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Contribution to the Special Issue: "Ocean Literacy across the Mediterranean Sea region"

The Rise and Fall of the Tide: Ocean Literacy in the United States

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Abstract

The words "Ocean Literacy" roll off the multilingual tongues of scientists, educators, and policy makers worldwide who understand the essential role of the ocean on this planet. However, this was not always the case. The Ocean Literacy campaign in the United States (US) was founded by individuals and institutions focused on raising awareness of the influence of the one global ocean on every living being on the planet. The original grassroots effort became a well-funded, well-organized campaign that spawned global initiatives that thrive to this day. Faced with a lack of critical resources, the US campaign currently relies on the services of dedicated members of the National Marine Educators Association (NMEA) whose vision of making known the world of water is part of their collective DNA.

Keywords: Ocean literacy; marine education; UN Decade of the Ocean.

Introduction

The Ocean Literacy campaign in Europe and beyond is based on the foundation designed and developed by individuals and organizations in the United States over a span of twenty years. This paper provides a brief history of the efforts, connecting them to recent developments in Europe and across the globe.

Defining Ocean Literacy and the origin of the Ocean Literacy campaign

The definition of Ocean Literacy, as well as the Essential Principles and supporting Fundamental Concepts, were developed through a grassroots, community-wide consensus-building process that established agreement among hundreds of scientists, educators, and policy makers. The resulting framework articulates what every person should understand about the ocean to develop an ocean-literate society (Schoedinger *et al*., 2010) (Fig. 1).

The roots of the Ocean Literacy campaign can be traced back to a few pivotal events: an in-person workshop in May 2000, sponsored by the National Science Foundation (NSF) to establish the Center for Ocean Sciences Education Excellence (COSEE), and a virtual workshop that took place over three weeks in 2004. The COSEE workshop report recommended the establishment of a nationally coordinated program with regional Centers (McManus *et al*., 2000). The virtual asynchronous workshop, sponsored by the National Geographic Society (NGS), brought together scientists and educators from across the United States to share ideas about what important concepts everyone should know about the ocean (Cava *et al*., 2005). The key concepts generated during the virtual workshop were later organized into the seven essential principles and the underlying concepts that support them (Cava *et al*., 2005). Around the same time, both the Pew Oceans Commission (2003) and the U.S. Commission on Ocean Policy [Commission] (2004) released reports noting, among other observations, Americans knew very little about the ocean. The Commission report specifically called for increased ocean education as a critical component of ocean policy moving forward. The question was how to do it.

The Commission report dedicated an entire chapter (Chapter 8: Promoting Lifelong Ocean Education; U.S. Commission on Ocean Policy, 2004)), specifically recognizing the NSF-funded COSEE and the National Sea Grant College Program (Sea Grant) as "ocean education

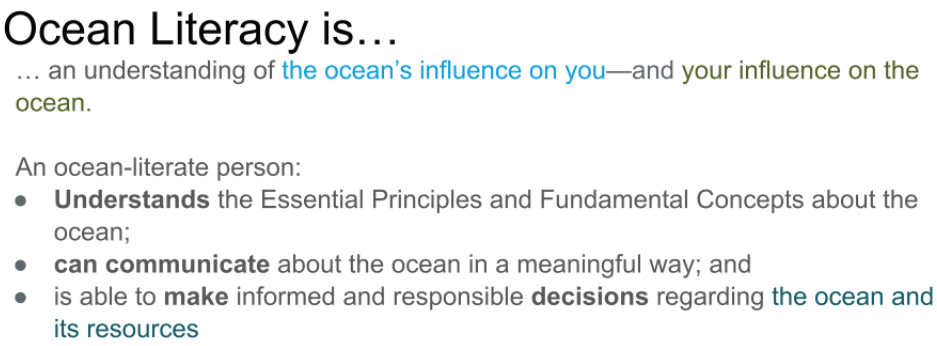

Fig. 1: Defining Ocean Literacy.

