



Teresa J. Kennedy *Editor*

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

Transforming Education, Research, and  
Engagement

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# Scientists for Ocean Literacy: Empowering Scientists as Ocean Advocates

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## Abstract

The UN Ocean Decade *Scientists for Ocean Literacy* project, led by EuroGOOS, brings together marine research institutions to promote Ocean Literacy through cross and multi-disciplinary collaborations and international

partnerships. The project aims to integrate Ocean Literacy into the core activities of research organisations and public agencies, strengthening the use of Ocean knowledge and information in policymaking, research, and innovation. In response to the UN Ocean Decade challenges, the *Scientists for Ocean Literacy* project promotes innovative outreach and engagement strategies, fostering dialogue between marine scientists and diverse societal actors. Activities include events, resources, surveys, trainings, and showcases. Building

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on the efforts of the EuroGOOS Ocean Literacy Working Group, the project aims to bridge the gap between science and society, deepening public understanding of the Ocean's importance while promoting marine science as a career path. This chapter presents case studies from the project's partners across Europe, illustrating best practices in integrating Ocean Literacy into science, policy, and society.

### Keywords

Ocean Literacy (OL) · Ocean science · Oceanography · Multi-disciplinary partnerships · Societal engagement · Science communication

## 20.1 Introduction: Linking Science and Society for Sustainable Ocean Stewardship

This chapter explores the role of scientists as active contributors to Ocean Literacy, which is essential for informed decision-making on environmental impacts, public policy, and maritime activities. The international Ocean Literacy framework encourages public engagement in science, fostering a well-informed, responsible relationship between society and the Ocean. The framework, built on seven core principles, highlights the Ocean's role in Earth's systems, climate, biodiversity, and the profound human-Ocean connection. Ocean Literacy also incites citizens to contribute to marine data collection and analysis through citizen science, providing solutions and supporting fit-for-purpose Ocean observations and services. The success of the UN Decade of Ocean Science for Sustainable Development 2021–2030 (UN Ocean Decade) and Agenda 2030 relies on effective Ocean observation, technological innovation, and data ser-

vices, which demand strong public and policy engagement. The Essential Principles of Ocean Sciences are defined as follows:

1. Earth has one big Ocean with many features.
2. The Ocean and life in the Ocean shape the features of Earth.
3. The Ocean is a major influence on weather and climate.
4. The Ocean makes Earth habitable.
5. The Ocean supports a great diversity of life and ecosystems.
6. The Ocean and humans are inextricably interconnected.
7. The Ocean is largely unexplored.

Ocean Literacy encompasses a profound comprehension of the reciprocal relationship between the Ocean's influence on individuals and their impact on the Ocean. An Ocean-literate person grasps the fundamental principles and essential concepts governing the Ocean's functioning, communicates effectively about Ocean-related matters, and makes informed, responsible decisions concerning Ocean resources (NOAA 2024). Although the term "Ocean Literacy" may not directly translate into many languages, variations such as "sea literacy," "sea culture," "Ocean culture," or "science popularisation" convey similar concepts, reflecting its widespread recognition in contemporary Ocean science and policy circles.

Aligned with the principles of the "new societal contract of science" (Gibbons 1999), which advocates for participative science engaging both the public and policymakers through co-design, consultations, and accessible communication of results, Ocean scientists play a pivotal role. They serve as key conduits for translating scientific research into actionable insights for shaping public policies, transcending the boundaries of academic research.

European Global Ocean Observing System (EuroGOOS) highlights Ocean Literacy as a vital link between Oceanography, policy, and society,

enabling public support and the sustained and fit-for-purpose operation of Oceanographic systems (Eparkhina et al. 2021; Eparkhina and Lehtonen 2017). Ocean Literacy also provides Oceanographic, environmental, and meteorological agencies with opportunities to engage diverse audiences across generations, professions, and socio-economic groups. This fosters intellectual, emotional, and creative connections with different sectors of society, helping scientific institutions resonate more deeply with the public.

Initiated and developed by EuroGOOS, the UN Ocean Decade *Scientists for Ocean Literacy* project seeks to foster synergies among Ocean Literacy initiatives undertaken by European scientific communities at national and institutional levels. By uniting Oceanographers, hydrographers, meteorologists, communicators, and policy experts, the project aims to amplify the scientific and societal impacts of these endeavours. Its overarching objective is to advocate for Ocean Literacy at institutional and funding levels, enhancing societal engagement through multidisciplinary and cross-sectoral collaborations.

The project places particular emphasis on engaging professionals from diverse sectors, including communications, social sciences, and multidisciplinary Ocean research spanning social, environmental, policy, and economic areas. By promoting the integration of Ocean Literacy into the core activities of research institutions and publicly funded agencies, the project aims to stimulate public engagement in Ocean science and help deepen collective awareness of the Ocean's fundamental role in shaping our world.

The EuroGOOS's *Scientists for Ocean Literacy* activities address pressing challenges identified by the UN Ocean Decade, such as pollution, climate breakdown and mitigation, biodiversity loss, and the need for fit-for-purpose Ocean observing systems. Of particular significance is the Ocean Decade Challenge 10, which embodies the multifaceted ambition of Ocean Literacy to restore humanity's relationship with the Ocean, fostering inclusive dialogue and co-design with all stakeholders in society (Fig. 20.1).



**Fig. 20.1** Left: EuroGOOS policy brief “Ocean Literacy in European Oceanographic Agencies – EuroGOOS recommendations for the UN Decade of Ocean Science for Sustainable Development 2021–2030”; Right: EuroGOOS

book “The Ocean is My Home”

Developed as a scientifically rigorous initiative with an emphasis on outreach and communication, the *Scientists for Ocean Literacy* project conducts surveys and capacity-building activities to document and enhance the evolution of Ocean Literacy as a focal area of research institute activities. Building upon the groundwork laid by the EuroGOOS Ocean Literacy Working Group, which comprises over 20 organisations, the project enhances Ocean Literacy initiatives developed within the scientific community to drive positive changes in policies, practices, and dialogue with society. This chapter describes the activities of the project partners spanning the promotion of Ocean knowledge, co-design between Oceanography and other creative and scientific disciplines, the use of Ocean technologies, innovative outreach and engagement techniques, and more.

