operational commitment to collaboration with and engagement of local and Indigenous knowledge holders will continue through the "My Ocean" campaign. This participatory initiative invites people from diverse backgrounds—including fishers, island residents, coastal elders, artists, and everyday Ocean users—to share what the Ocean means to them through stories, creative expression, and multimedia contributions. By foregrounding personal and cultural relations with the sea, the campaign captures place-based understandings often absent from formal science and policy contexts, making them visible and valued within national conversations on Ocean heritage and stewardship. This participatory and co-creative model reflects the Ocean Decade's emphasis on inclusive stakeholder engagement, the integration of local and traditional knowledge systems, and the co-design of Ocean solutions with communities rather than for them.

The Network will continue to strengthen existing partnerships and catalyse new ones across nations and among diverse Ocean actors through its role as an all-island, cross-sectional platform for Ocean Literacy. Through the "Shared Island and Ocean" initiative, developed collaboratively by the IOLN and Queen's University Belfast, the Network will strengthen North-South cooperation across the island of Ireland. The project uses the unifying concept of marine identity to bring together stakeholders who often operate in separate geographical, institutional, or disciplinary spaces. This structure directly reflects the Ocean Decade framework for cross-sectoral and transboundary collaboration in support of sustainable Ocean governance.

Through four Regional Co-creation and Community Dialogue Events—two in Northern Ireland and two in the Republic of Ireland—the project will connect coastal communities, marine and maritime practitioners, researchers, educators, and local organisations in structured, facilitated dialogue. These events create shared spaces where scientific knowledge, local expertise, cultural heritage, and lived experience interact on equal terms, echoing the co-design and knowledge co-production principles advocated in the UNESCO IOC *Ocean Decade Manual for NGOs*. Cross-border knowledge-sharing enables participants to explore common challenges related to climate change, biodiversity, livelihoods, and coastal resilience, while recognising regional specificities. The project will culminate in a Cross-Border Focused Event held in a border county, consolidating learning, strengthening relationships, and identifying concrete actions for future collaboration. In this way, the "Shared Island and Ocean" project not only reinforces existing connections but also establishes new, trust-based partnerships capable of extending beyond the project's lifetime—a key marker of sustainable NGO impact identified in *Empowering NGOs*.

At the European level, the IOLN's involvement in projects such as GuardIAS further expands its partnership base and strategic positioning. GuardIAS brings together organisations from multiple countries to improve the detection and prevention of invasive alien species in both marine and freshwater habitats using innovative methods. The IOLN curates the external communication, dissemination, and exploitation of project results, effectively sharing outcomes, maximising impact, engaging stakeholders, and fostering collaboration through targeted outreach. This reflects the IOC Ocean Decade guidance for NGOs regarding strategic communication, stakeholder mobilisation, and ensuring that research outputs are translated into

policy-relevant and community-accessible formats. Participation in this project strengthens links between education, science, technology, and community engagement, while aligning Ocean Literacy activities with broader European policy priorities and funding frameworks.

15.7 Challenges and Barriers

15.7.1 Funding and Initial Informal Structure

The main barrier faced by the IOLN over the years has been its informal status and the lack of a consistent income to support the day-to-day operations of the Secretariat. While this informal status may have slowed the development of the Network, it did not halt progress. Access to continuous funding, and consequently a stable full-time Secretariat, would likely have accelerated the IOLN's evolution; however, meaningful growth of the Network and notable initiatives like the 'We Are Islanders' campaign were achieved, nonetheless. The somewhat meandering evolution of the Network has likely been beneficial, allowing the IOLN to gain a deeper understanding of the importance of establishing its own identity and determining how to effectively support its membership.

It is important for the Network to provide a strong array of benefits to both existing and new members and sponsors to secure buy-in, increase membership, and encourage sponsor donations. However, determining the specific benefits to offer is challenging without a clear understanding of the income that will be generated from memberships and sponsorships. This has created a 'chicken and egg' scenario, where the Network must strategically design appealing benefits for each membership and sponsorship tier to drive sign-ups, while also avoiding the risk of overpromising.

15.7.2 Lack of Government Engagement

The loss of a dedicated Department of the Marine, and Minister for the Marine, for Ireland has posed a barrier for the Network. This department represented support from both a policy and governance perspective and was a significant loss to the ethos and vision of Ocean Literacy in Ireland.

15.7.3 The 'Ocean Literacy' Concept Is Not Intuitively Understood

The term 'Ocean Literacy' can pose a barrier due to its broad and somewhat abstract nature. Questions such as 'What do you mean by Ocean Literate?' and 'How do you become literate on the Ocean?' are commonly raised. Even with established definitions, achieving public buy-in and support for the concept remains challenging. Many individuals find it difficult to grasp its full scope, as it encompasses a wide range of knowledge, attitudes, and behaviours related to understanding and protecting the Ocean. This lack of clarity can lead to confusion and misinterpretation, making it difficult to engage diverse audiences and stakeholders. Consequently, the broadness of the concept often necessitates additional explanation and contextualization, which can hinder effective communication and advocacy efforts.

However, the breadth of the Ocean Literacy concept also serves as a significant strength. It allows for the inclusion of a diverse array of members, from educators and scientists to policymakers and community activists. This inclusivity fosters a multidisciplinary approach, encouraging collaboration and innovation across different sectors. By bringing together varied perspectives and expertise, Ocean Literacy initiatives can address complex marine issues more holistically and effectively.

15.7.4 The Role of National Networks

The experience of the IOLN increasingly demonstrates the need for neutral organisations to bring together individuals, communities, public bodies, and other stakeholders, providing spaces for open discussions and collaborative efforts to address the major Ocean challenges of our time. This need is shared by all countries, despite cultural and geographical differences. The Centre for

Ocean Literacy Collaboration (formerly the Canadian Ocean Literacy Coalition) serves as a strong example of the impact that an umbrella organisation can have in connecting various Ocean-related initiatives across the country, from local to national scales, to enhance Ocean Literacy and foster behaviour change.

The IOLN is recognised as one of the longest-running Ocean Literacy networks in Europe, serving as an ideal case study for understanding how an Ocean Literacy Network can operate successfully in the region. It exemplifies a cross-border network dedicated to promoting cooperation on marine-related issues. The mentorship role that the IOLN can play in seeding and supporting the establishment of other Ocean Literacy networks in Europe is one of the key reasons for its selection as part of the citizen engagement work conducted under the PREP4BLUE project.

It is key to recognise that cultural and historical contexts play a significant role when establishing national or cross-border networks. The model implemented in one country or region may not necessarily be effective in another. For instance, Whyte et al. (2024) found that in Ireland, strong traditions of voluntarism and the outsourcing of state support have influenced the development of the IOLN in its current form, which may not be applicable or successful in every setting (Whyte et al. 2024).

15.8 Conclusion

Looking back 10 years later, we can identify that national and international policy, along with a supportive funding environment, were key catalysts in the establishment of the IOLN. The passion of the founding members, initial seed funding for a secretariat, and extensive stakeholder engagement during the early years made the Network both relevant and inclusive. Tools such as face-to-face and online meetings, the IOLN website, and social media accounts established primary awareness of the Network and its members' actions toward promoting a Blue Ocean Society.

The openness of members to share knowledge, best practices, and information on funding opportunities fostered trust within the Network, creating a Community of Practice. The IOLN aimed to represent all its members equally, regardless of their status, size, or financial contributions. Although the term "Umbrella Organisation" has sometimes been used to describe the IOLN, rather than acting as a barrier to exclude water, it has worked to bring together every member—like drops of water—creating a wave of Ocean Literacy action.

Some key challenges along with potential solutions:

1. *Over reliance on in-kind contributions and lack of funding.*
   Solution: It is crucial to generate funding and establish a budget for your Network as early as possible. And to recognising that in-kind contributions are valuable; work and effort should be acknowledged as much as possible.
2. *The lack of formal structures and policies can be regarded as unattractive to collaborators and funders.*
   Solution: Advice should be sought on what kind of formal structure can be established for your network. The network should be thought of as a business—a caring Blue Society business that brings people together and supports their work towards a sustainable future, but a business, nonetheless. It must be capable of supporting itself to continue functioning.
3. *Unrealistic goals*
   Solution: A work plan for tasks should be created, and SMART (Specific, Measurable, Achievable, Realistic, and Time Bound) goals should be set. If tasks are carried out with in-kind contributions, it should be remembered that most individuals will have to prioritise their paid work, so extra time should be allowed for people to work at a reasonable pace.
4. *Losing sight of what is relevant to members on a local level. Getting pulled in other directions, away from the network's primary goals.*
   Solution: A strategy, work plan, realistic goals, and regular meetings should be established to review actions and plans to help maintain focus. Members should not be overstretched. A Board of Directors and/or Advisory Panel can also be used to ensure that the network remains

on the right track and to assist in evaluating opportunities or invitations strategically.

5. *Not including everyone in case difficult conversations or challenging issues ensue.*
   Solution: A safe space for approaching and dealing with challenging issues that might arise should be created through open dialogue, respect, and empathy for others' points of view. Excluding individuals from discussions due to differing viewpoints will not help overall and contradicts the essence of the network. Additionally, mindfulness regarding distinct levels of knowledge and awareness, as well as cultural backgrounds, is important to create a network that functions as a catchment area rather than a dam.

15.8.1 Summary

This chapter highlights key ideas, including:

- *Evolving a National Ocean Literacy Network.* The Irish Ocean Literacy Network (IOLN) progressed from an informal community to a formal nonprofit organization supporting marine connections across Ireland and Northern Ireland.
- *Collaborative Visioning Strengthens Direction.* Member reflections, reviews, and consultations helped shape the network's mission, values, and strategic priorities.
- *Sustaining Engagement Without Formal Funding.* The IOLN operated for several years without dedicated funding, relying on voluntary contributions and in-kind support from a wide range of stakeholders.
- *Building Capacity Through Partnerships.* Involvement in EU-funded projects, including PREP4BLUE, enabled the network to expand reach, formalize operations, and engage with international Ocean Literacy efforts.
- *Showcasing Local Voices Through Creative Campaigns.* Initiatives like *We Are Islanders* amplified diverse perspectives and supported regional outreach aligned with Ocean Decade goals.
- *Navigating Challenges and Embracing Change.* The chapter reflects on key barriers and lessons learned, offering guidance for others seeking to develop sustainable national Ocean Literacy networks.

15.8.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Challenge 10 White Paper: https://unesdoc.unesco.org/ark:/48223/pf0000390126.
- The Evolution of Ocean Literacy: A new framework for the United Nations Ocean Decade and beyond: https://doi.org/10.1016/j.marpolbul.2022.114467.
- Mission area: Oceans. Sessions from the European Research and Innovation Days 2020: https://www.youtube.com/watch?v=FeKg4HgaSdU French & Innovation (2020).
- Ocean Citizen Survey: Perceptions of the Irish public on priorities for the protection and sustainable use of the Ocean. Marine Institute, Galway, Ireland: http://hdl.handle.net/10793/1684. French, V. and McDonough, N. (2020).
- UNESCO Ocean Literacy Portal: https://Oceanliteracy.unesco.org/.
- Canadian Ocean Literacy Coalition—Guide to their work: https://colcoalition.ca/our-work/.
- Irish Ocean Literacy Website: www.irish-Oceanliteracy.ie.

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16

Ocean Literacy in Portugal: Three Decades of Experience and Innovative Educational Initiatives Supporting the Ocean Decade

Zara Teixeira, Raquel L. Costa, Patrícia Conceição, Cláudia Faria, and Laura Guimarães

Abstract

Portugal has been at the forefront of Ocean Literacy (OL) initiatives in Europe, pioneering efforts to promote knowledge and awareness of Ocean-related issues. Over three decades, many OL educational initiatives have been implemented. Despite these efforts, a significant gap remains in our baseline understanding of the reach and impact of these initiatives, highlighting a need for comprehensive assessment. This chapter aims to deepen scientific understanding and provide actionable insights on what has been done and lessons learned for the future. Overall, 114 initiatives were identified and implemented in Portugal since 1990. These initiatives were led by the academia, governmental agencies, non-governmental organisations (NGOs), the economic sector and private foundations. To achieve this, a quantitative and qualitative analysis was conducted. The target audience were students, teachers and the broader community. The study offers a comprehensive review of these OL initiatives, the implementation challenges they faced and the inspiring solutions proposed, serving as a call to action for a unified strategy to cultivate future generations of informed Ocean stewards.

Keywords

Ocean Literacy (OL) · Ocean Literacy Principles and Dimensions · Ocean Literacy and Sustainability Frameworks · Sustainability and scalability · School students and teachers · Public and private institutions

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16.1 Introduction

Leveraging its strategic geographical location and rich maritime heritage, Portugal has established itself as a European leader in Ocean Literacy (OL). For over 30 years, various academic, governmental, and non-governmental organisations have spearheaded OL initiatives aimed at educating the public and raising awareness of Ocean-related topics. Among the earliest initiatives, the Coastwatch Project, launched in 1990 by GEOTA, stands out. Annually, it engages 3500–4500 participants in coastal surveys and marine litter collection, making it one of Portugal's oldest and most impactful OL programs. In 1998, the opening of the Oceanário de Lisboa at the World Expo marked a significant advancement in public OL engagement, particularly among younger audiences through its exhibitions and educational programs. In 2011, recognising the need for a formal OL framework, Ciência Viva adapted the OL Principles (NOAA 2024) to the European context, enhancing the alignment of OL with Portugal's educational curricula (Costa et al. 2021). Afterwards, several initiatives started to bloom. Two of the most consistent are *CIIMAR at School* (born in 2012) (Gravina et al. 2019; Correia et al. 2020; Leitão et al. 2022a, 2022b; Almeida et al. 2024) and *O MARE Vai à Escola* (born in 2015) (Sequeira et al. 2017; Teixeira et al. 2024). These are broad-ranging programmes, led by researchers, that have significantly contributed to marine science education through experiential learning and teacher training. *CIIMAR at School* has later on, in 2022, established the *UNESCO Chair Ocean* Expert focusing on science education for Ocean stewardship.

Despite the dynamic institutional setting, the inclusion of Ocean topics in classrooms remained inconsistent. The *Blue School Programme*, launched in 2017 with the support of the former Ministry of the Sea, emerged to address this gap benefitting from the collaborative work of various national institutions. Using a "whole school approach", the programme integrates OL across all subjects and grades, aligning with SDGs 4 (Quality Education) and 14 (Life Below Water) (Costa et al. 2021). It has inspired international adaptations, such as the *All-Atlantic Blue Schools Network* and the *Network* of *European Blue Schools*. In 2018, cognizant that full integration into the national curriculum could only be achieved with the awareness and support of school teachers, Oceano Azul Foundation and Oceanário de Lisboa, in collaboration with the Directorate-General for Education (Portuguese Ministry of Education), launched *Educar para uma Geração Azul* (EGA, Educating for a Blue Generation). This programme supports primary school teachers with training and resources to teach OL. Its success prompted the Ministry of Education to establish a working group aimed at formalising OL within the national curriculum and expanding it to all Portuguese schools.

Over time, the diversity of OL initiatives in Portugal has continued to grow and adapt, particularly during the COVID-19 pandemic. For example, the *Kids Dive* programme introduced a virtual reality edition to remotely continue its immersive educational experiences (Malzone 2022). Another key development is the *#EstudoEmCasa* (#StudyAtHome) educational portal, developed by the Directorate-General of Education in collaboration with national television. This portal has integrated a wealth of OL content and continues to play a vital role in supporting inclusive education. The *Blue School Programme*, EGA, *CIIMAR at School*, the *UNESCO Chair Ocean Expert* and *Kids Dive* are all endorsed as Ocean Decade projects. The ongoing commitment of Portugal to

OL education aligns with the goals of the UN Decade of Ocean Science for Sustainable Development and key frameworks such as the Ocean Decade Vision 2030 (Challenge 10) and Mission Starfish 2030: Restore Our Ocean and Waters.

Although Portuguese efforts are remarkable, the information is dispersed, and there is limited knowledge and clear understanding regarding the specific initiatives implemented, key trends, who they are impacting and gaps that still need to be addressed. This chapter provides a comprehensive overview of Portugal's OL educational initiatives, offering valuable insights that can contribute to implementing similar initiatives in other regions and establishing a sustainable national OL framework. The research work was based on quantitative and qualitative assessments of the initiatives developed in Portugal and their comparison. The study encompasses educational initiatives targeting students, educators and the broader community. The chapter focuses on: (i) the survey of initiatives and programmes implemented; (ii) the OL principles, perspectives and dimensions addressed; (iii) the alignment of these efforts with the Decade Challenges and their contributions to the Sustainable Development Goals (SDGs); (iv) preparation and implementation challenges and (v) lessons learned, reflecting on key insights and inspiring readers to take informed actions based on the findings presented in the chapter.

16.2 Methods

Through collaborative efforts within the Portuguese OL community, a survey combining a questionnaire and qualitative interviews was carried out. Overall, 114 initiatives implemented between 1990 and 2024 were analysed. These were provided by 36 institutions, from academia (11), public organisations (10), non-governmental organisations (NGOs, 7) and private organisations in the economic sector (6) and private foundations (2). Most initiatives (70%) were implemented by academia (universities or research institutes) and public organisations (Fig. 16.1).

First, a structured questionnaire was completed by promoters of the initiatives. It encompassed six sections as described in Table 16.1. Each section contained multiple questions elaborated by a team of five OL experts.

Subsequently, 40 promoters were interviewed for a qualitative assessment, using 17 open-ended questions (Table 16.2). The interview aimed at uncovering latent layers of meaning and outline insights without considering pre-existing premises.

These data were collected with the questionnaire and subsequently validated and analysed using Chi-square tests with the Bonferroni correction to identify homogeneous subsets. For this purpose, the NGOs, economic sector organisations and private foundations were pooled together into a single category (referred to as 'Others') to meet the test application conditions.

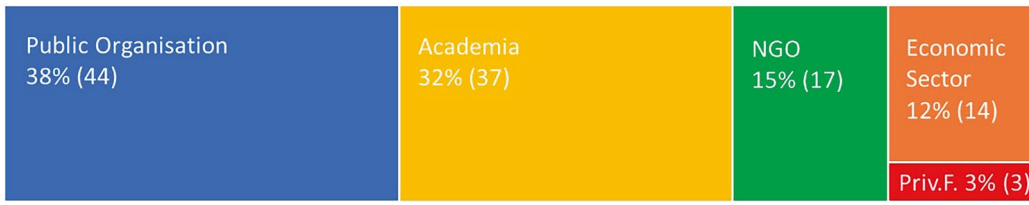


Fig. 16.1 Frequency of initiatives (percentage and total number) per type of organising institution. NGO: Non-governmental institution; Priv.F.: Private Foundation

Table 16.1 Questionnaire elaborated to characterise the 114 OL initiatives identified

Section	Items per section
Characterisation of the initiative	Institution; Name of the initiative/programme; Main target audience; Type of activities; Number of participants; Number of editions; One-off or continuous initiative; Frequency of initiatives; Start year; Duration; Time of preparation until launch; Number of team members; With/Without dedicated funding; Scale (local, regional; national); Main goal; With/Without impact evaluation
OL Principles	Which OL Principles were encompassed by the initiative
Multiperspective approach	Which of the UNESCO Multiperspective approaches were addressed
OL dimensions	Which of seven OL Dimensions were considered (*knowledge*, *awareness*, *communication*, *attitude*, *activism*, *behaviour*, *empathy*)
Sustainable Development Goals (SDGs)	Which SDGs were encompassed/targeted in each initiative
Ocean Decade Challenges	Which Ocean Decade Challenges were targeted in each initiative

Table 16.2 Qualitative assessment delivered to 40 promoters (40 initiatives)

Section	Items per section
Characterisation	Give a general description of the initiative/programme, including its specific objectives
	What do you consider to be the greatest impact of this initiative/programme and why?
	Can you share the activity that had the most positive feedback and explain what made it successful?
Educational approaches	When the initiative was designed, did you consider framing it within the OL Principles? If yes, why was this relevant? If not, why?
	When the initiative was designed, was it essential to explore various areas of knowledge (e.g. history, scientific method, geography, values, culture, sustainability)? If so, why was this relevant? If not, why?
	What tools, experiences or resources have you used to arouse interest and increase involvement in your initiative? Can you describe a strategy that you feel is particularly effective?
	What tools, experiments or resources have you used to address Ocean issues, such as marine litter, chemical pollution, acidification?
	Does your initiative include discussing immediate actions that participants can take to address the problem (e.g. sorting waste)?
	What were the main opinions expressed by the participants about the activities they carried out? And what impressed them the most?
	Did you assess whether the objectives of the initiative were achieved? If so, what aspects did you take into account and how did you evaluate them? If not, why didn't you?
Challenges	Did you face any challenges in implementing the initiative? Can you describe the most relevant ones and the solutions you used to solve them?
	Did you have specific funding for the activities you implemented? How did the funding (or lack thereof) affect the initiative?
	If your initiative is continuous, how do you maintain it in the long term?
	What factors influence the ability to expand or replicate the initiative, e.g. to other schools or locations?
SDG and Ocean Decade	How does your initiative align with the SDGs (e.g. SDG 14, SDG4, SDG13, …)?
	How has your initiative contributed to the objectives of the United Nations Decade of the Ocean?
	Was your initiative intended to have any societal impact, e.g. influencing policies, community behaviour, raising awareness among families? Were you able to achieve these goals? Can you give a positive example?

16.3 Results and Discussion

16.3.1 Initiatives and Programmes

The initiatives and programmes identified reflect the national genuine, albeit uncoordinated, efforts to incorporate OL into educational programmes. Some trends stand out: most of these initiatives targeted children, focused on practical approaches and primarily aimed to integrate OL into school curricula. While activities outside the school environment were less common, they remained highly substantial. Moreover, all types of institutions have been contributing, although with different levels of commitment (e.g. audiences addressed, educational levels covered and duration of activities). The importance of involving a diverse range of institutions in OL initiatives becomes evident when examining the duration and number of participants. Furthermore, it highlights their crucial role in bringing unique resources, perspectives and networks.

Most initiatives (63%) targeted children as audience, followed by the community in general (26%), which included individuals of all ages and societal sectors, such as children, adults and families ($\chi^2_8 = 16.9$, $p = 0.031$). School teachers were the least addressed audience (Fig. 16.2); academia was the main contributor with initiatives for this group (58%).

Among initiatives targeting school students, the majority (54%) were designed to encompass all school levels, ranging from preschool to Basic and Secondary Education (ages 3–18, 21%) or from Basic to Secondary Education (ages 6–18, 33%) (Fig. 16.3). Though, the different types of institutions do not target higher educational levels (2nd and 3rd Cycles and Secondary) with the

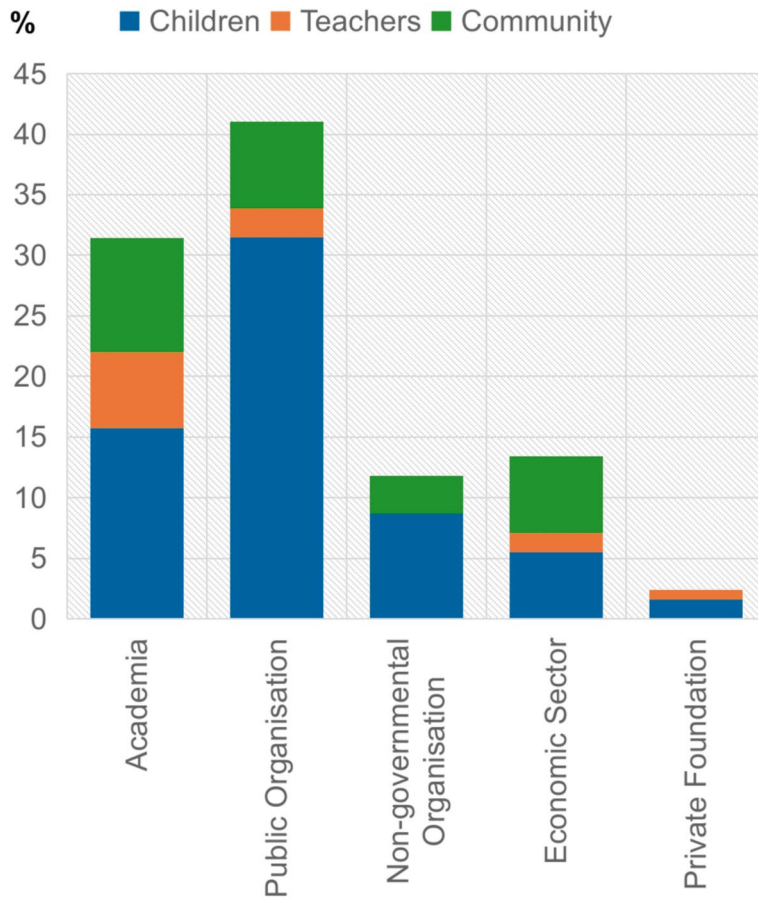


Fig. 16.2 Frequency of educational initiatives per main type of audience across type of institution

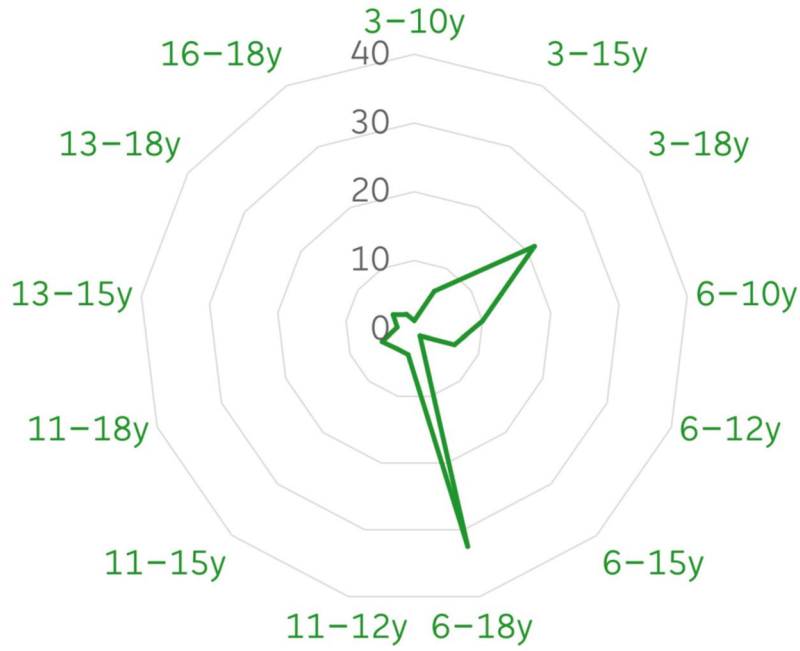


Fig. 16.3 Distribution of educational initiatives per student age range (y = years)

same frequency: 2nd Cycle (ages 11–12, $\chi^2_4 = 11.5$, $p = 0.021$), 3rd Cycle (ages 13–15, $\chi^2_4 = 21.6$, $p < 0.001$) and Secondary (ages 16–18, $\chi^2_4 = 14.1$, $p = 0.007$). Academia prioritises the 2nd Cycle, public organisations target both the 2nd and 3rd Cycles, NGOs prioritise the 3rd Cycle, whereas the private institutions seem to not discriminate between the three Cycles.

While most initiatives for schoolchildren were implemented within the school environment (55%), a relevant portion (45%) took place outside, such as visits to natural spaces or research laboratories. These experiences are particularly valuable for fostering meaningful connections with the Ocean and cultivating an emotional bond with the sea (Barracosa et al. 2019). Engaging students in practical actions addressing real-world issues within their local socio-environmental context is equally crucial, empowering to contribute to the collective well-being and sustainable development (Hadjichambis and Reis 2020).

Regardless of the location, practical approaches were the most commonly implemented by the initiatives (75%) (Fig. 16.4). Specifically, promoters highlighted in interviews the use of student-centred activities designed to actively engage students in the tasks. Examples included participatory exercises, hands-on activities, debates, role-playing, co-creation of various outputs (e.g. videos, gamification projects, flipped classrooms, drawings, dances and creative writing). The promoters were also very committed to develop and offer educational resources and tools that teachers could use in the classroom (mentioned by 60% of interviewees). These resources included videos, podcasts, itinerant exhibitions, and apps. Often, they involved scientists and other experts through lectures and webinars (68% of interviewees). They also included teaching materials (often digital), that schools could retain for ongoing use. Examples included didactic exploration guides and educational games, allowing integration into the curricula, thus sustaining the impact of the projects over time.

Regarding objectives and ambition, the initiatives primarily aimed to *Integrate OL into school curricula* (Fig. 16.5), a goal shared by all types of institutions (50%). This outcome reinforces the prevailing view that Portuguese institutions are committed to fostering a generation of future Ocean stewards. It also highlights the extensive experience in this field. A future OL strategy for

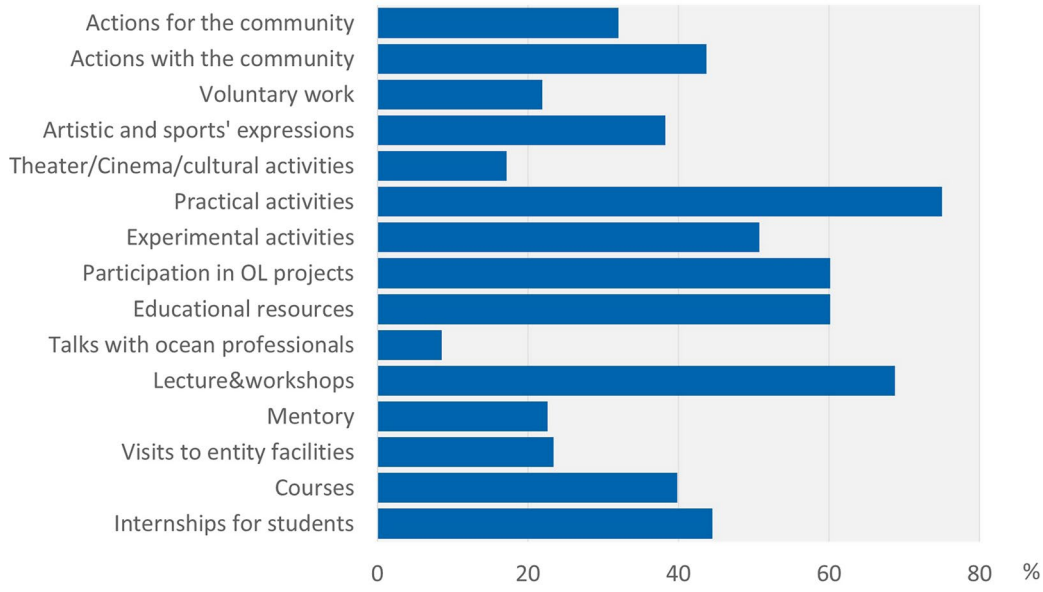


Fig. 16.4 Types of activities incorporated by the initiatives

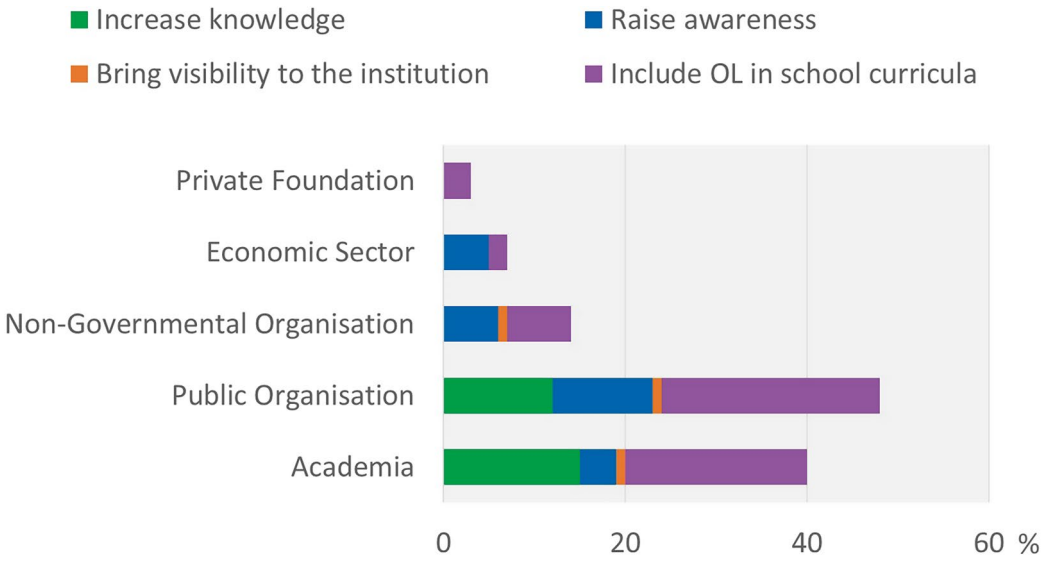


Fig. 16.5 Frequency of educational initiatives per main objective across type of institution

integrating OL into school curricula should thus be developed collaboratively, leveraging on this expertise. Key questions to address include: What practices should or should not be replicated? What are the primary challenges that need to be overcome? How can the approach be tailored to different regional contexts to ensure inclusivity? What strategies can be implemented to train and support educators effectively?

Raising awareness and *Increasing knowledge* are the second most addressed primary goals (Fig. 16.5). However, only academia and public organisations appeared primarily interested in *Increasing knowledge*. *Raising awareness* pre-

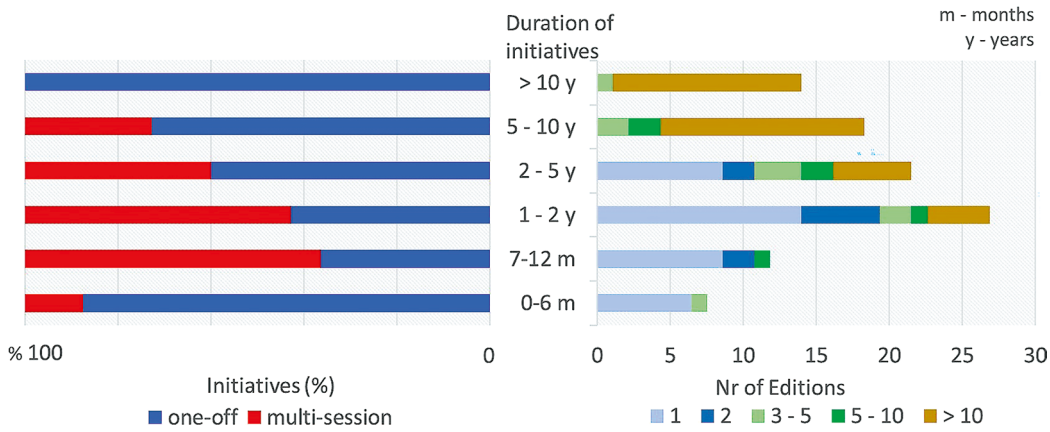


Fig. 16.6 Left panel: Frequency of initiatives per one-off (single, stand-alone events) *vs* multi-session (engagement with the same participants over time) educational initiatives across duration ranges. Right panel: Frequency of initiatives per number of editions across duration ranges

pares communities to respond effectively to Ocean challenges and reinforces the importance of marine sustainability (Almeida et al. 2024). On the other hand, improving scientific knowledge leads to a more scientifically informed public essential for informed decision-making and for combating Ocean myths and misinformation (Teixeira et al. 2024). Despite the discrepancies observed, no significant differences across the OL goals addressed were found among institutions, likely due to methodological issues (i.e. the necessary grouping for the statistical analysis; *see* Sect. 16.2).

The duration and the number of editions serve as proxies for the long-term sustainability of initiatives. Along with the number of participants and the type of engagement (one-off vs. multi-session), they also indicate the quantitative impact of the initiatives. For initiatives longer than 6 months, there was a trend toward favouring one-off activities (single, stand-alone events. Possible repeated, but not with the same participants) over multi-session programmes (involve a structured series of educational activities delivered over time to the same group of participants) as the duration increased (Fig. 16.6, *left*). This may be occurring because longer initiatives involving ongoing or repeated engagement with the same participants over time must address challenges such as participant fatigue and the need for flexibility to adapt to evolving contexts. As expected, the longer the duration the higher the number of editions (Fig. 16.6, *right*), indicating efforts have been made to maintain the initiatives over time.

Of the initiatives with more than 10 years of duration, five were led by NGOs. Private foundations and the economic sector also predominantly focused on long-duration initiatives (>5 years), but the latter tended to reach a smaller number of participants (<100) (Fig. 16.7). Public organisations, on the other hand, concentrated on both long- and medium-term initiatives (>1 year), collectively engaging the largest number of participants (over 1000, $\chi^2_{20} = 37.7$, $p < 0.01$).

16.3.2 Ocean Literacy Principles, Perspectives and Dimensions

The Principles of OL (NOAA 2024) encompass a broad range of the Ocean's characteristics, including its physical, geological, chemical, biological and ecological aspects. These principles provide a framework for understanding the Ocean's complexity. Portuguese initiatives are aligned with this view. They have addressed all Principles (Fig. 16.8) and promoters mentioned that explicitly considering OL Principles increases credibility and clarity of messaging.

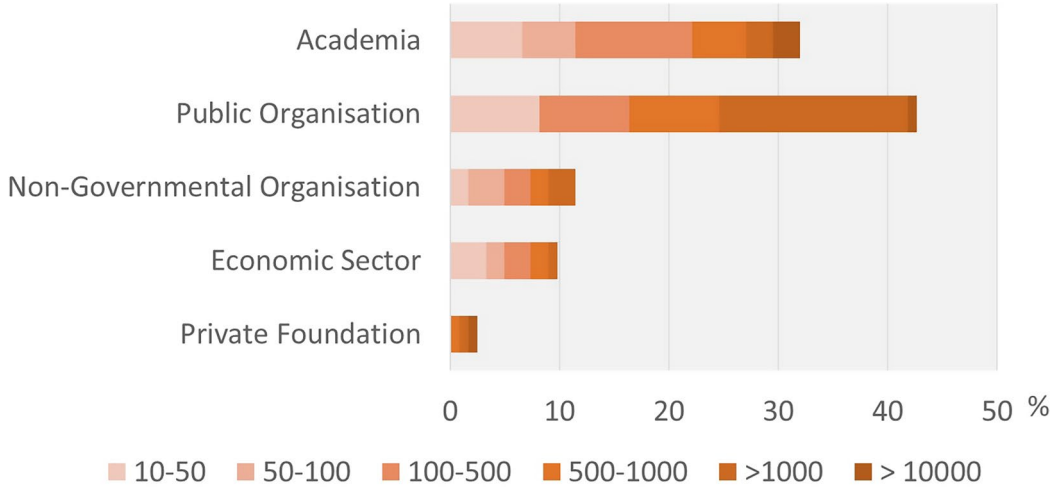


Fig. 16.7 Frequency of initiatives per number of participants across type of institution

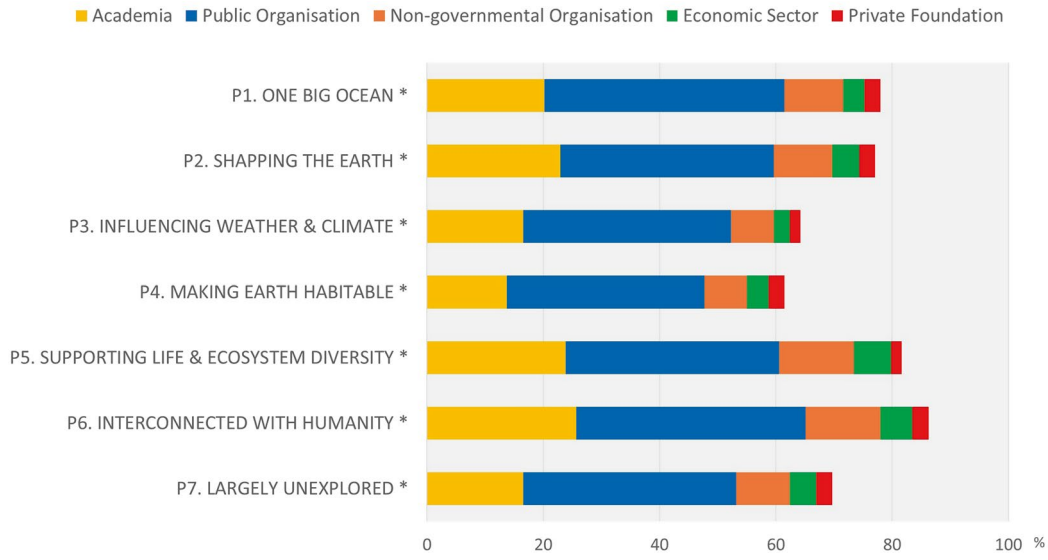


Fig. 16.8 Frequency of initiatives per OL Principle across type of institution. *Significant differences ($p < 0.05$) between institutions observed for all OL Principles

The most explored were Principles 5 (*supporting life and ecosystem diversity*) and 6 (*interconnected with humans*). The least explored were Principles 3 (*influencing the weather and climate*) and 4 (*making earth habitable*) (Fig. 16.8). The disparities found do not appear to be coincidental. Most promoters (73%, $n = 40$) stated they explicitly considered OL Principles in the preparation and implementation to align their initiatives with curriculum documents, official teaching and learning guidelines. In Portugal, topics related to biodiversity (P5) and humanity's relationship with the Ocean (P6) align closely with the early schooling curricula, which are the most targeted by the studied initiatives. In contrast, more complex scientific topics, such as climate issues and their planetary impact, are primarily addressed in upper secondary school curricula. A few promoters mentioned compliance with funding programme requirements,

which often mandate the explicit alignment with OL Principles.

Adopting a Multiperspective Approach in OL is a more recent and holistic strategy, supported by frameworks like UNESCO-IOC (2021). It integrates diverse fields, viewpoints, and cultural narratives (Máñez et al. 2023), emphasising the contextual and subjective interpretations of Ocean knowledge. This approach enriches OL by embracing diversity, fostering inclusivity, and encouraging a broader dialogue around Ocean-related issues (Worm et al. 2021; Mokos et al. 2022). Despite the advantages of this approach, a review of Portuguese OL initiatives reveals significant gaps (Fig. 16.9). While perspectives on *Sustainability* and *Science* are prominently addressed, others, such as *Gender Equality* and *History*, remain underrepresented. The reasons for this are unclear. Portugal has a deep historical connection to the Ocean, as the sea is woven into its cultural, historical and daily life. This identity could and should be leveraged to enhance students' relationship with the Ocean. Such gaps hinder the potential to achieve comprehensive Ocean Literacy, as shown in Fig. 16.10. These findings align with global challenges in Ocean Literacy, which require a more inclusive integration of regional and cultural perspectives (Mokos et al. 2022; Niner et al. 2024). Addressing these disparities is essential for fostering a global OL framework that is adaptable, equitable, and culturally sensitive.