programs of particular importance" (p.124). The authors of the report concluded that these programs, with other federal agencies, state departments of education, local school districts, informal education institutions (e.g., aquariums, zoos, museums), and professional societies (i.e., the National Marine Educators Association [NMEA] and National Science Teachers Association [NSTA]) could build a "collaborative ocean education network" (pp. 124-127). Seventeen recommendations were set forth in this chapter, including the establishment of a national ocean education office, a focus on increasing diversity, sustained funding for ocean education, and graduate education and workforce development. While the critical infrastructure recommendation (i.e., a national ocean education office) did not materialize, the ocean science education community worked together to take advantage of competitive funding opportunities through the establishment of COSEE and resultant partnerships.

Each original COSEE consisted of at least three partners - an ocean science research institution, a formal education institution, and an informal education institution. The first seven Centers and a National Coordinating Office were established in the fall of 2002, and three new Centers were added in 2004 (COSEE program solicitation, 2010). Most Centers included Sea Grant as a partner, and many required additional financial resources to operate at full capacity. Centers featured partnerships that brought disparate expertise together and provided backbone support for collective impact through sustained funding, personnel, and institutional capacity over several years (Strang *et al*., 2007; Schoedinger *et al*., 2010). While the entire vision of the Commission report was not fulfilled, the Centers provided the partnerships and mechanisms necessary to develop and distribute what would become the components of the Ocean Literacy Framework.

In 2004, the National Oceanic and Atmospheric Association (NOAA), the NSF-funded COSEE, NGS, NMEA, the College of Exploration, and the Lawrence Hall of Science, University of California Berkeley convened a series of meetings to define the most important ideas people should understand about the ocean. The meetings resulted in the seminal document, *Ocean Literacy: The Essential Principles of Ocean Sciences K–12*, originally published in 2005, and updated in 2013 and most recently in 2020. Now known as *Ocean Literacy: The Essential Principles of Ocean Sciences for All Audiences*, or simply the Guide, its original intent was to address the lack of ocean science content in American national and state science standards which frame curriculum, instruction, and assessment for public schools. The Guide influenced other groups and disciplines and became a model for additional "literacy guides" including climate, Earth science, and later the Great Lakes and Mediterranean Sea. The Guide in and of itself was not enough to improve Ocean Literacy. The Ocean Literacy community developed additional tools, collectively called the Ocean Literacy Framework, to facilitate the process.

The Ocean Literacy framework

Understanding the ocean is essential to protecting this planet on which we live. The challenge was to provide tools, resources, and multiple opportunities for learners and society at large to learn about the ocean and how we are inextricably interconnected to it, no matter where we are on Earth. Towards this end, the Guide (Fig. 2) became the centerpiece of the 4-part Ocean Literacy Framework:

- *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Science for Learners of All Ages (the Ocean Literacy Guide or the Guide)*
- *The Ocean Literacy Scope and Sequence for Grades K–12*
- *Alignment of Ocean Literacy to the Next Generation Science Standards*
- *The International Ocean Literacy Survey*