To advance Ocean Literacy and align marine scientific community efforts with broader societal needs, particularly within the UN Ocean Decade, EuroGOOS offers the following recommendations:

1. Foster innovative Ocean observation strategies: Prioritizing innovative Ocean observation strategies is essential to effectively address the complexity of the marine environment. Integrating Ocean knowledge with science-to-policy initiatives ensures that observations are both relevant and actionable. Ocean Literacy plays a key role in this process by engaging a diverse range of stakeholders and enhancing observational strategies through broader insights and citizen science contributions.
2. Increase public engagement: Oceanographic, environmental, and meteorological agencies should actively engage the public, policymakers, and the economy through Ocean Literacy initiatives. These efforts bridge the gap between marine research and societal goals, enhancing understanding and support for sustainable Ocean practices.
3. Focus on diversity and inclusivity: Ocean Literacy underscores the importance of diversity and inclusivity as the Ocean connects us all. Activities should be accessible to all audiences, including underserved groups such as those affected by disabilities or in hospitals or prisons. Partnering with education, social services, and other sectors, as well as adopting a co-design approach with different communities, will help ensure Ocean Literacy reaches a broad and diverse audience.
4. Leverage digital tools: Digital resources and online learning are essential for expanding the reach of Ocean Literacy. These tools should be used alongside interactive, hands-on activities to maximize engagement and effectiveness.
5. Foster partnerships: Collaborations with professionals from fields such as education, social sciences, arts, and others will make Ocean Literacy initiatives more versatile and impactful. Such partnerships are key to sharing Ocean knowledge, best practices, and innovative engagement tools across disciplines and countries.
6. Strengthen national and regional collaborations: Stronger national synergies are needed to engage both coastal and inland communities. Collaborating across regions enhances the consistency and reach of Ocean Literacy, driving broader societal impact and supporting more robust and aligned marine knowledge systems.
7. Expand funding and resources: Ocean Literacy activities often remain underfunded, relying on the dedication of individual researchers. Securing adequate financial and institutional support is essential. Strengthening Ocean Literacy programmes will also attract more professionals to marine research institutions. In addition, this investment will improve marine knowledge and information services and unlock new avenues for marine data collection.
8. Enhance impact monitoring: Better assessments of Ocean Literacy activities, including their spillover effects (where engaging one group influences others), will improve programme effectiveness and help track their broader societal impact. Furthermore, monitoring these impacts will enable researchers to refine their methods, ensuring Ocean Literacy activities contribute to actionable solutions.

These recommendations help align Oceanographic research with societal needs, promoting a sustainable and well-informed relationship between humans and the Ocean. Through Ocean Literacy, research institutions can not only promote sustainable behaviour, but also access richer sources of marine data, improve science-based solutions, and design fit-for-purpose Ocean observing and services that directly benefit society. United by the vision of impactful Ocean Literacy activities in research institutions, the initiatives presented in this chapter showcase European efforts addressing these recommendations and collaborating through the *Scientists for Ocean Literacy* project.

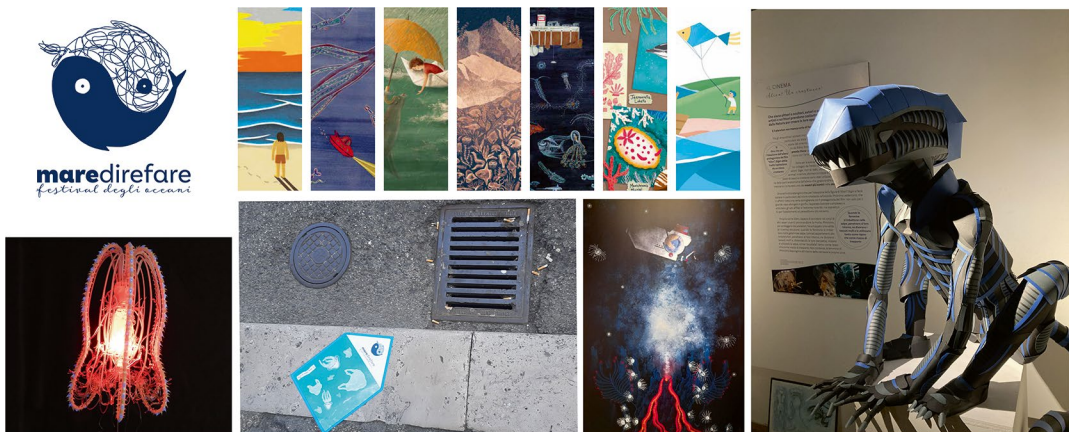
## 20.2 MareDireFare Festival: Fusing Art, Science, and Public Engagement to Promote Ocean Literacy

The National Institute of Oceanography and Applied Geophysics (OGS) in Italy is committed to scientific communication and public engagement on marine issues. Among its many initiatives, the *MareDireFare* Festival (*SeaSayDo*; <https://www.maredirefare.it/>) has emerged as a

success story dedicated to promoting Ocean Literacy across all ages and using diverse communication methods (Fig. 20.2).

The festival was launched in 2021 at the beginning of the UN Ocean Decade, focusing on “The World of Microscopic Marine Life”. In its inaugural year, 18 young artists participated in a major exhibition, which included 40 artworks. Over 50 public events were held, thanks to collaborations with schools, museums, libraries, environmental non-governmental organisations (NGOs), and artists, attracting a broad and engaged audience. Building on this success, the festival returned in 2022 with the theme “The Seven Ocean Literacy Principles”. This edition featured a national call for seven artists, each tasked with creating seven illustrations—one for each of the principles. A comic book telling the story of an octopus guiding a pupil to explore the Ocean was published in 2024.

The 2023 festival, themed “The Sea Starts in the City”, highlighted the fusion of creative expression and scientific research. This edition included two major exhibitions: one featuring photographs of tidal environments and another along an urban eco-path marked by artistic installations and street art. The 2024 festival, themed



**Fig. 20.2** Pictures of the artworks of the *MareDireFare* Festival. *Top left*: Festival logo; *Top centre*: Details of artwork from the 2022 edition “The Seven Ocean Literacy Principles”; *Right*: Sculpture depicting the movie character Alien, inspired by the marine organism *Phronima sed-*

*entaria* from the 2021 edition “The World of Microscopic Marine Life”; *Bottom left*: Sculpture of a *Mnemiopsis leidyi*; *Bottom centre*: Manhole illustration from the 2023 edition “The Sea Starts in the City”; *Bottom right*: Artwork from the 2023 edition. Credit: OGS

“Chronicles from the Deep”, delved into the mysteries of the seabeds from the Gulf of Trieste to the deep Ocean. The programme included a series of free events for adults and families, exploring the sea through science, art, history, and culture.