OL dimensions serve as a framework for understanding, learning, and teaching about the Ocean, emphasising competencies required to understand and engage with the Ocean system

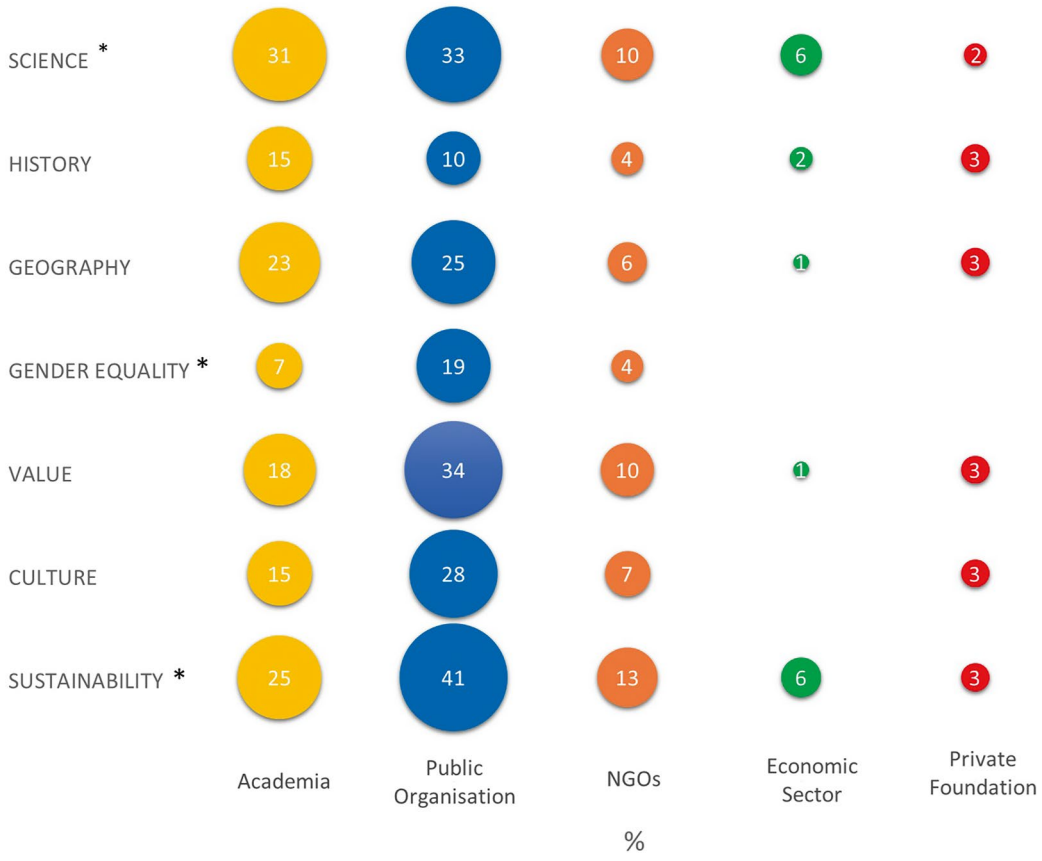


Fig. 16.9 Frequency of initiatives per OL perspective across type of institution. *Significant differences ($p < 0.05$) between institutions observed for *Science*, *Gender Equality* and *Sustainability*

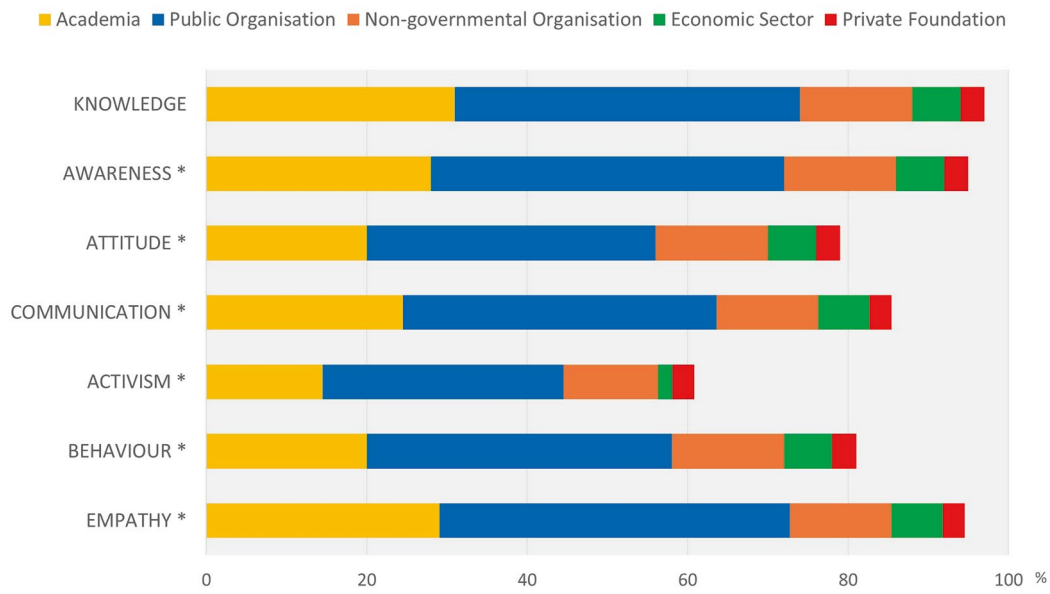


Fig. 16.10 Frequency of initiatives per OL dimension across type of institution. *Significant differences ($p < 0.05$) between institutions observed for all Dimensions, except *Knowledge*

effectively (such as *Knowledge*, *Awareness* and *Behaviour*) (McKinley et al. 2023). The Portuguese initiatives explored more frequently *Knowledge*, *Empathy* and *Awareness* (Fig. 16.10). *Knowledge*, in particular, has been the primary focus in the development of the OL concept. However, promoting knowledge and awareness alone may not ensure the desired behavioural changes in individuals. Students need to be actively involved in meaningful actions to build intrinsic motivation, relate personally to the issue, understand their potential to make a difference, develop a willingness to act and, most importantly, feel empowered to take action (Hadjichambis and Reis 2020; Devenport et al. 2021). In the initiatives analysed, *Activism* is the least explored dimension. Among the 40 initiatives whose promoters participated in the interviews, only 43% included strategies explicitly aimed at behaviour change. These strategies involved discussing immediate actions students could take to address the problem and, crucially, including them in co-creating and implementing concrete actions (e.g. participatory activities). This finding is significant. Developing action skills is widely recognised as one of the most challenging aspects of OL education. Therefore, there is an urgent need for a more robust and focused approach to effectively foster these skills and promote tangible, behaviour-driven outcomes.

The type of institution plays a crucial role in shaping the OL Principles, Perspectives, and Dimensions addressed by initiatives. Significant differences ($p < 0.05$) were observed among institutions for all OL Principles (Fig. 16.8), for *Science*, *Gender Equality* and *Sustainability* Perspectives (Fig. 16.9), and for all Dimensions except *Knowledge* (Fig. 16.10). Academia, for instance, tends to focus more on Principle 6 (*Interconnected with Humanity*), the *Science* perspective, and the *Knowledge* dimension. This focus reflects its mission to advance knowledge and explore complex interdisciplinary relationships, often integrating natural and social sciences. Public organisations prioritise Principle 1 (*One Big Ocean*), the *Sustainability* perspective, and the dimensions of *Awareness* and *Empathy*. This aligns with their role in translating scientific findings into actionable policies and community-oriented initiatives. NGOs, likely driven by their advocacy-oriented missions, emphasise

Principles 5 (*Supporting Life and Ecosystem Diversity*) and 6 (*Interconnected with Humanity*), the *Sustainability* perspective, and activities aimed at raising awareness, fostering positive attitudes, and promoting behaviour change.

16.3.3 Alignment with SDGs and Ocean Decade Challenges

The alignment of OL initiatives with global sustainability frameworks, particularly the UN Agenda 2030 Sustainable Development Goals (SDGs) and the Challenges and Outcomes of the UN Decade of Ocean Science for Sustainable Development (2021–2030) (United Nations 2021), is critical to achieving far-reaching societal impacts. This alignment is evident in Portuguese initiatives, evidencing their role to promote understanding of OL as a societal outcome where people value, care for and act responsibly toward the Ocean (Glithero et al. 2024). In particular, and as expected, the quantitative analysis strongly emphasised the alignment with SDG 14 (*Life Below Water*), the central Ocean-related goal, which was heavily prioritised across all sectors (Fig. 16.11). The SDG 4 (*Quality Education*) was also a strong priority, mainly through the efforts of public organisations and academia (Fig. 16.11). Additionally, SDG 12 (*Responsible Consumption and Production*) and SDG 13 (*Climate Action*) were more frequently addressed by public organisations than other sectors ($p < 0.05$), reflecting their commitment to broader societal issues, such as climate change, shifting consumption paradigms, and advancing a circular economy. This supports the idea that OL programs are intertwined with efforts to build resilience against climate change impacts, involving other SDGs beyond Ocean-related ones. Engagement with SDG 11 (*Sustainable Cities and Communities*) and SDG 12 suggests that OL initiatives are contributing to more sustainable lifestyles and communities. By linking Ocean health with societal sustainability, these initiatives may promote responsible consumption and resilient urban development, emphasising the importance of sustainable interactions between individuals, organisations, governments and Ocean resources.

The alignment with the Ocean Decade Challenges (Fig. 16.12) points out that Portugal's OL initiatives are intended to go beyond awareness-raising and contribute to address some

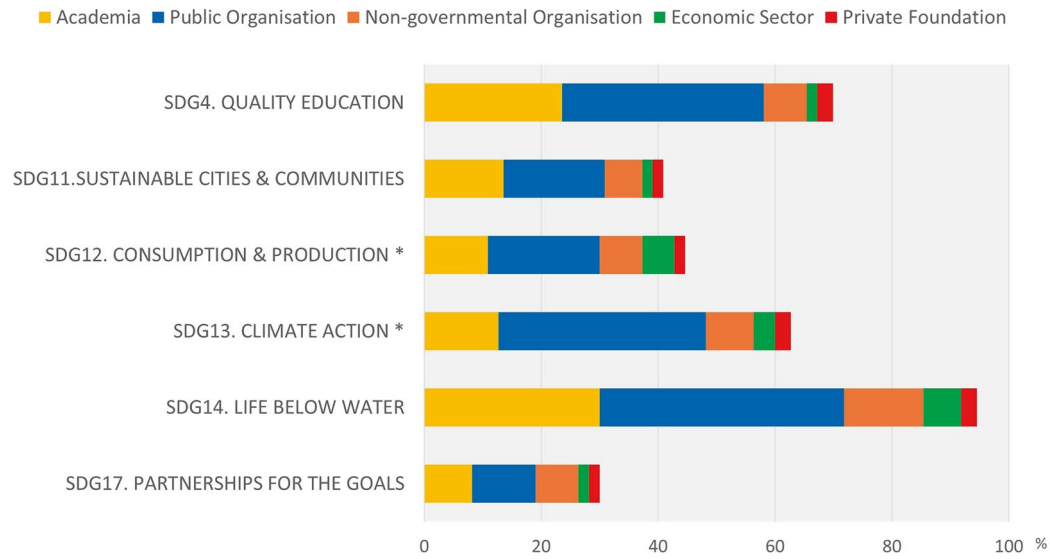


Fig. 16.11 Frequency of initiatives per SDG across type of institution. *Significant differences ($p < 0.05$) between institutions observed for SDG12 and SDG13

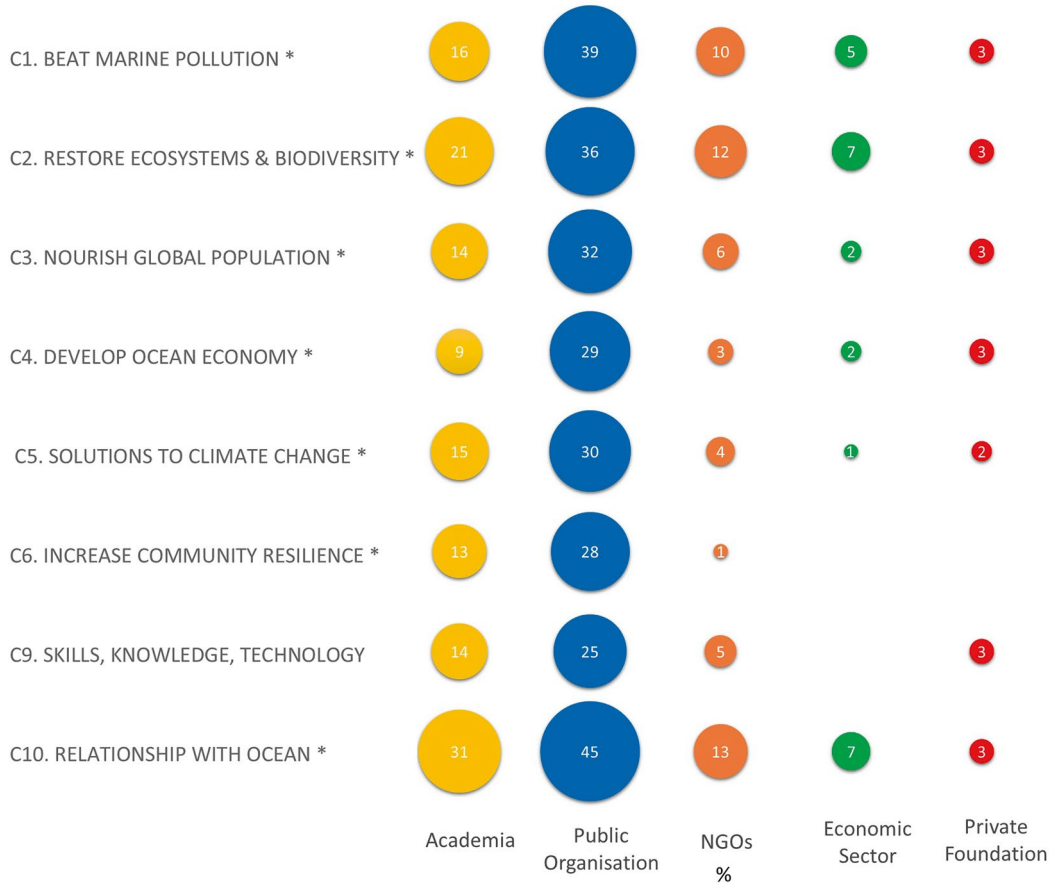


Fig. 16.12 Frequency of initiatives per Challenge across type of institution. Challenges 7 and 8 are not represented as no initiative reported addressing them. *Significant differences ($p < 0.05$) between institutions observed for all Challenges, except Challenge 9

of the most pressing Ocean-related challenges of our time. Challenge 10 (*Restore society's relationship with the Ocean*) is a top priority across all sectors, indicating a strong focus on increasing public understanding and engagement with Ocean issues through education. This reflects a solid commitment to building a more Ocean-literate society, which is foundational to the success of all other challenges.

Challenges 1 (*Understand and beat marine pollution*) and 2 (*Protect and restore ecosystems and biodiversity*) also show a high level of engagement from public organisations and academia, mirroring the trend found for SDG 14. NGOs and the economic sector are also aligned with these challenges, reflecting their growing work on such issues through advocacy and private-sector partnerships. These challenges are likely more frequently addressed because they are more accessible within educational settings. They involve tangible and relatable issues, like plastic pollution and biodiversity conservation, that are engaging for students of all ages. These issues lend themselves well to structured learning and are effective for building awareness and advocacy, making them ideal subjects for educational programmes. Challenge 6 (*Increase community resilience to Ocean and coastal risks*), crucial for Portugal due to its extensive coastline and vulnerability to Ocean-related threats, should be more frequently addressed, indicating a gap that must be bridged. Given the importance of

community resilience in climate change, future initiatives should address this challenge, helping prepare communities for the risks of rising sea levels, coastal erosion and extreme weather events. No relevant engagement with Challenges 7 (*Sustainably expand the Global Ocean Observing System*) and 8 (*Create a digital representation of the Ocean*) was found. They are pivotal for advancing scientific understanding of the Ocean and integrating digital technologies into Ocean management, representing an opportunity for innovation.

16.3.4 Challenges Uncovered

The content analysis of 40 interviews revealed challenges and concerns related to implementing educational initiatives. Some challenges occurred during the preparation phase, including logistical issues (45%) such as transportation, securing the necessary infrastructure and materials, coordinating schedules with schools and partners, and obtaining required authorisations). Other challenges included attracting participants (27.5%), ensuring the availability and stability of specialised human resources (12.5%), ensuring visibility for the initiative (12.5%) and dealing with limited preparation time (2.5%). Promoters provided examples such as: "arranging transport for students to beach cleaning sites"; "constraints and uncertainties in the composition and stability of the coordinating team" and "lack of materials for beach monitoring and insufficient time to carry out activities at school".

Additional challenges were associated with the implementation phase, including adapting scientific language for different learning cycles (2.5%), managing student behaviour (2.5%), and coping with weather conditions (2.5%). Long-term sustainability challenges included maintaining momentum and preventing demobilisation (2.5%), fostering behavioural and institutional change (2.5%) and securing funding for both the initial launch and ongoing operations (12.5%) Examples include: "lack of funding"; "difficulty for organisations in understanding, valuing and being willing to pay the fair cost of offers" or "we had to ask for support from local councils, as the budget didn't allow for additional expenditure".

Human resources were a key constraint mentioned by promoters, often due to limited funding. Funding was also used for transportation, materials, decentralisation, replication of initiatives, team travelling and to event diversification. Nearly half (47%, $n = 114$) of the initiatives claim to have secured external dedicated funding (e.g. public project calls), but none from the economic sector and only 34% ($n = 114$) from the public organisations. Alongside with the economic sector, these may have greater flexibility to accommodate expenses related to OL initiatives, particularly human resources (e.g. "funding was part of the annual budget" or "[the initiative] is developed with post-doctoral students"). However, for other institutions, lack of funding jeopardises many OL actions (e.g. "It affects us a lot because we can't respond to all the requests" or "reduced the potential for the production and dissemination of products"). Sustained funding is crucial for long-term effectiveness, with promoters suggesting "self-financing based on the requests that come in" as a potential solution.

According to the promoters, many of these challenges can be addressed through careful planning. Promoters highlight communication and outreach strategies (15%) for increasing visibility, motivating participation, and preventing demobilisation. This could include maintaining an active social media presence and reaching out directly to potential beneficiaries (e.g. "One strategy we used to boost public involvement was promoting the resource in schools within communities traditionally linked to this fishery"). Additionally, promoters stress the importance of support from local communities, school management and teachers (10%), during both the planning (e.g. "We reached out to dynamic individuals in the community") and implementation phases (e.g. "We made improvements based on teachers' suggestions"). This latter example highlights a solution to challenges requiring a high level of adaptability to changing circumstances. Such

solutions, mentioned by 25% of promoters, include extending the project duration to reach more participants and quickly adapting language (e.g. "we extended the project to integrate new students the following year"; "the solution was to adapt the offer to what was available"; "the solution was always to adapt the language, sometimes even during the sessions"). Flexibility in accommodating others' agendas, proposals, or formats, such as virtual sessions and digital resources which were widely used during the COVID-19 pandemic, was also emphasised (e.g. "The pandemic has meant that we've had to hold some sessions online and we've had to rely on virtual and video tools.").

When asked about the necessary conditions for long-term sustainability, funding was the main parameter mentioned (32.5%) for both daily expenses and human resources. The ability to link initiatives to existing structures (17.5%) such as educational curricula, activities, strategic plans, and organisational practices, was also important. An example of this is the "Educating for a Blue Generation" initiative, which led to recommendations from the 'Ocean Education' working group. This is expected to result in new public policies incorporating OL into school curricula and extending the pilot programme to all primary schools in Portugal. Another example is the "Conference of Ocean Teachers", which is included in the annual Activity Plan and the 2020–2030 Strategic Plan of Agência Ciência Viva. Promoters also mentioned the need for regular monitoring and updates to maintain interest and prevent demobilisation (5%, e.g. "These challenges have been adequately overcome […] by regular monitoring").

When asked about the necessary conditions for scalability, replicating the initiative in different contexts, funding-related issues were once again highlighted as the primary factor (60%). Other conditions include partnerships (12.5%), beneficiary interest (12.5%, e.g. "Dynamics of local agents (teachers in schools) who are available to support" or "From the schools' perspective, it is obviously important that Ocean Literacy is prioritised more."), administrative and management responsiveness (7.5%), and the relevance of proposed activities/materials and strategies (7.5%).

Lastly, assessment of effectiveness has also been mentioned for both sustainability and scalability. For this matter, initiatives in Portugal have incorporated monitoring to address challenges such as demobilisation and engagement (e.g. "These challenges have been adequately overcome […] by regular monitoring"). Others have introduced pilot phases to ensure scalability ("The implementation of a pilot phase and the process of evaluating the impact of this stage was very important because it made it possible to validate the suitability of the programme").

Despite the critical role of effectiveness assessment in measuring impact, guiding programme improvements, ensuring accountability and enhancing scalability (e.g. Almeida et al. 2024), only 30% (n = 114) of initiatives implemented goal-oriented evaluation schemes. These included tools such as questionnaires (22.5%, n = 40), observation and/or participant feedback (17.5%, n = 40) or mixed methods (10%, n = 40). This is surprising, given the importance of evaluation in understanding the impact of OL initiatives (Ashley et al. 2019), and the fact that 68%–70% of the Portuguese educational initiatives declare having addressed the *Attitude* and *Behaviour* Dimensions, respectively.

16.4 Lessons Learned

This chapter explored Portuguese OL initiatives in an educational context to unveil opportunities and alignment with OL Principles, Perspectives, Dimensions, SDGs and Ocean Decade Challenges. Here, we summarise the key lessons learned from our analysis.

16.4.1 Institutional Roles

Academia and public organisations played a significant role in developing OL initiatives, indicating that these institutions are pivotal in educational and community outreach efforts. Private foundations focused on long-term initia-

tives, showing their commitment to sustained impact. A key takeaway message is the importance of institutional diversity for broader societal impact. The diverse engagement of different types of institutions may be critical for success as it joins the strengths of each sector, i.e. governmental leadership, academic research, NGO advocacy, economic-sector innovation and private foundations' resources and visibility.

16.4.2 Variety of Initiatives

The diversity encountered reveals the multifaceted nature of Portuguese initiatives. They varied from short- (0–6 months) to long-term (>10 years); benefiting 10 to >10,000 participants; with both formal and non-formal educational approaches; with or without funding; some using standalone events repeated over time with different audiences, while other prioritising multi-session programmes; some focusing on increasing knowledge, while others on introducing OL in school curricula. This highlights the need to tailor OL initiatives to specific goals, audiences and circumstances.

16.4.3 Nature of Activities

Initiatives have been prioritising practical activities along with lectures & workshops. In the first case, promoters highlight the importance of student-centred actions fostering active participation & deeper learning. For the latter, they emphasise the learning process enrichment through the involvement of scientists and experts. The development of educational resources has also been highly used suggesting a concern about ensuring continuity and accessibility to educational content. Experiential learning, through school visits, cultural, artistic and sports activities, voluntary work, and actions with and for the community, was also a major part of Portuguese initiatives. This suggests a concern with providing a multifaceted approach to learning, as well as providing experiences that foster active and emotional engagement.

16.4.4 Preparation and Implementation Challenges

The main challenges outlined by Portuguese promoters are related to logistics, attracting participants, visibility of the initiative to secure participants, human resources and funding. These highlight the importance of thorough planning to ensure the success and sustainability of educational initiatives. This suggests that the scalability of OL initiatives is a product of adequate resources, leveraging pilot projects and continuously improving to adapt to unforeseen challenges.

16.4.5 OL Principles and Multiperspective Approach

Selection of OL Principles is primarily aligned with the school curricula to enhance the credibility and clarity of the initiatives. Consequently, there is a bias in the OL Principles addressed, benefiting P5 (*immense diversity of life*) and P6 (*interconnected with humanity*). Promoters believe integrating different Ocean perspectives contributes to a more comprehensive and interdisciplinary understanding of Ocean-related challenges and solutions. Still, Portuguese initiatives show a positive bias towards themes related to *Sustainability* and *Science*. These insights suggest that while there is a strong focus on certain OL principles and perspectives, there is room for including underrepresented areas like *Gender Equality* and *History*. This could enhance the overall impact of OL initiatives by providing a more comprehensive understanding of the Ocean's role in our world.

16.4.6 OL Dimensions

Portuguese initiatives emphasise the dimensions of *Knowledge*, *Empathy* and *Awareness* cultivating a strong foundation for understanding and valuing the Ocean. However, *Activism*—a critical dimension for driving tangible change—remains the least explored. This imbalance highlights a persistent gap between acquiring

knowledge and translating it into actionable behaviours. It suggests a need for innovative, targeted approaches that go beyond traditional educational strategies. For instance, integrating experiential learning methods, such as community-based projects, citizen science initiatives, or participation in Ocean conservation campaigns. Placing greater emphasis on *Activism* within OL initiatives can nurture a generation that not only understands Ocean-related challenges but is also equipped and motivated to contribute to solutions, driving meaningful progress towards Ocean sustainability.

16.4.7 SDGs and Ocean Decade Challenges

While public organisations and academia show the most robust involvement across both frameworks, meaningful participation is also seen in NGOs, private foundations and the economic sector. The alignment with these two frameworks emphasises the broad societal impacts of Portuguese OL initiatives, extending beyond a traditional education to foster contributions to Ocean health, climate resilience, and community sustainability. SDG14 (*Life Below Water*) and Challenge 10 (*Relationship with Ocean*) are heavily prioritised across all types of institutions. Still, there is also a concern about prioritising quality education through SDG4 (*Quality Education*) by public organisations and academia, as well as engaging with broader societal issues by aligning with SDG12 (*consumption & production*), SDG13 (*climate action*) and SGD11 (*sustainable cities & communities*), as well as Challenges 1 (*beat marine pollution*) and 2 (*restore ecosystems & biodiversity*).

16.5 Conclusion

In summary, Portuguese OL initiatives highlight the importance of engaging various institutions, implementing diverse and experiential educational activities, and thorough planning for initiatives' sustainability and scalability. While there is strong alignment with SDG goals and Ocean Decade challenges, there is a need to bridge the gap between knowledge and action for impactful OL initiatives and address underrepresented dimensions (i.e. gender equality, history) and themes such as community resilience and Ocean observation. Overall, the progress made brings a sound collaborative basis for the development of a national framework supporting the integration of OL into school curricula, as recommended by the High-Level Panel on the Teaching Profession established by the United Nations Secretary-General.

16.5.1 Summary

Key concepts explored in this chapter include:

- Three decades of national leadership were documented.
  - Portugal has pioneered Ocean Literacy (OL) in Europe since 1990.
  - The chapter analysed 114 initiatives across academia, government, NGOs and private sectors.
- Academia and public organisations led most initiatives, demonstrating the importance of institutional diversity in sustaining long-term OL engagement and outreach.
- Collaborative programmes such as *Blue School*, *Educar para uma Geração Azul*, *CIIMAR at School*, and *O MARE Vai à Escola* advanced the integration of OL into school curricula through hands-on, inquiry-based learning.
- Most initiatives employed practical, participatory activities, such as fieldwork, creative arts, and co-creation projects, promoting emotional connection and active participation.
- Portuguese initiatives favored OL Principles 5 (*Biodiversity*) and 6 (*Human Interconnection*) to align with national curricula, while Principles 3 and 4 (*Climate* and *Habitability*) remain underrepresented.
- Programs strongly emphasized *Sustainability* and *Science* perspectives, while *Gender Equality* and *History* perspectives were less

addressed, indicating opportunities for a more holistic approach.
- Emphasis has been on *Knowledge*, *Awareness* and *Empathy* dimensions. *Activism* (encouraging tangible behaviour change) was least explored, highlighting a need to move from knowledge to action.
- Initiatives demonstrate robust connections to SDG 14 (*Life Below Water*) and SDG 4 (*Quality Education*), and to Ocean Decade Challenge 10 (*Restore Society's Relationship with the Ocean*), with growing engagement toward Challenges 1 and 2 on pollution and biodiversity.
- Key barriers include logistical constraints, limited funding, human-resource instability, and maintaining visibility and participation. These point to the necessity of sustainable financial models and adaptable project design.
- Long-term success relies on stable funding, integration into existing structures (e.g. curricula, strategic plans), community partnerships, and continuous monitoring and evaluation.
- Only 30% of initiatives included systematic evaluation, revealing an urgent need for impact assessment frameworks to guide improvement and ensure accountability.
- Portugal's experience provides a replicable model for building a national Ocean Literacy framework, linking education, science, and community engagement to the Ocean Decade's transformative goals.

16.5.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Blue School Program (Portugal): https://escolaazul.pt/en
- Educar para uma Geração Azul: https://geracaoazul.org/
- CIIMAR at School: https://www.ciimar.up.pt/projects/ciimar-at-school/
- UNESCO Chair Ocean Expert: http://www.Oceanexpert.ciimar.up.pt/
- MARE Vai à Escola and other MARE Educational Programmes: https://www.mare-centre.pt/en/society/educational-programs
- Coastwatch Portugal: https://coastwatch.pt/
- Kids Dive: https://www.kidsdive.org/

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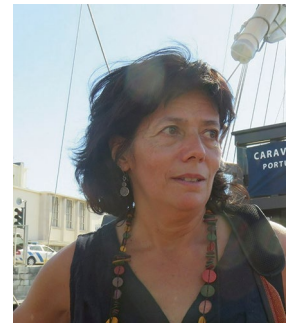
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17 The BlueSchoolsMed Project Experience: An Overview of the Conception, Implementation, Evaluation, and Dissemination of the "Blue Challenges" within Mediterranean Schools

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Abstract

Within the framework of the UN Decade of Ocean Science for Sustainable Development, alongside the EU efforts to promote Ocean Literacy (OL) across Europe (EU), and in line with the EU4Ocean Ocean Literacy Coalition, the Erasmus+ BlueSchoolsMed mobility proj-

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ect entitled "*Supporting the development of socially inclusive Blue Challenges in schools in the Mediterranean Sea basin*" (2020–2023) was designed and implemented to integrate the OL principles into school curricula. Ten partner institutions from Italy, France, Greece, and Malta worked together with teachers and students from 19 pilot schools to test innovative educational methods and activities focusing on sea-related topics. The three-year project was implemented in four phases: Conception, Implementation, Evaluation and Dissemination.

Despite the challenges imposed by COVID-19, the project succeeded in implementing its mobility activities (transnational partner meetings, training workshops for teachers and students, and public dissemination events) engaging partners, teachers, students, maritime stakeholders and high-level representatives of educational communities and international organizations. This chapter provides an overview of the challenges, lessons learnt, and recommendations derived from the project implementation, which can inform future Ocean Literacy initiatives in the Mediterranean.

Keywords

Ocean Literacy (OL) · Mediterranean Sea · Blue Schools · Sustainability education · Blue Challenges · NEBS

17.1 Introduction

Within the context of the UN Decade of Ocean Science for Sustainable Development (2021–2030), Ocean Literacy (OL) has been integrated as a fundamental component to achieve its vision, emphasizing the progression from awareness to behavior change in driving action towards Ocean sustainability (UNESCO 2021). In parallel with this growing recognition, OL gradually made its way to European policies, with multiple funds supporting the promotion of OL (Horizon 2020, Green Deal, EU Missions, etc.) and directed to projects such as SeaChange, ResponSEAble, BlueLightS, ProBleu, SHORE (information about each project can be found in the resources section). In fact, one of the significant milestones on a European level was the establishment of the EU4Ocean coalition in 2020, made up of three main components: The EU4Ocean platform, the Youth4Ocean forum and the Network of European Blue Schools (NEBS) (European Commission n.d.).



Fig. 17.1 The BlueSchoolsMed project logo

It is within this framework that the Erasmus+ BlueSchoolsMed project "Supporting the development of socially inclusive Blue Challenges in schools in the Mediterranean Sea basin" was developed (Fig. 17.1), with the objective to integrate the OL principles into Mediterranean school curricula. Ten partner institutions from four Mediterranean countries (Italy, France, Greece, and Malta) worked together with teachers and students from 19 pilot schools to design, implement, evaluate, and disseminate Ocean-related projects (Fig. 17.2).

The main project objectives were to: (a) increase students' understanding of the marine environment, the threats it is facing, and the need for sustainable management of its resources; (b) develop a sense of responsibility within the schools' ecosystems, promoting eco-citizenship and ownership in regard to the coastal and marine environment; (c) design multidisciplinary educational tools and OL resources that can be used by teachers of the Mediterranean Regional Sea Area (RSA) and beyond; (d) elevate the conversation



Fig. 17.2 Location map of the BlueSchoolsMed project's pilot Mediterranean schools

by engaging maritime stakeholders and policymakers.

The BlueSchoolsMed project lasted three years (2020–2023) and was implemented in four phases: (1) Conception: Planning the BlueSchoolsMed project activities; (2) Implementation: Designing and delivering the Blue Challenges/projects; (3) Evaluation: Assessing the impact of the Blue Challenges; and (4) Dissemination: Sharing the results of the project.

This chapter follows the same structure, outlining the key challenges and success stories experienced throughout the three years, and concludes with a list of targeted recommendations.

17.2 Conception Phase: Planning the BlueSchoolsMed Project

17.2.1 The BlueSchoolsMed Project Design

Based on the EU4Ocean objectives and the guidelines of Network of European Blue Schools (NEBS), as well as the Erasmus+ mobility requirements, the conception phase started by setting a detailed planning of the BlueSchoolsMed three-year activities, milestones, events and outputs.

To launch the project on the right track, the project team met regularly with invited teachers and principals of the schools involved. This step consolidated the consortium of partner institutions and helped to define their specific roles within the project and share their practical experiences in Mediterranean contexts.

This phase allowed the project team to explore collaboration opportunities and understand the challenges that teachers and schools could face in the process of joining the NEBS. This preliminary diagnostic revealed that teachers needed incentives, resources and recognition to remain engaged for the project's duration. It also helped in mobilizing schools and students that wished to be involved, and setting the stage for the upcoming activities' implementation.

The main output of this phase was the development of a guiding document, "The Mediterranean Blue challenges framework" which prepared the groundwork for the concep-

tion, implementation and evaluation of the Blue Challenges within the pilot schools (Alvisi et al. 2022).

17.2.2 The Project Framework

The BlueSchoolsMed project's core principles co-construction and co-design of the Blue Challenges, interaction and proactivity, inclusiveness, and sustainability guided the development of the framework document. The framework was further informed by the collection and validation of existing practices in "bringing the sea" to schools. As a starting point, the project team conducted an initial analysis of the resources and tools available at the EU and International level, focusing on content that teachers and educators can rely on to help schools join the NEBS. A handbook for teachers, previously published by the NEBS (Copejans et al. 2020) served as an initial key reference for the project activities.

The framework first defined the Blue Challenges and their scope, then proposed tools and methods for monitoring and evaluation, and finally outlined a roadmap for the development and implementation of the Blue Challenges.

The purpose of the Blue Challenges was to:

- Identify an Ocean-related topic, such as a good or a service that the Ocean provides for human daily life (e.g., fisheries/aquaculture, tourism/recreation, chemical/pharmaceutical products, biology/biotechnology, raw materials, climate/water cycle regulator, etc.), or a human activity that affects the Ocean (e.g., sand/mineral/oil extraction, overfishing and intensive aquaculture, pollution, eutrophication, transport, etc.);
- Co-develop a school project together with a local partnership (i.e., marine scientist/s, stakeholder/s, decision maker/s, etc.); and
- Communicate and share the school project with the society and the local community.

By bringing Blue Challenges into schools, teachers were encouraged to help students develop a stronger connection with the Ocean and marine ecosystems, whether their school is located by the sea or hundreds of kilometers inland. The objective was to increase the students' understanding of Ocean processes and the related issues, impacts, challenges, and threats that it is facing, while fostering a sense of responsibility to take action that support the protection and sustainable management of the Ocean.

The next step was proposing criteria for monitoring and evaluating the Blue Challenges to assess their added value and potential benefits. This required an understanding, from a teacher's perspective, of the most effective strategies for integrating OL into schools and, on that basis, define the steps to achieve this goal and support them in implementing these actions.

A survey was conducted among teachers from the pilot schools to identify their needs for setting up their own blue pathways at their schools, and a list of pros and cons for teachers' participation in the NEBS was compiled. The results indicated that many teachers, especially those participating for the first time, preferred to have a pre-established reference framework with clearly defined, transparent rules of participation and evaluation from the outset.

As such, a methodological path was proposed, structured around specific objectives:

- Align the educational pathways with the Agenda 2030 of the UN Sustainable Development Goals (SDGs), specifically target 4.7 on Education for sustainable development and global citizenship, empowering students and helping them to develop a sense of community;
- Provide training for Blue School teachers (and science animators/educators) on OL principles and concepts in general, with a specific focus on Mediterranean issues;
- Visualize the "big picture", or the spatio-temporal context in which the chosen Blue Challenge is situated;
- Encourage multi- and interdisciplinarity approaches;
- Strengthen critical thinking, scientific inquiry, and citizenship-related transversal skills (e.g.

problem solving, team building, participatory approach and discovery learning);
- Create shared OL resources and materials that teachers can use in schools at the Mediterranean RSA level as well as at European and international levels;
- Foster multi-level networks within the school, across local communities and among Mediterranean schools, with the aim to build local "blue" learning communities; and
- Promote the participation of the wider school community including teachers, students, principals, parents and family members.

17.3 Implementation Phase: Designing and Delivering the School Projects

17.3.1 Co-Designing Projects within Mediterranean Schools

Based on the Mediterranean Blue Challenge Framework document (Alvisi et al. 2022), partners, teachers and students from the four pilot countries were engaged in the co-design and implementation process of 19 Blue Challenges. The school projects are listed in Table 17.1. A detailed description of each of the projects is available online (see the resources section for more information).

To facilitate the co-design process, several communication channels were utilized during the project and varied across the four pilot countries. They ranged from in-person exchanges (events and meetings, personal communication, brochures, roll ups and multilingual flyers distribution, etc.) to online tools (school websites, e-mail lists, newsletters, interactive boards (e.g., Padlet), online storage platform, social media (e.g., X—formerly Twitter, Facebook, WhatsApp chats, etc.).

17.3.2 Engaging Teachers, Students and Marine Stakeholders

In addition to national school activities, three in-person training workshops were organized throughout the project, aiming to facilitate a direct exchange first between partners and teachers and subsequently with students' representatives. The workshops sought to expose students to different Mediterranean ecosystems and maritime activities across the host countries, as well as to the associated threats and challenges. This was achieved through a range of Ocean Literacy activities including field-based games, laboratory experiments, guided visits to local aquaria and museums, and excursions to beaches, natural caves and Marine Protected Areas (MPAs).

It is worth mentioning that the COVID-19 pandemic and its restrictions strongly disrupted the mobility activities, which required devising immediate alternatives. Additionally, the conflict between Russia and Ukraine in 2022 raised safety concerns regarding students' mobility, which also affected the attendance of almost half of the expected participants (French and Maltese students mainly). As a result, some of the in-person meetings and training workshops were organized online, or in a hybrid format. The three training workshops and their activities are summarized in Table 17.2.

The first training event (C1) was supposed to bring together partners and teachers from the four countries in one single transnational event but was replaced instead by national training workshops organized in Greece, Italy, Malta and France. While most teachers expressed their enthusiasm and interest through exchange with their peers, they also shared their doubts and concerns.

The COVID-19 pandemic adaptation measures often meant additional work to teachers and project partners alike, with little to no time allocated to extracurricular/outdoor activities, which are the core of the BlueSchoolsMed project. The challenge was to design an interactive and engaging project while ensuring the safety of the students. Additionally, teachers participated in this project to learn from other Mediterranean countries' context, explore new educational paths and innovative materials, and the COVID-19 restrictions certainly were a hindrance to this objective.

Table 17.1 List of blue projects designed and implemented by the BlueSchoolsMed participating schools

Country	City	School name (participants' age range)	Title of project
France	Villefranche-sur-Mer	École élémentaire Joseph Caldéroni (ages 6–11)	Adopt a float
	Marseille	École de la Roseraie (ages 8–9)	EMA of Anse de la Fausse-Monnaie
	Marseille	École Monnaie des Accoules (ages 9–10)	EMA of St. Estève
	La Ciotat	École Louis Marin (ages 10–11)	EMA of Grand Mugel
Greece	Alexandroupolis	6th Elementary School of Alexandroupolis (ages 9–10)	Tracing the invasive blue crab species (North Aegean Sea)
	Gournes Pediados	Elementary School of Gournes Pediados, Heraklion, Crete (ages 11–12)	Spot the alien Blue Crab: *Portunus segnis* (Cretan Sea)
	Alexandroupolis	11th Elementary School of Alexandroupolis (ages 11–12)	Getting acquainted with a typical Mediterranean estuarine system
	Korydallos, Athens	8th Junior High School of Korydallos (ages 12–15)	Robyssey
Italy	Quarto, Naples	Istituto Comprensivo Statale 3° Gadda—Middle school (ages 11–15)	No man is an island
	Lugo di Vicenza	Istituto Comprensivo Statale Bernardino Nodari—Middle school (ages 11–15)	The Mediterranean dream—A trip through the Mediterranean
	Rome	Ente Nazionale Giuseppini del Murialdo (Engim)—San Paolo (ages 14–18)	Blue Heart
	Forlì	Istituto Tecnico Tecnologico Statale Guglielmo Marconi (ages 14–18)	W.A.Te.R.—What A Teal Renewal
	Alghero	Istituto Istruzione Superiore Enrico Fermi (ages 14–18)	Sea in a bottle
	La Spezia	Istituto Istruzione Superiore Capellini-Sauro (ages 14–18)	ML-CSA—Study the Marine Litter dispersion: Citizen Science Application case
Malta	Mellieħa	Maria Regina College Mellieħa Primary School (ages 10–11)	Sea life
	Birkirkara	St Monica School (ages 11–15)	Sea vegetable use in food preparation
	Birkirkara	St Aloysius' College Secondary School (ages 11–14)	Raising awareness on local fish
	Mosta	Maria Regina College Mosta Secondary School (ages 13–16)	*Kahooting* our way through the sea
	Tarxien	St Thomas More College Ħal Tarxien Middle School (ages 10–12)	Fishing—a way forward

Table 17.2 Detailed list of training workshops that took place during the BlueSchoolsMed project including objectives, activities and number of different participants

Title	Objectives and participants	Activities	Location and date	No. partners	No. educators	No. students
C1—Learning, co-building and training	**Objectives**: To set a benchmark based on previous experiences **Participants**: Partners and Teachers	- Presentation of project framework and the Ocean Literacy communities; - Sharing experiences with teachers; - Free expression space for teachers; - Defining expectations and outcomes (for project implementation, communication); - Sharing educational content and materials	Italy	6	6	–
			France (hybrid)	5	7	–
			Greece	5	5	–
			Malta	4	11	–
C2—Transnational training of student ambassadors and teachers	**Objectives**: To set prerequisites; To create links between the different countries; To define online tools and instruments **Participants**: Partners, Teachers and students	- Guided tour at the Cretaquarium; - Field work (beach); - Laboratory activities (Cretaquarium); - Public presentations (by students); - Guided visit of the Heraklion Archaeological Museum; - Peer to peer workshops	Greece (Crete)	10	23	20
C3—Transnational training workshop	**Objectives**: To summarize lessons learnt; To identify key messages and recommendations **Participants**: Partners, Teachers and students	- Visit the National Institute of Oceanography and Applied Geophysics (OGS); - Public presentations by students; - Games for all ages; - Peer-to-peer workshops - Guided tour at the Giant Cave; - Guided tour at the BioMa Museum; - Guided tour at the Miramare Marine Protected Area	Italy (Trieste)	12	20	28

For the second and third training events, funding was only available for a limited number of students. Based on the framework guidance, students that attended were elected in a democratic process within the classroom but also had to adhere to certain criteria. Besides being actively involved in the project, participating students had to commit to representing their schoolmates, present their school projects in public during mobility activities, and report back their activities when they return home.

During the second training event (C2) that took place in Crete (May 2022), the students worked on their projects alongside their Mediterranean peers and were encouraged to use artistic expressions to present their work (visual artwork, music and dance). Teachers and project partners discussed for the first time in person the lingering issues related to the project's objectives (Koulouri et al. 2022a). During the third training event (C3) that took place in Trieste (March 2023) where partners, teachers and students met to present the school projects' outcomes, evaluation boards were tested to gather feedback from participants on the spot. In both training events, host partners organized indoor and outdoor activities, including guided visits and beach workshops (Figs. 17.3 and 17.4).

17.3.3 Key Messages from the Activities' Implementation

The success of the BlueSchoolsMed project implementation was driven by key enabling factors. Central to that was the ability to generate interest in the educational challenge, effectively motivating teachers and fostering collaborations. Previous successful partnerships with institutions and organizations were leveraged, along with the use of best practice and lessons learnt. Teachers' existing expertise provided a solid foundation for achieving the project's objectives, while students expressed a heightened sense of agency through the assignment of roles that encouraged active participation. Additionally, the continuation of certain initiatives beyond the scope of the project supported sustained engagement and contributed to the development of a project-based community.



Fig. 17.3 Group photo following a beach activity addressing plastic pollution with students (Crete, May 2022)

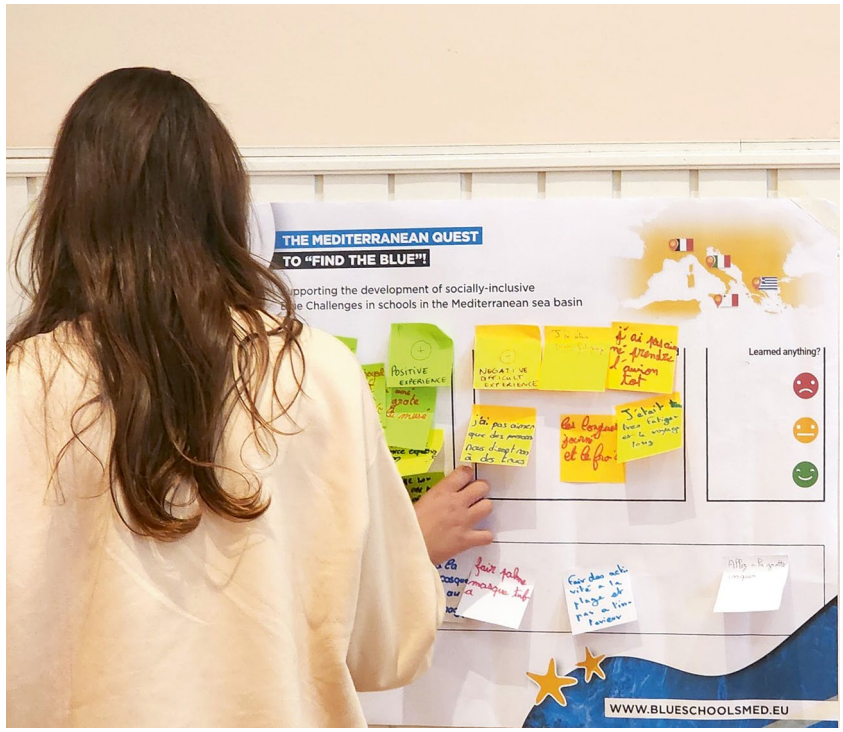


Fig. 17.4 Student adding her feedback on the evaluation board (Trieste, March 2023)

Notwithstanding these successful components, the project's full potential was hindered by a number of challenges. One of the main difficulties was adapting the existing school initiatives to fit the project's framework, timeline and working languages. Additionally, allocating sufficient time and space for OL activities within schools' schedules was complicated, especially during the COVID-19 pandemic. Primary schools generally found it much easier to integrate such activities as opposed to secondary schools. These constraints also further complicated the organization of mobility activities due to logistical challenges, bureaucratic hurdles, and the need for rapid adaptation to digital platforms for communication and project reporting. Other obstacles included navigating the differences across the four countries, namely regarding data protection regulations, the administrative procedures and permissions, as well as the varying degrees of flexibility in integrating OL within existing curricula.