The Ocean Literacy Guide describes the essential

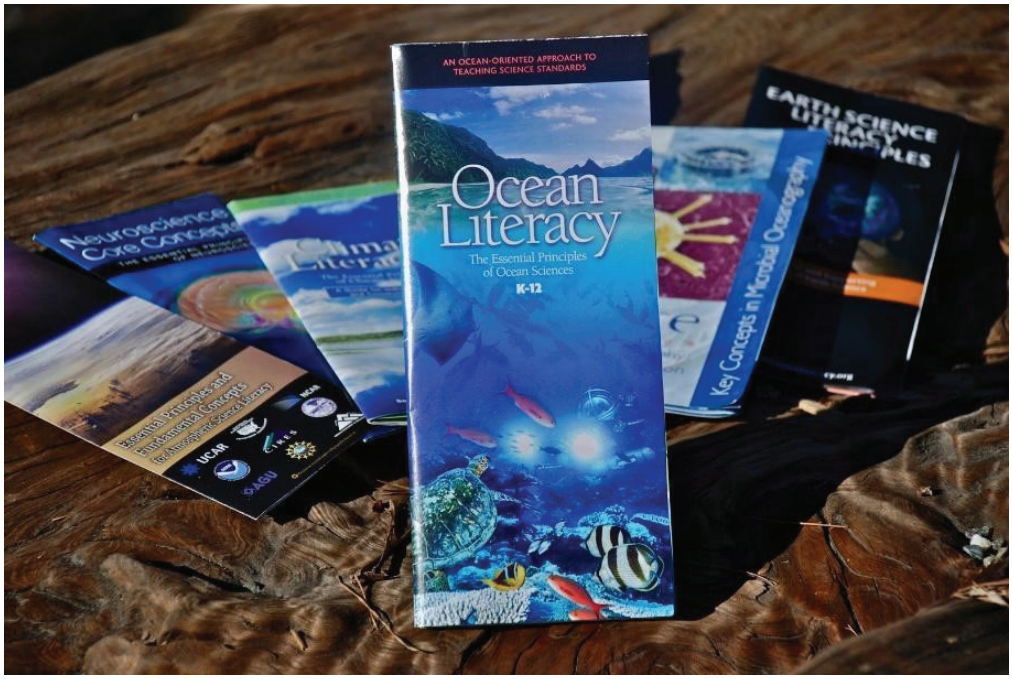

Fig. 2: Literacy Guides. Photo credit: C. Strang.

concepts an "ocean literate" person should know, yet provides no road map for how to get there. ***The Ocean Literacy Scope and Sequence for Grades K–12*** was developed with significant participation of hundreds of scientists and science educators. It provides specific guidance through a series of 28 conceptual flow diagrams that organize the ideas of the seven Ocean Literacy Principles into four grade bands, effectively showing what students should know at the end of 2nd, 5th, 8th, and 12th grade. It represents a community consensus regarding the essential ideas in ocean science that all learners should understand and provides specific guidance to help educators grow their learner's conceptual understanding of essential ocean concepts.

You can't be science literate without being ocean literate. The ***Alignment of Ocean Literacy to the Next Generation Science Standards*** provides evidence to prove that statement and tools to achieve it. This document details why teaching ocean concepts is integral and essential to achieving the learning vision of the Next Generation Science Standards (NGSS). In the United States, there is no national curriculum for science or any subject. Content standards are determined by each state. Curricular materials are adopted at the state or local level, depending on location. That said, the release of NGSS in 2013 created a shift in expectations for science teaching and learning. The standards themselves were based on the US National Research Council's "A Framework for Science Education," which was developed with input from scientists, educators, educational psychologists, and research on how people learn science. A draft of this framework was released prior to its final iteration and shared widely so individuals and organizations could share feedback and suggested edits. The ocean science education community, led by NMEA, analyzed the framework and submitted a coordinated response which included many more connections to the Essential Principles and Fundamental Concepts of Ocean Literacy. Some of these suggestions were incorporated in the final version of the framework; others were not. Since 2013, some states have explicitly adopted the NGSS while others created their own version. At this time, 46 states have either adopted or adapted the NGSS. Rather than a focus on rote facts and memorization, the NGSS requires educators to explore the "three-dimensional" view of science with students. The NGSS specify the three dimensions as the disciplinary core ideas (life science, Earth science, physical science, and engineering content and concepts); science and engineering practices; and cross cutting concepts (big ideas that pervade across science disciplines). Assessing mastery of the NGSS is quite complex, making implementation challenging for educators.