Throughout its editions, since 2021, the *MareDireFare* Festival has addressed the challenge of raising marine awareness amid intense competition from other cultural events, involving 35 artists that produced around 200 pieces of art (sculptures, illustrations, photos, etc.) and organising more than 100 public events in 4 years. The key factor has been the dynamic dialogue between art and science, significantly increasing the festival’s appeal, particularly to younger audiences. By leveraging diverse communication tools and engaging a wide array of local partners—including schools, museums, bookshops, libraries, NGOs, and artists—the festival has successfully elevated its visibility and impact

(Fig. 20.3). The festival has greatly helped to enhance the public’s understanding of marine ecosystems, biodiversity, and the broader implications of human activities on the Ocean. Through artistic and scientific lenses, it has bridged the gap between the marine world and societal pressures, such as land use, global policies, European Union regulations, and local planning. This multi-faceted approach has been instrumental in nurturing an “Ocean generation” that is both engaged and informed.

The format of the festival has allowed exhibitions to take place not only in Trieste but also in inland locations, reinforcing the idea that our connection with the sea extends far beyond coastal regions. Looking ahead, the festival will continue its Ocean Literacy activities, increasingly addressing important issues such as equality, accessibility, and inclusivity, while also leveraging Trieste’s strategic location on the border with Eastern Europe.



**Fig. 20.3** Pictures from the events of the *MareDireFare* Festival in Trieste. *Top left*: Exhibited artworks in a local café; *Top right*: Seminar for the general public; *Bottom*

*left*: Science café in a historic cafeteria; *Bottom right*: Artwork on display in a local museum. Credit: OGS

The *MareDireFare* Festival, as a cornerstone of OGS's scientific dissemination efforts, has proven to be an effective educational platform. Through partnerships with the Miramare Marine Protected Area of Trieste and other scientific institutions, it reinforces the connection between science and society, driving meaningful action toward Ocean sustainability.

### 20.3 Empowering Future Environmentalists: Hands-on Approach to Ocean Literacy and Marine Conservation

The Hellenic Centre for Marine Research (HCMR), a governmental research organisation in Greece, is developing educational programmes for all school levels, training courses for teachers, and workshops for stakeholders. During visits to HCMR facilities, students engage in interactive and hands-on learning activities, along with exhibitions related to marine technology and infrastructures. These activities help expand their understanding of aquatic environments, ecosystem mechanisms and functions, and the stresses these systems face due to anthropogenic pressures. Each year, approximately 5000 students participate in HCMR programmes and activities promoting Ocean Literacy and inspiring the next

generation of environmentalists. Scientists at HCMR, including those at the Hydrobiological Station of Rhodes and CretAquarium, work to raise environmental awareness and inspire local action, providing information and training on climate change, natural hazards, pollution, cultural heritage, and marine resources to more than 300,000 citizens and visitors annually.

Marine and freshwater scientists also communicate HCMR's research results to students, stakeholders, and the broader public by participating in various initiatives and projects. Since 2006, the Department of Ecology and Ecosystem Management at HCMR's Institute of Marine Biology, Biotechnology, and Aquaculture has been studying a coastal marine area in northeastern Crete (Elounda Bay), focusing on local marine environmental issues such as conservation, sustainable management of marine biological resources, and Lessepsian migration of marine species due to climate change. HCMR scientists have developed and implemented a non-formal educational intervention that includes short lectures, lab activities, and fieldwork. Students visit HCMR labs to get familiar with scientific equipment and observe marine species. Fieldwork includes visits to the study area, where pupils measure abiotic parameters *in situ* using scientific instruments and have the opportunity to speak with local fishers and authorities (Fig. 20.4).



**Fig. 20.4** HCMR's hands-on approach. *Left:* High school students (16–17 years old) discussing in the field with fishers in Elounda Bay (Crete, Greece). *Right:* Student

observing and becoming familiar with marine macrobenthic species using a stereoscope in the HCMR lab. Credit: HCMR

Additional resources and tools, such as the [MED EDUC pedagogical guide](#) and [Mediterranean Sea Literacy](#), are used to enhance learning. This intervention, with various adaptations (e.g., a short scientific article reviewed by high school students), has been implemented to date in three schools in the region of Crete reaching 100 students, within the framework of different European scientific projects (e.g., [GES4SEAS](#), [ERASMUS+ BlueS\\_Med](#)), and educational programmes of the Greek Ministry of Education (e.g., *Adopt a Terrestrial/Marine Ecosystem*). It also supports schools in joining the [European Blue Schools network](#) and serves as a best-practice lesson plan for teachers (e.g., [BlueMinds4Teachers](#)). Questionnaires are given to pupils before and after the intervention to measure the impact of the Ocean Literacy activities on their knowledge, attitudes, behaviour, and emotions. Finally, this study area will be developed into an [Educational Marine Area](#) under the European project [BlueLightS](#), where school students will manage a coastal maritime zone through a participatory approach, involving them in a citizen action project to protect the marine environment.

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## 20.4 Bridging Science and Education: The Role of Ocean Literacy and Interactive Learning in Climate Awareness

One of the objectives of Ocean Literacy is to reach people of all ages and social backgrounds, simplifying scientific concepts and making them captivating and understandable for the general public. A common, universally accessible language has always been visual. For this reason, many modern and ancient authors use images as a tool to convey scientific ideas and discoveries. Since its origins, science has placed images at the centre of its communication processes—using

drawings, diagrams, and later, photographs, satellite images, and maps.

The Italian National Institute of Geophysics and Volcanology (INGV), through the MACMAP, *A Multidisciplinary Analysis of Climate change indicators in the Mediterranean And Polar regions*, project, has performed a multidisciplinary analysis of climate change indicators in these regions, with an emphasis on outreach activities to engage the public with both the research process and the issues being addressed. One of the project's work packages aims to retrieve Oceanographic data from historical books, focusing on one of the earliest volumes dedicated to Oceanography: *Histoire physique de la mer*, an Oceanographic treatise on the Gulf of Lion published in 1725 by Luigi Ferdinando Marsili, which includes 40 illustrated plates (Fig. 20.5).