17.4 Evaluation Phase: Assessing Impacts

Throughout the project, the pilot schools developed and implemented 19 Blue Challenges following the requirements of the NEBS and the guidance of the BlueSchoolsMed framework. Teachers and students also participated in several transnational training events organized by the project team. To analyze the impact and effectiveness of this approach, the project devised monitoring and evaluation tools for these pilot projects (Noon et al. 2023).

Three main evaluation tools were specially designed for this project and administered to the participants on different occasions and stages of the project and were coupled with teachers' personal class evaluation tools. The results will be presented in two parts: quantitative and qualitative analysis.

17.4.1 Quantitative Analysis

Two separate surveys were designed to target teachers and students, and they were distributed after the implementation of the Blue Challenges projects. Their content was translated and validated by a panel of marine scientists and educators, while descriptive statistics were applied to analyze the results.

17.4.1.1 Teachers' Survey

The teachers' survey included five sections, and a total of 81 questions. They consisted mainly of five-point Likert-type statements and open-ended questions to allow teachers to fully express themselves. Its four parts aimed to evaluate: (a) the context of the school projects' development, (b) the extent to which they responded to the initial framework's principles and guidelines, (c) the extent of the school project's impacts on students (and beyond), (d) the types of outputs produced and (e) the lessons learnt throughout the process. The surveys were shared through Google Forms.

Twenty-two teachers, the majority of which are working in primary education (54.5%) and teaching science and humanities courses, reported that their joint effort with the students highly achieved the pre-determined project principles, such as being sustainable, interactive and proactive, inclusive and democratic (mean values ranged between 4.27 and 4.41).

In regard to teaching methods, most teachers preferred employing multidisciplinary approaches, identifying challenges related to the sea, and organizing fieldwork activities (4.27, 4.14, 3.95, respectively; Fig. 17.5).

In terms of the impact of their "blue" projects, teachers positively rated the increase in students' knowledge and awareness of sea-related issues (4.64), their satisfaction with the projects' results, (4.59), the development of a sense of community within the classroom (4.45), and of responsible attitudes (4.36) (Fig. 17.6).

The results of the outputs produced during the implementation of the 19 projects were as follows: fieldwork activities (68.2%), creation of posters and videos/animations (63.6% and 59.1%, respectively), events (54.5%), artworks (45.5%), and educational tools (40.9%).

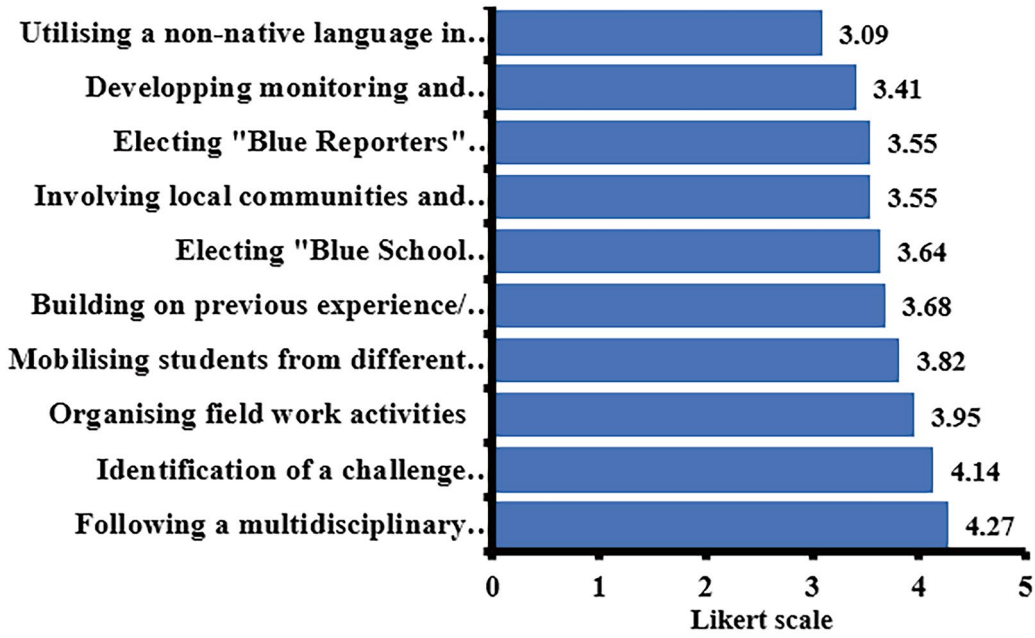


Fig. 17.5 Mean values of teaching preferences related to the sea as reported by teachers

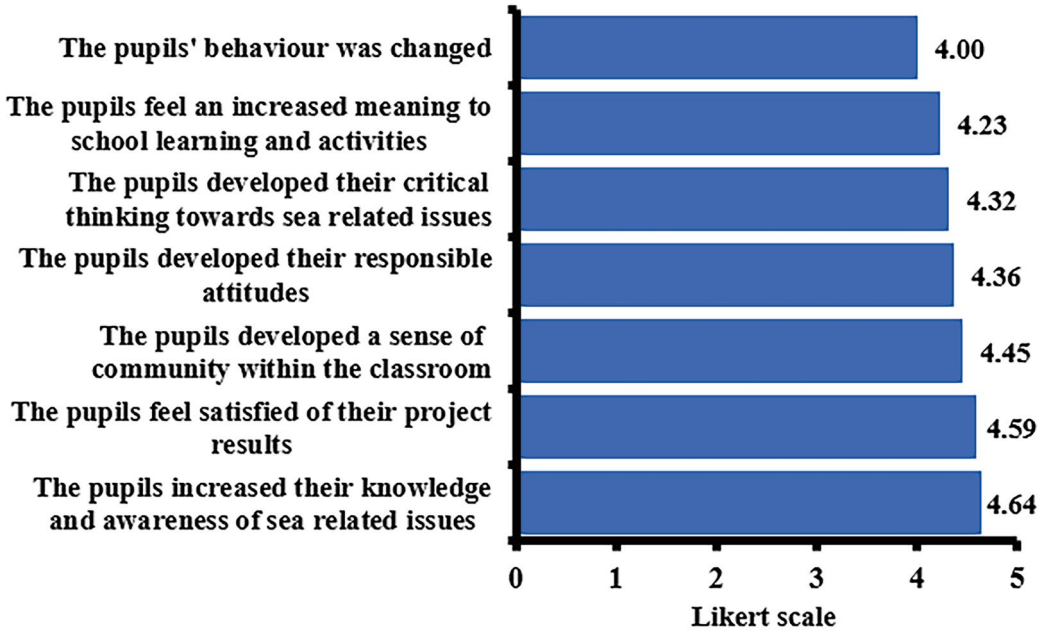


Fig. 17.6 Mean values of blue projects' impacts on students as reported by teachers

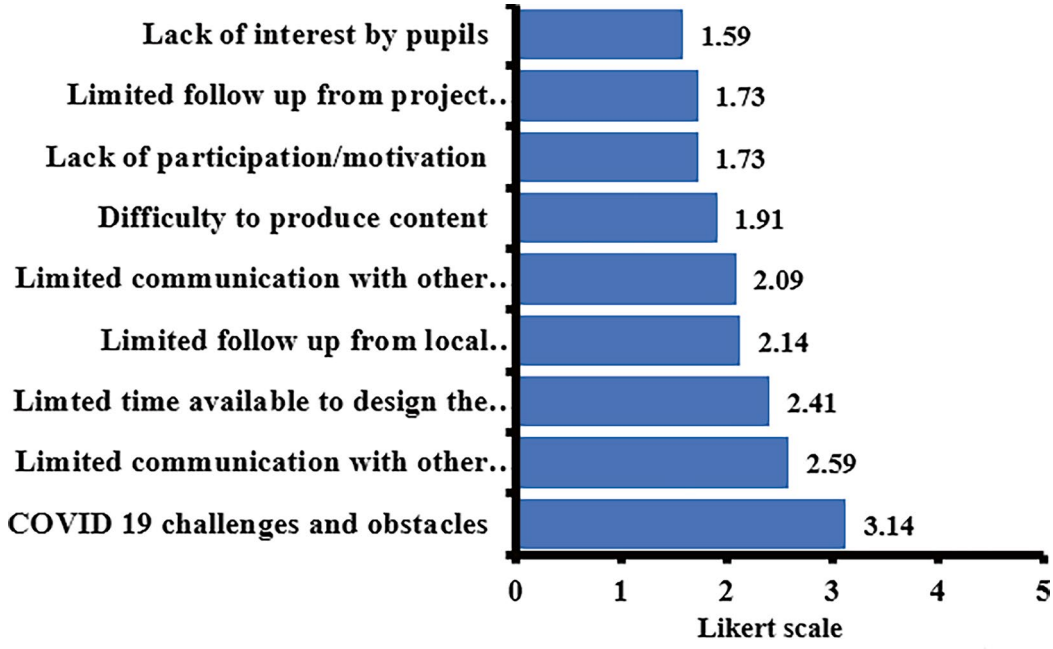


Fig. 17.7 Mean values on the challenges faced during the BlueSchoolsMed project as reported by teachers

All projects implementation faced several challenges, with the COVID-19 restrictions being the most important one (Fig. 17.7). Among the successful elements were the positive feedback received by students (4.59), the ideas and activities' originality (4.50), and the multidisciplinary aspect achieved (4.36) (Fig. 17.8).

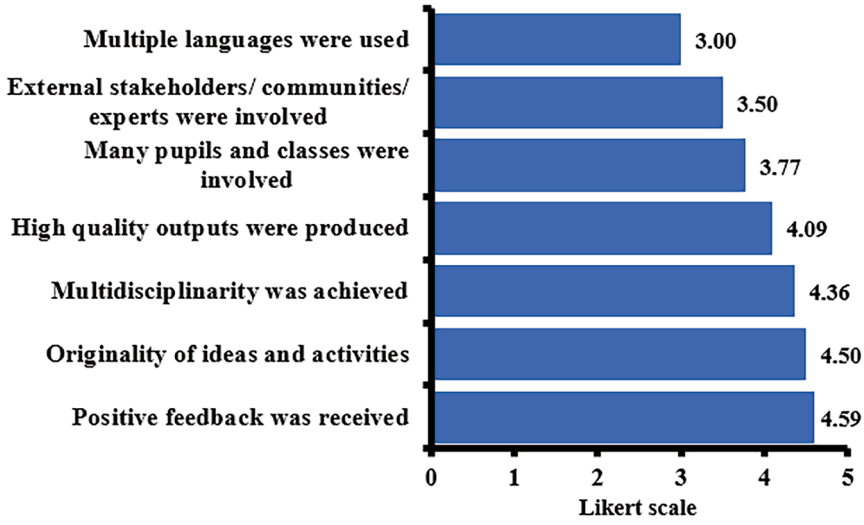


Fig. 17.8 Mean values on the elements that worked well during the BlueSchoolsMed project as reported by teachers

17.4.1.2 Students' Survey

The students' survey targeted both primary and secondary schools, and included four sections, and a total of 29 questions. These consisted of both closed and open-ended questions, five-point Likert-type statements, and a section for free expression.

The four parts aimed to evaluate (a) what students learnt, (b) what they think about certain statements, (c) what they do to protect the marine environment and (d) what they feel about marine related statements. The surveys were distributed in printed format for the younger students (primary schools) and in Google Forms for the older secondary level students. The wording used was simpler than the teachers' survey, with avoidance of jargon and technical terms.

In total, 230 students, aged between 9 and 19 years, participated in the survey from 18 primary and secondary schools, situated in 14 different cities within Greece, France, Italy and Malta. Slightly more than half of them were male students (53.9%) and about 83.7% of the students are living near the sea.

Just over half of the students (52.2%) had already participated in an activity about nature and the sea before this project. Students also stated that their teachers and the internet were their primary sources of information regarding nature in general as well as marine issues in particular (66.3% and 58.4%, respectively), and their favorite subject at school was Sports (44.9%) or Math (39.9%), while placing Civil Education (3.9%), Economics and Social Sciences (1.7%) last. It is worth considering that one of the reasons why social sciences and economics ranked low in this section is that primary schools were also involved in the survey, and these subjects are not part of their curriculum. Biology and Geography were deemed the two most important courses for learning about the sea, followed by History and Civil Education (Fig. 17.9).

The students were asked to express their feelings when thinking of the Ocean, and while working on the project. Regarding the former, they mainly felt peaceful and calm as well as happy and joyful (Fig. 17.10), while regarding the latter, happiness and joyfulness, along with fun and excitement, were the highest stated factors (Fig. 17.11).

After the end of the project, students reported increased knowledge of topics such as marine biodiversity, non-indigenous species, marine litter, sea currents and its physical/chemical parameters, etc. They also indicated improvements in their ability to collaborate with peers from other schools and countries and to share

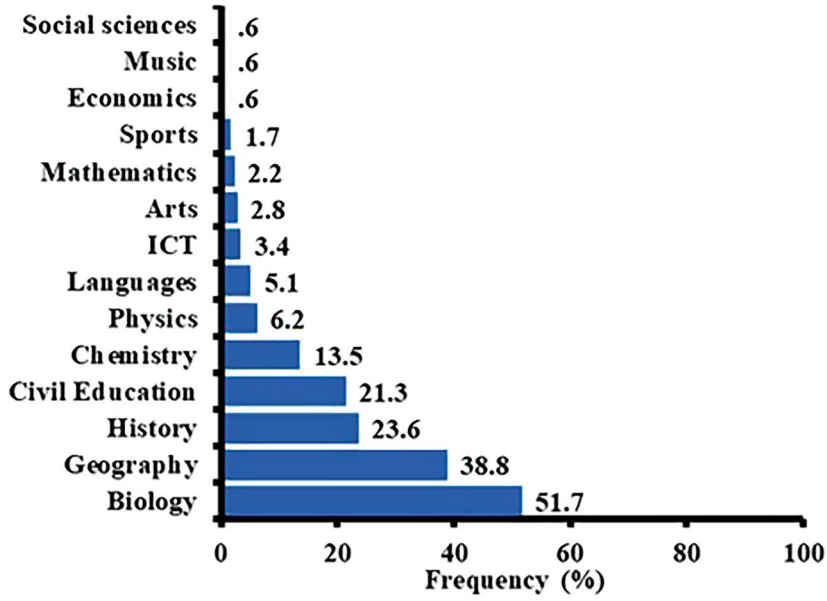


Fig. 17.9 Frequencies of school subjects teaching about Ocean issues

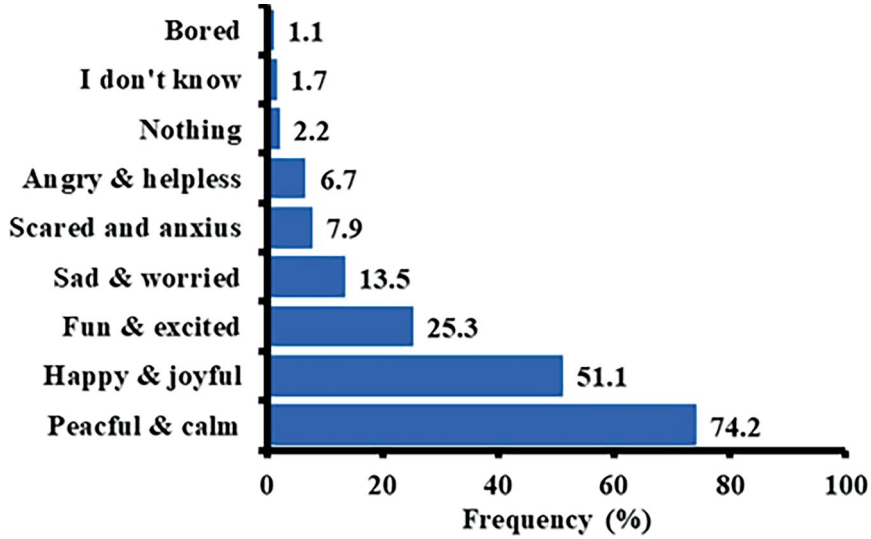


Fig. 17.10 Feelings expressed when thinking about the Ocean as reported by students

experiences across different contexts. In addition, students reported strengthened pro-environmental attitudes and more responsible behavior towards the marine environment, associated with an increased awareness of the vital role they can play as future active citizens.

17.4.2 Qualitative Analysis

Over the course of the three-year project, several transnational workshops and dissemination events were organized, involving both teachers and students from primary and secondary schools in a range of activities. To evaluate these events, the

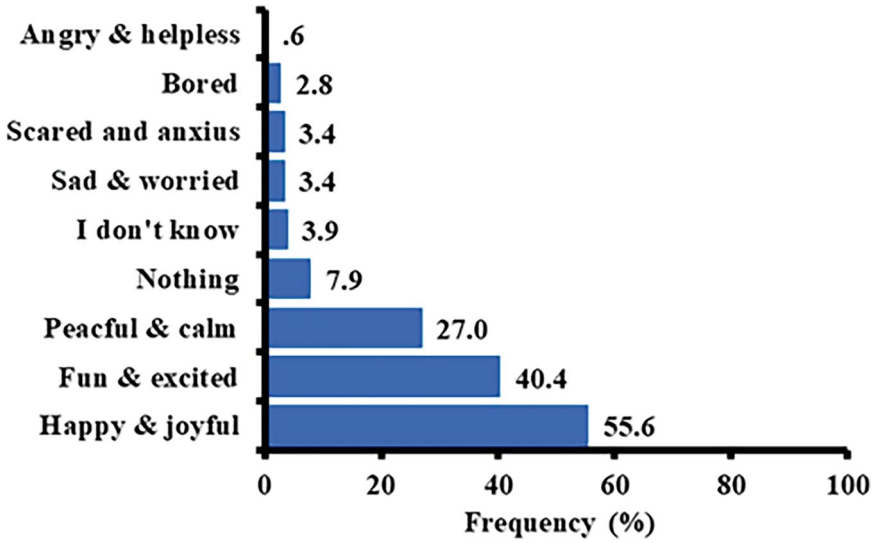


Fig. 17.11 Feelings expressed when working on the project as reported by students

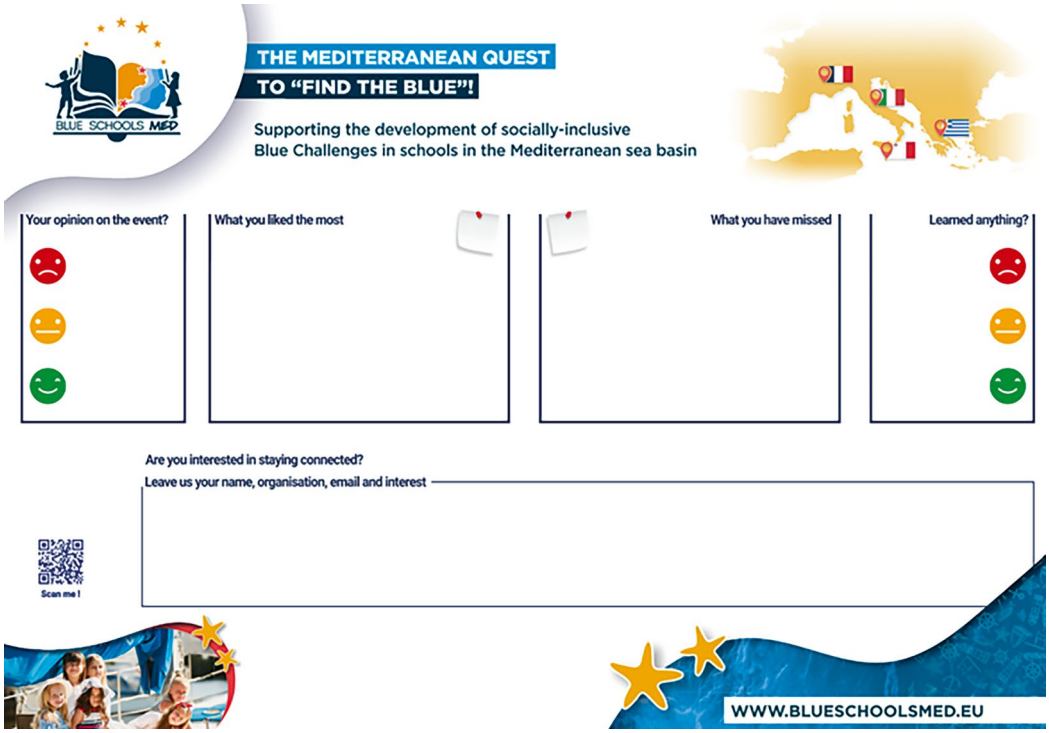


Fig. 17.12 Evaluation board sample used in in-person events and workshops organized by the BlueSchoolsMed project team

project team developed evaluation boards (Fig. 17.12) as a user-friendly qualitative and direct feedback tool. The boards featured simple and clearly formulated questions, and allowed participants to respond using post-it notes and stickers across five main prompts, providing immediate and interactive input. This approach helped the project team to identify which activities were per-

ceived as engaging, impactful and interesting, or conversely, less effective. In parallel, the team also drew on the assessments and feedback tools that teachers use routinely in their classrooms. Overall, results indicated a feeling of shared trust trust was felt by most of the teachers, although some expressed exceptional cases of limited follow-up from the project team.



Fig. 17.13 Drawing shared through the students' survey (6th grade student from Gournes school, Crete).

While EU national education systems have their own assessment rules for students and educational personnel, teachers also have the skills, the know-how and their specific methods to evaluate their students. This reflected trust in the teachers' existing methods and capabilities.

Many teachers agreed on the "Rubrics" methodology to evaluate the project's impact on students, and other innovative methods were also utilized, usually before and after the implementation of an activity to measure the difference (e.g., word clouds, drawings, writing exercises, presentations, etc.). The survey's final section offered the students a space for free expression through drawing and writing with sentences such as "*Life without plastic, is fantastic*!", "*I have the impression that I'm a multi-colored fish*" and "*This was an eye-opening experience, and it changed my perspective*" (Figs. 17.13 and 17.14).

17.4.3 Key Messages from the Evaluation Process

The BlueSchoolsMed project had a significant impact on both students and teachers. For students, the project facilitated reconnection with



Fig. 17.14 Word cloud generated from the student's survey based on topics that they would like to learn about in their next projects (words translated from all languages into English)

nature, allowing them to engage in sensory exploration of marine, coastal, and estuarine ecosystems through direct observation of marine life during field trips. They deepened their understanding of marine biodiversity through hands-on scientific experiments and laboratory visits, such as examining plankton samples using microscopes. This exposure enhanced their sense of responsibility toward the marine environment, particularly after learning about the various dimensions of marine protection. Students also acted as eco-citizens (supported by a successful example of Educational Marine Areas (EMAs) in France) and participated in beach clean-up campaigns. The projects integrated multiple subjects, including science, art, music, and geography, providing a well-rounded educational experience. Students were encouraged to express their creativity through artistic outputs such as music, dance, posters, and poems.

However, the evaluation revealed that students' knowledge of marine-related issues outside the formal curricula was limited, which affected the level of their pro-environmental attitudes and behaviors. This was echoed by several published research studies on students across the Mediterranean Regional Sea Area (RSA), including those by Cheimonopoulou et al. (2022), Koulouri et al. (2022b), Mogias et al. (2015), and Realdon et al. (2019).

Teachers, on the other hand, reported a high level of satisfaction with the project, as it helped them integrate Ocean Literacy (OL) into their teaching. Yet, they faced challenges related to adapting the project's framework to existing school structures, including time constraints, administrative hurdles, and varying levels of support for OL integration across countries. These challenges highlight their need for continuous support and recognition throughout the project.

As for the evaluation process itself, the experience provided valuable insights into its effectiveness. The project team noted the importance of establishing the evaluation process early on and communicating it clearly to educators to support alignment and transparency. Surveys were used at various stages of the project to collect both quantitative and qualitative data from students and teachers.

A key lesson learned was the need to tailor wording, content, and survey formats to the educational level of the students (primary or secondary), but also to adapt the expected outputs. Various factors, such as differences in educational contexts and language barriers, the number of students within each country and the age group highly influenced the results. As such, the project team emphasizes the need for critical reflection on the results and for reviewers to account for these influencing factors.

The findings from the mixed evaluation tools were first disseminated within the BlueSchoolsMed educational communities and key stakeholders, such as Ministries of Education, through national and international multiplier events (see next section). Beyond the framework of the project, the project team continues to share the lessons learnt to inform future OL initiatives and to ensure broader application and sustainability of the project's approach and an overall improved evaluation approach in future projects.

17.5 Dissemination Phase: Sharing Results

To mark the end of the Blue Challenge projects' implementation, dissemination events (referred to as multiplier events) were organized first on a national level (in France, Greece, Italy, and Malta), and later, an international level (Mediterranean). The objectives of these events were to showcase the activities and results of the BlueSchoolsMed project to other students, teachers and educational stakeholders of the four countries, and to work towards the widespread integration of blue education within their different curricular systems. (Table 17.3)

In the national events, the discussions prioritized the integration of students' perspectives into educational strategies, highlighting the importance of giving them a significant voice in shaping future educational frameworks. Additional covered topics included the importance of first-hand strategies and meth-

Table 17.3 List of multiplier events that took place during the BlueSchoolsMed project, including activities and number of participants

Multiplier event (ME) *(& location)*	Activities	No. of participants
French National ME *(France)*	Public presentations; World Café; Story telling pairs; Samoan circle discussion; Games; Theater show; Field activity in the local Educational Marine Area (EMA) of La Fausse Monnaie	13 partners; 7 teachers; 5 educators/scientific advisors/artists; 6 local stakeholders; 10 students; 5 parents
Greek National ME *(Greece)*	Public presentations; Hand crafts exhibition; Board games demonstrations; Digital application demonstrations	4 partners; 30 teachers; 20 students; 6 local stakeholders
Italian National ME *(Italy)*	Public presentations; Thematic workshops; Science fair	4 partners; 29 teachers; 20 students; 7 local stakeholders
Maltese National ME *(Malta)*	Digital tools demonstrations; Quizzes and games; Video screenings; Aquarium tour	8 partners; 16 teachers; 178 students; 14 local stakeholders
Mediterranean ME *(France)*	Panel sessions: - BlueSchoolsMed' process and results - BlueSchoolsMed' experience - Blue Schools examples and best practice - High level Blue Schools roadmap discussion Pupil activities: - Movie screening; - Workshops; - Speed meetings; - Student-led exhibition Guided excursions: - Educational Marine Area (EMA) of Frioul island - Guided visit of Cosquer Cave Museum	138 total participants including: 16 teachers; 89 students; 33 stakeholders

ods in scientific research and the formation of local community networks in synergy with the global landscape. The discussions also brought to light significant challenges, such as the necessity of more inclusive dialogues with students, enhanced support and recognition for teachers, and stronger interactions with policymakers to ensure the comprehensive incorporation of marine themes into national educational curricula. While the four countries' host institutions followed a unified agenda structure defined by the project coordinator, they also had the liberty to integrate different formats of workshops and educational activities (Fig. 17.15).

The Mediterranean event officially brought the project to an end, with a wide array of activities such as panel discussions, student-led exhibition, and outdoor excursions which took place over the course of three days.

Panel discussions between partners, teachers, experts, educational authorities' representatives and high-level speakers moved from the local level projects to the national ministries and educational representatives, going through Mediterranean RSA and EU and ended with a high-level international conversation. The discussion mainly addressed challenges and enablers for bringing the Ocean into classrooms, as well as targeted questions on the possibilities



Fig. 17.15 Theater of objects centered on the life cycle of a water drop, during the French multiplier event (Marseille, May 2023)

and roles of collaborations and networks on national, regional and EU scales. The sessions spotlighted similar OL initiatives from Egypt, Lebanon, Cyprus, Spain, and Finland, sharing experiences in spreading OL through various activities in different cultural, political and environmental contexts.

The two-day student-led exhibition displayed the three-year project outputs, where students presented the projects to participants through a "speed meeting" format. It was the highlight of the event as it reflected a high level of creativity and enthusiasm by the students, but also by external visitors (Figs. 17.16, 17.17, and 17.18).

Two excursions were organized during the event. The first one was to Frioul island, where one of the project's Educational Marine Areas is located (EMA St. Estève). The students from the local participant school presented their project and shared their learning outcomes (Fig. 17.19). The second guided tour to the Cosquer Cave Museum is noted for its pre-historic art and its unique geomorphology. These two trips exposed students and participants alike to diverse Mediterranean ecosystems and educational interventions.

While some logistical and organizational challenges were noted (linked to budget constraints, language barriers, safety of minors and travel issues), the event was deemed successful and useful by most participants. Key messages that emerged from multiplier events are integrated into the final section's recommendations.

17.6 Conclusions: From Challenges to Recommendations

The project's success was linked to several factors such as its international dimension, its experimental/transformative teaching methods and learning experiences, its multidisciplinary approaches as well as the promotion of (eco)citizenship, inclusiveness, participatory democracy and collaborative work. Rooted in a student-centric ethos and guided by Education for Sustainable Development (ESD), the project serves as a model for fostering empowerment and critical thinking among students.

However, the project implementation also faced its challenges. To begin with, COVID-19



Fig. 17.16 Board game designed by Italian students from Naples and presented at the Mediterranean Multiplier event (Marseille, May 2023)

was the first constraint that affected the entire project design, execution, budget utilization and mobility activities' organization. Aside from that, the different stakeholders experienced the project quite differently.

The project partners mostly struggled with administrative and bureaucratic issues while working with schools and throughout the events' organization, especially with traveling minors—a challenge that needs to be taken into consideration for similar mobility projects.

Teachers expressed limited confidence in addressing complex sea-related topics, but also an overall feeling of being undervalued. There was a sense of confusion amid the many EU education policies and rules, as well as communication difficulties linked to language barriers, which hampered the multi-cultural exchange opportunities among peers.

As for the students, there seemed to be a clear disconnection with nature, which was broken once they were on the field. Language barriers were also notable mostly among the younger students.

To better navigate such challenges, and to promote the enabling factors that drove the success of the project, below are some suggested recommendations aiming to support the successful uptake of Blue Challenges in Mediterranean schools (and beyond). They are the result of three years of exchanging experiences, raising debates, designing activities, facing challenges, organizing trips, events and training workshops and as well as collecting input from all project stakeholders. Recommendations cover several dimensions of the educational process, namely: (1) Policy, (2) Curriculum, (3) Teacher support, (4) Students engagement, and (5) Communication.

1. Policy. On a policy level, institutional support should be provided to build connections between formal and non-formal education entities (including research centers, scientists, academia, and national educational systems), as well as adequate school twinning and collaboration initiatives. In parallel, the Network of European Blue Schools (NEBS) could be

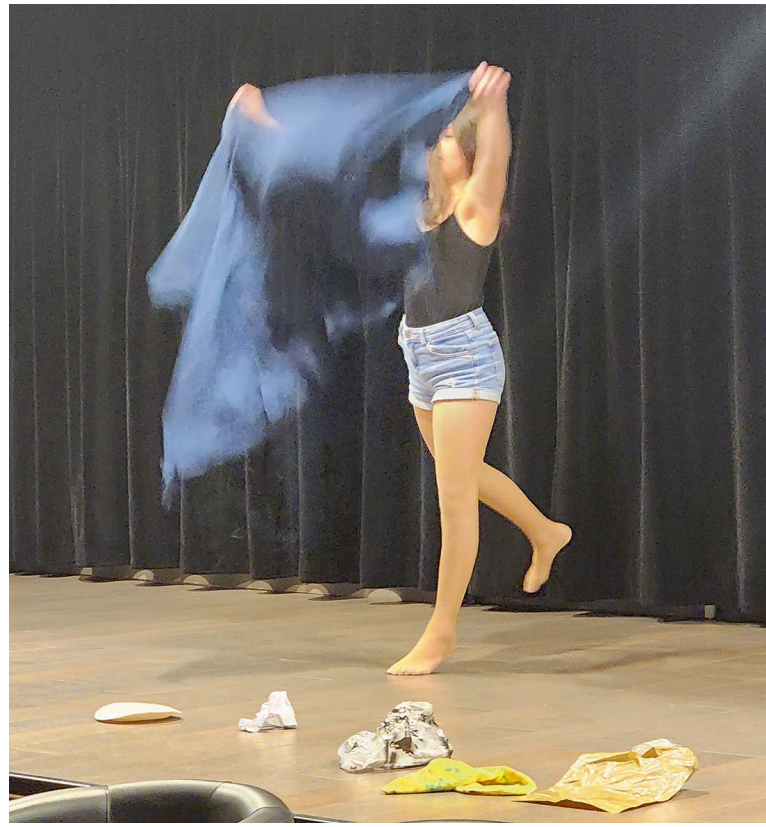


Fig. 17.17 Expressive dance by Greek student from Crete during the Mediterranean Multiplier event opening session (Marseille, May 2023)

strengthened through training opportunities, exchange programs, and funding mechanisms for multidisciplinary and international projects. Funding should be tailored to the receiving entity, and access/applications ought to be simplified to reduce bureaucratic hurdles. Formalizing these collaborations, through official agreements, for instance, will ensure effective teacher engagement, with funding and curricular recognition for the research partners and scientists involved. Within these agreements, clear expectations must be defined from both sides to ensure successful outcomes.

2. Curriculum. On the pedagogical level, several actions could be undertaken to render the curricula more inclusive of Ocean/environmental considerations. First, integrating, to the best extent, Sustainable Development Goals (SDGs) and Ocean Literacy (OL) into national school curricula as cross curricular themes (from kindergarten to secondary school), particularly SDG13 "Climate Action" and SDG 14 "Life under water". As such, marine topics would gain prominence alongside primary and other environmental education subjects. Experts are encouraged to take note of the different needs between primary and secondary school levels in terms of content development and pedagogical approaches. Moreover, a key recommendation is to promote cross-cultural exchange by increasing opportunities for collaboration between coastal/inland schools and across EU Regional Sea Areas (RSAs). The multicultural aspect of these projects could ultimately contribute to the joint conservation efforts of sea basins. Finally, the project fosters Open Schooling methods, where educational institutions partner and engage with families and local communities to enhance teaching and learning (Hazelkorn et al. 2015). This is accomplished by promoting flexibility, personalization, innovation, life-



Fig. 17.18 Students experiencing VR animations organized by Maltese schools in collaboration with the University of Malta (Marseille, May 2023)



Fig. 17.19 French student from Marseille explaining how to determine the seabed typology based on the visible shades of blue (Frioul island, Marseille, May 2023)

long learning (especially for teachers), collaborations, active participation and accessibility as a dynamic way to acquire knowledge, skills and values (Okada, 2023). This will ultimately lead to active citizenship in blue education, allowing teachers to freely experiment with various teaching and learning methods, according to their time and skills.

3. Teacher support. Teachers were the key driving force for achieving the project objectives and implementing/testing its framework. For that reason, giving them a voice and a space to express their needs was crucial, and became embedded in regular practice: they can be expressed in the following recommendations. First, it's important to provide targeted financing for school projects by facilitating access to EU, national and local funding opportunities, simplifying application and reporting procedures as well as ensuring that funds are reaching schools. Second, teachers need a supportive ecosystem around them. Creating a community of practice that brings together marine scientists and educators, NGOs, stakeholders and local communities in an educational network spread across territories can support teachers and students in their blue projects' development and implementation. Designing and delivering training programs for teachers in collaboration with research centers, universities and local networks is also recommended to enhance content knowledge, scientific methodologies and hands-on teaching. This will ultimately increase teachers' confidence in their capabilities to integrate Ocean related issues in their classroom. In fact, amid all the content being produced nationally and regionally, teachers require facilitated access to existing information and resources, which can be achieved by unifying online repositories where verified background knowledge is accessible and freely used to support teachers in their blue journey. Finally, helping teachers in the evaluation process by identifying evaluation metrics/indicators and by defining requirements once the project is closed.
4. Student engagement. Students are the project's main beneficiaries, and likewise, they are key to devising relevant and effective recommendations for future projects. What resonated the most with students is exploiting their natural curiosity by constructing a project with their interests in mind. Helping them rekindle their relationship with nature, focusing on field work and experimental activities proved to be a successful approach to help them retain information. Students also felt empowered by taking ownership of their blue projects and integrating digital tools or gamified elements to increase their engagement. Similarly, creating links with local communities by building/implementing the project with the help of families and friends, experts, and local stakeholders helped students to feel more engaged and committed to their local environment. This would serve as an introduction to eco-citizenship and as motivation to participate in similar initiatives beyond school hours.
5. Communication. In addition to implementing activities within schools, sharing outputs and results was a major significant outcome of the project. Communicating results in four countries and in five different languages presented its challenges. For this reason, overcoming language barriers could be achieved by using methods like games, interactive activities and performing arts to facilitate nonverbal cultural exchanges between the schools; by having interpreters at transnational events, especially to help younger students express themselves; and by integrating Ocean Literacy within English/foreign language school subject. Moreover, and to better transmit the knowledge, it is recommended to organize training courses, for both educators and students, on information/media literacy, journalism, science communication and content creation. Promoting collaboration between research centers and professional associations can improve their communication strategies and tools, fostering critical thinking about media, and developing content creation skills. This can subsequently contribute to a wider dissemination.

17.6.1 Summary

Key concepts explored in this chapter include:

- The BlueSchoolsMed project was built on international collaborations and a large network of educators, researchers and local stakeholders.
- The BlueSchoolsMed project combined traditional educational tools and Sustainable Development Goals to integrate Ocean Literacy into Mediterranean school curricula, in order to enhance students' understanding of the different marine environments, to foster eco-citizenship and to promote sustainable behavior.
- The BlueSchoolsMed project promoted the development of structured, multi/inter disciplinary and hands-on projects within Mediterranean schools to help teachers explore marine topics through multiple lenses. It encouraged the organization of fieldwork and outdoor activities, creative projects and peer-to-peer exchange to foster connection with nature while developing critical thinking towards the marine and coastal environments management.
- The BlueSchoolsMed project designed and tested evaluation tools tailored to teachers and students and included novel metrics (such as the emotional connection to the Ocean), and a space for free expression that added nuances to the quantitative results.
- The BlueSchoolsMed dissemination events provided a space for a student-led exhibition, which encouraged creativity, public speaking skills and decision-making roles within the schools. It also reached high-level representatives of ministries and international organizations to promote the integration of OL in national school curricula.
- The BlueSchoolsMed project team recommend simplifying funding application mechanisms for schools' projects, integrating sea-basin cross-cultural collaboration, increasing support and recognition for teachers, addressing language barriers for international exchange programs, and empowering students by encouraging leadership and agency within the classroom.

17.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- BlueSchoolsMed project website: https://www.blueschoolsmed.eu/
- Blue Challenges implemented throughout the project: https://www.blueschoolsmed.eu/wp-content/uploads/2023/05/blueschoolsmed-A4-projet-vF-web.pdf
- Example projects:
  - SeaChange: https://cordis.europa.eu/project/id/652644
  - ResponSEAble: https://responseable.acteon-environment.eu/
  - BlueLightS: https://blue-lights.eu/
  - ProBleu: https://probleu.school/
  - SHORE: https://shoreproject.eu/

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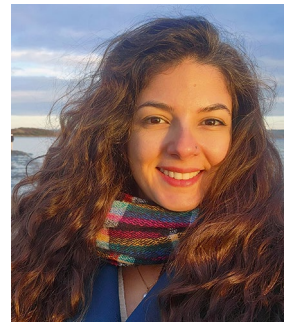
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18 Bridging the Knowledge Gap: Ocean Literacy as the Cornerstone for Achieving the UN Ocean Decade's Vision in the Arabian Gulf Region

Faiza Al-Yamani

Abstract

The Arabian Gulf region, with its distinctive marine biodiversity and vital socio-economic importance, faces escalating environmental challenges such as climate change, pollution, and habitat degradation. Ocean Literacy (OL) plays a pivotal role in addressing these issues by deepening public understanding of the Ocean's influence on people and the reciprocal effects of human activity. This chapter explores how Ocean Literacy can serve as a cornerstone for achieving the vision of the United Nations (UN) Ocean Decade for Sustainable Development (2021–2030) in the Gulf region.

It emphasizes the empowerment of individuals, communities, and policymakers with the knowledge needed to make informed decisions that support sustainable marine management and conservation. Drawing on examples of regional initiatives, educational programs, and awareness campaigns, the chapter highlights the need to bridge knowledge gaps and connect science, education, and policy. It further examines the alignment between national strategies and the Ocean Decade's objectives, identifying opportunities to enhance the integration of Ocean Literacy.

Finally, the chapter proposes a framework tailored to the Gulf context, centered on curriculum development, public awareness, and capacity building to foster a culture of Ocean engagement. Through these strategies, Ocean Literacy can advance the Decade's vision of a healthy, productive, and resilient Ocean in the Arabian Gulf region.

Keywords

Ocean Literacy (OL) · Marine conservation · Sustainable development · Knowledge gap · Environmental awareness · Marine ecosystems · Climate change · Biodiversity · Marine science education · Public engagement · Traditional knowledge

18.1 Introduction

All United Nations Member States adopted the 2030 Agenda for Sustainable Development in 2015 during the UN Sustainable Development Summit. This Agenda outlines 17 Sustainable Development Goals (SDGs), with SDG 14 specifically dedicated to protecting and conserving the Ocean, seas, and other marine resources (UNESCO 2019). SDG 14 addresses critical issues such as reducing the impacts of pollution, litter, habitat destruction, illegal fishing, and overfishing, as well as conserving marine pro-

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tected areas (MPAs) and enhancing the economic benefits derived from the Ocean.

To further these objectives, the United Nations launched the Decade of Ocean Science for Sustainable Development (2021–2030), often referred to as the UN Ocean Decade (IOC 2021). This global initiative seeks to reverse the decline in Ocean health by promoting international cooperation in Ocean science, knowledge-sharing, and actionable solutions. The Decade unites Ocean stakeholders worldwide behind a shared vision. Its goal is to ensures Ocean science supports sustainable development within the framework of the 2030 Agenda (UNESCO 2019).

The Ocean Decade also aligns with other international frameworks such as the Sendai Framework for Disaster Risk Reduction (UNDRR 2015), the Outcome Document of the Sustainable Development Conference (UNCSD 2012), the UNFCCC Paris Agreement, and the Call for Action of the United Nations Conference on SDG 14 (UN 2017). Its primary goal is to address the cumulative impacts of multiple stressors on marine environments by bridging critical knowledge gaps through comprehensive data collection, advanced technologies, targeted experimentation, and modeling that inform sustainable use and restoration of Ocean ecosystems.

Effective scientific communication and public awareness are vital to achieving these global ambitions. One key element of the Decade's vision is Ocean Literacy (OL), the understanding of the Ocean's influence on us and our influence on the Ocean. Ocean Literacy enables informed decision-making at individual, community, and policy levels, linking science with education and governance to foster long-term sustainability.

In the Arabian Gulf region, characterized by unique marine biodiversity, fragile ecosystems, and an economy deeply tied to coastal and offshore resources, bridging the knowledge gap through Ocean Literacy is essential. Challenges such as limited access to marine science education, fragmented communication between researchers and policymakers, and low public awareness hinder regional progress toward the Decade's vision. Strengthening Ocean Literacy across Gulf nations through integrated curricula, targeted outreach, and capacity-building initiatives can empower communities to participate in the collective effort to achieve a healthy, productive, and resilient Ocean.