Historical books are a priceless heritage, containing information that is often forgotten. Data from Marsili's book, such as water density measurements collected at various geographic locations in the Gulf of Lyon between 1706 and 1707, were converted into modern units and mapped with precise coordinates for comparison with current data (Locritani and Garvani 2024). Additionally, sea level data collected at the Port of Cassis in 1707 were transformed into M2 tidal amplitude and compared with current measurements (Locritani et al. 2024) (Fig. 20.6).

Given the central role of images in science and the interdisciplinary scope of the MACMAP project, a series of outreach initiatives was developed to engage students. One such activity involved designing an educational-scientific game (Fig. 20.7) to illustrate the project's value, its multidisciplinary approach, and the role of imagery in scientific communication.

The game covers both historical and scientific topics addressed in the MACMAP project. Its strategies and objectives are designed to immerse players in the scientific research process, highlighting both the fascination of the studies and the challenges faced. In the game, players act as



**Fig. 20.5** The title page of the historical volume “Histoire physique de la mer” by Luigi Ferdinando Marsili (1725) and some of the plates illustrated by him, which feature images of algae and corals. The volume contains 40 illus-

trated plates and 12 maps and tables. This evidence demonstrates that even in the eighteenth century, visual language was a significant aspect of scientific discourse

**Fig. 20.6** A map of the Gulf of Lyon (Northwest Mediterranean Sea) from “Histoire physique de la mer” by Luigi Ferdinando Marsili (1725), illustrating early bathymetric profiles that delimited the continental shelf (approx., 100 m)



researchers involved in the MACMAP project, each working on a specific work package such as management, observations, modelling, or historical data analysis. The game is won if all participants achieve their work package objectives within a set deadline (timeline in Fig. 20.7c).

However, if even one player fails to meet their objectives, the project fails, making the game both cooperative and competitive, simulating real scientific collaboration.

INGV has extensive experience in creating such games (Locritani et al. 2017; Locritani



**Fig. 20.7** The elements of the game: (a) Game tokens, (b) Game dice, (c) Timeline, (d) Work package cards, (e) Game sheets, (f) Playing card front, (g) Playing card back, (h) Gameboard. Credit: INGV

**Fig. 20.8** First game test during World Ocean Day 2024 in La Spezia, Italy, involving students from Centro Barontini. Credit: INGV



et al. 2020; Locritani et al. 2024; Locritani and Garvani 2020). However, this project is unique in involving high school students (aged 15–18) in the game’s design, supervised by their science, physics, and art teachers from two schools: Parentucelli High School in Sarzana, La Spezia, Italy, and Caravillani High School in Rome, Italy, collaborating with two research centres in Italy (INGV and CNR-ISMAR). The rules, strat-

egies, scientific and historical content, and illustrations were developed during the 2022–2023 and 2023–2024 school years. During World Ocean Day 2024 (Fig. 20.8) and Lucca Comics 2024, the game’s draft version was tested to identify potential errors and improve the gameplay.

Approximately 50 students played with the game in different sessions and suggested

reducing random actions (such as dice rolls) and theoretical components (such as questions) and including practical activities. These play sessions revealed that students aged 12–14 were the most engaged. The final version will be made available for download (online, printable at home on paper or cardboard via the INGV website), and printed in a larger format for use at temporary exhibitions, educational workshops, school open days, science festivals, and other events.

## 20.5 Summer Schools: An Effective Tool to Increase Ocean Literacy

AZTI is a science and technology centre in Spain specializing in marine and food research and innovation, with the goal of driving positive change for the future of humankind and contributing to a healthy, sustainable, and fair society. This includes a strong focus on Ocean Literacy, ensuring that outputs and developments are communicated to key stakeholders and end-users, including the general public, consumers, blue economic sectors, the scientific community, and regulators/decision-makers.

AZTI Summer Schools began in 2004 as a tool for sharing and exchanging knowledge on cutting-edge Ocean-related topics with these stakeholders and end-users. They also aim to promote engagement and professional careers in the field, support knowledge-based decision-making, and ultimately generate social change (in behaviour, research practices, regulations, etc.).

Summer schools are defined as “courses of lectures held during school and university summer vacations, taken as part of an academic course or as an independent course of study for professional or personal purposes” (Oxford Dictionary). While they are often considered academic activities, if carefully designed, they can serve as more than just tools for providing knowledge. They can also be means to network, engage, enjoy, and foster change.

Over the last two decades, AZTI has organized an annual Summer School covering a wide

range of marine-related topics, reflecting the diversity of challenges and innovations in the field. Themes have ranged from climate change and invasive species to genomic tools and the restoration of marine systems. In recent years, the focus has shifted to topics such as Ocean health and human health, multiple pressures at sea, and ecosystem services. More current themes emphasize science communication, Ocean optimism, and the role of monitoring in sustainable decision-making. These courses have consistently combined scientific content with cultural events. However, over the past decade, the content has evolved from a primarily theoretical approach to a more participative and interactive format, enhancing their effectiveness in fostering dialogue and understanding.

Each Summer School edition gathers 50–60 participants from 18–20 different countries worldwide and has reached more than 1000 people (primarily from Europe, but also from America, Africa, and Asia) since the initiative began. Furthermore, it is a collaborative effort involving European projects, with 8–12 trainers from 2–5 different institutions participating each year (over 70 entities in total), facilitating a high level of knowledge exchange, engagement, and dissemination worldwide. Yet, this is not the only success of the Summer School initiative.

In 2024, AZTI organized its 20th Summer School edition under the theme *Communicating Marine Science for an Informed Society and Decision-Making*, aiming to support scientists in enhancing Ocean Literacy across society in various roles (e.g., consumers, professionals, decision-makers). Also in 2024, the EU4Ocean Coalition awarded this Summer School initiative the MakeEUBlue Award for the best Ocean Literacy initiative organized by a research organisation.

AZTI’s Summer Schools continue with the 2025 edition focusing on the topic *Artificial Intelligence and Citizen Science in Marine Research* (Fig. 20.9).

Summer schools are just one of many Ocean Literacy initiatives in which AZTI is involved. The organisation is developing innovative ways to increase Ocean Literacy, such as co-



**Fig. 20.9** AZTI Summer School 2023. Credit: AZTI



**Fig. 20.10** European Rubik's Championship where the *Ocean Cube* has been used as a tool to increase Ocean Literacy. Credit: AZTI

developing marine board games, collaborating with Science Crunchers to create marine educational modules, and introducing the *Ocean Cube*, developed as part of the European Union GES4SEAS project. More than 400 *Ocean Cubes* have been distributed globally, serving as a tool to explain six key topics in marine management: (i) Healthy Ocean for healthy societies; (ii) Pressures in the marine environment:

1 + 1 is not always 2; (iii) Good environmental status: what it is and how it can affect your life; (iv) Tipping points: why it is best not to reach them; (v) Ecosystem-based management: managing the whole and not the hole; (vi) Ocean optimism: hope for the Ocean and societies. The *Ocean Cube* has been widely used to enhance Ocean Literacy among various audiences and sectors of society (Fig. 20.10).

## 20.6 Engaging Schools and Citizens in Their Relationship with the Mediterranean Sea

The Italian National Institute for Environmental Protection and Research (ISPRA) focuses its Ocean Literacy activities on enhancing scientific knowledge of the Mediterranean Sea. ISPRA employs a variety of communication tools such as exhibitions, videos, booklets, awareness events, and interactive dialogues with pupils, students, citizens, and stakeholders. These initiatives help convey scientific experiences to promote better understanding and protection of the Mediterranean Sea, fostering greater public responsibility for its valuable resources and ecosystem services.

Each year, several educational programmes are carried out, involving primary (6–11 years) and secondary (12–14 years) school pupils, as well as general awareness campaigns aimed at the broader public. ISPRA’s researchers focus on key topics and threats to Mediterranean ecosystems and biodiversity, such as marine litter, coastal erosion, land-sea pollution, and climate change, along with their impacts on marine organisms and coastal ecosystems. These activities help explain the importance of Mediterranean flora and fauna and their ecosystem services, which protect marine and coastal environments while supporting a sustainable blue economy.

To raise awareness of the importance of *Posidonia Oceanica*, a protected species crucial to the Mediterranean ecosystem that acts as a natural defence against storm surges and coastal erosion when deposited on beaches, ISPRA released a cartoon titled *Banquette to the Rescue* (Fig. 20.11). The cartoon explains the role of *Posidonia* meadows and banquettes in coastal protection (Pisapia et al. 2019). This resource was shared with 250 pupils and made available on ISPRA’s website for further viewing.



**Fig. 20.11** ISPRA comic book “Banquette Alla Riscossa!” addressing the importance of *Posidonia Oceanica* for beach protection. Credit: ISPRA

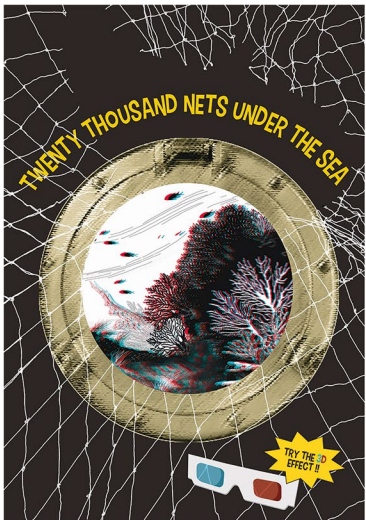
To illustrate the impact of marine litter, ISPRA published widely circulated comics. *Carrie – a Brave Turtle in a Changing World* tells the story of Carrie navigating the plastic-polluted sea (Fig. 20.12) (Matiddi et al. 2021), while *Twenty Thousand Nets under the Sea* (Fig. 20.13) addresses the issue of marine litter, focusing attention on its impacts on marine organisms and ecosystems (Pisapia et al. 2023). It also depicts positive actions achieved through collaboration between researchers and fishers aimed at mitigating the problem.

The environmental education project *Mare Nostrum: Let’s Discover the Mediterranean Sea Together* engaged 250 primary school pupils (6–11 years) and focused on three main themes: research at sea, life at sea, and marine environment protection. Pupils learnt about the organisms living in the Mediterranean Sea, the Ocean’s importance for our lives, and various aspects of Mediterranean marine research. The project showcased the use of research vessels and under-



**Fig. 20.12** ISPRAs comics. *Left*: “Carrie—A Brave Turtle in a Changing World,” which tells the story of a sea turtle’s adventures in a polluted sea. *Right*: Exhibition of

the comic story Carrie presented during ISPRAs annual event “Science Together”. Credit: Marco Pisapia—ISPRAs



**Fig. 20.13** ISPRAs 3D comic book “Twenty Thousand Nets under the Sea”. *Left*: The book cover; *Right*: Exhibition of the comic book presented during ISPRAs annual event “Science Together”. Credit: Marco Pisapia—ISPRAs

water scientific equipment, like Remotely Operated Vehicles (ROVs), and included a practical activity where pupils built their own cardboard ROVs (Fig. 20.14). A book was developed to complement this activity, titled *Let’s Go Down to the Bottom of the Sea: Travelling with an Underwater Robot* (Giusti et al. 2021), narrating the adventures of Pollux, an underwater robot, as

it explores the Mediterranean seabed. This book, aimed primarily at children but accessible to all, communicates marine research in an engaging and straightforward way.

Through these initiatives, ISPRAs successfully bridges scientific research with public awareness, engaging citizens and pupils (around 2150 in 2023 and 2024) in protecting the Mediterranean



**Fig. 20.14** *Left:* ISPRA book “Let’s Go Down to the Bottom of the Sea: Travelling with an Underwater Robot”. *Right:* Cardboard game of the Remotely Operated Vehicle (ROV) “Pollux” build by pupils. Credit: ISPRA

Sea and fostering a deeper understanding of Mediterranean marine ecosystems and their sustainable management.

### 20.7 Interactive Touchscreen Consoles: A Technology-Based Ocean Literacy Tool for Engaging Audiences

While Ocean Literacy activities have traditionally involved in-person interactions with school-aged children and the general public, the Norwegian Institute for Water Research (NIVA) has broadened its audience with interactive touchscreen consoles, reaching passengers on ships and visitors to science museums and national parks. For direct engagement, NIVA has partnered with local initiatives, involving children in hands-on activities focused on human impacts on the Ocean. Through collaborations with cruise companies, NIVA has also been providing Ocean Literacy experiences in the form of interactive demonstrations and presentations on Color Line, Hurtigruten, and Viking cruise ships.