This chapter therefore explores the current state of Ocean Literacy in the Arabian Gulf, focusing on existing initiatives, programs, and key stakeholders while identifying gaps and proposing strategies to enhance public understanding and engagement. Ocean Literacy in the Gulf is still developing, and while several initiatives exist, they remain fragmented across countries and sectors. Increasing Ocean Literacy requires collaboration among governments, educational institutions, non-governmental organizations (NGOs), and the private sector to empower individuals, communities, and policymakers with the knowledge and tools necessary to make informed decisions for sustainable marine management.

18.2 Current State of Ocean Literacy in the Arabian Gulf

The Arabian Gulf hosts a variety of rich marine ecosystems, including coral reefs, mangrove forests, seagrass meadows, oyster beds, and salt marshes, which are vital for both environmental and economic reasons. However, these ecosystems are increasingly threatened by overfishing, pollution, habitat degradation, and climate change. Consequently, Ocean Literacy is essential for the long-term preservation of marine biodiversity and the successful implementation of the UN Ocean Decade's goals in the region.

Formal education plays a vital role in fostering Ocean Literacy, and several Gulf countries have begun integrating marine topics into their school curricula. However, comprehensive and dedicated programs specifically targeting Ocean Literacy remain limited. For instance, in Qatar, environmental science is included in public school curricula, emphasizing local marine ecosystems such as coral reefs and mangroves and examining the impact of human activities on these ecosystems. Additionally, the Environmental Science Research Center at Qatar

University conducts research in various marine science disciplines, contributing significantly to regional knowledge. A notable initiative in Qatar is the UNESCO Chair in Marine Sciences, officially launched at Qatar University on 13 December 2020. This initiative focuses on the "oceanography of the Arabian Gulf, with particular reference to the exclusive economic zone (EEZ) of Qatar" (Qatar University 2024), highlighting the growing commitment to advancing marine science research in the region.

Universities across the Gulf Cooperation Council (GCC) region, including Kuwait University, the Arabian Gulf University in Bahrain, Sultan Qaboos University in Oman, King Fahd University of Petroleum and Minerals, King Abdullah University of Science and Technology in Saudi Arabia, Khalifa University, and the United Arab Emirates University, offer programs in marine biology and environmental sciences. While these academic programs contribute significantly to advancing marine research and knowledge within scientific communities, they often lack strong public engagement components to promote Ocean Literacy beyond academia. Addressing this gap requires a structured regional framework that prioritizes three interconnected strategies: (1) curriculum development, integrating Ocean Literacy themes across educational levels; (2) public awareness campaigns, using targeted communication approaches to raise understanding of the Ocean's significance; and (3) capacity building, equipping educators and policymakers with the tools to champion Ocean Literacy within their institutions.

Several national research institutions, such as the Kuwait Institute for Scientific Research (KISR), have established initiatives like the Coastal and Marine Resources Research Program and various outreach activities to enhance understanding of marine ecosystems. KISR actively participates in international environmental and conservation events, including World Ocean Day and World Environment Day, to raise awareness about marine sustainability. Notably, KISR recently published a scientific book (Al-Yamani 2021), which serves as a valuable contribution to the Ocean Literacy movement. Additionally, a series of educational books authored by Al-Yamani (2009a, 2009b, 2009c, 2009d, 2009e, 2009f, 2009g, 2009h, 2009i) were published earlier in both English and Arabic, focusing on marine biodiversity and conservation of the Arabian Gulf's marine environment. These were distributed to all government and private schools across Kuwait and made available in school libraries, ensuring widespread access to students and educators. This initiative reflects KISR's long-standing commitment to environmental education and its role in bridging the knowledge gap between scientific research and public understanding.

While formal education plays a role in building Ocean Literacy, non-formal and community-based programs are equally important in reaching a broader audience. Some Gulf countries have launched public awareness campaigns through the media, public talks, and interactive exhibitions. For example, the Scientific Center in Kuwait serves as a hub for environmental education enriched with knowledge of the marine environment.

National governments and environmental ministries are among the most influential stakeholders in promoting Ocean Literacy because they shape policy, legislation, and educational priorities. Environmental authorities across the Arabian Gulf have taken significant steps to raise public awareness about the marine environment. For example, the Environment Agency-Abu Dhabi (EAD) leads the Sustainable Marine Ecosystems campaign, which educates the public about marine pollution, overfishing, and the importance of marine protected areas through community workshops, media campaigns, and youth programs. Similarly, the Ministry of Municipalities Affairs and Agriculture in Bahrain manages coral reef restoration programs that have gained media attention, coupling conservation efforts with educational outreach to increase public understanding.

Non-governmental organizations (NGOs) are key drivers of Ocean Literacy efforts, leading public outreach, environmental advocacy, and community-based conservation programs. In

Kuwait, the Kuwait Environment Protection Society (KEPS), in cooperation with the Kuwait Environment Public Authority (KEPA) and KISR, plays a pivotal role in advancing environmental education and promoting Ocean Literacy. KEPS raises awareness of marine pollution and coastal ecosystem protection through public media, producing short films that showcase Kuwait's rich marine biodiversity. These are broadcast on national television and shared widely across social media platforms, reaching diverse audiences and fostering a deeper public connection with the marine environment. Together, such initiatives help strengthen the alignment between public engagement, scientific knowledge, and national environmental policies—one of the key objectives of the UN Ocean Decade.

In addition to KEPS, the Kuwait Dive Team exemplifies effective community engagement through regular marine cleanups, public awareness campaigns, and school outreach to educate youth about marine conservation. Their efforts, focusing on coral reef protection, debris removal, and habitat restoration, demonstrate the potential of grassroots action to support national sustainability goals.

The private sector, particularly the oil, gas, and shipping industries, exerts substantial influence on the marine environment. Encouragingly, some regional corporations have begun to incorporate environmental responsibility into their business models through corporate social responsibility (CSR) programs linked to Ocean Literacy and sustainability. For example, ADNOC (Abu Dhabi National Oil Company) supports seagrass and mangrove restoration projects while running environmental education campaigns for employees and communities. Likewise, QatarEnergy has embedded marine ecosystem protection and Ocean Literacy into its CSR strategy, aligning with the Qatar National Vision 2030.

Collectively, these academic, governmental, NGO, and private-sector initiatives reflect a growing awareness of the importance of Ocean Literacy in the Arabian Gulf. However, efforts remain fragmented and require stronger regional coordination, integration across education systems, and policy alignment to realize the Ocean Decade's vision. By building capacity, raising awareness, and embedding Ocean Literacy across all levels of society, Gulf nations can empower their citizens to contribute meaningfully to the sustainable future of the Ocean.

18.3 Knowledge Gaps in Ocean Literacy Within the Arabian Gulf

Despite the growing recognition of the importance of Ocean Literacy, significant knowledge gaps hinder effective marine conservation and informed decision-making in the Arabian Gulf. One of the primary challenges is the limited public awareness of the Gulf's unique marine ecosystems, coral reefs, intertidal zones, seagrass meadows, and mangroves. While these ecosystems are crucial for maintaining biodiversity and supporting local economies, many people, including policymakers, remain unaware of their ecological and economic value, as well as the threats they face from pollution, habitat degradation, and climate change.

Another critical gap lies in the limited incorporation of Ocean Literacy within national education frameworks. Although several Gulf countries include environmental or marine topics in school curricula, comprehensive and cross-disciplinary Ocean Literacy programs remain rare. Without clear curriculum guidelines and capacity-building opportunities for educators, awareness of marine issues often remains surface-level. Integrating Ocean Literacy systematically across all educational levels, from early schooling to higher education, would establish a strong foundation for future environmental leadership and policy engagement.

Moreover, local and traditional knowledge, particularly related to sustainable fishing practices and coastal management, are often overlooked in modern Ocean Literacy efforts. For instance, Kuwait's rich pearl-diving heritage offers valuable insights into sustainable marine

resource management (Al-Yamani 2021), yet this heritage is seldom incorporated into current conservation strategies. Reviving and integrating such traditional ecological knowledge could enhance Ocean Literacy by connecting scientific understanding with cultural identity and lived experience.

There is also a significant gap in accessible educational and outreach resources. While universities and research institutions conduct valuable marine research, this information is often not translated into public-facing educational materials. The disconnect between scientific research, public understanding, and policymaking limits the effectiveness of conservation initiatives. Bridging this gap requires stronger partnerships between academia, government agencies, and NGOs to develop shared platforms for communication and co-production of knowledge.

Finally, Ocean Literacy efforts in the Gulf region are often fragmented by national borders, with limited regional collaboration. Although Gulf countries share common environmental challenges, there is a lack of coordinated action and policy alignment under a unified regional framework. A more integrated approach, facilitated through the Gulf Cooperation Council (GCC) and aligned with the UN Ocean Decade's objectives, could foster joint research initiatives, harmonized education strategies, and cross-border awareness campaigns. Such coordination would not only strengthen Ocean Literacy but also ensure that collective efforts contribute effectively to the Decade's vision of a healthy, productive, and resilient Ocean shared by all Gulf nations.

18.4 Targeted Strategies to Address Knowledge Gaps

Addressing the knowledge gaps requires targeted strategies that involve key stakeholders such as government agencies, educational institutions, NGOs, and the private sector. Several strategies can help bridge the knowledge gaps and promote Ocean Literacy in the Arabian Gulf.

- Public Awareness Campaigns Focused on Local Marine Ecosystems: To foster a greater understanding of the unique marine ecosystems in the Arabian Gulf, targeted public awareness campaigns should be developed. These campaigns can highlight the importance of ecosystems such as coral reefs, seagrass, intertidal zones, and mangroves, as well as the threats posed by human activities and climate change.
- Interactive Media and Exhibits: Interactive media, virtual reality experiences, and public exhibits in aquaria and museums can engage the public in learning about the Gulf's marine biodiversity. Collaborating with local celebrities, influencers, and media outlets to spread awareness through documentaries, social media, and public talks can also significantly raise the profile of the need for marine conservation in the Gulf.
- Focus on Youth and School Programs: Integrating Ocean Literacy into school curricula through activities like field trips to coastal areas, marine protected areas (MPAs), marine-themed lessons, and interactive workshops can inspire younger generations to participate actively in conservation.
- Incorporating Traditional Knowledge into Ocean Literacy Programs: Traditional knowledge from local communities must be incorporated into Ocean Literacy efforts to fully understand and manage the Gulf's marine resources. This knowledge can provide valuable insights into sustainable fishing practices, marine navigation, and coastal resource management.
- Community Engagement Programs: Collaborative programs between traditional fishermen, coastal communities, women's associations, and scientists to blend scientific and local knowledge. Such initiatives can be formalized into workshops and educational materials and disseminated to the public.
- Oral History Documentation: Preserving the voices, memories, and perspectives of people with firsthand experience of maritime life through planned and recorded interviews of personal stories. An example is the live interviews

conducted by Kuwait Television with important Kuwaiti figures documenting their memories and biographies, which is commendable and deserves praise and encouragement. Government and research institutions can initiate projects to document local communities' maritime history and traditional ecological knowledge. This knowledge can be integrated into modern Ocean Literacy materials and shared with younger generations.

- Development of Accessible and Engaging Educational Materials: To bridge the educational gap, accessible and engaging Ocean Literacy resources that cater to different age groups and literacy levels are needed, ensuring that resources are culturally relevant.
- Digital Platforms and Mobile Applications: Interactive digital platforms and mobile applications (apps) that provide information on marine conservation, local species, and ecosystem services can engage the public in Ocean Literacy. For example, creating an app that allows users to identify marine species and track local conservation efforts can increase public participation.
- Collaborations with Schools, Research Centers, and Universities: Universities and research centers in the Gulf should collaborate with schools to develop marine science curricula and create educational resources that are scientifically accurate and easy to understand. Partnerships with NGOs and government agencies can help distribute these materials widely.
- Strengthening Research and Data Collection on Marine Pollution: To better understand the impact of pollution on the Gulf's marine ecosystems, there is a pressing need for enhanced research and data collection. This research should focus on the sources and effects of pollution, including oil spills, desalination by products, and plastic waste.
- Citizen Science Programs: Engaging the public in citizen science projects where individuals collect data on pollution levels, report marine debris and harmful algal blooms, monitor marine mortality and the health of coral reefs and seagrass meadows to contribute valuable data to researchers while increasing Ocean Literacy.
- Government-Funded Research Initiatives: Governments in the region can allocate funds to support long-term studies on marine pollution, habitat destruction, and resource overexploitation and their impacts on biodiversity. Publicizing the findings from these studies through the media and educational programs can help raise awareness about the importance of reducing pollution and effectively managing resources.
- Fostering Regional Cooperation for Ocean Literacy in the Arabian Gulf: Given the shared and interconnected nature of the Arabian Gulf's marine resources, regional cooperation is essential to advancing Ocean Literacy and addressing the region's pressing environmental challenges. A coordinated approach can lead to the development of educational programs, joint research projects, and transboundary conservation initiatives that enhance collective stewardship.

One effective strategy is the establishment of a Regional Ocean Literacy Network, bringing together diverse stakeholders, including government agencies, NGOs, universities, and private sector representatives from all Gulf countries. This network could facilitate the exchange of educational resources, promote regional awareness campaigns, and encourage joint research initiatives to understand and protect the Gulf's unique marine ecosystems.

The Regional Organization for the Protection of the Marine Environment (ROPME) is well-positioned to play a pivotal role in this endeavor. By leveraging its regional mandate, ROPME can catalyze cooperation, bridge knowledge gaps, and coordinate Ocean Literacy efforts among its member states. It can also support the UN Decade of Ocean Science for Sustainable Development by promoting the sharing of scientific knowledge, research findings, and best practices tailored to the Gulf's distinct environmental challenges.

Collaborative projects focusing on conserving shared marine ecosystems, such as migratory species such as fish and bird species, turtles, and dugongs, can foster a sense of regional solidarity and shared responsibility for the health of the Arabian Gulf. ROPME can play a vital role in promoting this initiative.

Through enhanced regional collaboration, Gulf countries can strengthen their Ocean Literacy initiatives and collectively contribute to global marine sustainability goals, ensuring a healthier and more resilient marine ecosystem for future generations.

18.5 Alignment Between National Policies and the Decade's Vision

The Arabian Gulf countries, including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE), are facing increasing environmental pressures due to urbanization, industrialization, and climate change. They have made significant strides in integrating sustainability into their national development agendas. These countries have recognized the need to protect their marine resources, which are critical for fisheries, tourism, and trade and essential for maintaining ecological balance in the region. For example, the UAE's National Environmental Policy emphasizes the conservation of marine biodiversity, the prevention of marine pollution, and the sustainable use of marine resources. Similarly, Saudi Arabia's Vision 2030 and Kuwait's National Development Plan (New Kuwait 2035) include environmental protection as a core objective, focusing on reducing pollution, safeguarding natural resources, and enhancing resilience against climate change.

However, while national policies in the region broadly align with the Decade's vision of sustainable Ocean management, a critical area where integration can be strengthened is Ocean Literacy, the understanding of the Arabian Gulf's influence on people and their influence on the Ocean they depend upon. Ocean Literacy is essential for fostering a culture of marine conservation and ensuring that national policies are effectively implemented at all levels of society.

Hence, the alignment between national policies in the Arabian Gulf and the Decade's vision for sustainable Ocean management presents a promising framework for marine conservation. However, to fully realize this vision, the integration of Ocean Literacy into public education, industry practices, community initiatives, and regional cooperation must be strengthened. By enhancing Ocean Literacy, Gulf countries can foster a culture of marine stewardship and empower citizens to take action to ensure the long-term protection of their valuable marine ecosystems. In doing so they will contribute to the sustainability of the Arabian Gulf and the global effort to safeguard the Ocean for future generations.

18.6 The Role of Ocean Literacy in Marine Conservation

Ocean Literacy promotes a deeper understanding of marine ecosystems, their threats, and the actions required to protect them. It empowers citizens, policymakers, industries, and educators to make informed decisions that support sustainable Ocean management. In the Arabian Gulf, where human activities such as oil and gas extraction, desalination, and shipping significantly impact marine environments, embedding Ocean Literacy is crucial to achieving the conservation goals in national policies and the UN Decade's vision.

Increasing uptake of Ocean Literacy will likely reduce harmful practices such as overfishing, habitat destruction, and marine pollution by fostering greater public awareness and engagement with marine issues. It can also promote a sense of stewardship among local communities, encouraging sustainable practices that protect marine biodiversity and support the health of coastal ecosystems. In addition to the sections on proposed targeted strategies and alignment between national policies and the Decade's vision, below are examples of focused areas where Ocean Literacy integration can be strengthened.

18.6.1 Education and Public Awareness Campaigns

While environmental education is part of many national curricula in the Gulf, there is a need to strengthen the focus on marine ecosystems. Integrating Ocean Literacy into school curricula at all levels can help future generations understand the importance of marine conservation. Public awareness campaigns, using mass media, social media, and community outreach programs, can also target the wider population, raising awareness of the Ocean's critical role in everyday life. For example, the UAE has launched initiatives like the Marine Biodiversity Conservation Program, but expanding these programs to include more educational components about the science of the Ocean and its ecosystems can increase public understanding. Similarly, in Kuwait and other Gulf countries, integrating marine conservation topics into the formal education system could encourage young people to become advocates for sustainable Ocean practices.

18.6.2 Industry Engagement and Corporate Responsibility

The Arabian Gulf economies heavily depend on industries such as oil and gas, shipping, and desalination, which can have substantial environmental impacts. Enhancing Ocean Literacy within these industries is essential for promoting environmentally responsible practices. Governments can work with industries to develop training programs and workshops that educate employees on marine conservation, pollution prevention, and sustainable resource use. Through its Vision 2030, Saudi Arabia has already begun promoting environmental sustainability and corporate social responsibility (CSR) in industries. By explicitly integrating Ocean Literacy into CSR strategies, companies in the region can play a pivotal role in supporting marine conservation efforts.

18.6.3 Community-Based Conservation Initiatives

Community involvement is vital to the success of marine conservation efforts. Governments in the Gulf can strengthen Ocean Literacy by supporting local conservation initiatives that engage coastal communities in monitoring and protecting marine ecosystems. For instance, citizen science programs in which residents collect data on marine life or report pollution incidents can be valuable for conservation and education. With their long-standing connection to the Ocean, Oman's coastal communities are well-positioned to participate in such initiatives. By involving local populations in conservation efforts and enhancing their understanding of marine issues, community-based initiatives can help bridge the gap between national policy and on-the-ground action.

18.6.4 Cross-Border Cooperation and Knowledge Sharing

The shared marine environment of the Arabian Gulf necessitates regional cooperation in Ocean management. Implementing Ocean Literacy initiatives across the region can strengthen collaboration between Gulf countries that are united in a common goal. Regional organizations, such as the Regional Organization for the Protection of the Marine Environment (ROPME), can play a pivotal role in fostering knowledge exchange and collaborative efforts to address common challenges such as marine pollution and overfishing and to participate in rehabilitation programs.

Gulf countries can pool their resources and expertise to protect their shared marine environment by developing joint educational campaigns, research initiatives, and conservation programs. This cooperative approach aligns with the Decade's call for enhanced global and regional Ocean science and management partnerships.

18.7 Framework for Enhancing Ocean Literacy in the Gulf

In Kuwait and other Gulf nations, the sustainable management of marine resources is a critical challenge, as the sea plays a central role in supporting local economies, food security, and biodiversity. Ocean Literacy is essential for fostering informed decision-making and promoting marine conservation. Enhancing Ocean Literacy across diverse sectors can ensure that the population is empowered to actively engage in protecting marine environments. A framework is proposed below for enhancing and improving Ocean Literacy rates in the Gulf region, focusing on the Gulf through education, policy, industry collaboration, and community engagement.

Ocean Literacy is encapsulated in seven essential principles, which include understanding the Ocean's interconnected ecosystems, the human impact on marine environments, and the need for sustainable practices to preserve Ocean health. Ocean Literacy aims to raise awareness about these issues and motivate individuals, industries, and policymakers to adopt behaviors and practices that ensure sustainable Ocean management. In Kuwait, where marine ecosystems are increasingly vulnerable to human activities, a targeted approach to enhancing Ocean Literacy is crucial for safeguarding the Ocean for future generations. Below is a proposed framework for enhancing Ocean Literacy programs in Kuwait and the Gulf.

18.7.1 Integrating Ocean Literacy into Educational Systems

Education is foundational in shaping environmental attitudes and behaviors. Enhancing Ocean Literacy in Kuwait can begin with embedding marine education into school curricula at all levels. While environmental education is already present in many Gulf states, a stronger focus on marine ecosystems, particularly those unique to the Gulf, can be incorporated. At the primary and secondary levels, students should be introduced to the importance of marine biodiversity, the effects of pollution, and the Ocean's role in regulating climate. Through experiential learning, such as field trips to coastal and marine protected areas, students can gain firsthand experience of the marine environment.

Additionally, introducing Ocean science as part of STEM (Science, Technology, Engineering, and Mathematics) programs at the tertiary level can inspire young people to pursue careers in marine biology, Oceanography, and environmental science, fostering a new generation of marine stewards. In Kuwait, partnerships between educational institutions and local organizations, such as the Kuwait Institute for Scientific Research (KISR), can support the development of Ocean-focused curricula. National campaigns promoting the "Blue Schools" initiative, similar to that found in the European Union, could certify schools for their engagement in marine education and encourage broader public participation in marine conservation efforts.

18.7.2 Public Awareness Campaigns and Community Engagement

Targeted public awareness campaigns are crucial to foster a broader understanding of Ocean Literacy. In Kuwait and other Gulf states, mass media, social media, and community events can be leveraged to promote key messages about the importance of the Ocean. These campaigns can highlight the dangers of marine pollution, overfishing, and habitat degradation while encouraging sustainable practices, such as reducing plastic consumption and participating in coastal clean-up efforts. Government agencies, non-governmental organizations (NGOs), and businesses can collaborate to organize nationwide awareness weeks, educational workshops, and beach clean-up campaigns to engage the public directly in conservation efforts.

For example, a "National Marine Week" could be launched in Kuwait to coincide with global events like World Ocean Day, where schools, businesses, and individuals can engage in Ocean-related activities, educational talks, and conservation actions. Furthermore, community

engagement is essential for promoting active participation in conservation initiatives. Local coastal communities, fishermen, and recreational sea users can be involved in citizen science programs, where they collect data on marine species, report pollution incidents, and monitor environmental changes. Such programs empower citizens to contribute to scientific research while deepening their connection to the Ocean.

18.7.3 Promoting Corporate Responsibility and Industry Collaboration

Industries in the Gulf, particularly those involved in oil and gas, shipping, and desalination, significantly impact marine ecosystems. Enhancing Ocean Literacy within these sectors can drive more sustainable practices and corporate responsibility. By providing educational programs and workshops for employees, companies can promote a better understanding of the environmental consequences of their activities and encourage more environmentally responsible behaviors. For example, government and private sector partnerships can incentivize industries to adopt sustainable practices in Kuwait, where the oil industry is central to the economy.

For example, oil companies can invest in marine conservation initiatives as part of their corporate social responsibility (CSR) strategies. They can support environmental research by funding studies on marine biodiversity, pollution reduction technologies, and sustainable resource management (e.g., the Saudi Arabian Oil Company [ARAMCO] and the Kuwait Oil Company [KOC]). They could also increase their sponsorship of educational publications and participate in outreach programs. Collaborative efforts between industries, research institutions, and government agencies can also help monitor the health of the marine environment and develop new strategies for reducing industrial impacts on the Ocean. In the Gulf, regional organizations such as the Gulf Cooperation Council (GCC) and ROPME can play a key role in promoting cross-border cooperation on marine conservation, creating standardized guidelines for industries to minimize their environmental footprint.

18.7.4 Strengthening Policy and Governance for Marine Conservation

As mentioned earlier, government policies play a crucial role in shaping the regulatory framework for marine conservation. In Kuwait, improving Ocean Literacy rates among policymakers and government officials can ensure that marine protection, which is prioritized in national development plans, is effectively implemented.

By integrating Ocean education into training programs for government employees, policymakers will be better equipped to design and implement effective marine conservation strategies. Kuwait's national policies, such as the Environmental Protection Law, address marine conservation issues, including pollution control and biodiversity protection. However, enhancing Ocean Literacy programs can further improve the implementation and enforcement of these laws.

Policymakers can also engage with regional organizations, such as ROPME, to address transboundary environmental issues like oil spills and marine debris. Additionally, governments can support the development of more marine protected areas (MPAs) and ensure that they are effectively managed and monitored. Therefore, expanding the network of MPAs and enforcing strict regulations within these zones can safeguard critical habitats for marine species and promote the long-term health of the marine environment.

18.8 Conclusion and Recommendations

The Arabian Gulf is a vital region where marine ecosystems and human activities are intricately connected. Its unique ecological characteristics—combined with the pressures of industrialization, urbanization, and climate change—demand tailored strategies that reflect the region's envi-

ronmental, economic, and cultural contexts. The proposed strategies presented throughout this chapter, including public awareness campaigns, the integration of traditional knowledge, enhanced educational resources, strengthened research, and regional cooperation, collectively provide a roadmap for bridging the significant knowledge gaps that persist in Ocean Literacy (OL) across the Gulf region.

Improving Ocean Literacy rates in Kuwait and across the wider Gulf region is critical for the sustainable management and conservation of marine resources. Embedding Ocean Literacy into school curricula, increasing public awareness, promoting corporate environmental responsibility, and reinforcing marine policies will create a holistic framework that supports greater Ocean engagement. Collaborative efforts among government bodies, NGOs, educational institutions, and the private sector are essential to develop cohesive programs that elevate public understanding of the Gulf's marine ecosystems and foster responsible and sustainable behavior. By cultivating a deeper regional awareness of the intrinsic link between Ocean health and human well-being, the Gulf can secure a more sustainable and resilient future for its marine resources.

This chapter has highlighted the importance of Ocean Literacy as a cornerstone for achieving the UN Ocean Decade's goals in the Arabian Gulf—a region defined by its fragile yet economically vital marine ecosystems. The analysis presented has identified the current state of Ocean Literacy, explored knowledge gaps, proposed targeted strategies, assessed policy alignment with the Decade's vision, and developed a framework for advancing regional Ocean Literacy.

The current state of Ocean Literacy reveals that efforts remain fragmented, though promising initiatives exist, such as Qatar's Environmental Science Curriculum, university-level marine biology programs, and public awareness campaigns. Key stakeholders, including governments, NGOs, the private sector, and research institutions, have contributed meaningfully, yet the lack of coordination and accessible educational resources have limited impact. Persistent knowledge gaps include insufficient public awareness of the Gulf's ecosystems, underrepresentation of traditional knowledge, a weak connection between scientific research and public understanding, limited data on marine pollution, and minimal regional cooperation.

To address these challenges, the chapter proposed several targeted strategies: developing public awareness campaigns centered on local ecosystems; integrating traditional knowledge into Ocean Literacy programs; creating accessible and culturally relevant educational materials; expanding research and citizen science initiatives on marine pollution; and strengthening regional collaboration through a unified Ocean Literacy Network.

While Gulf nations have taken significant steps toward sustainability through national development plans such as Saudi Arabia's Vision 2030, Kuwait's New Kuwait 2035, and the UAE's National Environmental Policy, integrating Ocean Literacy more deeply into education, industry, and community engagement remains essential to fully realize the UN Ocean Decade's vision. Ocean Literacy not only empowers citizens, policymakers, and industries to make informed decisions about sustainable Ocean management but also fosters stewardship, encourages innovation, and reduces harmful practices that threaten marine biodiversity.

Finally, the proposed Framework for Enhancing Ocean Literacy in the Gulf emphasizes the interconnected roles of education, policy, industry, and community engagement. It calls for the incorporation of Ocean Literacy into formal education systems, the promotion of community-based conservation and corporate responsibility, and the reinforcement of policy and governance structures for marine protection. Implementing these actions will help bridge the knowledge gap, strengthen regional cooperation, and support the long-term sustainability of the Arabian Gulf's marine ecosystems, contributing to the global mission of the UN Ocean Decade to achieve a healthy, productive, and resilient Ocean for future generations.

18.8.1 Summary

Key concepts explored in this chapter include:

- The pivotal role of Ocean Literacy (OL) in bridging the gap between scientific knowledge, policy, and public awareness within the Arabian Gulf.
- The Gulf's unique, vulnerable ecosystems demand region-specific, culturally grounded OL approaches.
- Current OL efforts exist but are fragmented across countries, sectors, and institutions.
- Major knowledge gaps persist, including low public awareness, limited use of traditional knowledge, scarce accessible materials, inadequate pollution data, and weak regional coordination.
- Education is pivotal. Embed OL across K-12 and tertiary curricula with experiential learning and "Blue Schools"-style initiatives.
- Public awareness campaigns, interactive media, and museums/aquaria can scale community understanding and engagement.
- Capacity building for educators and policymakers links science, education, and governance.
- Industry engagement matters. Integrate OL into CSR and employee training across oil, gas, shipping, and desalination.
- Citizen science can expand data collection (reefs, seagrass, debris, HABs, marine mammals' sightings) while boosting public ownership.
- Policy alignment is improving (e.g., Vision 2030; New Kuwait 2035; UAE policy) but requires deeper OL integration, supported by stronger GCC/ROPME coordination on curricula, research, and cross-border awareness campaigns.
- Expand and effectively manage MPAs. Pair protection with outreach and compliance education.
- Prioritize multilingual, culturally relevant resources accessible to diverse communities.
- Fund long-term research on pollution sources/effects and translate findings into public-facing tools.
- A practical framework centers on four pillars: education, policy/governance, industry collaboration, and community engagement.
- Empowering youth and women as Ocean stewards strengthen intergenerational engagement and social inclusion.
- Strengthening OL will enable informed decisions, foster stewardship, and secure a healthy, productive, resilient Ocean for the Gulf.
- Ocean Literacy (OL) is the cornerstone for achieving the UN Ocean Decade's vision in the Arabian Gulf.

18.8.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Abu Dhabi National Oil Company (ADNOC): https://www.adnoc.ae
- Kuwait Environment Protection Society (KEPS): https://www.keps.org.kw
- *Kuwait* Institute for Scientific Research: https://www.kisr.edu.kw.publications
- Kuwait Oil Company (KOC): https://www.KOCKW.com
- Qatar National Vision 2030: https://www.qatarenergy.qa
- The Regional Organization for the Protection of the Marine Environment (ROPME): https://ropme.org
- The Saudi Arabian Oil Co. (ARAMCO): https://www.aramco.com
- The Scientific Center in Kuwait: https://www.tsck.org.kw/en/

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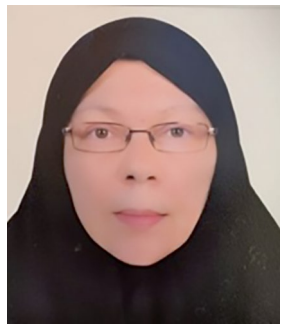
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19 Hybrid Artificial Reefs in Ocean Literacy and Conservation: Insights from the Ocean Rescue Alliance International

Shelby Thomas and David K. Weinstein

Abstract

While coastal communities have used artificial reefs for thousands of years, many of these communities have placed a variety of recycled or waste material into the water without a deeper understanding of ecological, hydrological, or societal impacts. As such, the success of historical efforts has been highly variable and often failed to blend with the surrounding environment, resulting in unintended negative consequences. However, the concept of developing hybrid artificial reefs through scientific research to restore critical marine ecosystems and protect coastal infrastructure is relatively new. Recent studies have shown great potential, but much more work is needed, including an Ocean Literacy focus on large-scale projects. The Ocean Rescue Alliance International (ORAI) contributes to pioneering marine conservation through innovative hybrid artificial reef (HAR) structures that combine nature-based designs, ecological restoration, coastal protection, and artistic engagement. This chapter explores artificial and hybrid reefs, including ORAI's efforts through flagship projects and initiatives, and the impact on Ocean Literacy through the lens of environmental restoration, coastal resilience, community engagement, and education. By leveraging HARs, ORAI enhances marine biodiversity, supports fisheries, and strengthens resilience against climate change, while simultaneously inspiring stewardship through art.

Keywords

Ocean Literacy (OL) · Ocean Decade (OD) · Ocean stewardship · Artificial reefs · Hybrid reefs · Hybrid artificial reef (HAR) · Blue economy · Coastal resilience · Community engagement · Environmental education · Marine biodiversity · Marine conservation

19.1 Introduction

Humans have intentionally and unintentionally placed artificial structures on the Ocean floor since at least the Neolithic period (Lima et al. 2019). The concept of artificial reefs, with a wide geographical range of origins (Seaman 2019), dates back at least 3000 years (reviewed by Lima et al. 2019; Ram et al. 2021). There is currently little scientific literary consistency in terminology (Higgins et al. 2022), but artificial reefs are generally defined as man-made structures delib-

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erately placed on aquatic substratum to mimic some characteristic of natural reefs for various purposes such as producing shelter for organisms or dissipating wave energy (Jensen 1998; Lima et al. 2019). Efforts to evaluate past artificial reef effectiveness are often stifled by multivariable factors such as limited and inconstant monitoring and self-assessments, and differing objectives (Vivier et al. 2020). For example, one seminal literature review found that less than 50% of artificial reefs studied met the structures' intended objectives (Baine 2001). Additionally, artificial reefs have often been designed to dispose of unwanted material (Macdonald 2009). The Osborne Reef off southern Florida provides a classic case study of poor design and mismanagement (Morley et al. 2008).

More recently, artificial reefs have demonstrated their effectiveness as tools for addressing coral reef conservation objectives (Higgins et al. 2022). These structures may serve as needed, targeted conduits for marine restoration given the continued decline of sensitive ecosystems such as coral reefs (Hughes et al. 2017). A recent modeling effort indicated that hybrid coral reef restoration efforts could serve as economical coastal protection solutions (Storlazzi et al. 2025). Additionally, as populations increase and reefs are more stressed by tourism use, a study in Israel found that strategically placed artificial reef structures can reduce pressure on adjacent natural reef systems (Shasha et al. 2024).

The Ocean Rescue Alliance International (ORAI), a marine conservation organization established in 2021, is committed to protecting marine ecosystems through innovative strategies such as scientifically formulated artificial reefs designed to target specific local community and/or environmental needs. Specifically, ORAI focuses on deploying hybrid artificial reef (HAR) structures that serve ecological, economic, hydrodynamic, and/or cultural functions. In combining habitat restoration with creative engagement, ORAI works to enhance public understanding of Ocean conservation and foster Ocean stewardship. This chapter reviews the importance of integrating science, engineering, and creative expression to foster long-term Ocean Literacy and sustainable blue economy practices through artificial reef development, with the efforts of ORAI serving as a case study.

19.2 Hybrid Artificial Reefs: A Sustainable Conservation Approach

The concept of hybrid artificial reefs, herein defined as structures that integrate natural and artificial components ("gray" and "green" elements; Paxton et al. 2024) to enhance marine ecosystems while potentially providing coastal protection, has rapidly gained attention worldwide (Norris et al. 2025; Paxton et al. 2024; Storlazzi et al. 2025). As coral reefs continue to degrade as a result of changing climatic conditions, coastal development, and pollution (Hughes et al. 2018; IPCC 2022; Klein et al. 2024), there is an urgent need for scalable, effective restoration strategies that restore ecosystem function and protect vulnerable coastal populations (Kuffner et al. 2019; Storlazzi et al. 2025).

Designed to emulate the ecological and structural complexity of natural reefs while introducing engineered resilience (Norris et al. 2025), hybrid reef design often leverages eco-friendly construction materials and biomimicry that support marine biodiversity (Anand et al. 2024; Ruszczyk et al. 2025; Maslov et al. 2024). Reef design may also include artistic elements that provide public engagement opportunities regarding Ocean conservation (see Sect. 19.2.3). Hybrid reefs are not simply ecological luxuries; they may serve a role for future resilience. Without intervention, coastal flooding and erosion risks are likely to escalate, costing billions of dollars

annually and threatening coastal communities and economies (Storlazzi et al. 2025). While hybrid reef concepts have recently been exemplified through models and pilot studies and there has been an expanded effort to explore hybrid reef approaches (see Paxton et al. 2024), more work is needed to implement at an operational scale while including ecological integration and active public participation.

ORAI applies large-scale, hybrid reef design concepts holistically by blending science, engineering, artistry, and community engagement. ORAI hybrid reefs incorporate: (1) biomimetic forms that replicate natural reef morphology, such as shelves, interstitial isolated chambers, branching coral structures or complex crevices, to maximize habitat availability (Fig. 19.1); (2) eco-friendly materials including pH neutral concrete and calcium carbonate; and (3) artistic elements (Fig. 19.2) that transform underwater habitats into public engagement spaces designed to promote Ocean Literacy through aesthetic and emotional connections. These reef systems are deployed in areas experiencing severe habitat degradation to restore lost ecosystems, attract diverse marine species, and provide surfaces for coral outplanting. While hybrid reefs serve many functions (see Paxton et al. 2024), ORAI primarily designs systems for ecological, coastal resilience, and/or artistic and cultural benefits aiming to positively impact the "blue economy."

19.2.1 Ecological Benefits

Artificial reefs have historically been deployed primarily to provide recreational opportunities, enhance fisheries, and attract fish biomass; over 80% of early deployments worldwide driven by fisheries management objectives (Baine 2001; Pickering and Whitmarsh 1997). However, the scope of artificial reef deployment has greatly evolved. Increasingly, reef projects aim to restore ecological functions, enhance biodiversity, and mimic natural reef systems at a structural and biological level (Higgins et al. 2022). Additionally, evidence clusters generated from an examination of 258 articles regarding built structures in shallow, tropical coral reef locations indicated at least moderate evidence for diversity, recruitment, and growth with hybrid structures (Paxton et al. 2024).

To achieve long-term ecosystem benefits, artificial reefs should be designed with ecological principles in mind, such as habitat complexity, substrate material, spatial arrangement, and connectivity to natural habitats (Paxton et al. 2022; Seaman 2000). Structural complexity is particularly critical; reefs with higher rugosity and variability in surface features support more species, higher fish biomass, and enhanced benthic recruitment (Graham and Nash 2013). Walker et al. (2002) found that artificial reefs with complex surfaces significantly increased coral recruitment compared to low-complexity structures. Additionally, artificial reefs have been found to match or exceed the ecological functions of natural reefs, particularly where natural habitats are heavily degraded (see Folpp et al. 2020).

19.2.1.1 ORAI's Approach

ORAI takes a nature-inspired approach to artificial reef design, ensuring that structures provide high surface area, natural porosity, and microhabitats to maximize shelter opportunities (see Fig. 19.1a). ORAI installations are also designed to mimic natural reef structure informed by geological study that promote benthic recruitment and fish aggregations and are composed of eco-friendly concrete mixtures with surface textures conducive to coral larval settlement (Ghiasian et al. 2020) and long-term durability.

In addition to promoting biodiversity, ORAI's reefs act as spawning grounds and nursery habitats, contributing to the replenishment of regional fish stocks. For example, images and post-deployment surveys using Florida Fish and Wildlife Commission (FWC) methodology on ORAI structures off West Palm Beach, Florida indicated early recruitment by juvenile grunts (*Haemulon* spp.), snappers (*Lutjanus* spp.), damselfish (*Stegastes* spp.), and marine benthic recruitment 9 months after deployment. Structures were nearly completely covered by

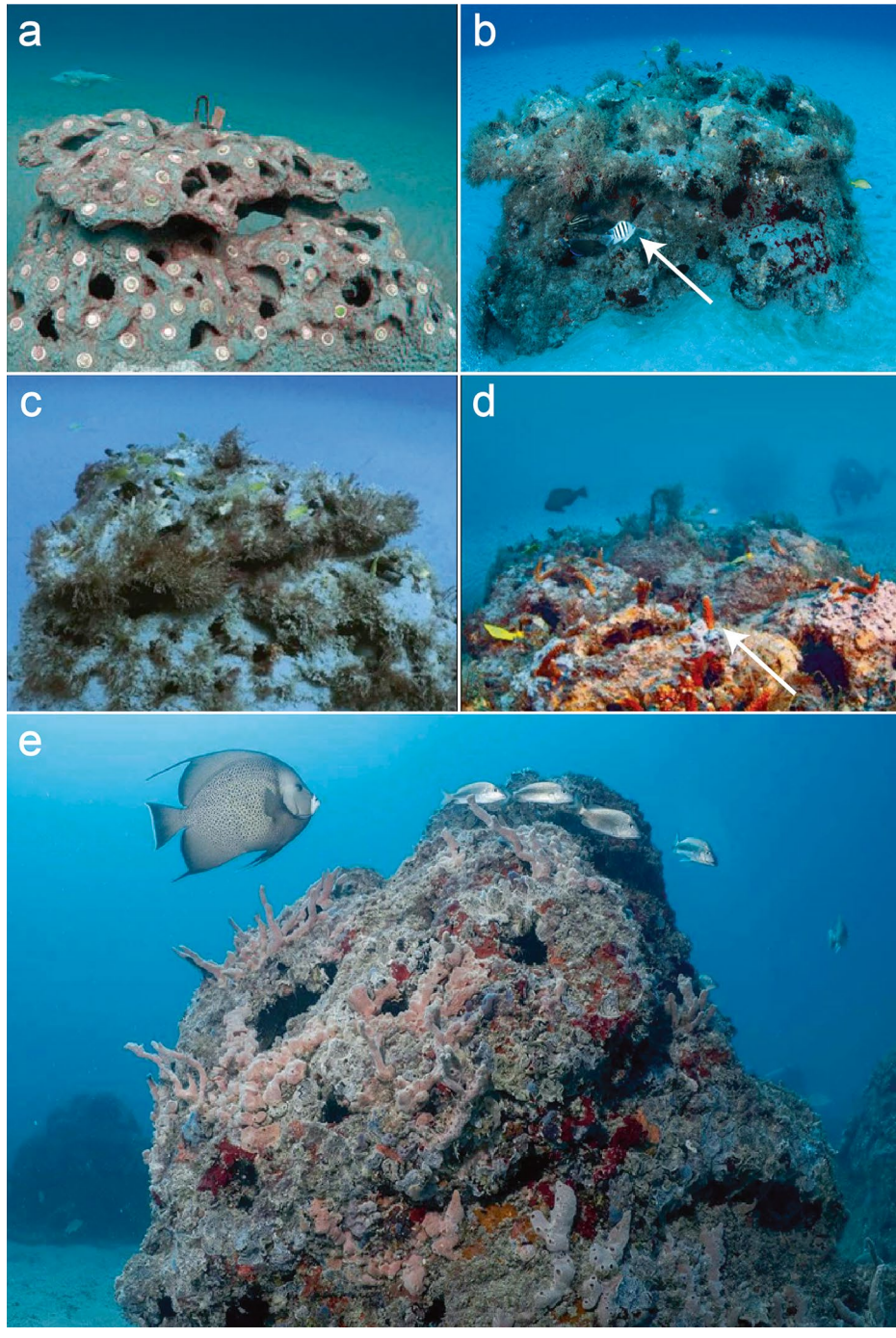


Fig. 19.1 ORAI hybrid reef deployments off (a–d) West Palm Beach, Florida, as part of ORAI's *1000 Mermaids Project*, and (e) off Hollywood, Florida. (a) One week after deployment. (b) Nine months after deployment, highlighting rapid recruitment of benthic species and fish such as the sergeant major *Abudefduf saxatilis* (arrow). (c, still from video; d) Hard coral species successfully outplanted after 1.5 years of deployment for assisted migration research of the staghorn coral Acropora cervicornis (arrow in d), in partnership with the University of Miami. (e) ORAI *Ocean Heart Reef* after 3 years, demonstrating the organization's ongoing commitment to marine life and community engagement. Photos (b, c) by Megan L. Griffin, makingwavespro.com; photos (d, e) by Timothy M. Sullivan, makingwavespro.com



Fig. 19.2 ORAI's 1000 Mermaids Reef project deployed off West Palm Beach, Florida at 26° 45.26′ N, 80° 01.628′ W, supports the restoration of reef habitats while connecting people to the Ocean through artistic reef sculptures. One major goal of the project is to use the symbol of the mermaid to inspire a connection to the Ocean. Further connection and inspiration are fostered through interactive elements such as (a) photo opportunities to "become" a mermaid using a selfie tail, (b) imagining oneself as a hard-hat diver, and (c) observing mermaid sculptures that now provide habitat for reef fish. Photo (a, b) by Ricardo Nascimento (@ricardo.saltwater)

benthic organisms within 1.5 years (Fig. 19.1c). This implies that careful design tailored to habitat needs with complex structures (Walker et al. 2002) can greatly accelerate ecosystem establishment. By aligning design with ecological needs, ORAI not only restores habitat but also enhances ecosystem services, such as supporting commercial and recreational fisheries vital for local economies and food security. Preliminary, statistically significant results of newer artificial reefs recently deployed for the "Guardians of the Reef" project at a swimmable distance from the Hollywood, Florida shore also found rapid benthic and fish colonization, with final results scheduled for future publication.