The interactive touchscreen consoles have been a key Ocean Literacy tool for NIVA over the past 7 years. Initially developed through the European ResponsSEable project (2015–2019; Grant no. 652643), the consoles feature a graphical user interface designed for touch-

screens ranging from approximately 20 to over 50 inches. The Ocean Literacy content has been continuously updated and expanded, with translations into six languages: English, German, Norwegian, French, Spanish, Polish, and Russian. This development has been supported by several European Union projects, including INTAROS (2016–2022; Grant no. 727890) and JERICO-S3 (2020–2024; Grant no. 871153), as well as the Research Council of Norway’s SATVIEW project (2021–2022; Grant no. 322714).

The consoles offer two main modules of Ocean Literacy content. The first, *Key Ocean Literacy Stories*, focuses on human impacts and Ocean-related issues, including pollution, over-fishing, eutrophication, renewable Ocean technologies, invasive species, and coastal tourism. This content is presented through videos (live-action and animated), photos, data plots, text, and a simple video game. Although designed with school-aged children in mind, it also appeals to adults. The second module, *Ocean Data Products and Near-Real-Time Observations*, includes an interactive global viewer of Ocean surface temperature, salinity, currents, and ice cover using data from the European Copernicus programme and the US National Oceanic and Atmospheric Administration (NOAA). It also features an interactive viewer for satellite remote sensing products in European seas and near real-time data

from NIVA's FerryBoxes—automated systems installed on ferries and ships that collect Ocean data, such as temperature, salinity, and water quality, while the vessels are traveling their regular routes. Users can view measurement locations on a map and access time-variable plots, along with short descriptions of key Ocean variables and their societal importance.

The interactive touchscreen consoles have significantly helped NIVA make complex Ocean-related topics more accessible and engaging for a broad audience. Installed in high-traffic locations, these consoles reach thousands of users each month, promoting awareness of critical issues like pollution, overfishing, and climate change. Viewing statistics, assuming two viewers per interaction, averaged 4387 views per month on a Color Line ship and 3820 views per month on a Hurtigruten cruise ship over a three-month period. During this same period, content was accessed in German (44%), Norwegian (25%), English (19%), and French (12%), with Spanish, Polish, and Russian translations not yet implemented. By combining interactive tools, real-time data, videos, and educational games, the consoles effectively engage both children and adults, deepening their understanding of human impacts on the Ocean. Continuous feedback from user interviews and surveys further refines the content, ensuring it resonates with diverse audiences and strengthens their connection to Ocean knowledge and conservation (Fig. 20.15).

**Fig. 20.15** Touchscreen console on MS *Roald Amundsen* displaying near real-time data from FerryBox ship of opportunity observations. Credit: Kai Sørensen



## 20.8 Engaging Future Generations: A Commitment to Marine Science Education and Ocean Conservation

The Institute of Oceanography and Fisheries (IOR) in Croatia has a long-standing commitment to educating new generations of marine biologists and popularizing marine science among diverse audiences. A dedicated group of scientists at the institute actively engages in science communication, targeting various demographics through multiple channels. This approach enables the broad dissemination of marine knowledge, with scientists tailoring their methods to focus on youth, the general public, or media.

Recently, IOR has implemented several projects specifically aimed at science popularisation. Two notable initiatives are the *Blue-connect* and *Blue-connect 2.0* projects, in which IOR is a partner, and the *More budućnosti (Future Sea)* project, which is exclusively managed by IOR. Over the past two and a half years, IOR scientists have organized a wide range of activities, including lectures and workshops in schools and kindergartens, on-site institute tours, exhibitions, culinary workshops, and more. Between 2022 and 2024, these two projects alone facilitated over 100 activities, engaging approximately 2500 children, young people, and their teachers across Croatia. These activities are vital, as formal education often lacks comprehensive coverage of

key Ocean Literacy principles and concepts (Ezgeta-Balić and Balić 2024).

Under the motto “I Explore,” as part of the *Blue-connect* project, IOR scientists participated in the European Researchers’ Night in 2022, 2023, and 2024, bringing Ocean-related topics closer to the public in the city centre of Split (Fig. 20.16). In addition to the main events, IOR conducted numerous workshops, such as *Marine Diaries—Bivalve Shells and Their Secrets*, *Life Under the Surface*, *Marine Litter Art*, and *Life in a Drop of Water*. A culinary workshop, *Small Pelagic Fish in Gastronomy*, was organized in collaboration with a professional chef, where students prepared healthy dishes and learned about the benefits of seafood. Moreover, in collaboration with an art school, an exhibition titled *Earth without Ocean* was held, where students created sculptures from waste materials, presenting a dystopian vision of a sea-less Earth to raise awareness about the Ocean’s importance. Various creative approaches were used to engage children and youth in Ocean-related topics, with most activities focused on Split, Croatia’s second-largest city, and its surroundings.

In contrast, the *Future Sea* project emerged from the recognition that children in rural areas and smaller towns have fewer opportunities to

engage with marine science compared to their urban counterparts. To address this disparity, the project aimed to enhance Ocean Literacy among primary school students in underserved areas along the Adriatic coast and inland Croatia. These workshops covered various aspects of Ocean conservation, including the importance of a healthy Ocean, environmental changes, and necessary conservation actions (Fig. 20.17).

An interesting aspect of this project was the series of workshops conducted in small, remote schools with only five to ten students. Although the reach of these workshops was relatively limited, their impact was significant, fostering inclusivity and engagement in these isolated areas. Students from inland schools, many of whom had never seen the sea, expressed amazement as they discovered the Ocean’s profound impact on their lives.