ORAI structures also serve as platforms for coral, oyster, or mangrove restoration by offering stable hard substrates critical for the settlement of coral larvae and facilitating the assisted migration and reestablishment of reef-building species, such as *Acropora cervicornis* and *Orbicella* spp (Fig. 19.1d). ORAI focuses on building the skeletal foundation for reef systems along coastlines to help provide suitable habitat for marine species while aiding in scalable restoration.

19.2.2 Coastal Protection and Climate Resilience

Artificial reefs, when properly designed, have the potential to function beyond biodiversity enhancement; they can provide coastal defense by reducing erosion and protecting shorelines from storm surge (Silva et al. 2016; Storlazzi et al. 2025). Weather events over the past decade resulted in more frequent coastal flooding and erosion (see Adhikari et al. 2025), with impacts predicted to increase in severity as a result of sea-level change and demographic surges, and cause billions of dollars in damages annually (Hallegatte et al. 2013; Hanson et al. 2011; Nicholls et al. 2007).

The loss of even 1 m of reef relief can double the capital at risk from coastal flooding during major storm events (Beck et al. 2018). However, studies have shown that hybrid coral reef restoration can offer substantial benefits for coastal defense (Storlazzi et al. 2025) demonstrated through regionally modeled flood risk analyses that restoring even 20% of coral reefs along Florida and Puerto Rico's coastlines could yield economic benefits greater than the costs, protecting vulnerable communities from coastal hazards. Hybrid reef structures have the potential to replace lost reef elevation, restoring critical hydrodynamic functions that natural reefs may take decades or longer to recover on their own. As such, the U.S. Department of Defense recently, through the Defense Advanced Research Projects Agency (DARPA), recognized the critical role hybrid reefs can play in national resilience strategies. DARPA's Reefense program emphasizes using biologically inspired hybrid reefs for coastal protection (see resources section for more information).

19.2.2.1 ORAI Coastal Defense Initiatives

Recognizing the critical intersection of ecology and resilience, ORAI has started planning large-scale breakwater reef projects such as the Gulf Coast Coastal Resilience Reef (Table 19.1). This project features modular reef units designed to reduce wave energy, stabilize sediment, and protect low-lying coastal communities from sea-level rise and hurricane storm surges. Unlike traditional seawalls and bulkheads, which may be inefficient and exacerbate erosion elsewhere (Nunn et al. 2021; Rangel-Buitrago et al. 2018), ORAI's reefs are often designed to restore natural hydrodynamic functions. The concrete formulations have low pH impacts and promote marine growth, further enhancing roughness and energy dissipation over time (see Ghiasian et al. 2020). The DARPA Reefense program echoes ORAI's approach, highlighting the growing institutional acceptance of hybrid reefs as part of national adaptation and security strategies. Thus, ORAI's work sits at the cutting edge of nature-based climate adaptation, potentially offering a replicable, resilient, and regenerative model for coastal communities worldwide.

Research led by the University of Miami at the Alfred C. Glassell, Jr. SUSTAIN (SUrge-STructure-Atmosphere INteraction) Laboratory

Table 19.1 Current and upcoming flagship ORAI initiatives engineered from marine-grade, eco-friendly materials and designed with textured surfaces, cavities, crevices, and natural porosity, ideal for coral larval settlement and fish habitat creation.

Project	Location and initial deployment	Scope and depth	Details
1000 Mermaids Artificial Reef	Three locations in West Palm Beach and Hollywood, Florida. Initial deployment June 2018, July 2019, November 2020 (N 25°59.2913 W80°05.6623)	35 mermaid sculptures and over 300 habitat reefs currently, with more planned. Depth: 14 m	Going beyond restoration, the project uses mythology to frame the Ocean as a realm of mystery, beauty, and responsibility, inspiring the public to view themselves as Ocean Guardians
Hollywood Offshore 1000 Mermaids Reef	Hollywood, Florida. Initial deployment July 2022 (N 26°45.2600 W80°01.6280)	25 modules, including 5 artistic and 20 habitat reefs. Depth: 15 m	This offshore reef off Hollywood Beach combines marine habitat restoration with public art. Featuring *Mermaid* sculptures, it supports marine life and invites the community to engage in Ocean conservation through diving, education, and stewardship
Guardians of the Reef	Hollywood, Florida. Initial deployment May 2025	50 modules, including 15 artistic and 35 habitat elements. Depth: 2.5–4.5 m	This initiative, designed as the largest shore-accessible snorkeling installation in the United States, features an underwater sculpture park including larger-than-life figures such as Mermaids, Poseidon, and a selfie station
Gulf Coast Coastal Resilience Reef	Florida's Gulf Coast. Site coordinates to be determined 2027 deployment	Two-mile-long breakwater and habitat enhancement project	Large-scale nature-based project developed in collaboration with local communities, governments, and academia, designed to absorb wave energy (reducing coastal erosion and flood risk), create new marine habitat, enhance water quality through increased benthic habitat and filtration, and support community engagement through citizen science monitoring and education programs
Kukulkan's Underwater Sanctuary	Tulum, Mexico. Site coordinates to be determined 2028 deployment	Underwater sculpture park	This installation, centered around Kukulkan (feathered serpent deity revered in ancient Mayan culture), will allow visitors to experience and connect with Indigenous heritage while actively engaging in Ocean conservation

demonstrated that a hybrid artificial reef model combined with branching coral skeletons could reduce wave height by more than 35% and wave energy by up to 63% (Ghiasian et al. 2020). Adding simulated coral growth enhanced wave energy dissipation by an additional 10%–14%, proving that restoring reef topography alongside structure greatly improves coastal resilience. These results mirror ORAI's on-the-ground projects, where reef modules are not merely breakwaters but living, evolving ecosystems. Previously focused primarily on creating reefs that support marine biodiversity and incorporate restoration principles to scale reef (coral and oyster) and mangrove restoration, ORAI is now expanding structure designs to include natural breakwater infrastructure. Additionally, ORAI is building upon studies like Ghiasian et al. (2020) to address coastal protection but also enhance habitat value and scale restoration beyond concepts such as geometric structures. ORAI's hybrid designs highlight and incorporate principles from reviewed scientific literature and internal testing, ensuring that every structure deployed offers ecological benefits alongside physical coastal defense if appropriate for the project.

ORAI scientists are currently designing experiments to quantify the hydrodynamic performance of the "Guardians of the Reef" structures deployed 70–100 m from the Hollywood, Florida, beach in May 2025 to better inform the state of the field and optimize design and deployment parameters for future projects.

19.2.3 Artistic and Cultural Integration

Art has long been recognized as a powerful catalyst for social and environmental change (Holm et al. 2015), transcending barriers of language, culture, and background to convey complex scientific or ecological ideas through emotional resonance (Curtis 2012). By combining aesthetic beauty with ecological function, artistic reefs evoke a sense of wonder and foster personal investment in marine conservation efforts (Beans 2018). Underwater art installations tap into what researchers call the "affective domain" of learning, engaging emotions, values, and attitudes that are critical to motivating behavior change (Jacques 2015). People are more likely to care about protecting the Ocean when they have a memorable and meaningful experience, which art can uniquely help to foster.

Several prominent examples around the world have demonstrated the immense potential of integrating art into marine conservation or exposing the public to pressing environmental concerns included Museo Subacuático de Arte (MUSA) in Mexico (Taylor 2015), the Museum of Underwater Art (MOUA) in Australia (Smith et al. 2022), the Christ of the Abyss statue in Florida, and the Molinere Underwater Sculpture Park in Grenada by Jason de Caris Taylor deployed in 2006. These structures serve both ecological and tourism functions, drawing thousands of visitors annually while relieving pressure on nearby natural reefs (Taylor 2015).

19.2.3.1 ORAI Artistic Initiatives

ORAI integrates artistic design into artificial reef structures to foster deep emotional, cultural, and symbolic connections between people and the Ocean. Through sculptural reefs, artistic figures, and interactive underwater exhibits (see Fig. 19.2), ORAI's initiatives aim to transform restoration infrastructure into living museums that inspire curiosity, storytelling, and conservation action by allowing nature to become the artist on every reef. This fusion of art and ecology serves multiple purposes such as enhancing public engagement, boosting sustainable tourism, supporting local economies, and creating cultural symbols of environmental stewardship. Unpublished initial diver surveys at ORAI's sites show visitors consistently reporting higher levels of emotional engagement and memorable experiences compared to visits to natural reefs alone. Florida tourism operators now include ORAI's art reefs as key destinations, helping to diversify and strengthen the sustainable tourism economy.

A major value of artistic integration is associated with the production of community engagement, inviting public curiosity to connect with the Ocean. ORAI has anecdotally found art to serve as a symbolic language to bridge people to the Ocean with the opportunity to tell compelling stories about nature, communities, and culture. ORAI's projects build on past examples but extend the concept of artistic artificial reefs further. Installations are designed not only for aesthetic and educational purposes but with ecological principles embedded into the structure itself. For example, ORAI's "Guardians of the Reef" project features 12 artistic reefs and 48 habitat reef modules (Fig. 19.3). The artistic reefs are sculptures of mythological "protectors" including Poseidon and Amphitrite (Greek god and goddess protectors of the Ocean), mermaids (capturing the half human—half fish connection to the Ocean's mystery and magic), and marine "guardians" which each represent a different trait such as an octopus (wisdom), sea turtle (peace), seahorse (fragility), manta ray (elegance), and a manatee (resilience). Additionally, mermaid and diver selfie stations (encouraging you to become a Guardian of the Reef) function as artificial reefs but also reach a deeper sentiment to connect people to the Ocean, while the reefs' intricate surfaces are designed to provide microhabitats for coral larvae, fish, and invertebrates. Over time,

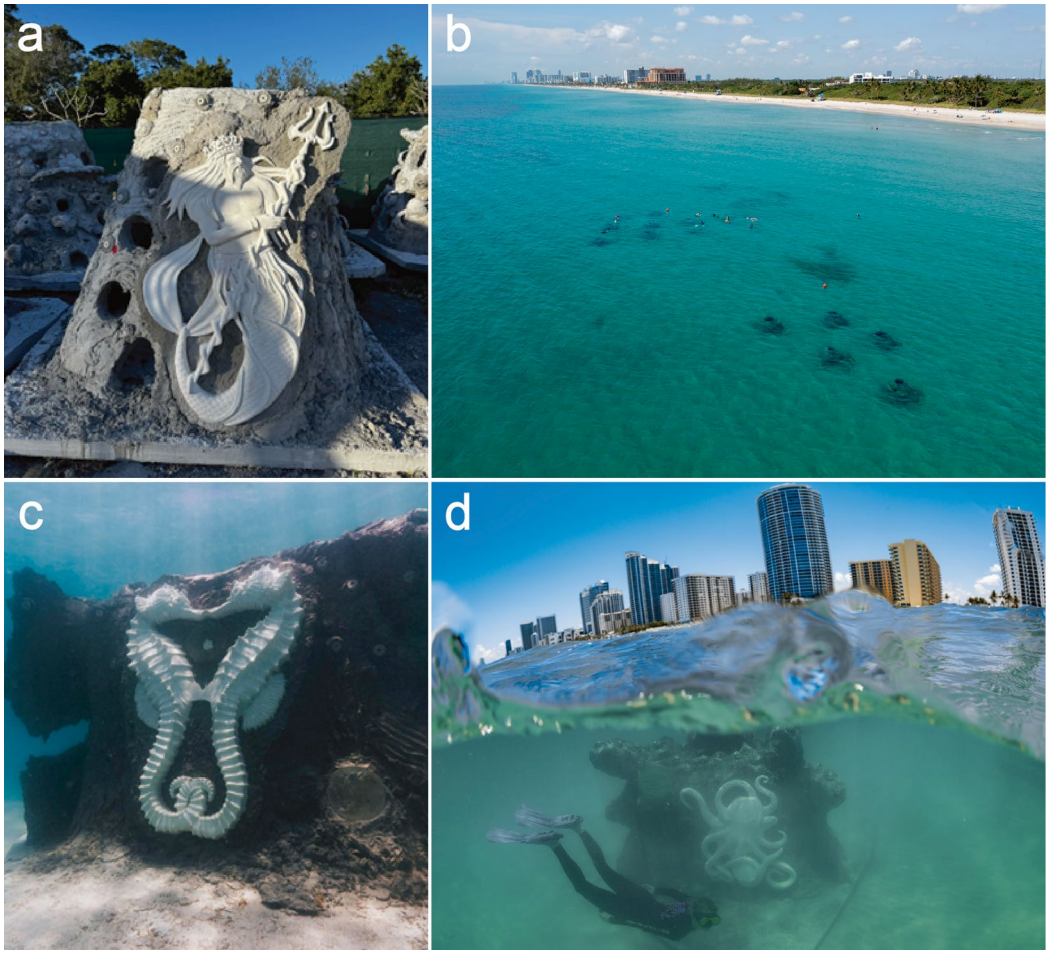


Fig. 19.3 ORAI's "Guardians of the Reef" project off Hollywood, Florida. The project includes sculptures of (a) mythological "protectors" and the modules are easily identified with buoys (b) as indicated through drone imagery of one of the four sites. The project also includes marine "guardians" such as (c) seahorses and (d) an octopus, as well as nature-mimicking elements to promote coral restoration, enhance marine habitat, and inspire Ocean stewardship. The project integrates art and science to create an engaging ecological landmark that supports biodiversity and community connection to the Ocean. Photos (b, d) by Timothy M. Sullivan, makingwavespro.com; photo (c) by Ricardo Nascimento, @ricardo.saltwater

the sculptures transform into living reef communities, illustrating the dynamic relationship between art, nature, and humanity. Similarly, ORAI's 1000 Mermaid Reef Project uses mythology to reconnect people to the ancient guardians of the sea while embodying the mythical stories and folklore around mermaids, their mystery and magic. By blending storytelling with ecological restoration, these sculptures create lasting emotional imprints, particularly among younger generations, nurturing a new wave of Ocean stewards. ORAI scientific teams are currently conducting studies to document the added benefits of these specific features to the public.

19.2.4 The Economic Dimension: Supporting the Blue Economy

Globally, coastal and marine tourism represents a major sector of the Ocean economy, generating approximately $390 billion annually and directly supporting over 7 million jobs (OECD 2016). Dive tourism is a major contributor. Caribbean

marine-based tourism and recreation are valued at over $25 billion annually, and coral reef-associated tourism globally is worth $36 billion per year, supporting around 70 million trips annually (Spalding et al. 2017). Dive tourism also accounts for up to 25% of tourism revenue in many small island developing States (Cesar et al. 2003). Additionally, Beck et al. (2018) found that up to $6 in coastal protection benefits can be generated for every $1 invested in reef restoration and protection, including with artificial reefs. Related, nature-based tourism, including visits to underwater art sites, produces significantly more local employment opportunities per dollar spent compared to conventional tourism (UNEP 2016).

Underwater art museums specifically create opportunities to attract new market segments including adventure travelers, cultural tourists, and marine conservation enthusiasts. When randomly examining lists of recommended diving destinations, Belhassen et al. (2017) noted that artificial reefs, including those featuring artistic sculptures such as ORAI's installations, are increasingly attracting divers worldwide. This trend alludes to the aesthetic appeal of submerged marine artwork and a growing potential for tourism development linked to their visual and cultural value. Valuing sculptures as tourism assets involves visitors' willingness to pay and market-related values to the tourism sector that pays for experiences at sites featuring underwater art. As an in-land example, public art sculpture trails have been shown to raise $1–40.4 million USD (Thompson and Day 2020). Artistic reefs likely not only provide direct fiscal benefits but also substantial economic opportunities. As such, artistic reefs may be considered critical assets that benefit the blue economy, defined by the World Bank as the sustainable use of Ocean resources for economic growth, improved livelihoods, and Ocean ecosystem health. For example, MUSA attracts more than 200,000 visitors per year, contributes to a 15%–20% increase in dive and snorkel tourism revenue in the region, and has led divers to indicate they felt less pressure to visit the natural reefs, resulting in reduced environmental stress (MUSA Annual Report 2018; Taylor 2015). As global tourism trends shift toward sustainability, destinations that offer unique eco-cultural experiences are increasingly preferred by travelers. Underwater art installations like those developed by ORAI position communities to: (1) attract eco-conscious travelers seeking meaningful, sustainable experiences, (2) extend visitor stays by offering additional dive/snorkel attractions beyond natural reefs, (3) diversify income streams beyond traditional beach tourism, and (4) build regional branding around marine conservation and innovation.

19.2.4.1 ORAI Contributions to Local Economies

Preliminary research demonstrates that ORAI projects stimulate coastal economies through eco-tourism and sustainable development. Reports from local dive shop partners indicate that various local artisans and contractors have generated income and employment opportunities through the creation and deployment of ORAI reef structures. Dive operators incorporate reef ecology lessons and conservation storytelling into every visit and offer opportunities to participate in reef monitoring to enhance their experience. Additional anecdotal surveys from dive shops indicate that visitors often dine, stay, and shop locally during dive and snorkel trips centered on ORAI's reef installations. Community-led ORAI educational programs (see Sect. 19.3.1) also draw school groups, boosting local awareness and engagement while creating educational tourism opportunities.

Initial projections based on unpublished data from a University of Florida survey and a tourism study suggest that ORAI's reef deployments could boost regional eco-tourism revenues by 10%–15% within 3 years post-deployment in key sites, a result comparable to early MUSA performance. ORAI's installations have helped attract divers and snorkelers to ORAI project sites, as evidenced by the fact that approximately 20 local dive shops and operators feature ORAI reef sites as part of their ecotourism offerings. At the same time, ORAI offers reef adoption programs to local businesses and individuals to "sponsor" reef modules (Fig. 19.4). The combination of these efforts over time provides



Fig. 19.4 Examples of ORAI's Reef Adoption Program. Businesses and individuals can sponsor or co-create artistic reef modules that restore marine habitats while generating economic and community benefits. Photo (underwater image) by Timothy M. Sullivan, makingwavespro.com

diversified income options for coastal communities increasingly vulnerable to the economic impacts of climate change and coral degradation (Chen et al. 2015). Through artistic reef deployments, ORAI helps advance a triple bottom line: protecting ecosystems, enriching communities, and strengthening local economies.

19.3 Artificial Reefs and Ocean Literacy

Ocean Literacy is generally defined as a comprehensive understanding of the Ocean's impact on human life and humanity's impact on the Ocean (Santoro et al. 2020; Cava et al. 2005). According to UNESCO's Intergovernmental Oceanographic Commission (IOC), Ocean Literacy is critical for fostering an informed, engaged public that understands the Ocean's central role in sustaining life on Earth and is motivated to act responsibly to protect marine ecosystems (UNESCO-IOC 2021). The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) identifies enhancing Ocean Literacy as a foundational goal to achieve transformative change in society's relationship with the Ocean.

While research has shown that marine education programs, aquariums, and marine protected areas increase Ocean Literacy (Fauville 2017; Guest et al. 2015), few large-scale systematic studies have specifically measured the contribution of artificial reefs to traditional Ocean Literacy metrics. Anecdotal reports and case studies indicate that artificial reefs may act as platforms for informal marine education, increase public exposure to marine ecosystems, foster emotional connections to Ocean environments, and serve as catalysts for citizen science and stewardship behaviors (Ditton et al. 2002; Newton et al. 2020; Schofield et al. 2007).

For example, research on diving experiences around artificial reefs, such as the USS Oriskany in Florida and the HMAS Brisbane in Australia, found that divers often leave these experiences with heightened ecological awareness and appreciation for marine conservation (Schofield et al. 2007; Ditton et al. 2002). Moreover, initiatives such as MUSA and the Coral Greenhouse in Australia have not only documented notable increases in tourism but also enhanced visitor-reported awareness and understanding of coral reef decline, climate change, and the significance of reef restoration efforts (MOUA Annual Report 2021; Taylor 2015). Therefore, even if the concept of Ocean Literacy is not often formally assessed as an educational outcome, artificial reefs nonetheless function as effective entry points for core components of Ocean Literacy such as Ocean engagement, education, and stewardship.

19.3.1 How ORAI Embeds Ocean Literacy in Artificial Reef Design

ORAI explicitly designs artificial reefs to maximize Ocean Literacy outcomes, moving beyond passive education to active, emotional, and experiential learning. This is achieved through: (1) interactive art and storytelling, (2) emotional and cultural relevance, (3) public accessibility, (4) citizen science initiatives and educational partnerships, and (5) an extensive internship and mentorship program. ORAI's artistic reefs, such as the "Guardians of the Reef" and the "1000 Mermaids Reef Project," leverage mythology, symbolism, and narrative to draw emotional connections between people and the Ocean. Storytelling is a powerful method for enhancing environmental literacy, fostering empathy, and motivating action (Dahlstrom 2014). Unlike some traditional reef restoration that is often invisible offshore, ORAI's visually compelling sculptures foster place attachment, community pride, and identity linked to marine stewardship. Research shows that emotional attachment to natural places significantly predicts pro-environmental behavior (Vaske and Kobrin 2001). Also, by locating artistic reef sites near accessible coastal communities and tourism hubs (e.g., Hollywood, Florida), ORAI ensures that broad sectors of the public, not just dedicated divers, can interact with marine conservation narratives. Accessibility is a key component of equitable Ocean Literacy promotion (Fauville 2017).

Experiential learning is one of the most effective strategies for building Ocean Literacy, particularly among youth and non-traditional audiences (Ballantyne et al. 2011). Public participation and education are fundamental to ORAI's mission. ORAI delivers direct experiences with marine ecosystem restoration efforts through reef monitoring programs, coral planting initiatives, and educational dives. This is accomplished through collaboration with local schools, universities, tourism operators, and citizen scientist programs to integrate marine science education and local Ocean Literacy concepts and marine conservation into dive tours, school curricula, and the public ethos. Each project serves not only as a site for ecological restoration, but as a platform for education, inspiration, and hands-on engagement. This ensures that people of all ages and backgrounds are directly involved in restoring and protecting the marine environment. Since 2021, ORAI has engaged with over 2500 students from schools and universities in marine conservation activities, conducted more than 100 educational workshops and community reef restoration events, employed over 20 interns, and partnered with over 30 organizations such as Mission Blue, Frost Museum of Science, Reef Cells, Palm Beach and Broward County, University of Florida, University of Miami, and the Coral Restoration Foundation (Fig. 19.5).

One pathway ORAI employs for experiential learning efforts includes the Coral ORAI Rangers, a dynamic volunteer and youth leadership program designed to actively involve community members and future conservation leaders in marine restoration and stewardship efforts. Through this program, participants gain hands-on experience in coral reef restoration, ecological monitoring, and environmental education, while building valuable skills in science, leadership, and community engagement. Coral ORAI Rangers empowers youth and volunteers to become active agents of change, bridging education, action, and advocacy. More recently, ORAI implemented the LiveBlue initiative designed to connect people to the concept of Ocean healing power through wellness, action, education, and experience. This holistic, community-centered program is envisioned as a free community offering that removes financial barriers by offering monthly workshops that integrate wellness, such as yoga and meditation (Fig. 19.5), beach clean-ups, educational experiences, and dive-ins (snorkeling adventures).

Ultimately, ORAI's Ocean Literacy model intentionally bridges scientific knowledge and cultural engagement with flagship initiatives (Table 19.1), ensuring that marine protection becomes a shared social and emotional responsibility and not just a technical challenge. While work has currently concentrated in Florida, ORAI has a project in Barbuda and one in development



Fig. 19.5 To increase Ocean Literacy and project impacts, ORAI is active within local communities through scientific collaborations (a) such as coral outplanting with the Coral Restoration Foundation in the Florida Keys, and other partnerships. ORAI is also dedicated to providing community-centered programing like wellness classes adjacent to project sites, such as (b) yoga by the nearshore Hollywood, Florida artificial reef project, to increase community activism and engagement, and Ocean appreciation

in Mexico (see Table 19.1), and is working with other private and public partners in other major tropical Ocean basins. ORAI's company vision (Fig. 19.6) moves beyond the traditional function of artificial reefs as habitat structures and into the realm of transformative Ocean Literacy, empowering individuals and communities to understand, value, and act for the Ocean.



Fig. 19.6 Digital rendering of ORAI's vision to transform coastal communities into thriving ecosystems that protect coastlines through wave breaks, create marine habitat, restore marine resources, increase tourism revenue, and connect communities to the Ocean through art

This vision aligns with the priorities of the United Nations Ocean Decade, UNESCO's Ocean Literacy Framework, and Sustainable Development Goal 14: *Life Below Water*. As climate change accelerates and Ocean degradation intensifies, building a globally Ocean-literate public will be essential (United Nations General Assembly 2015), one in which NGOs can and should play an active role in fostering collaboration, community engagement, and transformative action, as outlined in the *UNESCO IOC Ocean Decade Manual for NGOs* (Kennedy et al. 2024). ORAI's work demonstrates a scalable, inspiring, and effective pathway to achieve this critical mission.

19.4 Conclusion

As challenges facing our Ocean ecosystems grow more urgent, the need for innovative, scalable, and community-driven solutions becomes more critical. Hybrid artificial reefs provide a potentially transformative solution for restoring marine ecosystems, protecting coastlines, and fostering resilient coastal communities by merging ecological science with innovative engineering. Additionally, integrating art, culture, and experiential learning into reef design has been shown to enhance Ocean Literacy, emotional connection, and public stewardship, innovatively bridging science and society. ORAI represents a case study of an organization at the intersection of science, engineering, art, and education by advancing a new model for marine restoration and Ocean Literacy. ORAI's initiatives align with the United Nations Sustainable Development Goals (SDG) (United Nations General Assembly 2015), particularly SDG 11 (integrating Ocean Literacy into urban planning and sustainable tourism), SDG 13 (building coastal resilience against climate change), SDG 14 (enhancing marine biodiversity through reef restoration), and SDG 17 (collaborating with governments, NGOs, and research institutions).

By deploying hybrid artificial reefs that restore marine habitats, protect coastlines, and connect people culturally and emotionally to the Ocean, ORAI demonstrates that restoration can be both functional and transformative. Combining ecological design with compelling storytelling and public engagement creates a ripple effect that fosters stewardship, strengthens communities, and builds resilience. Artificial reef deployment coupled with targeted programs, including LiveBlue and Coral ORAI Rangers, exhibit how positive outcomes may extend beyond reef structures to empower individuals of all ages to take direct action for the Ocean. By integrating citizen science, youth leadership, cultural education, and sustainable tourism, ORAI is working to cultivate

a deeply rooted, globally connected network of Ocean advocates.

Aligned with the United Nations Ocean Decade goals and the Sustainable Development Goals, ORAI's work serves as a beacon for how holistic, nature-based solutions can regenerate ecosystems, economies, and human emotions. The future health of Earth's Ocean may depend on bold, inclusive, and creative action. ORAI's model offers not just a path forward but an invitation to reimagine, reconnect, and restore the blue planet that sustains us all.

19.4.1 Summary

Key concepts explored in this chapter include:

- Hybrid artificial reefs (HARs) integrate natural and engineered elements to restore marine ecosystems, enhance biodiversity, and protect coastlines.
- Ocean Rescue Alliance International (ORAI) unites science, engineering, art, and community engagement to foster Ocean Literacy and sustainable blue economy practices.
- Nature-inspired reef designs promote rapid colonization, support endangered species recovery, and provide vital habitats for fish and coral.
- Hybrid reefs function as living breakwaters, reducing wave energy, stabilizing coastlines, and building climate resilience for vulnerable communities.
- Incorporating art into reef structures creates emotional and cultural connections that inspire conservation action and Ocean stewardship.
- ORAI projects, such as "1000 Mermaids Reef" and "Guardians of the Reef", transform restoration sites into underwater museums that attract sustainable tourism.
- Artistic reefs generate economic benefits by boosting ecotourism, creating jobs, and strengthening local economies through reef adoption programs and dive operations.
- ORAI embeds Ocean Literacy into all projects through storytelling, citizen science, youth leadership programs, and accessible educational experiences.
- Flagship initiatives like Coral ORAI Rangers and LiveBlue foster hands-on engagement and build a global network of future Ocean stewards.
- ORAI's work aligns with the United Nations Ocean Decade (2021–2030).
- Sustainable Development Goals (SDGs), demonstrating how hybrid reefs can regenerate ecosystems, communities, and economies.

19.4.2 Recommended Resources

The following resources provide further insights and support on this topic:

- Ocean Rescue Alliance: https://Oceanrescuealliance.org
- 1000 Mermaids Artificial Reefs: https://1000mermaids.com/home
- United Nations Ocean Decade Initiative: https://Oceandecade.org
- Defense Advanced Research Projects Agency (DARPA) Reefense Strategy: https://www.darpa.mil/program/reefense
- TEDx Talk: Through Serving Nature We Serve Ourselves | Shelby Thomas: https://www.youtube.com/watch?v=2N9HuXawwvc

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20

Ocean Literacy in Action: Advancing Sustainable Coastal Futures Through the Foundation for Environmental Education

Johann Durand and Lee Wray-Davies

Abstract

The Blue Flag programme, established by the Foundation for Environmental Education (FEE) in 1987, has made substantial contributions to Ocean Literacy over its 35-year history, by promoting environmental education, sustainable tourism, and marine conservation. The Blue Flag programme has influenced policies, engaged communities, and enhanced public awareness of marine ecosystems on a global scale. This chapter explains FEE's vision to advance sustainable development through education, detailing its international network, and Blue Flag Programme's pivotal role in fostering Ocean Literacy through education, public engagement, and policy influence. It also shows how FEE's initiatives, such as the Global Action Days Campaign and the GAIA 20:30 Strategy, are closely aligned with the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) as well as with the United Nations Decade on Ecosystem Restoration (2021–2030), contributing to scientific research, marine conservation, pollution reduction, and climate resilience, while strengthening global cooperation for sustainable Ocean management. The GAIA 20:30 Strategy supports international sustainability goals by emphasising climate action, biodiversity protection, and sustainable livelihoods. Through citizen science, advocacy, and partnerships, these efforts drive Ocean Literacy and promote responsible marine stewardship, underscoring the importance of integrating education, research, and policy to ensure Ocean sustainability now and in the future through both Decades. As environmental challenges intensify, the continued expansion of FEE's initiatives will be critical in cultivating a global culture of Ocean Conservation and ensuring the long-term health of marine ecosystems.

Keywords

Ocean Literacy (OL) · Environmental education · Sustainable Development Goals (SDGs) · United Nations Decade of Ocean Science for Sustainable Development (Ocean Decade) · United Nations Decade on Ecosystem Restoration · Marine conservation · Sustainable tourism · Climate resilience · Marine pollution · Coastal management · Foundation for Environmental Education (FEE) · Blue Flag Programme (BF) · Green Key (GK) · Eco-schools · Young Reporters for the Environment (YRE) · Learning About

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Ecosystems and Forests (LEAF) · Global Action Days (GAD)

20.1 Introduction

The Foundation for Environmental Education (FEE), established in 1981, is a globally recognised non-governmental, non-profit organisation dedicated to promoting sustainable development through environmental education. Operating globally with a vast network of national member organisations spanning more than 80 countries, FEE's mission is to encourage positive behavioural change and environmental stewardship through a variety of educational programmes, of which the Blue Flag initiative is one of the most well-known.

Consistent with the United Nations Decade of Ocean Science for Sustainable Development (Ocean Decade), FEE envisions a world where people are actively engaged in protecting the environment and promoting sustainable development. As such, FEE's objectives align with global sustainability goals, including those set by the United Nations Sustainable Development Goals (SDGs). Specifically, FEE encourages individuals and organisations to take meaningful action toward environmental sustainability, leveraging flagship programmes, campaigns and partnerships that inspire collective responsibility. It promotes educational initiatives that raise awareness about pressing issues such as climate change, biodiversity conservation, waste management, and responsible resource use, ensuring these topics are accessible to diverse audiences. FEE also strengthens international collaboration by fostering partnerships across its global network, amplifying its impact through shared knowledge and resources. Empowering young people is a cornerstone of its work, with programmes such as Young Reporters for the Environment designed to cultivate environmental leadership among future generations. Additionally, FEE advocates for stronger environmental policies at local, national, and international levels, influencing governance to prioritise sustainability and environmental education. These efforts collectively position FEE as a leader in driving global environmental education and action.

FEE's strength is underpinned by its collaborative approach, with over one-hundred member organisations tailoring their programmes to regional and local contexts, thus ensuring that its educational initiatives are culturally and geographically relevant. This extensive network allows for knowledge-sharing, capacity building, and large-scale environmental impact. See Fig. 20.1 for a map depicting the Foundation for Environmental Education international network.

Partnerships with international bodies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the European Union (EU), and various corporate and non-governmental organisations enhance FEE's ability to leverage expertise, resources, and advocacy efforts, amplifying its impact on global environmental education. By working with governments, academic institutions, businesses, and local communities, FEE adopts a multi-stakeholder approach that integrates scientific research, policy advocacy, and grassroots initiatives into a holistic strategy for sustainable development.

20.1.1 The Link Between FEE and Ocean Literacy

Ocean Literacy (OL), the understanding of the Ocean's influence on humans and vice versa, is at the core of FEE's mission. Through its programmes, FEE equips individuals and communities with the knowledge and tools to value and protect marine environments. This is achieved through an interdisciplinary approach that integrates marine science, environmental ethics, and policy discussions into school curricula and public campaigns, ensuring a comprehensive understanding of Ocean issues. Experiential learning opportunities, such as beach clean-ups, marine



Fig. 20.1 The Foundation for Environmental Education Global Network

biodiversity monitoring, and sustainable fishing practices, deepen people's connection to the Ocean by offering hands-on engagement. Community workshops, seminars, and citizen science projects further empower local populations to actively participate in marine conservation, fostering a sense of ownership. Additionally, FEE collaborates with governments and international organizations to advocate for policies that promote sustainable Ocean management, translating education into actionable governance.

20.1.2 FEE's Impact on Global Ocean Literacy

FEE's influence on OL is multifaceted. Over the years, its programmes have driven policy changes, with many national governments integrating Blue Flag standards into coastal management frameworks, resulting in stricter environmental regulations and enhanced marine conservation efforts. These educational campaigns have also shifted behaviours, encouraging millions worldwide to adopt sustainable habits, tourists at Blue Flag beaches, for instance, are more likely to respect marine environments and participate in conservation activities. Scientifically, FEE's collaborations with research institutions have advanced global understanding of marine pollution, water quality, and sustainable coastal development, contributing valuable data to the field. Economically, the sustainable tourism fostered by programs like Blue Flag (focusing on beaches, marinas, sustainable tourism boats, water quality, environmental management, environmental education, and safety) and Green Key (focusing on responsible business practices and resource efficiency for tourism establishments like hotels, restaurants, and campsites), have boosted revenue for coastal communities while prioritizing environmental integrity, demonstrating that growth need not compromise ecosystems.

By integrating OL into every aspect of its educational framework, FEE has made a lasting impact on how individuals, businesses, and policymakers' approach marine conservation. The organisation's holistic strategy ensures that environmental education translates into real-world action, reinforcing the principles of sustainability across generations.

FEE operates five major educational programmes each designed to promote sustainability in different contexts (see Fig. 20.2 for each program's logo).

Descriptions of each programme follow.

- Blue Flag: Recognised internationally as a leading certification for beaches, marinas, and tourism boat operators, the Blue Flag programme sets high environmental, safety, and educational standards for coastal areas. It plays a significant role in fostering OL by educating the public on marine conservation and best practices for sustainable tourism.
- Green Key: This global certification programme promotes sustainability in the hospitality industry. Hotels, resorts, and other tourism-related establishments that meet Green Key's environmental standards commit to reducing their ecological footprint. By encouraging responsible tourism, Green Key complements the Blue Flag initiative and reinforces OL among travellers.
- Eco-Schools: This programme engages millions of students and teachers worldwide in firsthand learning about sustainability. Schools participating in the programme work on environmental projects, conduct assessments, and implement sustainability initiatives. The Eco-Schools initiative contributes to OL by educating young people about marine ecosystems, water conservation, and pollution prevention.
- Learning About Ecosystems and Forests (LEAF): This initiative promotes forest conservation and environmental awareness through educational programmes and outdoor activities. While its primary focus is on forests, it also connects with broader environmental themes, including the interdependence of ecosystems and the importance of biodiversity, which relate to marine conservation.
- Young Reporters for the Environment (YRE): This programme empowers young people to investigate environmental issues and share their findings through journalism, photography, and digital storytelling. Many YRE participants focus on marine conservation topics, helping to spread awareness about Ocean pollution, overfishing, and climate change impacts on coastal communities.

Each of FEE's programmes strategically engages different education pathways to ensure wide and inclusive outreach. Eco-Schools and LEAF operate primarily within *formal education systems*, reaching millions of students and teachers globally through curriculum-based learning. In contrast, Blue Flag and Green Key influence *informal and non-formal learning environments*, engaging tourists, hospitality workers, and local communities through practical experiences and public-facing educational content. Young Reporters for



Fig. 20.2 Foundation for Environmental Education (FEE) Programme Logos

Table 20.1 Foundation for Environmental Education (FEE) Programmes Supporting Ocean Literacy

Programme	Audience Type	Primary Audiences
Blue Flag (BF)	Informal/ Non-formal	Tourists, beach users, local communities, municipal authorities, marina operators
Green Key (GK)	Informal/ Non-formal	Hospitality sector staff, hotel guests, tourism operators
Eco-Schools	Formal	Students (primary to secondary), teachers, school staff
Learning About Ecosystems and Forests (LEAF)	Formal/ Non-formal	School communities, educators, forest managers, environmental educators
Young Reporters for the Environment (YRE)	Formal/ Non-formal	Youth aged 11–25, teachers, journalists, student groups
Global Action Days (GAD)	Informal/ Non-formal	Community members, NGOs, students, businesses, educators, local authorities

the Environment (YRE) bridges *formal and non-formal education*, empowering youth in and out of school to use investigative journalism to explore environmental issues. The Global Action Days (GADs) campaign is a prime example of *non-formal education*, mobilizing communities, businesses, and civil society actors to participate in collective environmental action. This multifaceted approach ensures that Ocean Literacy is accessible, inclusive, and tailored to diverse audiences across age groups and sectors (see Table 20.1).

Through these programmes, FEE has established itself as a global leader in environmental education. By integrating experiential learning, community engagement, and scientific research, FEE fosters a culture of sustainability that extends beyond formal education systems.

This chapter focuses on the Blue Flag Programme's impact on OL, detailing its contributions to environmental education, community engagement, and policy influence. It also examines FEE's Global Action Days and GAIA 20:30 Strategy, demonstrating their alignment with the Ocean Decade objectives. Case studies and model practices illustrate how these initiatives enhance OL and contribute to Ocean sustainability. As FEE's most prominent marine-focused initiative, The Blue Flag programme serves as a practical application of the Ocean Literacy Principles. By requiring Blue Flag sites to meet strict environmental and educational criteria, FEE ensures that coastal managers, tourists, and local communities engage in sustainable practices that protect marine ecosystems.

20.2 The Blue Flag Programme: An Overview

The Blue Flag Programme, initiated by the Foundation for Environmental Education (FEE) in 1987, has been a global leader in advancing OL by fostering sustainable tourism, environmental education, and marine conservation. Over the past 35 years, the programme has played a crucial role in enhancing public understanding of Ocean-related issues while supporting global sustainability efforts, particularly the United Nations (UN) Sustainable Development Goals (SDGs) and the UN Decade of Ocean Science and Sustainability (Ocean Decade) Challenges and Outcomes.

The Blue Flag is a prestigious eco-label awarded to beaches, marinas, and tourism boat operators that meet high environmental, educational, safety, and accessibility standards. The programme operates in fifty countries and has recognised thousands of sites for their commitment to sustainable coastal management (see Fig. 20.3 for a map of the Blue Flag countries). The Blue Flag's criteria ensure that awarded sites implement effective measures to reduce pollution, enhance biodiversity, and promote public awareness about marine conservation.

The Blue Flag programme's recognition of excellence has created a global network of environmentally responsible coastal locations. The rigorous certification process ensures that only the most committed sites are awarded, thereby setting an international benchmark for sustain-

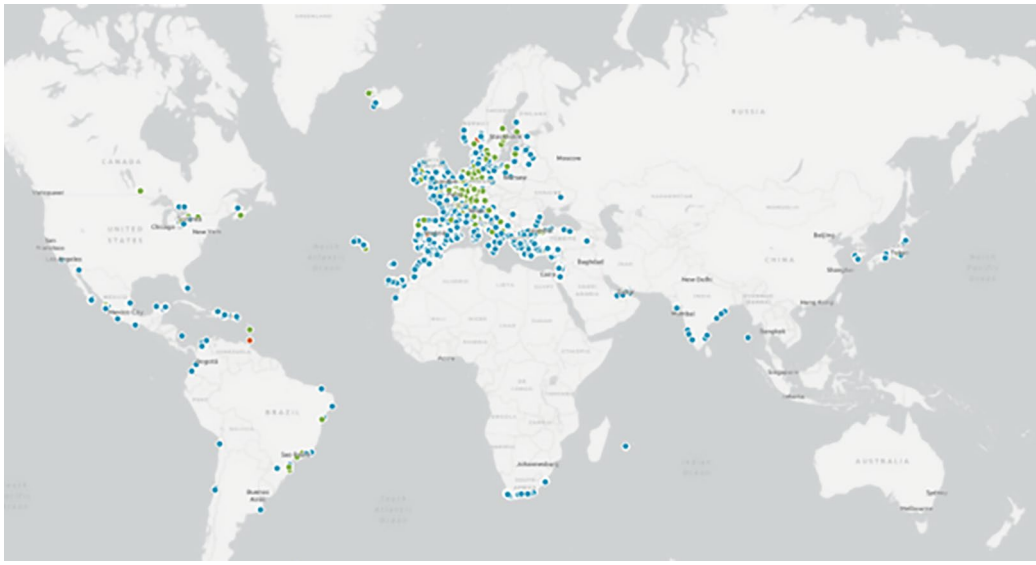


Fig. 20.3 Blue Flag Countries

able beach and marina management. The extensive reach of the programme has contributed to a widespread culture of environmental stewardship, influencing policies at local, national, and international levels.

Beyond the award itself, the programme fosters a sense of pride among communities and stakeholders. Municipalities and beach managers are motivated to uphold the exacting standards required by the programme, leading to long-term investments in environmental management, sustainable tourism practices, and local conservation initiatives. The continuous monitoring and assessment process ensures that Blue Flag sites maintain or improve their environmental standards over time, reinforcing their commitment to OL.

20.2.1 Blue Flag and Environmental Education and Awareness

The Blue Flag Programme significantly enhances OL through its focus on environmental education. Certified sites are required to provide detailed information on local ecosystems and biodiversity, ensuring visitors understand the marine environment with which they are engaging. Educational activities, such as workshops, beach clean-ups, and guided eco-tours, are organized for visitors, schools, and local communities, fostering hands-on learning experiences. Interpretation boards and online resources further promote marine conservation awareness, while collaborations with schools, research institutions, and NGOs develop tailored educational materials. These efforts cultivate a deeper intellectual and emotional connection to the Ocean, addressing key issues like biodiversity, climate change impacts, sustainable fishing, and marine litter reduction in culturally adaptable ways.

Environmental education initiatives under the Blue Flag programme are designed to cultivate a deeper understanding of marine ecosystems among the public. By integrating scientific knowledge with direct experiences, these programmes help people develop an emotional and intellectual connection with the Ocean. Educational campaigns often cover key issues such as marine biodiversity, climate change impacts on coastal regions, sustainable fishing, and the importance of reducing marine litter.

Furthermore, Blue Flag's educational framework is adaptable to diverse cultural and geographic contexts. This flexibility ensures that communities across the globe can tailor their

educational efforts to address specific local environmental concerns. Public events such as beach clean-ups, marine biodiversity workshops, and guided eco-tours contribute to a participatory approach to learning, reinforcing the principles of OL.

20.2.2 Enhancing Public Engagement in Marine Conservation

Through its community-based initiatives, the Blue Flag programme encourages public participation in marine conservation. Beach clean-ups, citizen science projects, and educational workshops empower individuals to take proactive steps in protecting coastal environments. The involvement of local communities strengthens stewardship and enhances the effectiveness of conservation efforts.

Local engagement is a cornerstone of the programme's philosophy. By involving communities in conservation activities, the Blue Flag initiative fosters a sense of ownership and responsibility toward local marine environments. Citizen science programmes, where volunteers collect data on water quality, biodiversity, and pollution levels, have become an integral part of the initiative. These activities not only contribute valuable scientific data, but also help volunteers develop a greater appreciation of oceanic ecosystems.

Additionally, businesses and tourism operators associated with Blue Flag beaches and marinas are encouraged to implement sustainability initiatives such as waste reduction, eco-friendly infrastructure, and marine wildlife protection measures. This engagement extends the reach of the Blue Flag programme beyond local governments and environmental organisations, embedding Ocean Literacy Principles into the economic and social fabric of coastal communities.

> "The experience of implementing Blue Flag in India since 2018 has highlighted and demonstrated key aspects of beach management for consideration towards a sustainable future. A key element is to design and evolve coastal interventions, programs and activities with the spirit of people's engagement, participatory approach, nurturing of local partnerships and scope for multiple stakeholders to contribute positively to the development process. The role of women and providing opportunities for their proactive participation and decision-making is an important aspect of beach management and operations. Blue Flag beaches have showcased how women from local communities may be oriented and employed in various beach operations, including visitor hospitality, maintenance of facilities and safety and security services. This is a tremendous opportunity for women empowerment, benefiting local communities, and particularly women. Coastal management in India, therefore, requires inclusive participation across various levels to ensure sustainable approaches and practices for beach and coastal area development" (Dongre et al. 2023).

20.2.3 Improving Coastal and Marine Management

The Blue Flag's stringent environmental criteria require sites to implement sustainable waste management systems, reduce single-use plastics, and maintain high water quality standards. By enforcing these requirements, the programme has significantly reduced pollution and helped mitigate the impact of human activities on marine ecosystems. These actions support the principles of OL by demonstrating the link between human behaviour and Ocean health.

Through continuous monitoring and annual assessments, the Blue Flag Programme ensures that certified sites remain leaders in best practices for coastal and marine management. This comprehensive framework prioritises maintaining high water quality standards to safeguard both human and marine health, ensuring bathing waters meet stringent criteria. Cleanliness and water quality are critical Blue Flag indicators for beachgoers, particularly due to their importance in sanitation. Knowing that a Blue Flag-certified beach reliably maintains high water quality standards provides bathers with valuable reassurance. A study by the same authors, based on 5000 coastal monitoring points across the EU-27's top three tourist destinations—Spain, France, and Italy—found that regions with the highest number of Blue Flag beaches consistently exhibited significantly cleaner waters, as defined by the

European Union's Bathing Water Directive (Escrivá-Beltrán and Currás-Móstoles 2023). It also promotes robust waste management strategies, encouraging recycling initiatives, waste reduction programs, and bans on harmful pollutants to minimise environmental impact. Biodiversity conservation efforts are central, with the programme protecting dune systems, coral reefs, and marine habitats through habitat restoration and sustainable tourism policies that balance ecological preservation with visitor access. Additionally, climate resilience strategies address pressing challenges like rising sea levels, coastal erosion, and extreme weather events, implementing adaptive management plans to enhance the long-term sustainability of coastal ecosystems.

20.2.4 Influencing Policy and Governance

Over 35 years, the Blue Flag programme has shaped local and national policies by promoting best practices in coastal management. Governments and municipalities often adopt the programme's standards as benchmarks for environmental legislation. This alignment fosters a culture of sustainable Ocean governance, ensuring that marine conservation remains a priority in policymaking.

By aligning with international conventions such as the United Nations Sustainable Development Goals (SDGs), the Paris Agreement, and regional environmental treaties, the Blue Flag initiative has amplified its influence in shaping marine conservation policies worldwide. Many governments integrate Blue Flag criteria into national environmental policies, reinforcing the commitment to maintaining high environmental and educational standards in coastal management.

Blue Flag certification also demonstrates significant political and institutional strength in areas critical to beach management, particularly in the realm of effective coastal governance and the advancement of integrated coastal certifications. In a research project conducted in Colombia, an expert panel identified key aspects of beach certifications that contribute to effective coastal management. While the Blue Flag program was recognized for its strong emphasis on biophysical criteria, reflected in the high number of environmental indicators, it was also found that institutional objectives were equally important. These included a diverse set of sustainability-related goals: (1) strengthening coordination among authorities and administrative policies; (2) supporting integrated management through legislation and regulation; (3) raising public awareness of sociocultural and environmental sustainability in coastal areas; and (4) resolving conflicts over coastal space and resources. However, the study also noted that these indicators are most applicable to large coastal zones and may not directly align with the more localized objectives of beach certification programs. (Zielinski and Botero 2023).

20.2.5 Encouraging Sustainable Tourism

Tourism plays a crucial role in shaping public attitudes toward the Ocean. The Blue Flag certification helps create a model for sustainable tourism by promoting responsible travel behaviour, encouraging eco-friendly accommodations, and ensuring that tourism development aligns with environmental conservation. This approach contributes to OL by educating tourists on the importance of preserving marine environments.

Sustainable tourism under the Blue Flag initiative prioritises a holistic approach to environmental stewardship and visitor engagement. It encourages the development of eco-friendly infrastructure by promoting the use of renewable energy, sustainable building materials, and water-efficient facilities, ensuring that tourism operations minimize their ecological footprint. The programme also fosters conservation-oriented visitor activities, offering nature-friendly experiences such as snorkelling in marine reserves, guided eco-tours, and educational exhibits on marine conservation, which deepen tourists' understanding of Ocean ecosystems while preserving their integrity. Furthermore, it empha-

sises ethical wildlife interactions, ensuring that marine tourism does not disrupt local wildlife through adherence to guidelines for ethical diving, dolphin-watching, and responsible boating practices, thereby balancing enjoyment with the protection of marine biodiversity.

20.2.6 Advancing Scientific Research and Innovation

Through collaborations with research institutions and conservation organisations, the Blue Flag programme has contributed to scientific advancements in marine protection. Monitoring water quality, assessing biodiversity, and studying the impacts of climate change on coastal areas have all been integral to the programme's efforts. These research initiatives provide valuable data that support OL efforts and inform global marine conservation strategies.

20.2.7 Challenges and Future Directions

Despite its successes, the Blue Flag programme faces challenges such as climate change, increasing marine pollution, and the need for greater global participation. Future strategies should focus on expanding the programme to more developing countries, integrating digital tools for environmental education, and strengthening partnerships with international conservation organisations.

20.3 The Role of FEE Global Action Days and Its Contribution to the Ocean Decade

The award-winning, Global Action Days (GADs) campaign focuses on sustainability and community empowerment. From Ocean plastics to ecosystem restoration, each year hundreds of thousands of participants from schools, universities, hotels, local authorities, Blue Flag beaches, private companies and NGOs take part in environmental activities, ranging from beach litter picks to mangrove planting initiatives. Since its start, the GADs campaign has engaged over 50,000 schools, across more than one hundred countries (see Fig. 20.4 for FEE Global Days Global Impact).

In 2024 directly involving over half a million people and indirectly reaching millions more through family and community networks. With such scale and supporters such as the UNESCO, IUCN, WSOM and Parents International the GADs campaign shows an ability to bridge education and community action.

Through these coordinated actions, GADs not only promote individual and community participation, but also serve as a catalyst for long-term environmental change, reinforcing the principles of OL on a global scale.

20.3.1 Aligning Global Action Days with the Ocean Decade

The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) is a landmark initiative aimed at leveraging scientific knowledge to support sustainable Ocean management. The Ocean Decade emphasises the need for transformative action to ensure healthy, productive, and resilient Ocean. The GADs campaign actively contributes to these efforts through community-driven science, education, and advocacy.

By inspiring grassroots action and uniting local and global communities, GADs strengthen international cooperation in protecting marine and coastal environments, directly supporting the restoration objectives of the Ocean Decade. Additionally, GADs are recognised as an example of best practice under the Greening Education Partnership—Pillar 4: Greening Communities, as it mobilises diverse groups to take collective action towards Ocean sustainability.

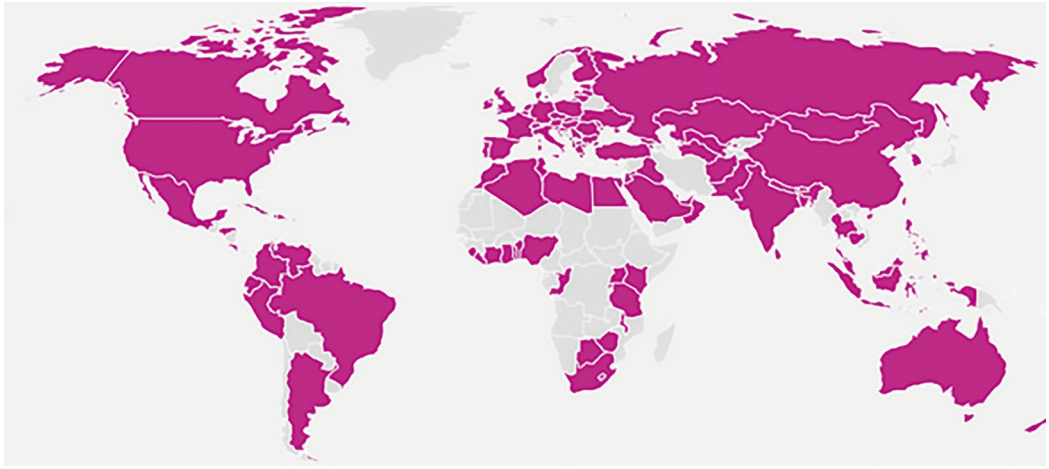


Fig. 20.4 FEE Global Action Days Global Reach 2024

20.3.2 Raising Awareness on Ocean Literacy and Marine Conservation

The Global Action Days (GADs) initiative significantly enhances OL by creating educational materials, promoting interactive events, and leveraging social media campaigns to engage diverse audiences. FEE provides comprehensive resources on marine ecosystems, conservation strategies, and sustainable practices, with the 2025 GAD themes—such as soil health and plant protection—underscoring the interconnectedness of land and Ocean ecosystems and emphasizing terrestrial restoration's critical role in marine health; these materials are distributed in multiple languages by schools, universities, and environmental organizations to maximize accessibility and impact.

Additionally, GADs promote interactive events through intergenerational activities like community interviews and hands-on restoration projects, which encourage direct engagement with nature, deepen participants' understanding of ecosystem restoration's contributions to Ocean sustainability, and strengthen community bonds across age groups. The initiative further amplifies its reach by leveraging social media campaigns, where participants share their experiences using hashtags like #GlobalActionDays and #GenerationRestoration, raising widespread awareness about ecological restoration's vital role in marine conservation and inspiring global action.

20.3.3 Supporting a Clean and Healthy Ocean

Marine pollution, encompassing plastic waste, oil spills, and industrial runoff, poses one of the most significant threats to Ocean ecosystems, causing widespread ecological damage. The Global Action Days (GADs) initiative plays a vital role in supporting Ocean health by implementing community-driven clean-up initiatives that encourage local restoration projects, such as wetland and mangrove rehabilitation, which serve to filter pollutants and safeguard coastal areas from erosion.

Beyond physical clean-ups, GADs inspire waste reduction advocacy by engaging participants in water quality assessments and environmental reporting, generating valuable data that contributes to marine restoration research and informs broader conservation efforts. Additionally, through citizen science monitoring, participants actively collect data on pollution levels and share their findings with scientific organizations, enhancing research on marine pollution and empowering communities to contribute directly to the scientific understanding and mitigation of these threats.

20.3.4 Promoting Sustainable Ocean Economies

A thriving sustainable blue economy hinges on the vitality of marine ecosystems, and GADs support this by promoting economic practices that prioritize environmental health. The initiative delivers bioeconomy education, drawing on traditional ecological knowledge to encourage sustainable fishing and responsible marine resource use, equipping participants with the insights needed to balance economic benefits with ecological preservation. It also promotes community engagement by highlighting local restoration efforts, such as seagrass restoration, which not only supports biodiversity and sustainable fisheries, but also empowers coastal communities to take an active role in environmental stewardship, fostering a sense of ownership and responsibility.

Furthermore, GADs advocates for sustainable tourism initiatives that prioritize the restoration and conservation of marine environments, encouraging eco-friendly practices that align tourism with the long-term health of Ocean ecosystems, thereby contributing to both economic vitality and environmental sustainability.

20.3.5 Enhancing Community-Driven Science and Innovation

Scientific research and innovation are vital pillars of Ocean sustainability, and the Global Action Days (GADs) initiative significantly contributes to these efforts by engaging communities in meaningful scientific endeavours. GADs facilitate data collection projects that involve volunteers in monitoring coastal and marine environments, gathering critical information on water quality, marine life, and coastal erosion, which supports ongoing research at both local and global levels and enriches the scientific understanding of Ocean health.

Beyond data collection, the initiative fosters community connectivity by creating networks of action that unite participants in a shared mission, aligning with the Ocean Decade's goal of building a global Ocean movement. This collaborative spirit extends to partnerships with research institutions, strengthening ties between citizen scientists and academic organizations to enhance Ocean monitoring and ensure that community efforts inform professional research.

Additionally, GADs encourage technological innovations by promoting the development and use of sustainable technologies, such as biodegradable alternatives to plastic and AI-driven Ocean monitoring tools, driving forward-thinking solutions that support long-term marine conservation.

20.3.6 Strengthening Global Cooperation for Ocean Sustainability

The Ocean Decade underscores the necessity of global cooperation for effective Ocean conservation, recognizing that international collaboration is key to addressing shared challenges, and FEE's Global Action Days aligns seamlessly with this objective by fostering transnational partnerships and collective action. GADs create opportunities for schools, NGOs, and local governments from different countries to collaborate, sharing best practices and innovative solutions for marine conservation that enhance global knowledge and implementation efforts.

The initiative also engages policymakers through advocacy campaigns that encourage governments to adopt policies protecting marine ecosystems, aligning national strategies with international conservation goals and amplifying their impact. Furthermore, GADs host global challenges and annual events that bring together participants from diverse regions to collectively tackle shared Ocean-related issues, cultivating a sense of global solidarity and purpose in the pursuit of sustainable Ocean management.

20.3.7 Looking Ahead: Strengthening the Impact of Global Action Days

To maximize its alignment with the Ocean Decade, FEE is committed to enhancing the reach and efficacy of Global Action Days through strategic advancements. The initiative aims to

expand participation by increasing the involvement of schools, communities, and organizations, with a particular focus on small island states where localized OL and restoration efforts can have an immediate and profound impact on Ocean health, ensuring broader engagement in community-led conservation projects.

GADs also seek to enhance data collection efforts by strengthening citizen science projects, enabling them to contribute more robustly to global Ocean research initiatives and provide valuable insights for scientific advancement. Leveraging technology is another key focus, with plans to utilize digital tools and artificial intelligence to facilitate lifelong OL education and engagement, both within and beyond formal classroom settings, making learning accessible to diverse audiences. Finally, GADs will advocate for policy integration, encouraging governments and international organizations to incorporate insights from the initiative into official sustainability strategies, thereby embedding community-driven findings into broader governance frameworks and amplifying their influence on global Ocean sustainability.

By driving grassroots engagement, enhancing scientific collaboration, and fostering policy change, the FEE Global Action Days initiative is making a tangible contribution to the goals of the Ocean Decade. As an initiative that brings communities together and serves as an example of best practice under the Greening Education Partnership's Pillar 4: Greening Communities, GADs embody the principles of inclusive, science-based action for Ocean sustainability. Moving forward, continued investment in community-driven initiatives and knowledge-sharing platforms will be essential in ensuring a thriving Ocean for future generations.

20.4 The Importance of the FEE GAIA 20:30 Strategy and Its Support for the Ocean Decade

The GAIA 20:30 Strategy, an ambitious and forward-thinking framework developed by the Foundation for Environmental Education (FEE), guides its global initiatives toward a sustainable future by focusing on three overarching pillars: climate action and resilience, biodiversity and ecosystem protection, and sustainable societies and livelihoods. This strategy addresses the impacts of climate change with a particular emphasis on marine and coastal environments, implementing measures to mitigate rising sea levels and extreme weather events that threaten these ecosystems.

It also prioritizes the enhancement of marine ecosystem protection, fostering responsible interactions with nature to safeguard biodiversity through initiatives like habitat restoration and sustainable tourism practices. Furthermore, GAIA 20:30 encourages sustainable economic practices in industries such as tourism, fisheries, and coastal development, promoting models that balance economic growth with environmental integrity, such as eco-friendly fisheries management and low-impact coastal infrastructure.

By embedding these principles into its network of environmental programmes, including Blue Flag, Green Key, and Eco-Schools, FEE ensures that its initiatives contribute directly to global Ocean sustainability goals, creating a ripple effect that strengthens marine conservation efforts worldwide.

20.4.1 The Role of GAIA 20:30 in Ocean Literacy and Public Engagement

At its core, the GAIA 20:30 Strategy seeks to enhance public understanding of Ocean ecosystems and cultivate a stronger global commitment to Ocean stewardship through a multifaceted approach encompassing educational outreach, experiential learning, and digital engagement. This begins with integrating OL into school curricula, where FEE collaborates with the Eco-Schools programme to educate students about marine biodiversity, the effects of climate change on the Ocean, and sustainable consumption habits, equipping young learners with the knowledge to make informed environmental choices. "A fundamental aspect of the Ocean Decade is its 'whole of society' approach, which strengthens

connections between science, governments, private companies, NGOs, civil society, and all actors of sustainable development. This approach emphasizes collaborative co-design and co-production of knowledge products and solutions" (Kennedy et al. 2024, p. 9).

The strategy also empowers coastal communities through knowledge-sharing initiatives, providing local stakeholders with scientific insights and practical solutions—such as community-led water quality monitoring or sustainable fishing techniques—to bolster Ocean conservation efforts at the grassroots level. Additionally, GAIA 20:30 leverages technology to expand OL utilizing digital tools, mobile applications, and virtual experiences to bring Ocean science closer to a wider audience, making complex topics accessible to people across diverse regions and backgrounds. By ensuring that knowledge about Ocean health and sustainability is both actionable and widely disseminated, GAIA 20:30 strengthens FEE's capacity to drive global awareness and inspire behavioural change among individuals, businesses, and policymakers, fostering a collective responsibility for marine ecosystems.

20.4.2 GAIA 20:30 and the Ocean Decade Goals

The Ocean Decade aims to enhance global understanding of the Ocean's role in sustainability and to promote the use of scientific knowledge in policymaking and resource management. The FEE GAIA 20:30 Strategy aligns with and actively supports these objectives in multiple ways.

20.4.2.1 Advancing Ocean Science and Research Collaboration

The Ocean Decade emphasizes the promotion of scientific research to tackle pressing marine challenges, and GAIA 20:30 contributes significantly to this goal by encouraging citizen science initiatives that enable individuals to contribute valuable data to marine research projects, such as tracking coastal erosion or monitoring marine species populations. It also fosters partnerships with universities and research institutions to integrate community-based monitoring programs, enhancing the scope and accuracy of Ocean data collection through collaborative efforts. Moreover, GAIA 20:30 promotes unrestricted access to scientific findings, ensuring that Ocean data informs both local conservation actions and global strategies, thereby bridging the gap between community engagement and professional research.

20.4.2.2 Strengthening Marine Ecosystem Protection

A shared priority of GAIA 20:30 and the Ocean Decade is the restoration and protection of marine biodiversity, which the strategy supports by expanding the Blue Flag programme's conservation efforts to encompass marine protected areas and coastal resilience projects, such as dune restoration or coral reef rehabilitation. It promotes sustainable fishing practices and works to reduce harmful human activities that degrade marine habitats, advocating for responsible resource use that preserves ecosystem health. Additionally, GAIA 20:30 pushes for stronger policies and regulations at national and international levels to safeguard marine biodiversity, ensuring long-term protection through legislative support.

20.4.2.3 Reducing Ocean Pollution

Marine pollution, particularly from plastic waste and chemical runoff, is a major focus of the Ocean Decade, and GAIA 20:30 addresses this through comprehensive waste reduction campaigns that encourage individuals and businesses to minimize plastic use and adopt zero-waste strategies, fostering sustainable consumption habits. The strategy expands coastal cleanup programs, supporting citizen-led waste monitoring projects that remove debris and track pollution trends, contributing to cleaner marine environments. It also advances circular economy initiatives, promoting sustainable production and consumption models that reduce marine pollution by prioritizing recyclable materials and reducing waste at the source.

20.4.2.4 Climate Resilience and Coastal Adaptation

With rising sea levels and increasing climate variability posing significant risks, coastal communities require robust adaptation measures, and GAIA 20:30 aligns with the Ocean Decade's climate resilience efforts by supporting research into coastal climate adaptation strategies, such as mangrove restoration to buffer storm surges. It provides educational resources tailored for coastal communities, equipping them with the knowledge to implement resilience measures like flood-resistant infrastructure. Furthermore, the strategy advocates for sustainable infrastructure and nature-based solutions, such as wetland preservation, to enhance coastal protection against climate impact.

20.4.2.5 Sustainable Blue Economy Development

GAIA 20:30 supports the Ocean Decade's push for sustainable economic practices by encouraging eco-tourism initiatives through the Blue Flag and Green Key programmes, which promote low-impact tourism that preserves marine environments while boosting local economies. It also supports responsible aquaculture and fisheries management, ensuring that marine resources are harvested sustainably to maintain ecological balance. Additionally, the strategy promotes sustainable business practices in Ocean-reliant industries, encouraging innovation in areas like renewable energy and eco-friendly coastal development to foster a thriving blue economy.

20.4.3 Looking Ahead: Scaling Up GAIA 20:30's Impact

To maximize its contributions to the Ocean Decade, FEE is committed to scaling up the GAIA 20:30 Strategy's impact through strategic advancements. This includes expanding outreach programs to bring OL and conservation awareness to more communities worldwide, particularly in underserved regions where education can drive meaningful change. The strategy enhances policy engagement by collaborating with governments and international bodies to integrate GAIA 20:30 principles into environmental legislation, ensuring that its insights shape sustainable governance. It also strengthens partnerships with scientific institutions, facilitating joint research initiatives and knowledge-sharing platforms that amplify the strategy's scientific contributions. Finally, FEE plans to invest in digital education tools, developing interactive platforms that make Ocean science more accessible to diverse audiences, from students to policymakers, thereby broadening the reach and influence of GAIA 20:30 as a driving force for Ocean sustainability and global environmental stewardship.

20.5 The Intersection Between the Objectives of the Ocean Decade and the UN Decade on Ecosystem Restoration

The United Nations has designated the years 2021–2030 as both the Ocean Decade and the Decade on Ecosystem Restoration. These two global initiatives seek to address interconnected environmental challenges and support the achievement of the Sustainable Development Goals (SDGs). Their alignment emphasizes the need for an integrated approach to restoring marine and terrestrial ecosystems while advancing scientific knowledge and sustainable development practices.

20.5.1 Understanding the Objectives of Both Decades

The UN Decade of Ocean Science for Sustainable Development (2021–2030), led by UNESCO's Intergovernmental Oceanographic Commission (IOC), aims to improve our understanding of the Ocean's role in global sustainability. Key objectives include:

- Expanding Ocean research and scientific knowledge to inform sustainable policy decisions.
- Enhancing global Ocean observation and data-sharing networks.
- Strengthening OL and public engagement in Ocean conservation.

- Addressing marine pollution, climate change, and biodiversity loss.
- Promoting a sustainable blue economy.

The UN Decade on Ecosystem Restoration (2021–2030), spearheaded by the UN Environment Programme (UNEP) and the Food and Agriculture Organization (FAO), focuses on preventing, halting, and reversing ecosystem degradation worldwide. The initiative's goals include:

- Restoring degraded ecosystems, including coastal and marine habitats.
- Enhancing ecosystem services to improve human well-being and biodiversity.
- Mobilizing funding and partnerships to scale up restoration efforts.
- Strengthening policies and governance for sustainable ecosystem management.

20.5.2 Shared Goals and Synergies Between Both Decades

Both UN Decades recognize the urgent need to protect and restore natural environments, particularly marine and coastal ecosystems, which are among the most threatened by human activities.

20.5.2.1 Restoring Marine and Coastal Ecosystems

The Decade on Ecosystem Restoration prioritizes mapping and monitoring marine ecosystems to inform effective conservation strategies, while it emphasizes firsthand restoration activities, such as coral reef rehabilitation, mangrove reforestation, and seagrass restoration. Collaborative projects integrating both approaches can lead to evidence-based restoration strategies, ensuring that restoration efforts are guided by scientific knowledge and long-term sustainability goals.

20.5.2.2 Tackling Marine Pollution and Habitat Degradation

Marine pollution, particularly plastic waste and chemical runoff, is a major concern for both initiatives. While the Ocean Decade advances research into pollution reduction and innovative solutions, the Decade on Ecosystem Restoration promotes active clean-up and waste reduction initiatives. Integrated approaches can leverage scientific insights to design scalable pollution mitigation projects, including Blue Flag initiatives focused on waste management and sustainable tourism practices.

20.5.2.3 Enhancing Climate Resilience

Both UN Decades recognize that healthy ecosystems function as natural climate buffers. Coastal ecosystems, such as mangroves, salt marshes, and seagrass beds, provide essential carbon sequestration services and protect shorelines from extreme weather events. Restoration projects that align with scientific research on Ocean-climate interactions can enhance the resilience of vulnerable coastal communities while contributing to global climate change mitigation efforts.

20.5.2.4 Strengthening Ocean Literacy and Community Engagement

The Ocean Decade places a strong emphasis on public education, ensuring that scientific knowledge reaches policymakers, educators, and local communities. The Decade on Ecosystem Restoration focuses on engaging communities in hands-on conservation projects. Combining these efforts enhances OL by providing communities with the knowledge and skills needed to actively participate in ecosystem restoration. Initiatives such as FEE's Global Action Days exemplify how education and action can be integrated to achieve meaningful conservation outcomes.

20.5.2.5 Supporting Sustainable Blue Economy Development

The Ocean Decade promotes research and innovation in sustainable Ocean-based industries, including fisheries, aquaculture, and eco-tourism. The Decade on Ecosystem Restoration encourages economic models that prioritise ecological integrity and long-term sustainability. Blue Flag initiatives align with these goals by setting sustainability standards for coastal tourism, reduc-

ing the environmental footprint of marine industries, and promoting best practices for ecosystem-friendly economic development.

20.5.3 Model Practices in Action

Several ongoing initiatives demonstrate how the objectives of the UN Decades can be successfully integrated:

- Blue Flag and Marine Protected Areas (MPAs): Blue Flag sites that overlap with MPAs ensure that tourism development aligns with conservation efforts while benefiting from scientific research on ecosystem health.
- Coral Reef Restoration Projects: Combining scientific monitoring (Ocean Science) with hands-on rehabilitation (Ecosystem Restoration) has led to successful coral restoration programmes in areas such as the Great Barrier Reef and the Caribbean.
- Mangrove Reforestation and Coastal Adaptation: Initiatives that blend traditional knowledge with scientific research enhance coastal resilience while protecting biodiversity.
- Sustainable Fishing and Aquaculture Innovations: Research-driven policy changes and habitat restoration efforts help ensure the long-term viability of marine resources.

20.5.4 Moving Forward: Strengthening Collaboration Between the UN Decades

To maximise impact, stakeholders from both UN Decades should:

- Promote interdisciplinary collaboration between Ocean scientists, restoration ecologists, policymakers, and local communities.
- Integrate restoration priorities into Ocean research agendas, ensuring that scientific findings translate into actionable restoration efforts.
- Expand educational initiatives that bridge the gap between marine science and ecosystem restoration, fostering greater public engagement.
- Leverage global funding mechanisms and policy frameworks to support projects that simultaneously advance OL, ecosystem restoration, and sustainable development.

20.6 Conclusion

Programmes, initiatives, and strategies such as Blue Flag, the Global Action Days, and GAIA 20:30 exemplify how sustainability standards, education, and conservation can work together to achieve the shared objectives of both UN Decades. Moving forward, continued collaboration and interdisciplinary action will be essential in ensuring a healthier and more resilient Ocean for future generations. Alignment between the UN Decade of Ocean Science for Sustainable Development and the UN Decade on Ecosystem Restoration presents a unique opportunity to address critical environmental challenges through integrated approaches. By combining scientific research with hands-on restoration, education, and public engagement, these global initiatives can drive meaningful progress in protecting and restoring marine ecosystems.

20.6.1 Summary

Key concepts explored in this chapter include:

- The Blue Flag Programme has been instrumental in advancing OL and fostering sustainable coastal and marine management.

- The integration of OL into environmental education initiatives enhances public understanding of marine conservation issues.
- The programme aligns with global sustainability frameworks, including the SDGs and the Ocean Decade Challenges.
- Community engagement and citizen science initiatives play a crucial role in strengthening OL.
- The GAIA 20:30 Strategy offers a comprehensive framework for achieving long-term Ocean sustainability goals.
- Continued collaboration between policymakers, educators, scientists, and communities is essential for enhancing OL efforts worldwide.

20.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

20.6.2.1 Books

- UNESCO. (2021). *Ocean Literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization.* https://unesdoc.unesco.org/ark:/48223/pf0000373812
- Cousteau, J. (2010). *The human, the orchid, and the octopus: Exploring and conserving our natural world.* Bloomsbury Publishing.
- Earle, S. (2014). *Blue hope: Exploring and caring for Earth's magnificent Ocean.* National Geographic.

20.6.2.2 Journals

- *Marine Policy* (Elsevier): https://www.journals.elsevier.com/marine-policy
- *Ocean & Coastal Management* (Elsevier): https://www.journals.elsevier.com/Ocean-and-coastal-management
- *Journal of Environmental Education* (Taylor & Francis): https://www.tandfonline.com/journals/vjee20

20.6.2.3 Websites

- Foundation for Environmental Education (FEE): https://www.fee.global/
- Blue Flag International: https://www.blueflag.global
- Global Action Days 2025—Foundation for Environmental Education:https://www.fee.global/global-action-days-2025
- United Nations Decade of Ocean Science: https://Oceandecade.org/
- UNESCO Ocean Literacy Programme: https://Oceanliteracy.unesco.org

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Johann Durand serves as the International Blue Flag Director at the Foundation for Environmental Education (FEE), headquartered in Copenhagen, Denmark. In his role, he oversees the Blue Flag programme, a globally recognised eco-label awarded to beaches, marinas, and tourism boats operators that meet stringent environmental, educational, safety, and accessibility criteria. Under his leadership, the programme has expanded its reach, promoting environmental awareness and sustainable practices in the tourism sector. Durand's commitment to environmental sustainability is further evidenced by his active participation in implementing the Blue Flag programme worldwide in collaboration with local, subnational, national, regional, and global organisations to enhance environmental standards in the hospitality industry. His efforts contribute significantly to FEE's mission of engaging communities worldwide in environmental education and action.



Lee Wray-Davies is the Director of Education at the Foundation for Environmental Education (FEE), bringing over 25 years of expertise in environmental education and sustainable development. Her extensive background includes significant contributions to green education policy and youth engagement strategies at both national and global levels. Before joining FEE, Lee served as the Eco-Schools Manager for Keep Britain Tidy in England, where she played a pivotal role in promoting environmental awareness among students. Notably, she authored content for the UK children's television programme "Go Green with the Grimwades," which gained prominence by securing a prime early morning slot and earning nominations for two children's TV awards. In her current role at FEE, Lee leads initiatives such as the Global Action Days, empowering educators, and students worldwide to participate in environmental sustainability efforts.

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21

Ocean Literacy in Formal Education: The Case of the Network of European Blue Schools

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Abstract

This chapter provides an overview of how Ocean Literacy is integrated into formal education at all levels through a grassroots approach facilitated by the European Commission (EC) and Ocean Literacy experts.

The Network of European Blue Schools (NEBS) is currently the largest blue school network globally, with more than 600 members from EU Member States and associated countries. The concept was developed as one of three pillars of the EU4Ocean Coalition, which aims to unite Europeans' Ocean Literacy voices and efforts to make the Ocean a concern for everyone.

To present the development and evolution of the Network, cover the milestones of this initiative such as the initial survey and focus group meetings, curriculum analysis, the handbook for teachers, the development of online courses and other resources for teachers, support of local initiatives and networks, and creation of funding opportunities for Blue Schools within the framework of 3 EU funded Horizon projects. The NEBS applications dataset is utilised to explore the Network composition in terms of school levels and types (kindergarten, Primary, middle, secondary, VET, special education), connection to school curricula (natural sciences,

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culture, physical education, etc.), geographic distribution (coastal, inland, sea basins, etc.).

Keywords

Blue Schools · Formal Education · European Union · Ocean Literacy (OL) · Marine Education · Europe

21.1 Introduction

Although environmental education and education for sustainable development are gaining increasing attention in European school curricula, Ocean Literacy (OL) has yet to achieve comparably widespread diffusion (Mokos et al. 2020). Formal education is considered "Ocean blind," even in countries with direct access to the Ocean or sea (see Sect. 2.2). Since 2020, the EU's EU4Ocean Coalition for OL has aimed to increase Ocean awareness in formal education by creating a program on Blue Schools. The label of a blue school is granted to schools dedicated to bringing the Ocean into the classrooms.

The idea of a blue school took shape in 2015 as part of an EU-funded project to increase OL in Europe called the Sea Change Project. Here, the theoretical concept of Blue Schools was developed through consultation rounds in eight European countries (Sea Change Project Blue Schools Final Report 2018). The research revealed how difficult it is to engage teachers to address Ocean topics in classrooms, while these are hardly part of the curricula. Besides the lack of financial and political support, well-established environmental education programs and the extensive cultural and educational diversity were the main obstacles to setting up such a significant pan-European or national blue school initiative. Regardless of the prospective difficulties, in 2017, the Portuguese Ministry of the Sea established the first blue school program (see Sect. 21.4.2).

Following the example of a success story in Portugal, in 2020, the European Commission's DG MARE (The Directorate-General for Maritime Affairs and Fisheries) established the European Coalition for Ocean Literacy (EU4Ocean), which includes a community of blue schools (Network of European Blue Schools—NEBS), as well as a community of young Ocean advocates (Youth4Ocean Forum) and organizations and individuals involved in Ocean Literacy initiatives (EU4Ocean Platform).

The main goals of the NEBS are to:

- Create a more Ocean-literate society where schools become agents for change and sustainability.
- Build bridges between Ocean professionals and schools.
- Set up a network where teachers can share experiences and collaborate with other schools, nationally and internationally.

This chapter provides an overview of the history, composition, and functioning of the Network of European Blue Schools.

21.2 Creating the Network of European Blue Schools

21.2.1 Initial Survey and Focus Groups

Before the Blue School Program's creation in 2020, a survey targeting teachers, school managers, staff from ministries of education, and professionals in marine science education was developed to understand the gaps and needs in teaching Ocean topics.

A total of 300 respondents from 17 EU countries (and 3 from the United Kingdom, 1 from Turkey, and 3 from outside Europe-specifics not provided) answered the questionnaire. The majority of respondents reported living in a coastal town (within 20 km of the sea; 76%). Most respondents were teachers (67%; with Secondary Education > Primary Education > Higher Education > Kindergarten), followed by marine educators (14%) and marine researchers (9%).

Survey results revealed strong engagement with Ocean education. In fact, 97.8% of respondents reported including Ocean and aquatic topics in their teaching practices. However, they also indicated that the primary reasons for not addressing these topics (either not at all or less frequently) are the "limited visibility of Ocean content in educational resources" (66.7%), followed by "insufficient time and planning in the curriculum" (63.33%) and "lack of opportunities for students to engage with the marine environment" (50%). Despite the challenges of integrating Ocean topics into school curricula, respondents stated that they relate Ocean teaching practices to a total of 35 school subjects, primarily those related to science, including "Biology" (52.81%), "Natural Sciences" (39.33%), and "Geography" (31.46%). "Ocean pollution" was the most commonly addressed topic (71.6%), followed by "Ocean and Climate" (56.1%), "Marine Ecology" (56.5%), "Marine Biology", and "Marine Conservation" (both 50.6%).

Respondents revealed that they mainly teach about the Ocean through "Lectures and reading" (74.6%), "Films and documentaries" (67.9%), and "Outdoor activities" (48.9%). Other approaches included "Laboratory experiments," "Inviting a speaker to the classroom," "participating in Citizen science," and developing "Artistic projects."

To engage stakeholders in the co-creation process for the NEBS, a series of eight virtual focus group meetings took place in Portugal, France, Ireland, and Romania, covering various sea basins (Mediterranean Sea, Atlantic, North, and Baltic Seas) throughout May and June 2020. These meetings typically involved eight to twelve stakeholders (teachers, education professionals, marine experts) and lasted between two to three hours, with a total of 76 individuals participating. The objective was to collect information on existing Ocean school projects and gather opinions on best practices, challenges, certification processes, handbook content, and the conditions necessary for a successful network.

The focus group analysis identified the following preconditions:

- There is strong interest in the NEBS;
- Developing Ocean-related projects is difficult due to curricular constraints;
- The handbook should offer guidance on joining the Network;
- The certification criteria should remain flexible to allow adaptation to the local context;
- A straightforward and non-bureaucratic process could promote the NEBS's growth.

21.2.2 Importance of the School Curricula

The NEBS published a curriculum analysis (Pocze et al. 2020) covering the primary and secondary curricula of nine countries. This report revealed that OL is incorporated into various topics in primary education, such as natural sciences, material processes and states of matter, and animals and humans. In secondary education, some Ocean-related topics are present within the science subjects (Physics, Geography,

Biology, Geology). However, while Ocean-related topics appear sporadically in the curricula, none of the programs adequately address the Ocean's significance for life on Earth, climate, and humanity.

This finding aligns with previous research, confirming that European school curricula have limited Ocean topics (Mogias et al. 2019; Realdon et al. 2019; Fauville et al. 2018; Barracosa et al. 2019). Teachers who participated in NEBS professional development activities also noted that OL is absent from the curriculum, and professional development in this area remains primarily driven by personal initiative. Consequently, textbooks, which are mainly curriculum-based, predominantly focus on terrestrial topics (Copejans 2014). A review of Croatian elementary textbooks identified gaps in integrating Ocean Literacy principles (Ezgeta-Balić and Balić 2024), while a similar analysis of Greek secondary textbooks found minimal content on Ocean science (Mogias et al. 2021). Without a structured didactic framework—encompassing learning objectives, teacher training, and textbook content—teachers are unable to effectively introduce Ocean topics in the classroom. Recognizing this gap, UNESCO has emphasized through its Blue Curriculum initiative (UNESCO 2022) the necessity to integrate Ocean Literacy into national educational frameworks by 2025 as part of the broader Sustainable Development agenda.

21.2.3 The NEBS Foundations

The survey, focus groups, and Portuguese Blue School program (see Sect. 4.2) helped define the foundations of NEBS. A European Blue School is defined as a school where teachers actively engage students in bringing the Ocean into the classroom through project-based learning and open schooling. Students can explore Ocean-related topics not included in the curricula by incorporating project education. This approach encourages the development of critical thinking and problem-solving skills as students collaborate on real-world challenges and connect their learning to their local communities. Open schooling further extends learning beyond the classroom, fostering partnerships with local organizations, marine scientists, NGOs, and maritime companies, providing students with direct experiences and insights into Ocean stewardship and careers. Through these methods, European Blue Schools can cultivate a sense of responsibility and awareness about the importance of the Ocean in sustaining life on Earth.

The NEBS educational model is based on ten key criteria (Fig. 21.1a and b). These criteria serve as guidelines for developing a project and standards for self-evaluating applications to become a European Blue School. Five criteria are mandatory, while the others are optional and will enhance the project.

The compulsory criteria ensure that (1) students gain more in-depth knowledge and skills by working for an extended period to explore and investigate an Ocean topic, (2) students are encouraged to be active and productive learners, (3) projects employ an active, student-centered pedagogy where students develop secondary skills (social skills, solution-oriented thinking, creative thinking), (4) a connection is built with local Ocean stakeholders, and 5) the project is widely disseminated.

The five optional criteria encourage teachers to develop more complex project ideas, enhance authentic and outdoor learning experiences, and collaborate with colleagues from different disciplines, age groups, and geographic areas.

21.2.4 Support to Teachers

Direct communication and interaction among teachers, along with various forms of networking, have been central to the NEBS since this initiative began. A key benefit of the NEBS is its European cultural dimension, where teachers exchange experiences, practices, tools, and methods across borders.

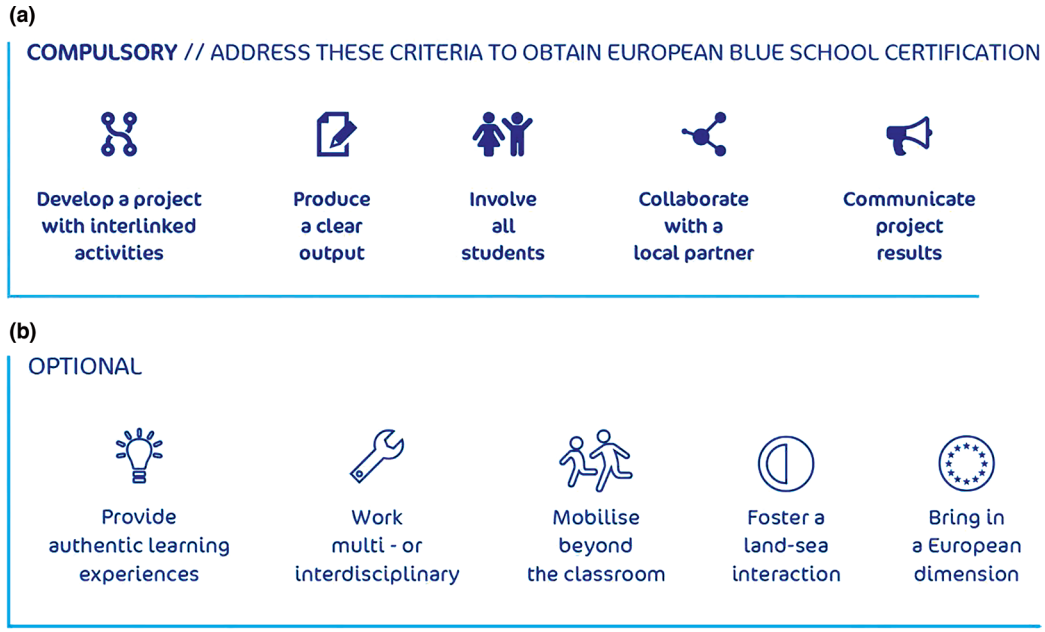


Fig. 21.1 The five mandatory (**a**) and five optional (**b**) criteria to become a European Blue School (Copejans et al. 2022)

To facilitate networking, the NEBS organizes online networking sessions. Additionally, the NEBS has launched its official group on The European School Education Platform (ESEP), aiming to gradually transfer its Facebook group there. ESEP (funded by the European Commission) is the largest collaboration platform for school staff, researchers, and policymakers to engage, share news, publications, resources, and find partners for Erasmus+ (the EU's program to support education, training, youth, and sport in Europe) funded projects, making it a strategic place for the NEBS to engage. ESEP can also be used to help students interact and assist teachers in finding collaborations to bring the Ocean into their classrooms.

An additional effort to engage teachers with NEBS involves equipping them with the knowledge and tools needed to create impactful blue projects and draw inspiration from existing initiatives. In 2022 and 2024, a series of Science Projects Online Workshops (SPOWs) focused on various Ocean topics were held in collaboration with European Schoolnet and Scientix. These interactive three-week online workshops offered personalized training with content knowledge, teaching guidelines, and classroom resources to a group of educators new to blue schools.

A more comprehensive course on becoming a blue school was launched in 2024 by the European Schoolnet Academy, attracting over 1100 teachers. The 'Bring the Ocean into Your School MOOC (massive open online course)' has successfully inspired teachers to start projects. According to a post-course survey, 97% of participants indicated that they would implement the ideas and examples from the course in their daily teaching, expressing increased confidence in incorporating Ocean-related topics in their schools. Subsequent evaluations of NEBS applications in Spring 2024 revealed that teachers executed projects developed during the MOOC and applied them successfully to NEBS. The course materials remain accessible at the European Schoolnet Academy.

In April 2024, an additional online course on Ocean Literacy, BlueMinds4Teachers, funded by EU4Ocean, was offered to teachers. The project aimed to enhance the skills of educators in OL through collaboration with marine and freshwater scientists, experts in educational and social sciences, experienced teachers implementing

Ocean-related projects, and young Ocean ambassadors. Between 70 and 90 participants attended the course. According to the post-course survey, participants reported feeling more confident in developing Ocean-related projects, achieving a mean rating of 4.24 on a scale from 1 (totally disagree) to 5 (totally agree) (refer to Chap. 8, *BlueMinds4Teachers: The Chronicle of an EU4Ocean Project Fostering Ocean Literacy in Education for Sustainable Development).*

21.3 NEBS in Practice

21.3.1 Certification of a Blue School

Any public or private school, whether coastal or inland, can become a European Blue School if it has conducted or is currently undertaking an Ocean-related project that aligns with the NEBS criteria (see Sect. 21.2.3). The process for becoming a European Blue School and accessing its benefits is completed online. Teachers fill out the application form on the Maritime Forum (EU Platform for Maritime Stakeholders) Blue Schools Community website, providing project details and contact information while meeting the specified criteria. Additionally, the application form collects information such as the sea basin connected to the project, the school's geographic coordinates, the number of participating students, connection to the curriculum, and other related initiatives. The data presented in this section comes from the application forms.