In total, more than 45 workshops were organized at 25 primary schools across Croatia in 1 year. The project culminated in a creative exhibition featuring over 140 student works during European Researchers’ Night in Split in 2023 and the publication of *The Ocean in Our Hands: A Guide to Ocean Literacy* in Croatian (Fig. 20.18). The *Future Sea* project has gained both local and national recognition as a platform



**Fig. 20.16** Presentation of the Institute of Oceanography and Fisheries at European Researchers’ Night in Split under the theme *I Explore....* The event featured interactive presentations, games, and educational materials developed by IOR scientists. Part of the Reconnecting

Science with the Blue Society—*Blue-connect 2.0* project, funded by the European Union’s HORIZON-MSCA-2023-CITIZENS-01 programme. Credits: IOR and CROPIX



**Fig. 20.17** Workshops in schools held as part of the project *More budućnosti (Future Sea)*, funded by the Adris Foundation. During the workshops, pupils explored topics such as plankton, shellfish, and diving through virtual real-

ity after a brief presentation. Students created Ocean-inspired artwork, which was exhibited during European Researchers’ Night 2023 in Split. Credit: IOR



**Fig. 20.18** Ocean Literacy resources developed through the “Blue-connect” and “Future Sea” projects for Croatian teachers and pupils. *Left*: A guide outlining key Ocean Literacy principles and concepts for teachers, including ideas for hands-on experiments. *Middle*: An educational

classroom poster explaining the main Ocean Literacy principles. *Right*: An illustrated picture book created with contributions from children at the Rusulica kindergarten. All resources are freely available in Croatian at [www.futuresea.eu](http://www.futuresea.eu)

for spreading marine knowledge among students and teachers, facilitating information exchange.

Through these diverse initiatives, the Institute continues to play an important role in educating the public about marine science and fostering a deeper understanding of Ocean conservation across various demographics in Croatia.

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## 20.9 Accessibility as a Key Enabler Towards More Effective Scientific Dissemination

The Ocean is a fundamental resource for all living beings. For humans, it serves as a social, economic, political, and linguistic connector, as well as an aesthetic and physical one, covering more than 70% of our planet. Today, global challenges highlight the complexity of the Ocean in terms of environmental variables, stakeholders, governance, and economic assets. Complex systems are often unpredictable, with rapid changes occurring faster than our ability to adapt or control them. In this context, scientists, policymakers, and the general public must collaborate to assess the impact of human activities on the Ocean and achieve sustainable resource management.

Additionally, the overwhelming influx of data and news adds further complexity to a chaotic global scenario where science is increasingly called upon to support policy decisions and effective solutions. Dissemination and scientific communication are crucial enablers in this process and statutory missions of many research institutions, such as the National Research Council of Italy (CNR). CNR promotes, enhances, and applies research results while contributing to the transfer of knowledge to society.

Effective science dissemination, communication, and education, particularly when developed with a long-term strategy, play a crucial role in transferring research-derived knowledge to the public, especially younger generations. By providing access to information and knowledge, these tools empower individuals to participate in the global debate and reconnect with the environment.

The growing interest in environmental issues, climate change, and their evident effects on daily life has placed increased pressure on scientists to

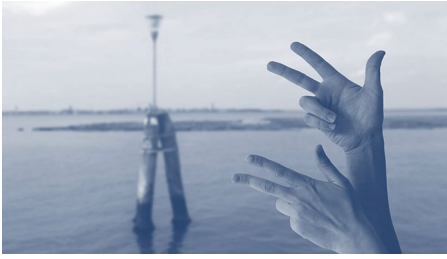
disseminate their findings promptly and respond to inquiries from the media, citizens, and institutions. Furthermore, the complexity of these issues necessitates collaboration with professionals from other sectors to combine expertise, perspectives, and skills, ensuring initiatives are impactful.

Developing accessible products and collaborative, co-designed initiatives is essential to effectively disseminate knowledge and ensure inclusiveness across diverse audiences without losing meaning or content. A notable example is *Abecedarium: The Ocean in Sign Language*, a long-term participatory project launched in 2020 by Ocean Space and CNR-Institute of Marine Sciences, in collaboration with ENS-Ente Nazionale Sordi ONLUS (The Italian National Agency for the Deaf) and CNR-Institute of Cognitive Sciences and Technologies.

The project aims to create an eco-glossary in Italian Sign Language (LIS) on environmental and marine-related issues through a participatory process involving the deaf community. The initiative reflects the urgency of making scientific communication and Ocean Literacy accessible to all, adopting a multidisciplinary and multisensory approach that enables engagement beyond national boundaries.

The project has benefited from contributions across various disciplines, offering diverse perspectives and encouraging critical reflection. By fostering dialogue between the deaf community and Ocean scientists to develop a shared and recognized LIS vocabulary for Ocean-related terms, *Abecedarium* leveraged digital media during the pandemic to connect participants from different regions and backgrounds, incorporating their Ocean experiences and knowledge. Participants engaged in 15 training sessions led by scientists, artists, and architects, exploring issues related to Ocean preservation and focusing on the linguistic refinement of existing and known signs for marine concepts.

*Abecedarium* contributes to the development of educational resources that prioritize accessibility and inclusion. Originating within the deaf community and employing an artistic and aesthetic approach, it addresses the needs of a broader audience while offering valuable insights to scientists. Art and culture possess transformative power, inspiring individuals to reconnect



**Fig. 20.19** *Abecedarium*. Credit: Ocean Space and CNR-Institute of Marine Sciences

with nature and deepen their commitment to its preservation. The project also explores the interplay between nature and language, uncovering the contradictions that emerge from their interaction (Fig. 20.19).

## 20.10 Conclusion

The key recommendations from the introduction are vividly reflected in the diverse European initiatives showcased throughout the chapter. These efforts demonstrate the vital role that scientific institutions play in promoting a deeper understanding of the Ocean's significance in shaping our environment and sustainable future.

Ocean Literacy is a critical tool for translating scientific research into societal impact, especially when embedded within research institutions. As global challenges like climate breakdown, pollution, and resource management demand urgent solutions, scientific institutions must bridge the gap between Ocean science and society. Through Ocean Literacy initiatives, they transform complex data into accessible knowledge, fostering informed decision-making among the public, policymakers, and stakeholders. This shift from purely academic research to socially engaged science underscores the importance of integrating Ocean Literacy into the core missions of scientific organisations.

The case studies presented in this chapter illustrate how European research institutions are

leading by example. AZTI's Summer Schools provide a platform for exchanging Ocean knowledge among scientists, policymakers, and professionals, encouraging informed societal actions. HCMR in Greece combines scientific research with community-based marine conservation, directly involving schools, local authorities, and fishers in Ocean Literacy activities. The MACMAP project in Italy empowers high school students to co-design educational games, fostering experiential learning. Meanwhile, ISPRA demonstrates how creative outreach tools such as comics and ROV-building workshops, effectively communicate marine science to diverse audiences. NIVA in Norway leverages technology through interactive touchscreen consoles, offering real-time Ocean data to audiences in high-traffic locations and enhancing public engagement with marine science.

The importance of sustained funding and resources is another key takeaway. Scaling and sustaining such initiatives require adequate financial and institutional support. Many Ocean Literacy activities currently depend on short-term project funding, posing significant challenges to their long-term continuity and impact. Expanding and diversifying resources for Ocean Literacy will be critical to broadening societal reach and ensuring lasting impact, enabling initiatives to thrive beyond the limitations of temporary funding cycles.

Ocean Literacy activities serve to increase the visibility and relevance of marine science in everyday life. By collaborating with sectors like art and education, as exemplified by the *MareDireFare* Festival in Italy, scientific institutions extend the cultural footprint of Ocean Literacy, making marine science more accessible and inspiring to broad audiences. These interdisciplinary collaborations transcend traditional academic boundaries, promoting creativity and inclusivity.

The chapter's initiatives further emphasize the need for inclusivity in Ocean Literacy efforts. Projects like *Abecedarium* in Italy, which creates a marine-related sign language eco-glossary for the

deaf community, and *Future Sea* in Croatia, which focuses on underserved rural communities, ensure that Ocean Literacy reaches a broader audience. Such initiatives foster inclusive dialogues and equitable access to marine education, making sure that all groups, regardless of physical, social, or geographic barriers, can engage with Ocean science.

These case studies underscore the transformative role scientific institutions play in advancing Ocean Literacy and fostering sustainable Ocean stewardship. By embedding Ocean Literacy into their core activities, institutions contribute to the UN Ocean Decade's challenges and the 17 Sustainable Development Goals of Agenda 2030. They bring critical Ocean issues to the attention of policymakers and empower society to take informed, responsible actions, recognizing that the Ocean's future is intrinsically tied to our own. This alignment of scientific research with public engagement is essential for building an Ocean-conscious society, driving meaningful change, and supporting the long-term sustainability of Ocean ecosystems on both regional and global scales.

### 20.10.1 Summary

Key concepts explored in this chapter include:

- Bridging science and society. Ocean Literacy helps turn marine science into knowledge that drives policy and public action. It is essential for informed decision-making and sustainability.
- Art and science working together. The *MareDireFare* Festival of the National Institute of Oceanography and Applied Geophysics (OGS) blends creativity with research, using art to make Ocean topics more engaging and accessible.
- Hands-on learning inspires action. The Hellenic Centre for Marine Research (HCMR) connects the public with marine conservation efforts through interactive experiences, sparking respect and action for our Ocean.
- Learning through games and visuals. Istituto Nazionale di Geofisica e Vulcanologia (INGV) makes Ocean and climate science fun and interactive, inviting young people learn through engaging games and co-design.
- Summer schools as hubs of Ocean knowledge. AZTI's summer schools bring together experts and learners of all ages, offering immersive experiences that explore key marine issues and build capacity.
- Connecting people to the sea. The Italian National Institute for Environmental Protection and Research (ISPRA) raises awareness about the Mediterranean Sea ecosystems using comics, games, and interactive exhibits.
- Technology bringing Ocean Literacy to new spaces. The Norwegian Institute for Water Research (NIVA) uses touchscreen consoles in ferries, cruise ships, parks, and museums, providing real-time Ocean data to thousands of visitors.
- Inspiring future marine scientists. The Institute of Oceanography and Fisheries (IOR) engages students in both coastal and inland areas, making marine science exciting and accessible through hands-on activities.
- Making Ocean Literacy truly inclusive. The National Research Council of Italy's *Abecedarium* project breaks barriers by creating Ocean Literacy resources in sign language, showing how inclusion can empower everyone to engage in Ocean sustainability.
- A roadmap for stronger Ocean Literacy. EuroGOOS outlines eight key recommendations to align Oceanographic research with societal needs, driving sustainable behaviours, improved observations, and science-based solutions. Through the *Scientists for Ocean Literacy* project, European initiatives are working together to turn Ocean knowledge into action.

## 20.10.2 Recommended Resources

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

- Blue-connect and [Blue-connect 2.0](https://jaistrazujem.hr/) projects: <https://jaistrazujem.hr/>
- [BlueLightS](https://blue-lights.eu/) project: <https://blue-lights.eu/>
- [BlueMinds4Teachers](https://maritime-forum.ec.europa.eu/empowering-teachers-trainer-network-european-blue-schools_en): [https://maritime-forum.ec.europa.eu/empowering-teachers-trainer-network-european-blue-schools\\_en](https://maritime-forum.ec.europa.eu/empowering-teachers-trainer-network-european-blue-schools_en)
- [BlueS\\_Med](https://www.blueschoolsmed.eu/) project: <https://www.blueschoolsmed.eu/>
- EuroGOOS Scientists for Ocean Literacy project: <https://eurogoos.eu/Ocean-literacy/>
- EuroGOOS Ocean Literacy resources library: <https://eurogoos.eu/Ocean-literacy-resources/>
- GES4SEAS Ocean Cube: <https://www.youtube.com/watch?v=E7qFN2AxIdY>
- GES4SEAS project “Achieving Good Environmental Status for maintaining ecosystem services by assessing integrated impacts of cumulative pressures”: <https://www.ges4seas.eu/>
- MED EDUC project: <https://www.mededuc.eu/en/>
- Mediterranean Sea Literacy: <https://www.emseanet.eu/fins-water-library>
- [More budućnosti](https://futuresea.eu/) (Future Sea) project: <https://futuresea.eu/>
- [ResponSEable](https://responseable.acteon-environment.eu/) project: <https://responseable.acteon-environment.eu/>

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<sup>3</sup>Ángel Borja: Writing—Original Draft, Review, and Editing.

<sup>4</sup>Donata Canu: Co-conceptualization, Writing—Original Draft, Review, and Editing.

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<sup>6</sup>Elena Giusta: Writing—Original Draft, Review, and Editing.

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