The application periods are open twice a year—from September to December and January to May. The NEBS Secretariat reviews the applications. During the evaluation process, teachers may be contacted for further details, and once the results are ready, they will receive them via email. If approved, the European Blue School Certificate is issued for the current school year; if declined, the project can be modified to meet the requirements and resubmitted.

Upon project completion, schools remain in the Network. This approach allows for continuous communication and collaboration with teachers beyond their project timelines, provides ongoing support, facilitates networking opportunities, and promotes the exchange of best practices, effectively enhancing the quality of Ocean education in Europe.

The growing interest in NEBS underscores the necessity of adapting the program to better align with the current landscape of blue education and to address the evolving challenges and opportunities within this field. Therefore, after thorough analysis and evaluation, three types of European Blue Schools were recognized in the summer of 2023:

- European Blue School—Schools that meet the criteria and are located in one of the EU countries.
- Associated Blue School—Schools that meet the criteria and are situated in countries associated with Horizon Europe (the EU's key research and innovation funding program until 2027).
- Partner Blue School—Educational institutions such as maritime VET schools, teacher training centers, non-formal education centers, and more.

While the NEBS criteria emphasize the importance of project-based learning and open schooling, there are no requirements regarding engagement related to project duration or a whole-school approach. This flexibility is intentional, as it encourages schools to adopt Ocean Literacy at their own pace and in a way that best fits their educational objectives. However, it is important to recognize and appreciate the varying levels of engagement among schools and teachers within the Network. Some may show high dedication and sustained involvement over long periods, while others may engage more sporadically or on a smaller scale.

To acknowledge and celebrate this diversity, the NEBS introduced diversified certificates or levels of European Blue Schools:

- Blue School (Entry Level),
- Aquamarine Blue School (Intermediate Level),
- Ultramarine Blue School (Advanced Level).

These differentiated certificates will recognize and reward schools and teachers who demonstrate exceptional commitment and dedication to the NEBS. Schools can advance through various certification levels by extending project durations, submitting repeated applications with evolving projects, and demonstrating ongoing engagement with Ocean Literacy principles. Furthermore, by honoring those who are deeply engaged with NEBS, the diversification of certificates will serve as a powerful motivator for others to enhance their involvement and advocacy for Ocean Literacy.

21.3.2 NEBS Composition

Schools in the NEBS are not evenly distributed across locations and certification types. The majority (80%, 504 schools) are within the EU, located in 22 of the 27 member states. Twenty percent (126 schools) of NEBS members are situated in EU-associated countries, primarily in Turkey (Fig. 21.2a, b, and c). A significant number of blue schools are found in the Mediterranean Sea basin (61% EU, 41% non-EU) and the Black Sea region (15% in EU, 50% non-EU) (Fig. 21.3),

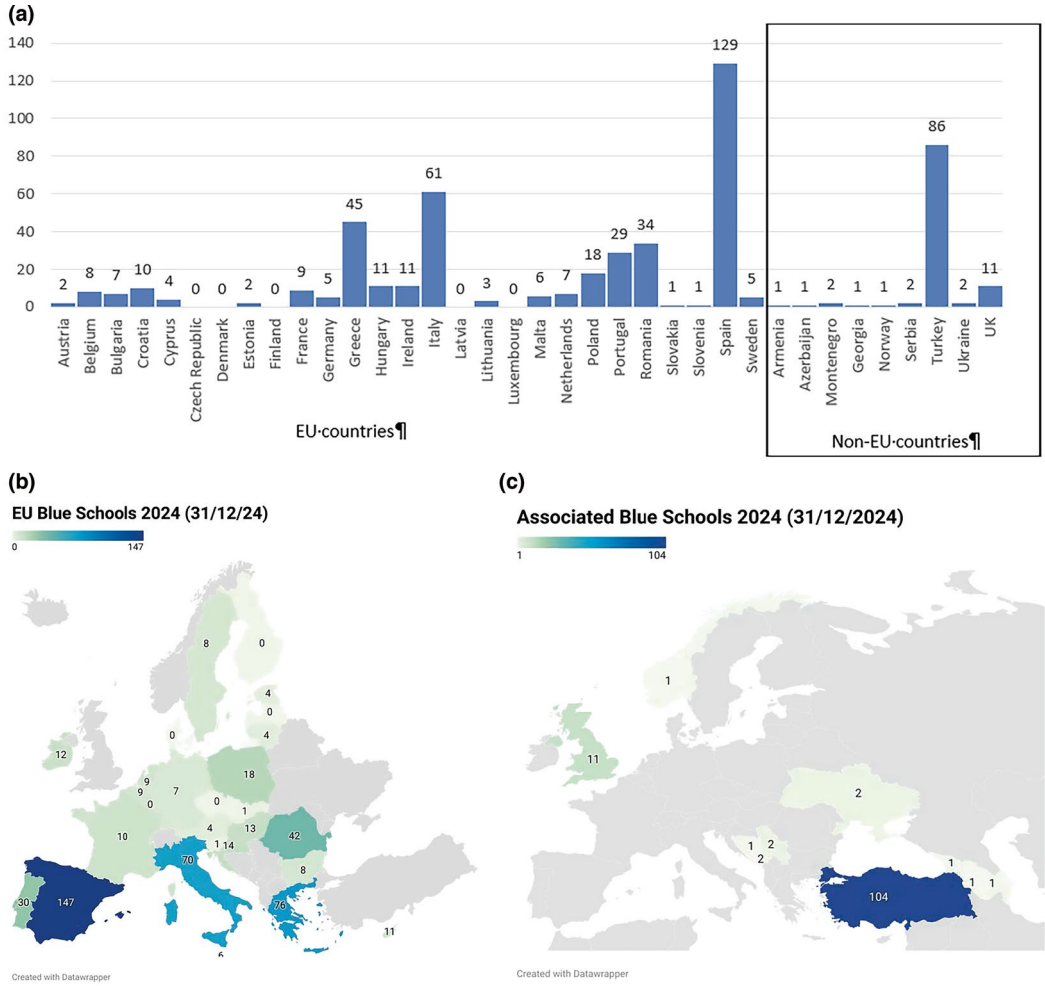


Fig. 21.2 Number of certified Blue Schools per country as of December 31, 2024. (**a**) Bar graph showing the number of certified Blue Schools in EU countries (listed alphabetically) followed by associated countries (also listed alphabetically). (**b**) Map illustrating the number of certified EU Blue Schools per country. (**c**) Map illustrating the number of certified Associated Blue Schools per country

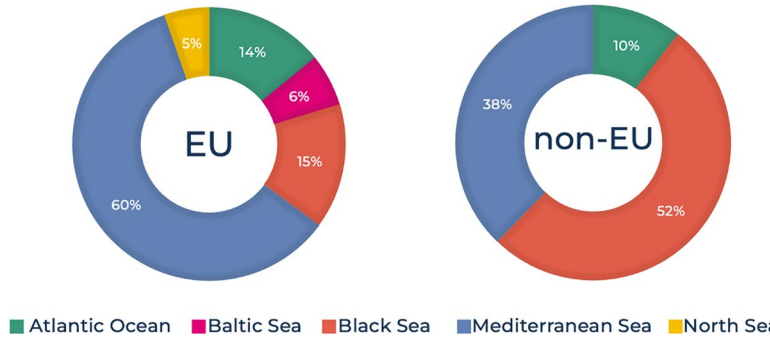


Fig. 21.3 Distribution of Blue School projects by sea basin

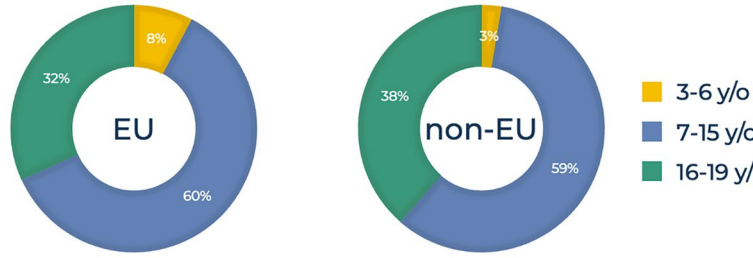


Fig. 21.4 Network composition by age groups

with Spain, Greece, Italy, Romania, and Turkey being the leading countries.

The NEBS composition regarding school levels is best analyzed by considering age groups due to the diversity of educational systems: 3–6 years old (preschool), 7–15 years old (primary, middle, and junior high school ~ K-8), and 16–18 years old (high school, vocational, and technical schools ~6–9). Projects developed for primary to junior high school students (ages 7–15) are common in both EU and non-EU countries, accounting for 56% and 55%, respectively. Secondary schools make up 36% of EU projects and 43% of non-EU projects (Fig. 21.4).

21.4 Local and Regional NEBS Support

21.4.1 Growth of the Network

The NEBS has been growing steadily since its inception, with 704 certified blue projects from the school year 2020–2021 to 2023–2024. The growth gained momentum in the school year 2023–2024, as evidenced by the increasing number of schools joining the network and the rising number of submitted applications since 2020 (Fig. 21.5). In 2024, three new Horizon Europe-funded projects were established to support the NEBS's growth. The ProBleu, SHORE, and BluelightS projects aim to foster environmental awareness and promote water literacy through blue schools in Europe.

Local, regional, or national support is essential for engaging new schools in the NEBS. The two countries with the highest number of schools, Spain and Turkey (Fig. 21.2a), are directly linked to local support. In Spain, 94 out of 147 schools are situated in the Balearic Islands, primarily in Mallorca, and received support from the Erasmus+ funded *Some Escoles Blaves* project (see Sect. 21.4.3). The substantial number of Turkish schools is associated with the support of the SHORE project and the Turkish Ministry of Education, leading to a significant rise in applications from Turkey during the 2023–2024 school year (more than 400 applications).

Another example of a country where schools received additional support to join the NEBS is Poland (18 schools, Fig. 21.3a). The Gdynia Aquarium of the National Marine Fisheries

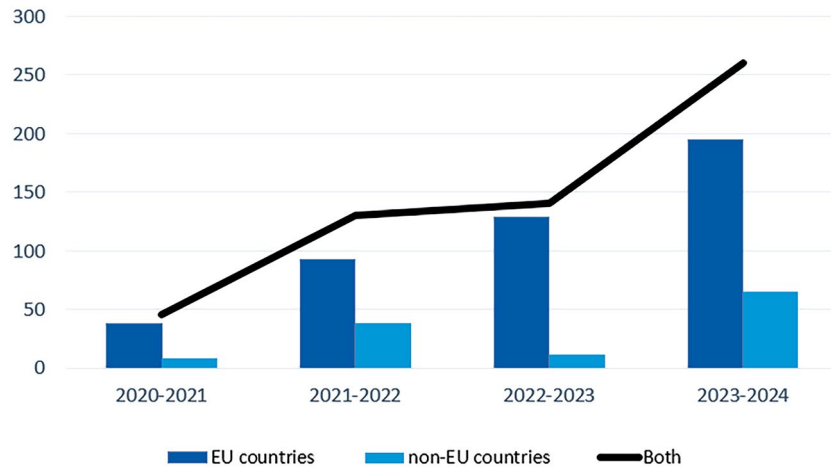


Fig. 21.5 Increase in issued certificates per school year

Institute, funded by Gdynia City Hall, developed a program for local schools. This program assisted teachers throughout the project's development, implementation, and application process, leading to 11 schools joining the NEBS during the 2021–2022 school year. Such support is evident in the NEBS composition, with Poland currently having the highest number of schools among all Baltic countries and ranking sixth among EU countries (Fig. 21.3a).

The growth of NEBS also appears to be influenced by funding. According to a survey conducted in June (see Sect. 21.5), 45% of teachers identified the lack of funding as a significant obstacle (Fig. 21.7). A substantial increase in applications and subsequent network growth was observed in relation to funding opportunities for schools from SHORE, ProBleu, and BlueLightS. These funding schemes target already-certified blue schools or require them to be certified before completing the funded project. The first two ProBleu funding calls were launched in November 2023 and March 2024, followed by SHORE in January 2024. All three projects opened calls in September 2024, with deadlines in November.

However, funding availability is not the only factor contributing to the rise in applications from these projects. Each project also offers webinars and information sessions on funding calls, during which NEBS is presented through both online and in-person events. The significant increase in applications also coincided with the organization of the MOOC and other online courses (see Sect. 21.2.4), which attracted new schools.

21.4.2 Escola Azul

In a setting as diverse as the EU regarding education systems, languages, and cultural ecosystems, no pan-European community can exist without regional, national, or local support. The NEBS directly draws from the first national Blue School program established in Portugal in 2017—Escola Azul.

In Portugal, the Ocean is deeply woven into culture and identity, shaping its history, economy, and daily life. Yet, despite this connection, a surprising gap remains in the public's understanding of the interdependence between human life and the Ocean. Long before OL gained traction in Europe, Portugal began incorporating sea-related activities into educational programs. Environmental centers, NGOs, companies, science centers, museums, and aquariums promoted scientific literacy, environmental education, and science communication efforts. These initiatives, while valuable, were often isolated, lacking the cohesion needed to embed Ocean Literacy into the educational system. After two decades of

dedicated work in OL and environmental education, particularly within schools, it became clear that more needed to be done to cultivate a comprehensive understanding of the Ocean's critical role in our lives (Carneiro 2010).

Recognizing these gaps, the Escola Azul Program was conceived and launched as a pilot in 2017. This initiative addressed the need for an integrated and sustained approach to Ocean education. The Escola Azul Program was designed with flexibility at its core, ensuring that OL could be woven into the educational fabric of schools in diverse ways—across different subjects, educational cycles, and regions. It wasn't about fitting the Ocean into a single subject but making it part of the entire academic journey, impacting every student, teacher, and community member meaningfully (Costa et al. 2021). Currently, the Escola Azul Program has reached 478 schools, engaging over 107,784 students and involving 125 partners across Portugal. Endorsed by the Ministry of Economy through the Directorate General for Maritime Policy, the program's mission is to foster a generation that understands the Ocean and is committed to its sustainability. The program's objectives reflect this mission:

- Holistic Ocean Education: Providing students with a comprehensive understanding of the Ocean that extends beyond scientific knowledge to include cultural, historical, and social perspectives.
- Citizenship and Social Activism: Promoting active citizenship and social activism, fostering a sense of responsibility in students while inspiring them to make positive behavioral changes.
- Curricular Integration: Incorporating Ocean-related topics and activities throughout the school curriculum to ensure that OL becomes a consistent and systematic part of the learning process.
- Community, Science, and Sectoral Connection: Strengthening collaboration between schools, local communities, the scientific community, and the maritime sector to create a network of knowledge and action.
- Sustainable Blue Economy: Educating students about the importance of a sustainable blue economy and encouraging them to pursue practices and careers that support the sustainable use of marine resources resources.

When schools join the program, they receive a welcome kit and embark on a two-year journey within the Escola Azul network. To remain part of Escola Azul, a new project must be submitted every other year. Schools are encouraged to collaborate with partners, participate in OL initiatives, and celebrate Escola Azul Day, which brings together all participating schools for a common cause. One memorable example is a human chain formed by over 350 schools, local communities, and partners from various municipalities, symbolizing their collective commitment to Ocean protection. This powerful image not only attracted the attention of policymakers and the media, but also strengthened the determination of the participants to continue their work toward Ocean conservation sustainability.

The strength of the Escola Azul Program lies in its community spirit. Teachers, students, scientists, and local stakeholders share experiences, successes, and challenges, bridging different realities and fostering a shared sense of purpose and belonging. This aspect is often highlighted by teachers as the most valuable part of their involvement in the program. The pedagogical model of the Escola Azul Program draws from international educational guidelines set by the European Commission (2018), the OECD (2018), and UNESCO (2014). It is also aligned with the United Nations Sustainable Development Goals, such as Quality Education (Goal 4), Life Below Water (Goal 14), and Partnerships for the Goals (Goal 17). On a national level, the program is informed by critical documents such as the National Ocean Strategy (Direção-Geral de Política do Mar 2014) and the Education Guidelines issued by the Ministry of Education (Martins et al. 2017).

In alignment with the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), the Escola Azul Program actively contributes to Challenge 10, aiming to transform Ocean education and strengthen the connection between people and the Ocean. The program also supports the White Paper of the Decade and the Venice Declaration, which emphasize the essen-

tial role of education in promoting OL and sustainability (Glithero et al. 2024; UNESCO 2024). With its innovative and adaptable approach, Escola Azul not only addresses the educational gaps in OL but also inspires a new generation of Ocean stewards—empowered, informed, and ready to take action for the future of our Ocean.

21.4.3 Som Escoles Blaves

The NEBS draws from the experiences of regional communities and catalyzes the development of new local communities. The Som Escoles Blaves (We Are Blue Schools) initiative in Mallorca, Spain, was a pioneering project that aimed to establish a network of 100 European Blue Schools on the island, focusing on fostering environmental awareness and sustainability skills among young people through OL. While receiving some support from Erasmus+ grants, the project was primarily funded by Sea Teach, a company specializing in maritime training dedicated to environmental education. The initiative connected students and teachers with local environmental actors, businesses, and NGOs through engaging, hands-on learning activities, promoting a deeper respect for marine environments and inspiring sustainable practices from an early age.

Som Escoles Blaves employed a grassroots approach, prioritizing the development of strong, meaningful relationships with schools instead of imposing rigid frameworks. The project's core strategy involved close collaboration with schools, evaluating their existing environmental activities, and guiding them toward the goals of the European Blue Schools certification program. This flexible and supportive method enabled schools to integrate OL and sustainability practices into their curricula in ways that were both practical and contextually relevant, minimizing the overwhelm often associated with adopting new practices programs.

In the project's early stages, extensive research was conducted to understand the landscape of schools in Mallorca. More than 300 schools were evaluated based on their engagement in environmental education and sustainability programs. Outreach efforts included emails, phone calls, and social media campaigns to raise awareness about the Blue Schools certification program and generate interest among educational institutions.

The project conducted a survey to assess educators' knowledge and attitudes towards OL and the Blue Schools concept. A total of 143 teachers from 64 schools participated. The survey revealed that 73 of the 143 teachers did not include OL in their curriculum, mainly due to its low visibility in their subjects and a lack of time for planning. Additionally, only 54 teachers understood what OL involved, and just 29 were knowledgeable about the Blue Schools concept.

Despite the low awareness levels, there was tremendous enthusiasm for the Blue Schools initiative. An impressive 139 out of 143 teachers believed that incorporating Blue School principles would benefit their schools. The survey also examined how much time teachers could allocate to Blue Schools-related activities. When asked how many hours per week they could dedicate to these efforts, 68 teachers indicated they could commit between 1 and 2 hours per week, while another 58 teachers stated they could devote 1 hour per week.

The survey also revealed that 68 schools felt unprepared to apply for Blue School certification, emphasizing the necessity for customized support and step-by-step guidance to develop their required capacity.

Following the survey and evaluation of the schools' needs, the project team conducted visits to understand each school's unique challenges and opportunities, providing personalized guidance to help them align with the Blue Schools certification goals. Achieving certification required schools to meet specific Ocean and environmental education criteria. To support this, the project offered a comprehensive manual with guidance, project ideas, and examples from other schools. The certification process was designed to be flexible and supportive, accommodating schools of various sizes and resources, ensuring they could work toward certification without feeling overwhelmed.

The project expanded its support beyond initial visits and guidance by organizing events and launching Blue Projects to assist schools in developing their Ocean-related initiatives. A

comprehensive collaboration model was created, allowing each school to closely work with four key types of local partners: companies, environmental NGOs and research centers, local governments, and media outlets. These partnerships enhanced the educational process, with companies sponsoring activities such as beach cleanups, marine research centers providing hands-on learning experiences, and local governments offering administrative and financial support.

By the end of the project, over 100 schools in Mallorca had been certified, involving approximately 15,000 students and more than 500 teachers in a network that promoted a culture of environmental stewardship across the island. The success of the initiative inspired other regions in Spain to adopt a similar approach, resulting in the creation of the Spanish Network of Blue Schools, which now includes participation from eight autonomous communities.

Building on their initial success, the "We Are Blue Schools" team continued their efforts in the Balearic Islands by establishing a sustainable framework to keep schools engaged. This framework was structured around three challenges per academic term, each focusing on a distinct theme: coastal health, biodiversity, and maritime culture. These challenges ensured that OL remained a dynamic part of curriculum.

The project also aimed to expand opportunities for teachers through collaborations with other initiatives, such as a twinning program that connected schools in Mallorca with landlocked schools in Madrid. This broadened the scope of OL by involving students from regions without direct access to the sea.

Additionally, a second assessment was conducted to evaluate the project's long-term impact on schools, focusing on teachers in the Mallorcan Blue Schools network. The results were promising, with 15 out of 17 teachers reporting an increase in the incorporation of OL content in their classes and a greater understanding of OL compared to when they first started. Furthermore, 14 out of 17 teachers shared the concept of Blue Schools with their peers, and 12 out of 17 involved multiple classes and colleagues in their school's Blue Project, highlighting the growing collaboration within schools.

Overall, these results highlight the positive impact of the "We Are Blue Schools" program on teachers and students, demonstrating its ongoing importance in promoting OL and environmental stewardship throughout Mallorca. The initiative has not only built a network of certified Blue Schools but has also established a lasting legacy of sustainability education on the island and beyond.

21.5 Impact and Value

In June 2024, a survey conducted at the EU level aimed to explore the impact and value of NEBS for its members, emphasizing the significant role of the Blue School projects in advancing OL. The survey sought to identify the primary obstacles and challenges faced and to create a platform for further improvement and development for teachers, students, and the broader community.

This online survey was distributed to all NEBS members, excluding the schools in Mallorca (Som Escoles Blaves), as this area was the focus of a separate research approach. A total of 80 participants from 14 countries responded to the survey. Sixty-six percent of the responses came from southern European nations (Italy, Spain, Greece, and Turkey), reflecting the network's highest concentration of Blue Schools (Fig. 21.2a). Seventy percent of the schools are located in urban areas and coastal communities, 10% are from island schools, and the remaining responses come from schools in suburban and rural areas.

The respondents viewed the enhancement of awareness about the Ocean and the development of OL in local communities as the main outcomes of being a Blue School. However, the teachers acknowledged all outcomes as highly important, with rankings between 77% and 92% (Fig. 21.6).

When asked about the obstacles encountered during the implementation of the Blue School project, 45% of teachers identified the lack of funding as a major challenge, while over 33% pointed to a lack of time (Fig. 21.6). In contrast, 83% of teachers reported no difficulties in securing school board support for OL projects, 80% had no trouble engaging their students, and 75% found it easy to connect their projects with the

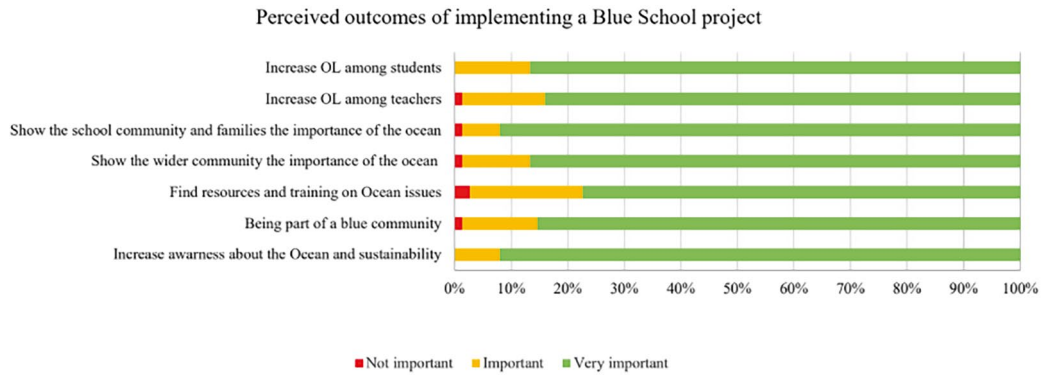


Fig. 21.6 Evaluation of the primary outcomes of the schools' project implementation

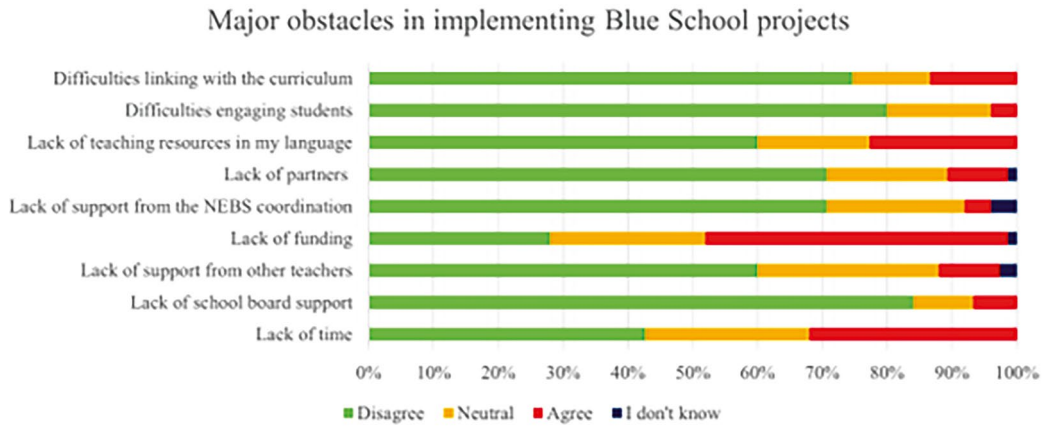


Fig. 21.7 Assessment of the obstacles to implementing OL in European Blue Schools

curriculum (Fig. 21.7). This aligns with the findings from the 2020 initial survey and the data from the application form, which show that 95% of respondents in EU countries and 93% in non-EU countries indicated that the project was related to school curricula (Fig. 21.8).

The data from this survey represents a limited sample of European Blue Schools, which prevents us from drawing definitive conclusions. However, it still offers valuable insights and considerations that can help improve and adapt the pedagogical model of European Blue Schools.

21.6 Conclusion

The Network of European Blue Schools is evolving to better serve educators, students, and institutions. Initially a grassroots effort to certify schools for Blue Projects, NEBS has expanded across Europe and has the potential to develop in the coming years with local and regional support and funding into a vibrant community where educators can share resources, best practices and collaborate on projects promoting water literacy, sustainability, and environmental stewardship schools.

By fostering Ocean Literacy and encouraging active engagement with marine environments, the Network of European Blue Schools supports the goals of the UN Decade for Science for Sustainable Development (2021–2030) by empowering students and educators to become Ocean ambassadors. As European Blue Schools teach young people about the significance of the Ocean, its current challenges, and the necessity for scientific research and sustainable practices, this project not only raises awareness but also inspires action, thereby aligning with the UN

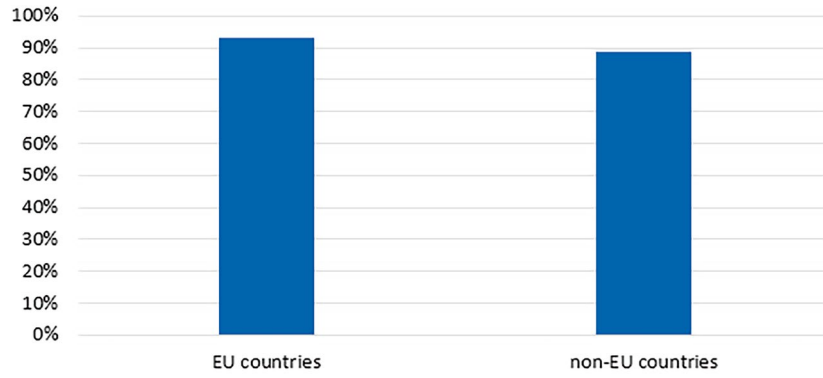


Fig. 21.8 The percentage of projects connected to school curricula

Decade's vision of "the science we need for the Ocean we want."

21.6.1 Summary

Key concepts explored in this chapter include:

- The Network of European Blue Schools (NEBS) originated as a grassroots initiative to certify schools for "Blue Projects."
- Over the years, NEBS has expanded throughout Europe, evolving into a vibrant, well-supported community where educators can collaborate and share resources.
- NEBS focuses on promoting water literacy, sustainability, and environmental stewardship within educational settings.
- With its emphasis on Ocean Literacy, NEBS empowers both students and educators to serve as ambassadors for marine protection and conservation.
- The initiative directly supports the UN Decade for Ocean Science for Sustainable Development (2021–2030) by raising awareness of Ocean challenges and inspiring young people to take action.
- It aligns with the UN Decade's vision of achieving "the science we need for the Ocean we want," integrating scientific research with sustainable practices for the long-term health of the Ocean.

21.6.2 Recommended Resources

The following resources provide further insights and support on this topic:

- NEBS website https://maritime-forum.ec.europa.eu/theme/Ocean-literacy-and-blue-skills/Ocean-literacy/network-european-blue-schools_en
- NEBS criteria—https://maritime-forum.ec.europa.eu/theme/Ocean-literacy-and-blue-skills/Ocean-literacy/network-european-blue-schools/how-develop-project_en
- NEBS projects search tool—https://maritime-forum.ec.europa.eu/blue-school-member_en
- Escola Azul website—https://escolaazul.pt/
- Som Escoles Blaves webiste—https://weareblueschools.eu/
- EU4Ocean Coalition website—www.eu--Oceanliteracy.eu
- Bring the Ocean into Your School MOOC—https://www.europeanschoolnetacademy.eu/courses/course-v1:EU4OCEAN+Blue Schools+2024/about

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22 Building a Coalition and National Strategy to Advance Ocean Literacy in Canada: The Story of COLC

Diz Glithero, Meghan Callon, Jen McRuer, and Krystyn Tully

Abstract

Canada has the world's longest coastline, over 243,000 kilometers, and holds one-fifth of the world's freshwater, with over two million lakes and 8500 rivers draining into five Ocean watersheds. The country's relationship with the Ocean is shaped by regional, historical, economic, cultural, and linguistic perspectives, all contributing to the diverse ways in which people understand, value, and care for the Ocean. However, the term 'Ocean Literacy' does not resonate with all people who live in Canada, especially for inland and Indigenous communities. For those living inland, it may feel less relevant; for Indigenous communities, it may be seen as a modern intervention that does not fully capture their ways of knowing. This chapter shares the efforts of the Canadian Ocean Literacy Coalition (COLC)—now known as the Centre for Ocean Literacy Collaboration—which launched in 2018, to conduct a national study to assess the state of Ocean Literacy, identify gaps, barriers, and enablers, and make recommendations. The study's multi-regional, multi-sectoral methodology is discussed, leading to the co-development of the Canadian Ocean Literacy Strategy in 2021, making Canada the first country in the world to do so. The chapter highlights the Strategy's focus on a collaborative framework for action, while respecting regional and cultural diversity, as well as addressing the limitations of an imperfect term. Next, the National Strategy Impact Measurement Program, which tracks progress and impact of Key Initiatives, such as Ocean Week Canada, is explained, including impact themes, metric families, representation, and measurement limitations. The chapter concludes with a reflection on the coalition model, lessons learned, and future steps to advance Ocean Literacy in Canada and globally.

Keywords

National Ocean Literacy Strategy · Methodology and co-development process · Impact measurement · Canada · Ocean Decade

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22.1 Introduction: Framing the Ocean in Canadian Society

Canada has the longest coastline in the world, stretching over 243,000 kilometers. Containing one-fifth of the world's freshwater, the country is

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home to over two million lakes and more than 8500 named rivers, all of which eventually flow into one of Canada's five Ocean watersheds: the Atlantic Ocean, Hudson Bay, the Arctic Ocean, the Pacific Ocean, and the Gulf of Mexico (Natural Resources Canada 2010/2022). For the 5.5 million people in Canada living within 10 kilometers of the shoreline (Statistics Canada 2024), the Ocean is intricately woven into the fabric of their community livelihoods, food security, and overall well-being. For the remaining 33.5 million people living inland, more than 50% of which live in the Great Lakes and St. Lawrence River ecoregion, the Ocean plays a vital role in regional and national economies, transportation, and serves as a recreational playground for millions of residents and global visitors annually.

Currently, nearly 350,000 people in Canada work in the Ocean economy, contributing $36 billion to the country's gross domestic product (Canada's Ocean Supercluster 2018). And yet, the Ocean space is not solely defined by its species and industries; it is also about people, relationships, and identity (Glithero and Zandvliet 2021). Amidst such abundance of Ocean and freshwater, a range of complex factors shape peoples' relationship with water. These include diverse knowledge systems, values, and experiences. Regional (e.g., coastal, inland), cultural (e.g., Inuit, First Nations, Métis, settler, newcomer), and linguistic (e.g., English, French, Indigenous languages) perspectives all play a role (Glithero et al. 2020), alongside other considerations such as education, food security, livelihoods, governance, politics, and more. Understanding the many Ocean connections that shape daily lives, and fostering a knowledgeable and engaged citizenry, is the essence of Ocean Literacy.

Although regulations and policies are critical to ensuring Ocean and human health, sustainable blue economies, and social equity, so too is motivating people to better connect with and care for the Ocean. With approximately 85% of Canada's population living inland however, it is through the vast interconnected landscape of wetlands, lakes, rivers, and waterways that these people-Ocean connections are made. What commonalities and differences can we identify in how people connect with water and the Ocean? How can we mobilize a citizenry to make decisions and act in ways that ensure the health of local waterways and the Ocean?

As Canada works hard to meet its marine protection commitments to protect 30% of its Ocean waters and species' habitats by 2030 (Government of Canada 2024, June 20), and broader Ocean conservation and sustainable development goals as demonstrated by the United Nation Decade of Ocean Science for Sustainable Development ('Ocean Decade,' 2021–2030), increased public education, engagement, and collaboration is needed.

22.2 Establishing a Coalition and Designing a National Study: 2018–2020

The Centre for Ocean Literacy Collaboration (COLC), formerly know as the Canadian Ocean Literacy Coalition, is a nationally and internationally recognized catalyst and center for Ocean Literacy research and innovation. COLC convenes and leads collaborative action across regions, sectors, and scales, with work focusing on education and engagement, research and evaluation, leadership and advocacy. COLC formally launched during the Oceans Inspiration Expo in September 2018 as part of the G7 Ministerial Meetings in Halifax, Nova Scotia. Since inception, it has operated as a national project office. COLC's administrative headquarters was first established at the Canadian Museum of Nature (2018–2021), then Ocean Networks Canada at the University of Victoria (2021–2024), and now at the Ocean Frontier Institute led by Dalhousie University (2024–).

The initial aim and purpose of COLC was to design and lead a nation-wide research initiative to better understand people in Canada's varying relationships with the Ocean and to examine how Ocean Literacy is understood and practiced across the country. The *Understanding Ocean Literacy in Canada* study, led by an all-women

research team (see Acknowledgements section), was guided by three central research questions: (1) What is the current state of Ocean Literacy in Canada? (2) What are the current gaps, barriers, and enablers to Ocean Literacy in Canada? and (3) What are the key recommendations to advance Ocean Literacy in Canada? These questions were examined across five regions (Pacific, Inuit Nunangat (Arctic), Atlantic, Great Lakes-St. Lawrence, and inland Canada), and within nine sectors (Education & Youth, Government, NGO & Advocacy, Academia & Research, Industry, Community, Media, Arts & Culture, and Health). The wider ambition behind this effort was threefold: first, to provide evidence to inform the development of a national Ocean Literacy strategy that could help to synthesize multi-sectoral partner and public perspectives; second, to mobilize its use by partners and communities to guide Ocean engagement across society; and third, to serve as a global example of how such an effort may be undertaken in diverse regions.

Between September 2019 and March 2020, data was collected using a mixed methods approach. This included a national survey, a national poll, interviews, an organizational asset mapping survey, youth workshops, arts-based research, a document scan, as well as both media and social media analyses. The study engaged over 3000 people and more than 400 organizations in Canada, most involved in Ocean- or water-related work. The study identified three core dimensions of Ocean Literacy: Ocean knowledge (e.g., increasing understanding of the Ocean through diverse knowledge systems such as academic, Indigenous, and local perspectives); Ocean values (e.g., strengthening emotional connections with the Ocean), and Ocean actions (e.g., motivating both individual and societal engagement in Ocean-related decisions, policies, and pro-Ocean behaviour). Related to these dimensions, key gaps, barriers, and enablers to Ocean Literacy in Canada were identified and resultant key recommendations drawn. Figure 22.1 below illustrates the conceptual framework for the national study, integrating the five regions, nine sectors, and three dimensions of Ocean Literacy, as outlined above.

The study's results and data helped to establish, for the first time, a baseline understanding of Ocean Literacy in Canada, building on the efforts of (Ammendolia et al. 2020; Glithero 2020; Glithero and Zandvliet 2020; Hoover 2020; MacNeil 2020; Ostertag and Ammendolia 2020; Yumagulova 2020). The study findings also served to highlight projects underway across the country prior to the launch of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030, hereafter "Ocean Decade"). Moreover, the comprehensive design process importantly provided a foundation for fostering collaboration and networking, while also identifying regional and national priorities and recommendations. These findings played a critical role in shaping the development of the Canadian Ocean Literacy Strategy, shared in more detail below.

22.3 Co-developing the World's First National Ocean Literacy Strategy: 2020–2021

After publishing the initial study reports in 2020 and building on the momentum from community-driven engagement, COLC shifted its focus to co-developing the world's first national Ocean Literacy strategy. Grounded in principles of collaboration, inclusivity, and transparency, the national project office team led an eight-month participatory process to draft the National Strategy (see Table 22.1). This process directly built on the findings and 10 common national priorities that emerged from the Canada-wide study. The evidence-based, bottom-up, and participatory approach ensured that the National Strategy was developed by, and for, people and communities in Canada.

Through the participatory process, 10 common national priority areas were identified, including specific, targeted actions (e.g., Grow Ocean Week Canada), as well as broader, cross-cutting action areas (e.g., Improve current state of access and diversity in Canada's blue spaces).

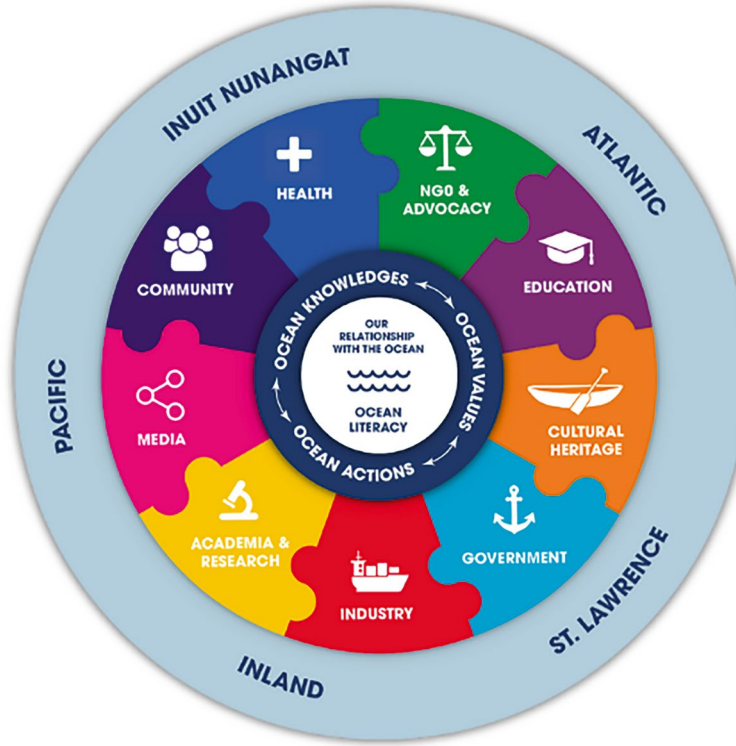


Fig. 22.1 The conceptual framework for the *Understanding Ocean Literacy in Canada* study, integrating the five regions, nine sectors, and three dimensions of Ocean Literacy

Table 22.1 Participatory process and timeline to develop the National Strategy

July 2020	Public workshop series (six workshops: one per region (five) and one national) to discuss key findings from the study's reports.
August–October 2020	Regional working meetings with stakeholders from each of the five regions to ensure key regional priorities were reflected in the emerging Strategy draft.
October–November 2020	Targeted review sharing circles of the emerging Strategy draft with Indigenous contributors, youth & early career professionals, and government and industry representatives.
November 2020	Two public national workshops to share and discuss the emerging draft of the Strategy.
December 2020	Formal review of first draft with over 100 reviewers and contributors.
January 2021	Final review of the Strategy.
February 2021	Final revisions, translation, and graphic design of the Strategy.
March 2021	Launch of the National Strategy, Land, Water, Ocean, Us: A Canadian Ocean Literacy Strategy.

These refined national priorities, along with the regional recommendations detailed in the study reports, directly shaped the vision, goals, and priority actions (referred to as 'Action Streams') within the National Strategy.

The vision of the *Land, Water, Ocean, Us: A Canadian Ocean Literacy Strategy* (COLC 2021a) states: 'We take action together to ensure a healthy, sustainable, and equitable relationship with the global Ocean and Canada's waterways for present and future generations.' The National Strategy's goals align with the three core dimensions of Ocean Literacy identified in the initial study: Ocean knowledge, Ocean values, and Ocean actions. These dimensions frame the Strategy's Action Streams and corresponding objectives, as highlighted in Fig. 22.2 below. Together, the Strategy's vision, Action Streams, and objectives reflect COLC's overarching mission—empowering people in Canada to better understand, value, and care for the Ocean. The National Strategy (see link in the resources sec-



Fig. 22.2 Action Streams *(1–9)* within *Land, Water, Ocean, Us: A Canadian Ocean Literacy Strategy.* Note: Action Stream 10 was added in 2022 (see Sect. 22.4 below)

tion) provided the Ocean Literacy community a collaborative framework for action at the start of the Ocean Decade.

22.3.1 Implementation and Impact Measurement (Phase 1: 2021–2024)

The Action Streams and objectives outlined in the National Strategy are closely aligned with broader national and international frameworks. Domestically, examples of these initiatives include Canada's Oceans Protection Plan, Canada

Target 1 Challenge, Ocean Plastics Charter, Truth and Reconciliation Commission of Canada, Canada's Blue Economy Strategy, and Canada Water Agency. Internationally, examples of relevant frameworks include, but are not limited to: Sustainable Development Goals, Ocean Decade, UN Water Action Decade (2018–2028), UN Framework Convention on Climate Change, Convention on Biological Diversity, and UN Declaration on the Rights of Indigenous Peoples. See the resources section for links.

The National Strategy exemplifies and recognizes that we each have a role to play in building an 'Ocean-literate society,' or a society that better understands, values, and cares for the Ocean (Glithero et al. 2024). Achieving Ocean sustainability, healthy waterways, and community well-being requires intergenerational, multi-regional, and multi-sectoral collaboration. Leadership, innovation, and commitment from a wide range of specialists and interested and/or affected groups across nine key sectors (represented as puzzle pieces in Fig. 22.1), are essential to driving measurable change. This effort extends beyond these sectors, requiring collective action from all members of society.

22.3.2 Launching the Strategy with an Imperfect Term

The National Strategy was developed with full awareness of the complexities and broader implications surrounding the term 'Ocean Literacy.' For example, for many Indigenous Peoples in Canada, Ocean Literacy is a new framing for a relational understanding that has been lived and practiced for thousands of years (Glithero et al. 2020). The seminal article, *Coming to Terms with the Term Ocean Literacy* (MacNeil et al. 2021), explores the colonial and linguistic aspects of the term. As an example, for Inuit communities, 'Ocean Literacy' is an inadequate term when viewed through the lens of their knowledge system, Inuit Qaujimajatuqangit, which translates to 'that which Inuit have always known' (Karetak et al. 2017). Inuit Qaujimajatuqangit is closely linked to how Inuit understand and relate to the Ocean, encompassing ice, land, and coastal areas. It reflects the entirety of the Inuit experiences, as well as the values, principles, beliefs, and skills that have evolved through those experiences (Karetak et al. 2017).

An additional place-based example is that for inland communities in Canada, for whom the term 'Ocean Literacy' often feels less relevant or dismissive of existing freshwater-focused efforts. Outside of academia, education, and government, the term can be perceived as abstract or unappealing. Furthermore, while the English name 'Canadian *Ocean Literacy* Coalition' benefited from internationally recognized terminology, the French translation 'Coalition canadienne de la connaissance de l'Ocean' was chosen as the best equivalent by the translation team at the time of COLC's launch in 2018. The lack of a localized approach to translation—one that considers factors such as interpretation, cultural references, idioms, and regional linguistic variations (Katan 2014)—accentuates the power imbalances between sociolinguistic communities. This is particularly true for 'Ocean Literacy' in French, Indigenous, and other languages, where such nuances may be overlooked, leading to a lack of cultural and linguistic resonance (MacNeil et al. 2021).

For the purposes of the National Strategy, the term 'Ocean Literacy' is understood and used with the following nuances that reflect a Canadian context:

- The Ocean is recognized as a singular, interconnected, and living ecosystem, transcending boundaries and requiring shared responsibilities.
- The Ocean is more holistically understood as a continuum, or one broad, interconnected water system. This continuum includes freshwater, coastal areas, sea ice, and open Ocean, recognizing the interdependencies between each.
- There is no one singular way of connecting to the Ocean; the values many individuals and communities hold for the Ocean are shaped by cultural, spiritual, linguistic, aesthetic, recreational, economic, and other relationships, reflecting Canada's vast diversity of Ocean connections.

22.4 Strategy Implementation and Impact Measurement (Phase 1: April 2021–March 2025)

The National Strategy Impact Measurement Program is intended to track progress and efficacy, enabling COLC and its partners to make data-driven decisions. In 2021, COLC partnered with Entremission, a Montréal-based social enterprise, to develop an impact measurement framework. A preliminary framework was launched in March 2022, one year into Strategy implementation. The framework operates as a nested system, where each layer of the National Strategy feeds into the next. Projects—referred to as 'Key Initiatives'—are implemented by the COLC project office team and the partner community. These Key Initiatives, national in scope and collaborative in nature, bring the Action Streams of the National Strategy to life. The Action Streams, in turn, are designed to achieve the Strategy's goals (Ocean knowledge, Ocean values, Ocean actions).

The Strategy's goals are considered lagging indicators, meaning their outcomes can only be measured after the National Strategy has generated its intended impact. To achieve these goals quickly and efficiently, we also need to track leading indicators of Key Initiatives. Leading indicators provide real-time insights into progress, allowing adjustments to be made while projects are still underway. These indicators are derived from observable components of Key Initiatives, such as the number of events hosted or new partnerships formed, helping to ensure that efforts remain aligned with the overall Strategy and its goals.

The leading indicators, or metrics, to track for each Key Initiative are collaboratively identified by project and partner leads, with impact measurement data collected annually and the framework refined through an ongoing, iterative process. Each year, COLC publishes an annual National Strategy impact report (see COLC, 2023a, 2023c, 2024), providing insights to the COLC project office team and members of the Canadian Ocean Literacy community on the impact of recent Key Initiatives and related activities. More specifically, these annual reports serve to:

- document and report progress on the implementation of the National Strategy, ensuring transparency and accountability to partners, funders, and the public regarding commitments made under the National Strategy and work led by COLC;
- support continual learning and innovation amongst the project team and partner community;
- document and make replicable, activities and projects that achieve significant impact, exchanging better practice principles;
- inform decisions to add, modify, or remove Key Initiatives, Action Streams, and/or cross-cutting objectives under the National Strategy;
- identify gaps and support the recruitment of additional partners and resources for projects that support the National Strategy; and
- document learnings that can be shared with the international Ocean Literacy community.

The act of measuring and sharing impact data has an ongoing influence on National Strategy activities, direction, and outcomes. As an example, a tenth Action Stream was introduced in 2022 to capture the important leadership and community-building activities that are driving the National Strategy forward in Canada, and how these efforts are helping to advance the Ocean Literacy movement globally. They include COLC's role in co-chairing and co-authoring the Ocean Decade Challenge 10 White Paper (Glithero et al. 2024; and also see Chap. 2 in Volume 1 of this book series, *Actioning the Ocean Decade Challenge 10 White Paper: A Theory of Change*).

22.4.1 Impact Themes: Organizing Action Streams and Key Initiatives

Each of the Action Streams and corresponding Key Initiatives are organized into one of three impact themes: (1) Education & Engagement; (2)

Research & Evaluation; and (3) Leadership & Advocacy. These themes explain why a particular Key Initiative or activity is being undertaken and are described in COLC's National Strategy Impact Report 2023 as such:

- Education & Engagement initiatives are intended to actively engage members of the public, increasing their knowledge of the Ocean while fostering personal connections to water. These initiatives focus on promoting behaviours and actions that contribute to Ocean conservation. By making knowledge and points of connection more accessible through a range of participatory experiences, these initiatives can inspire action and cultivate a sense of shared responsibility toward protecting the Ocean.
- Research & Evaluation initiatives collect data and information about Ocean Literacy efforts, providing valuable insights into which experiences and approaches effectively transform people's understanding of, connection to, and relationship with the Ocean. These initiatives also identify gaps and opportunities in Ocean Literacy work, while documenting the elements that foster agency, drive behaviour change, and influence policy. By providing evidence-based feedback, these initiatives play a critical role in advancing and strengthening the field of Ocean Literacy, helping to shape more effective programs and strategies for long-term impact.
- Leadership & Advocacy initiatives aim to develop support for Ocean Literacy both within Canada and internationally. These initiatives help other institutions and sectors understand the value of Ocean Literacy and the linkages between Ocean and climate action. They also focus on generating funding and research support for Ocean Literacy and marine social sciences, strengthening partnerships, and expanding the Ocean Decade community and Ocean spaces.

The impact themes provide a simple way to summarize the strategic purpose of COLC's work, particularly to aid partners, advisors, and funders.

22.4.2 Metrics and Metric Families

In 2023, the National Strategy Impact Measurement Framework used a consistent set of 95 metrics to track progress and impact of nine Key Initiatives. In 2022, as a comparison, 26 metrics were used (for a complete list of metrics, see Appendix in COLC's National Strategy Impact Report 2023). Each metric is part of a 'Metric Family,' which is a grouping that enables results from different activities to be aggregated and compared. The primary Metric Families for the National Strategy reflect the main indicators of impact, and include, as described in the report, the following:

- Resources. A general term to describe deliverables, reports, toolkits, funding, and other products or services that increase the Ocean Literacy community's capacity to promote and strengthen Ocean knowledge, Ocean values, and/or Ocean actions.
- Engagement. The number and degree to which people are participating in each project and activity. For example, one important indicator of engagement is the number of partner organizations helping to implement an initiative.
- Perceptions. Subjective feedback and survey responses that indicate one or both of these things: whether Ocean knowledge, values, and/or actions are increasing or decreasing and/or whether the Ocean Literacy community's capacity to promote the above dimensions are increasing or decreasing. Perception metrics may be collected at the activity, project, or national level. They may be collected from the Ocean Literacy community or from the general public.

A set of secondary cross-cutting metric families provides additional insight into the nature of the primary Metric Families, helping to assess how well the data reflect the values and intent of the National Strategy. The National Strategy explicitly states the importance of using narrative techniques to engage people in Ocean Literacy efforts. It also highlights the impor-

tance of representation in the leadership of, production of, and engagement in Ocean Literacy activities. The cross-cutting metrics families are as follows:

- Stories. Written, visual, audio, or video story content that shares Ocean knowledge, values, or inspiration from one person (or group) to another. This metric does not stand on its own; it must reference specific resource results.
- Representation. The presence of youth (ages 16–28), early career professionals, Canadian geographic regions, languages, Indigenous communities, cultural groups, and the freshwater community in activities and resources. This metric does not stand on its own; it references other engagement or resources results.

22.5 Impact at a Glance: 2023 Snapshot

In the second full year of National Strategy implementation, COLC stewarded $2.07 million (see Key Insights section 'Funding' below for more information) in funding for nine Key Initiatives, all of which were national in scope and involved multi-partner collaborations. The 2023 metrics data highlighted a significant trend: growth in both scale and impact of these Key Initiatives. More partners were engaged, more people were reached, and participant feedback was overwhelmingly positive. One of the most exciting trends was the increase in partner engagement. In 2023, 632 unique organizations and individuals helped to bring Ocean Literacy initiatives to life. All sectors participated (as per Fig. 22.3), with partners reporting a 90–100%



Fig. 22.3 Sample photo of the *Ocean, Freshwater, and Us* giant floor map (8 m × 11 m) which includes Inuktitut language and syllabics, as well as Inuit place names. Image credit: Meghan Callon, Centre for Ocean Literacy Collaboration

satisfaction rate with their involvement, based on follow up experience surveys.

In 2023, the Key Initiatives collectively produced and circulated 92 Ocean Literacy resources that directly engaged over 2.5-million people in Canada through educational and participatory experiences. People from across the country took part, from the Pacific to Inuit Nunangat, the Atlantic, Great Lakes-St. Lawrence, and inland regions.

Throughout the year, a total of 378 events and activities were held, the majority of which were free, family-friendly, and youth-oriented. These events were primarily offered in English and/or French, with some held in Indigenous languages. The vast majority of events in 2023 took place in-person, fostering direct, on the ground community engagement.

More than $130,000 in community micro-grants were invested in 74 activities, supporting Ocean Literacy events, artistic projects, and early career professional development opportunities.

Additionally, 11 research projects were undertaken, developing a deeper understanding of public Ocean perceptions and the field of Ocean Literacy.

Beyond this 12-month (2023) impact snapshot, ongoing tracking of public Ocean perceptions (COLC 2023b; Nanos 2024) illustrate that most people in Canada (89%) agree that Ocean health is important, with 82% agreeing that action is needed to protect it, and 73% expressing a willingness to make lifestyle changes to support Ocean health. Furthermore, our research into public Ocean perceptions also provides valuable insights for sector-specific partners. For example, at the time of this writing, environmental and conservation organizations (ENGO) are by far the most trusted groups by people in Canada to protect the Ocean, significantly outpacing other sectors. These findings not only provide motivation for ENGO partners but also inform media outlets to better highlight ENGO voices in order to align with their audiences' desires and expectations.

Moreover, by tracking where people in Canada learn about the Ocean, we gain insight into the places and approaches or experiences (e.g., storytelling, outdoor experiences, community- science, hands-on learning) that are most effective in fostering Ocean Literacy. The following data illustrates in what ways individuals are most likely to connect with the Ocean:

- Visiting the Ocean for recreation or leisure (64.5%)
- Media (e.g., news, social media, movies, podcasts) (63.9%)
- Museums, aquariums, science camps, or interpretative centers (53%)
- Family, friends, and/or community members (30%)
- Arts and culture (e.g., books, theatre) (24.5%)
- Public events (e.g., workshops, talks, interactive spaces) (20.7%)
- Food gathering activities (e.g., fishing) (16.6%)
- Digital technology (e.g., virtual reality, computer games) (11%)
- Working in or around the Ocean as part of one's livelihood/employment (8.1%)

22.5.1 Representation in Key Initiatives

In addition to tracking the impact of Key Initiatives annually, the cross-cutting metric family of 'representation' is also being continually measured to assess how well these initiatives align with the core values of the National Strategy, and its commitment to improving equity, diversity, and inclusion in Ocean-related sectors. For the past two years, six representation metrics have been tracked, including:

- Participation from geographic regions (provinces, territories, and Ocean watersheds)
- Languages used
- Youth (ages 16–28) and early career Ocean professional representation
- Participation from and/or representation of Indigenous communities and languages
- Freshwater community engagement
- Participation from sectors

As examples of representation tracking from 2023 reporting, all COLC materials, including website and publications, are published in both English and French. Some Key Initiative-based resources and video collections include Indigenous languages–of note is the *Ocean, Freshwater, and Us* giant floor map and augmented reality app content (see Fig. 22.3). Beyond languages used, Community Grants were distributed across nine (of 13) provinces in 2023, and 29% of the Ocean Week Canada Community Event Grant projects were Indigenous led. Freshwater communities were active in the creation of all Key Initiatives and digital engagement opportunities; freshwater communities and information were also represented in all resources created. Specific to sector representation, an important indicator for evaluating Ocean Literacy's reach and impact, all nine sectors (as per Fig. 22.1) participated in one or more Key Initiative(s) in 2023.

22.5.1.1 Limitations of Impact Measurement

There are inherent limits to what can be observed or captured through traditional, linear impact measurement. The following factors and limitations have been considered in the development of the National Strategy Impact Measurement Framework, as outlined in our inaugural 2022 impact report:

- Complexity: Ocean Literacy reflects a complex web of societal perceptions, attitudes, and values that shape behavioural intentions, willingness, and commitment to act in pro-Ocean ways, mobilized through various pathways, including diverse knowledge sharing; experiences, storytelling, and celebration that build emotional connection; and capacity and opportunities that enable action. It requires participation from all sectors in all geographic regions of the country. Additionally, the current dimensions of Ocean Literacy—knowledge, values, actions—are also deeply interconnected and reinforce each other, making it impossible to measure them as purely independent outcomes.
- External Variables: Global trends, beliefs, and actions—both positive and negative—can influence Ocean Literacy in ways beyond the control of specific initiatives.
- Timeframe: There is often a significant time gap between activities, measurable changes in Ocean Literacy, and actual measurable impact on Ocean health. In many cases, these changes unfold over several years or even generations, making it difficult to verify direct cause-and-effect relationships between projects, outputs, and long-term impact.
- Local vs. Population Level Impact: Growth in Ocean Literacy is unlikely to follow a straightforward, linear trajectory. Ocean Literacy is the result of numerous local initiatives that, when combined, can have collective impact that generates population-level change.
- Scientific Uncertainty: The National Strategy feeds into a world-wide effort to safeguard the global Ocean. Given the challenges of measuring planet-wide Ocean health, it remains uncertain what degree of knowledge or action is 'sufficient' to generate a global impact. In the face of scientific uncertainty and shifting conditions, it is difficult to determine what specific actions will be 'enough'. When talking about measuring progress on the National Strategy, it must be recognized that the finish line is constantly shifting.

22.6 Key Insights and Moving Toward an Updated National Strategy (2025–2030)

Looking ahead to the next phase of the National Strategy implementation (2025–2030), several key insights have emerged that will guide Ocean Literacy progress in Canada and beyond. COLC's collaborative model has proven successful in mobilizing efforts across diverse sectors, regions, and communities. The National Strategy framework, with its emphasis on partnerships, inclusivity, and community engagement, will continue to serve as a foundation for scaling-up efforts nation-wide, while at the same time continuing to

play a leadership role in the international Ocean Literacy movement. Transdisciplinary research and collaborative impact measurement will remain priorities, anchoring and guiding COLC's work. Upon reflection of COLC's structure and approach to date, three key insights specific to multi-partner implementation, coalition model, and funding will now be discussed.

22.6.1 Multi-Partner Implementation

Implementation of the Action Streams within the National Strategy is not possible by any one organization, level of government, or region. Collaboration is essential and requires both a national coordinating and community-led approach. With this in mind, two potential pathways for implementation were suggested at the time of the National Strategy launch, as outlined in the *Implementation Plan: Pathways for Collaboration* (COLC, 2021b). On a national level, the suggested pathway was to establish a Canada-wide team for each Action Stream that would work closely with COLC's national project office; with each team serving as a coordinated national voice, ensuring leadership, momentum, Canada-wide collaboration, and measured progress. On a community level, an initial concept of a tool to track community-led projects and on-the-ground advancement of each of the Action Streams from coast to coast to coast was created (i.e., the Canadian Ocean Action Streams Tracker (C.O.A.S.T.). The idea was that community groups would self-register their initiative(s) on the C.O.A.S.T., which would then be integrated into evaluating our collective progress.

As the initial Strategy Implementation phase began, momentum grew and partners mobilized around some of the most tangible Action Streams in which a Key Initiative (i.e., Ocean Week Canada) was a full implementation of a single Action Stream (i.e., Action Stream #4—Grow Ocean Week Canada). In this case, the COLC project office, together with a Canada-wide team of partners, were able to move quickly to establish co-designed resources and engagement tools, regional hubs and event hosts, and shared communication toolkits for broad outreach. However, in other cases, multiple initiatives serve the same Action Stream; for example, Blue Schools Canada and the *Ocean, Freshwater, and Us* Giant Floor Map initiative both advance Action Stream #3: Strengthen Ocean Education. Some Action Streams have a clear end point (e.g., Action Stream #1, Develop the Digital Canadian Ocean Literacy Map & Community Platform), while others could continue in perpetuity (e.g., Action Stream #5, Enhance Ocean Knowledge through Media, Storytelling & the Arts). For these reasons, the initial Implementation Plan proved impractical and lacking in strategic clarity. In turn, we pivoted in the following ways:

- COLC's project office needed to fill a critical gap, serving as the catalyst, convenor, and coordinator of multi-partner Canada-wide initiatives, joint fundraising, and collective impact measurement; and
- In recognizing that community groups did not have the capacity or motivation to upload their events onto a central tracking tool, COLC needed to develop communication and opportunity sharing platforms, make stronger connections, build local relationships, and support capacity exchange through providing community microgrants, accessible resource sharing, and training in order to better support community groups.

To further strengthen these trajectories, we are deepening our understanding of the structure and scope of COLC's partner community through recent social network analysis (SNA) research - a joint effort by COLC's Research and Impact Measurement teams with professional consulting and modeling by Limnology Research Corp. These emerging visualizations provide insights on: how various entities are interconnected; potential opportunities for more efficient collaboration, streamlining of processes, and allocation of resources; and (but not limited to) areas of strength and vulnerability within the network. Three examples of our emerging SNA visualizations are highlighted in Figs. 22.4, 22.5, 22.6 below, by sector, partners, and key initiatives, respectively.

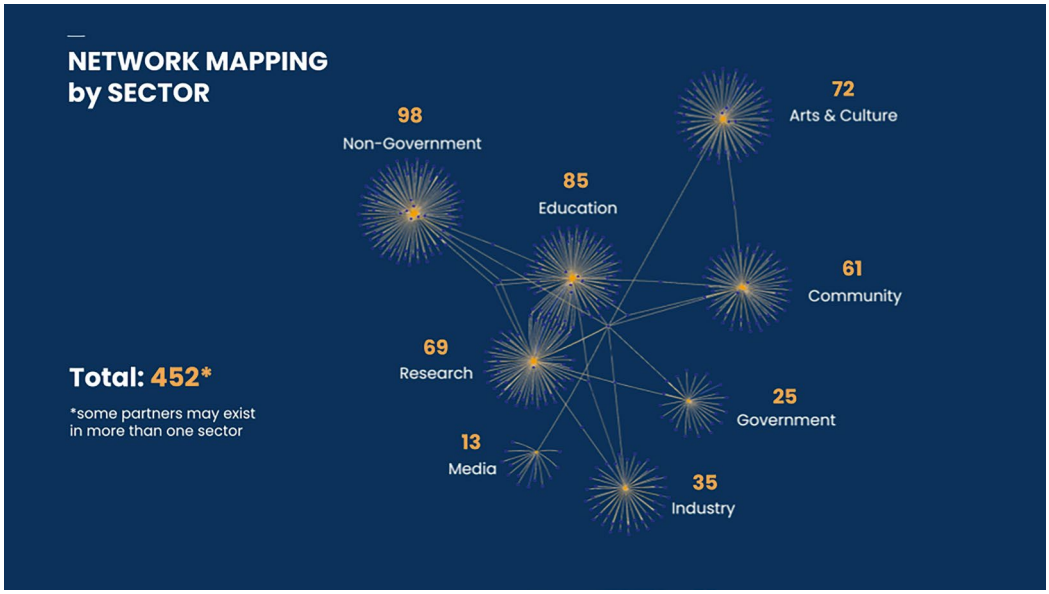


Fig. 22.4 COLC network visualization through the lens of sector engagement from 2023–2024

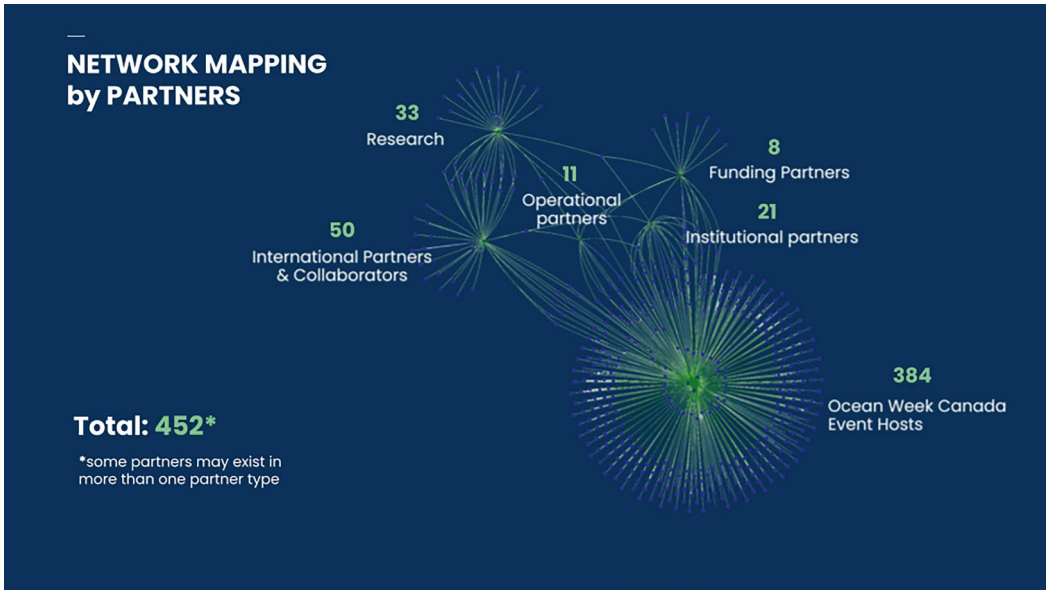


Fig. 22.5 COLC network visualization through the lens of partner engagement from 2023–2024

22.7 Coalition Model

As noted in the introduction, COLC grew out of a small and informal collective of organizations from multiple sectors recognizing the need to better understand and advance Ocean Literacy in Canada. A coalition was formed in 2018 to complete a very specific, albeit complex, task—to support a team of researchers to design and lead a national study, generating the evidence and insights upon which a National Strategy could be developed. COLC's coalition model, under the

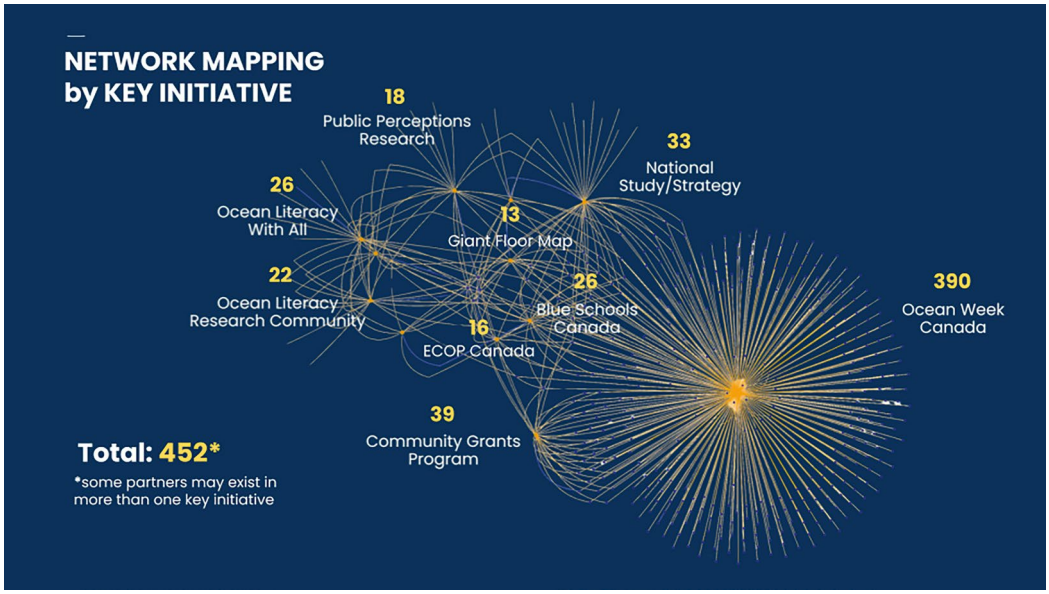


Fig. 22.6 COLC network visualization through the lens of Key Initiatives from 2023–2024

leadership of a National Coordinator (now Executive Director) and Advisory Board, was fluid: any organization, institution, community, or individual that self-identified with this work and mission could join. There was no formal membership structure. The scale of contributions and engagement levels varied, ranging from: contributions of funds to support postdoctoral and graduate students (see Acknowledgements section); administrative support, including HR, legal, and training; participation in data collection; providing regional, cultural, and community expertise; strategic communications and results sharing; and opportunity mapping and partnership building.

Four years into the implementation of the National Strategy, COLC functions less as a coalition and more as a collaborative centre focused on Ocean Literacy research and innovation. In turn, COLC changed its name in late 2025 to better reflect what it has become—Centre for Ocean Literacy Collaboration. Our national project office currently has five full-time staff who are grant-funded employees at Dalhousie University (COLC's current administrative headquarters), along with multiple consultants, interns, and early career researchers. This rename and reframe is part of the next phase of COLC's work (2026-2030) and the updated National Strategy implementation (see concluding remarks).

22.7.1 Funding

In COLC's initial launch period, September 2018 to March 2021, nearly $one million in funding was raised, reflecting a blended funding model inclusive of government, private sector, and academic grants and contributions. Over the first phase of National Strategy implementation, April 2021 to March 2026, just over $seven million was secured, with the majority coming from a multi-year contribution from the Government of Canada's Oceans Management Contribution Program (see Fig. 22.7).

The National Strategy impact to date and COLC's success in securing funds to advance this work is based, in part, on two important and strategic approaches. These include: (1) socializing and situating Ocean Literacy's relevance as a necessary aspect of a national government's marine planning and conservation program; and (2) focusing on joint funding proposals. Specific to the first approach, the Government of Canada's

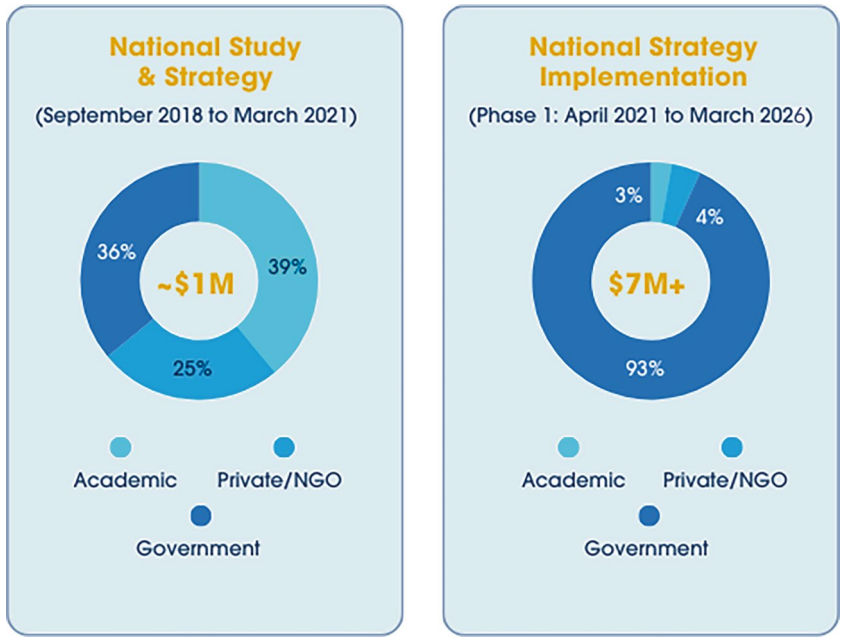


Fig. 22.7 COLC's funding structure since inception in 2018

prioritization of Ocean protection, creation of funding opportunities that include outreach and engagement, and commitment to collaboration (beyond a sole funding role) have been instrumental in advancing Ocean Literacy in Canada to date. In terms of the second strategic approach, COLC's focus on spearheading the writing of multi-year funding proposals that convene a team of partner organizations around a shared project vision, goals, and timeline, with clear objectives and deliverables specific to each partner's capacity and expertise, has enabled all parties to benefit through a single funding ask. Across all funding raised by COLC to date (up until March 2026), 52% has been allocated to partner organizations, 35% to COLC's national project office, 10% to COLC's administrative home institutions, and 3% to community microgrants.

Informed by experience to date, joint funding initiatives that are rooted in collaboration, trust, and transparency will remain an important approach moving forward, as will progressing toward more blended funding models that are strengthened by increased partnerships with the private sector and foundations.

22.8 Concluding Remarks: Looking Ahead

Since the launch of the National Strategy in March 2021, COLC's efforts have iteratively evolved as we have learned by doing. Through this period of rapid growth, we have succeeded in establishing partnerships, collaborative structures, and resources to build and advance Ocean Literacy in Canada. COLC's mission, since inception in 2018, remains the same—empowering people in Canada to better understand, value, and care for the Ocean. We will continue to approach this mandate in ways that resonate with as many geographies, cultures, and realities as possible. Relationship-building and collaborative action will remain the foundation and driver of COLC's work in Canada and on the international stage, as we continue to position Ocean Literacy as a societal outcome.

Guided by an updated iteration of the National Strategy (2026–2030), expected to be released in spring 2026, COLC's continuing vision will focus on deepening support, investment, and leadership in national and international initiatives aiming to strengthen people-Ocean connections. One example will be to prioritize initiatives that advance marine social science and public Ocean perceptions research, to in turn inform results-based Ocean communication, education, and engagement training. In this way, we can fill a need to connect with the broad Ocean community–for example, scientists, policymakers, communication specialists, educators, businesses, tech entrepreneurs, funders, and the public–to extend the impact of our work, bolster their endeavours, and leverage the strength in collaborative partnerships. Through continued impact monitoring, the collective aim of these, and other dovetailing initiatives, is to help move targeted audiences, communities, and broader society from awareness, apathy, and concern to tangible changes in behaviour that ultimately support Ocean health.

22.8.1 Summary

Key concepts explored in this chapter include:

- Canada's extensive coastlines and freshwater resources shape diverse relationships with water, influenced by cultural and regional perspectives.
- 'Ocean Literacy' is viewed as a limiting term in Canada, particularly by inland and Indigenous communities, who feel it doesn't fully reflect their connection to water.
- COLC launched a national study in 2018, resulting in the world's first national Ocean Literacy strategy in 2021.
- A National Strategy Impact Measurement Program tracks the progress of Key Initiatives' (e.g., Ocean Week Canada) and assesses efficacy.
- The chapter reviews the coalition model, insights learned, and future goals for advancing Ocean Literacy in Canada and beyond.

22.8.2 Recommended Resources

The following resources provide further insights and support on this topic:

- The full Canadian Ocean Literacy Strategy can be found on the COLC website: www.colcoalition.ca/our-work/canadas-Ocean-literacy-strategy/
- Annual National Strategy Impact reports can be found on the COLC website: https://colcoalition.ca/our-work/colc-publications/
- All reports from the *Understanding Ocean Literacy in Canada* national study (2019–2020) can be found on the COLC website: https://colcoalition.ca/our-work/national-study/
- Canada's Oceans Protection Plan: https://tc.canada.ca/en/initiatives/Oceans-protection-plan/canada-s-Oceans-protection-plan
- Canada Target 1 Challenge: https://www.canada.ca/en/environment-climate-change/services/nature-legacy/canada-target-one-challenge.html
- Ocean Plastics Charter: https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/international-commitments/Ocean-plastics-charter.html
- Truth and Reconciliation Commission of Canada: Calls to Action: https://www2.gov.bc.ca/assets/gov/british-columbians-our-governments/indigenous-people/aboriginal-peoples-documents/calls_to_action_english2.pdf
- Canada's Blue Economy Strategy (emerging): https://www.dfo-mpo.gc.ca/campaign-campagne/bes-seb/index-eng.html
- Canada Water Agency: https://www.canada.ca/en/canada-water-agency.html
- 2030 Agenda for Sustainable Development - Sustainable Development Goals: https://sdgs.un.org/goals
- UN Decade of Ocean Science for Sustainable Development (2021–2030): https://Oceandecade.org
- UN Water Action Decade (2018–2028): https://www.un.org/sustainabledevelopment/water-action-decade/

- UN Framework Convention on Climate Change: https://unfccc.int/
- Convention on Biological Diversity: https://www.cbd.int/
- UN Declaration on the Rights of Indigenous Peoples: https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf

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- Diz Glithero: COLC's National Coordinator (Study); lead co-author (Strategy)
- Sarah MacNeil*: COLC's Administrative and Communications Coordinator (2018–2021); Great Lakes and St. Lawrence Regional Coordinator (Study); lead co-author (Strategy)
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- Lilia Yumagulova**: Pacific Regional Coordinator (Study); contributing author (Strategy)
- Carie Hoover**: Inuit Nunangat Regional Coordinator (Study); contributing author (Strategy)
- Justine Ammendolia*: Atlantic (Newfoundland) Regional Co-coordinator; Inland Regional Co-coordinator (Study)
- Noemie Roy*: Research Assistant and lead author, Youth Report (Study)
- Shannon Monk: Inland Regional Co-coordinator and research consultant (Study).

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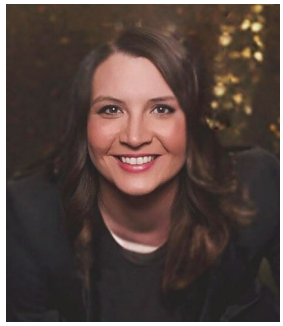
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[2]Meghan Callon: Conceptualization, Review and Editing, and Graphic design.
[3]Jen McRuer: Conceptualization, Review and Editing.
[4]Krystyn Tully: Conceptualization, Review and Editing.
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One Ocean, One Future

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Pathways Forward: Communicating One Ocean Future

Teresa J. Kennedy

One Ocean, One Future defines the collective work presented in Volume III where 87 authors from 25 countries/regions that demonstrate how communication, technology, and global collaboration are shaping the future of Ocean Literacy.

The chapters portray a world where educators, youth leaders, scientists, artists, policy makers, designers, engineers, and community members work together to strengthen society's relationship with the Ocean. Although the approaches vary widely, the shared purpose across the volume is unmistakable.

A central theme throughout the volume is that communication is not simply about disseminating information but about building understanding, meaning, and connection. Several chapters explore how evidence-informed messaging, narrative framing, and accessible design can help the public make sense of complex Ocean issues. Strategic communication frameworks, media-based engagement, and storytelling approaches inspire responses based on facts combined with emotional resonance and opportunities to participate. These insights highlight the importance of designing communications that reflect diverse languages, identities, and lived experiences while maintaining scientific accuracy and clarity.

Technology emerges as another powerful driver of Ocean Literacy. From immersive digital platforms and virtual voyages to augmented and virtual reality learning and emerging applications of artificial intelligence (AI), machine learning (ML), and deep learning (DL), these innovations create new pathways for discovery and understanding, and expand participation in Ocean learning.

Global collaboration is central to advancing Ocean Literacy. Regional, national, and transnational efforts demonstrate how partnerships deepen impact. From Small Island Developing States (SIDS) working to co-design Ocean science, to the Mediterranean's collaborative Blue Challenges, to continental initiatives like the Network of European Blue Schools, Volume III demonstrates how collective action helps align local initiatives with international goals.

Youth empowerment is another strong theme. Multiple programs place young learners, emerging leaders, and Early Career Ocean Professionals (ECOPs) at the center of Ocean action through leadership training, mentorship, cultural exchange, and experiential learning. Whether aboard research vessels, within national training academies, or through community-led conservation work, they take on active roles in advancing Ocean Literacy. These initiatives emphasize confidence building and professional pathways.

Cultural heritage and traditional knowledge feature prominently in this volume. Several chap-

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ters highlight how communities have long-standing relationships with the Ocean and how cultural perspectives enrich understanding of marine environments. By honoring heritage, local practices, language, and place-based identity, Ocean Literacy becomes more inclusive and reflective of the many ways people understand and value the Ocean. These perspectives reinforce the connections between Ocean issues and community identity.

Organizational and national strategies aimed at systemic change are also emphasized. From Taiwan's and the Republic of Ireland's coordinated national frameworks, and Portugal's decades-long commitment to advancing Ocean Literacy, the chapters offer examples of policy alignment, institutional collaboration, and scalable models that support long-term engagement.

National and regional coalitions also demonstrate how shared vision can influence policy and public behavior. Canada's Centre for Ocean Literacy Collaboration's mapping of knowledge across watersheds, development of a national strategy, and integration of Indigenous knowledge offer insights into how stakeholders across large, diverse countries can work together toward shared goals. Similar efforts across the globe highlight the potential of networks to scale local efforts into coordinated regional change.

Hybrid artificial reef systems, underwater art installations, and restoration projects illustrate how science, engineering, and creativity can work together to enhance biodiversity, support community engagement, and create new spaces for public connection with the Ocean. These examples show that conservation can be both ecological and cultural, providing opportunities for education, tourism, and community identity.

Together, these chapters provide a comprehensive understanding of what it means to advance Ocean Literacy in the twenty-first century. They show that Ocean Literacy is not only an educational pursuit but also a cultural, technological, scientific, and societal one. Progress depends on inclusive partnerships, creative communication, and the willingness to view the Ocean through multiple lenses.

As this volume closes, the insights presented here underscore a shared message: strengthening society's relationship with the Ocean requires approaches that honor diversity, foster connection, and encourage responsibility. The contributions in Volume III illustrate the many ways this work is already underway and provide inspiration for how international, regional, and local initiatives can continue moving forward. While the contexts and methods differ, the overarching goal is consistent: to create a world where people understand, value, and engage with the Ocean as a vital and interconnected system that supports all life.

This concluding reflection brings the three-volume *Ocean Literacy: The Foundation for the Success of the Ocean Decade* series to a close by recognizing the ongoing work of many actors within the global Ocean Literacy community. Together, these volumes illustrate how education, community engagement, creativity, the Sustainable Blue Economy, communication, technology, and global collaboration collectively strengthen society's relationship with the Ocean. They demonstrate that restoring this relationship requires: learning that inspires understanding; community action that sustains participation; creativity that sparks emotional connection; innovation that expands access; and cooperation that transforms ideas into lasting change. It has been an honor to learn from the remarkable examples, insights, and collaborations shared across the 65 chapters of this three-volume series, and to recognize how each contributes to building a more Ocean-literate and sustainable world. Together, they point the way toward a sustainable future for the one Ocean that connects us all.

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Volume III Acronym List

The following acronyms related to Ocean Literacy were included in this volume.

Acronym	Full Name
3D	Three-Dimensional
AC(s)	Advisory Committee(s)
ADDIE	Analysis, Design, Development, Implementation, and Evaluation (model used to build the Ocean Literacy Leadership Competency Model)
ADNOC	Abu Dhabi National Oil Company
AFS	Aboriginal Fisheries Strategy
AI	Artificial Intelligence
AMEA	Asian Marine Educators Association
AR	Augmented Reality
ARAMCO	Saudi Arabian Oil Company
ASLO	Association for the Sciences of Limnology and Oceanography
ASPEA	Portuguese Association for Environmental Education
BF	Blue Flag Programme
BFP	Blue Futures Pathways
BIPOC	Black, Indigenous, and People of Color
CBD	Convention on Biological Diversity
CLAMER	Climate Change and European Marine Ecosystem Research
COP21	21st Conference of the Parties
COSEE	Centers for Ocean Sciences Education Excellence
COVE	Centre for Ocean Ventures and Entrepreneurship
CSR	Corporate Social Responsibility
CS	Citizen Science
DC(S)	Decade Challenge(s)
DFO	Department of Fisheries and Oceans [Canada]
DIVE4Ag	Distant Immersive Virtual Experiences for Agriculture
EAD	Environment Agency Abu Dhabi
EC	European Commission
Eco-Schools	Global Environmental Program (FEE)
ECOP(s)	Early Career Ocean Professionals
EE	Environmental Education
EEZ	Exclusive Economic Zone
EFA	Exploratory Factor Analysis
EGA	Educar para uma Geração Azul (Educating for a Blue Generation)
EID	Environmental Identity Scale
EINS	Extended Inclusion of Nature in Self Scale
EJ	Environmental Justice
EMSEA	European Marine Science Educators Association
EPA	Environmental Protection Agency
ERN(s)	European Researchers' Night(s)
ESD	Education for Sustainable Development
ESEP	European School Education Platform
EU	European Union
EU-27	Group of 27 member states of the European Union
EU4OCEAN	European Union Coalition for Ocean Literacy
FAO	Food and Agriculture Organization of the United Nations
FCL	Free-Choice Learning
FLORES	Forward Looking at the Offshore Renewables (EU Skills Partnership)
GAD(S)	Global Action Day(s)
GCC	Gulf Cooperation Council
GIS	Geographic Information System
GK	Green Key

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Acronym	Full Name
GOLS	Global Ocean Literacy Survey
GPD	Gross Domestic Product
GRID	Global Resource Information Database
HAB(S)	Harmful Algal Blooms
ICASE	International Council of Associations for Science Education
ICMM	International Council of Maritime Museums
ICT	Information and Communication Technology
IMPAC5	Fifth International Marine Protected Areas Conference
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPMEN	International Pacific Marine Educators Network
IUCN	International Union for Conservation of Nature
JEDI	Justice, Equity, Diversity, and Inclusion
K–12	Kindergarten through 12th Grade (ages 5–18)
KEPA	Kuwait Environment Public Authority
KEPS	Kuwait Environmental Protection Society
KOC	Kuwait Oil Company
LDC(s)	Local Decade Challenge(s)
LEAF	Learning About Ecosystems and Forests
MAR	Mesoamerican Reef
ME(s)	Multiplier Event(s)
MMRI	Maldives Marine Research Institute
MOOC	Massive Open Online Course
MOU	Memorandum of Understanding
MPA(s)	Marine Protected Area(s)
MSCA	Marie Skłodowska-Curie Actions [European Union]
NAMR	National Academy of Marine Research [Taiwan]
NASA	National Aeronautics and Space Administration [USA]
NBS	Nature-Based Solutions
NEBS	Network of European Blue Schools
NGO	Non-Governmental Organization
NGSS	Next Generation Science Standards [USA]
NGZ	No-Go Zone (areas in World Heritage coral reefs showing no presence of coral or potential for recovery)
NKS	National Knowledge Systems
NMEA	National Marine Education Associations [USA]
NOAA	National Oceanic and Atmospheric Administration [USA]
NSF	National Science Foundation [USA]
OAC	Ocean Affairs Council [Taiwan]
Ocean Decade	Decade of Ocean Science for Sustainable Development
OD	Ocean Decade
ODC(s)	Ocean Decade Challenge(s)
OECD	Organization for Economic Co-operation and Development
OL	Ocean Literacy
OLBN	Ocean Literacy Benchmark Nation
ORAI	Ocean Research and Innovation
OSS	Ocean and Society Survey
OSS	Ocean Science Sequence (Ocean Literacy teaching materials developed by UC Berkeley and NOAA)
PAM	Passive Acoustic Monitoring
PMM	Personal Meaning Mapping
PORT	Portal for Opportunities, Resources, and Talent (BFP platform)
QNV 2030	Qatar National Vision 2030
R&I	Research and Innovation
R/V	Research Vessel
ROPME	Regional Organization for the Protection of the Marine Environment
ROV(s)	Remotely Operated Vehicle(s)
RSA(s)	Regional Sea Area(s) (Mediterranean Region Sea Area)
SBE	Sustainable Blue Economy
SC(s)	Steering Committee(s)
SCUBA	Self-Contained Underwater Breathing Apparatus
SDG(s)	Sustainable Development Goal(s)
SDG 4	Sustainable Development Goal—Quality Education
SDG 11	Sustainable Development Goal—Sustainable Cities and Communities
SDG 12	Sustainable Development Goal—Responsible Consumption and Production
SDG 13	Sustainable Development Goal—Climate Action
SDG 14	Sustainable Development Goal—Life Below Water
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SIDS	Small Island Developing States
SOFAR	Sound Fixing and Ranging Channel
STEAM	Science, Technology, Engineering, Arts, and Mathematics

Acronym	Full Name
STEM	Science, Technology, Engineering, and Mathematics
TAT	Teens as Teachers
TEK	Traditional Ecological Knowledge
TOS	The Oceanography Society
UN	United Nations
UN Ocean Decade	United Nations Decade of Ocean Science for Sustainable Development
UNCCD	United Nations Convention to Combat Desertification
UNCSD	United Nations Conference on Sustainable Development
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vocational Education and Training
VHF	Very High Frequency
VR	Virtual Reality
VSL	Visual Solutions Lab
W2O	World Ocean Observatory
WASCAL	West Africa Science Service Centre on Climate Change and Adapted Land Use
WCS	World Conservation Strategy
WebGL	Web Graphics Library
WLD	World Listening Day
WOPAMD	World Ocean Passive Acoustic Monitoring Day
WP(s)	Work Packages
WSOM	World Summit on Media
WWF	World Wildlife Fund
XR	Cross Reality (covers AR, VR, and mixed reality)
YRE	Young Reporters for the Environment