Intended for teachers, school leaders, informal educators, and curriculum developers, the Alignment of Ocean Literacy to NGSS document provides critical guidance about when and how ocean concepts should be strategically inserted into the K–12 science curriculum and can be used to influence state, district and school science implementation plans. This alignment is a necessary tool to focus attention on places in the NGSS where Ocean Literacy is essential to understanding the disciplinary core ideas but the connection may not be obvious. For example, in kindergarten, students learn about Earth and Human Activity, including being able to meet the NGSS performance expectation, "Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. [Clarification statement: Examples of relationships could include that deer eat buds and leaves, therefore they usually live in forested areas; and, grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system" (NGSS Lead States, 2013). The Ocean Literacy alignment document for grades K-2 notes that: *understanding the natural resources that liv-*

ing things need is not complete without knowing that life as we know it does not exist without water. Almost all the water on Earth is in the ocean, and the ocean provided and continues to provide water, oxygen, and nutrients needed for life to exist on Earth (see NMEA 2015, p. 3 for specific alignments).

The alignment document also provides strong justification and specific recommendations for educators to provide ocean science learning experiences to supplement traditional texts that don't adequately address ocean concepts.

Despite considerable investments in Ocean Literacy over the last 15 years, it is difficult to show progress of the Ocean Literacy campaign in part because no widely adopted measurement tool was developed when the Guide and Scope and Sequence were published. The need for a common shared measurement tool has been widely expressed by members of the Ocean Literacy community around the world to determine the impact of particular interventions, to establish a baseline of Ocean Literacy in particular communities, to detect changes in Ocean Literacy levels in communities over time, and to compare differences in levels of Ocean Literacy across communities. ***The International Ocean Literacy Survey (IOLS)*** was initiated in 2015 to address this challenge. The IOLS is a community-based measurement tool that allows the comparison of levels of ocean science knowledge among 15 to 17 year olds across time and location. It includes multiple choice questions addressing ideas about the ocean described in the Ocean Literacy Framework. IOLS went through four rounds of extensive field testing in 24 countries and 17 languages. Results provide evidence that IOLS is psychometrically valid and reliable and measures only one latent trait: Ocean Literacy (Fauville *et al*., 2019; Chen *et al*., 2020). This instrument, however, only measures one facet of ocean literacy -content knowledge. Numerous studies in environmental education have illustrated that improved content knowledge alone does not necessarily result in positive behavioral changes (McKinley & Burdon, 2020). When combined with other intermediary factors (i.e., awareness, attitude, intention, skills), content knowledge can be a behavior antecedent, although additional considerations (i.e., focus on local issues, partnerships, and action) are key to achieve conservation outcomes (Ardoin *et al*., 2020).

What started with modest seed funding from the National Geographic Society (NGS) for an online workshop blossomed into a full-fledged campaign due to the confluence of several factors in the mid-2000s. The NGS provided a model for NMEA, NGS, COSEE and NOAA to convene a workshop focused on defining Ocean Literacy and identifying the key ocean science concepts. NMEA signed on as an in-kind partner as it had already established an *ad hoc* committee to identify the ocean science concepts that should be in the US science education standards, should the opportunity arise to revise them. NOAA provided initial in-kind support because the US Commission on Ocean Policy recommended the government agency take a greater role in improving public Ocean Literacy. The linchpin in these efforts was the backbone support provided through the primarily NSF-funded COSEE network. From 2002 to 2015, NSF funded a total of 15 Centers and a National COSEE Office. The work was regionally or thematically focused but as a whole the network contributed financial and/or intellectual assets to develop the Ocean Literacy Guide, Scope and Sequence, and promote the use of the Framework components within the broader STEM community. This backbone support enabled other organizations and federal agencies to provide supplemental support for the continued use and promotion of the Ocean Literacy Framework. When the NSF-funding ended, much of the effort to further develop the Ocean Literacy Framework and promote it in the United States and abroad fell on the shoulders of a largely volunteer effort through NMEA's Ocean Literacy Committee, with modest funding provided by NOAA for smaller targeted projects.

The influence of the Ocean Literacy campaign

The Ocean Literacy Framework was created in an American context for use in the United States. Almost immediately, the idea of Ocean Literacy became the basis for meetings, conferences, and organizations. The International Pacific Marine Educators Network (IPMEN), formed in 2007, held its inaugural meeting in Honolulu, Hawaii, United States after the idea to form the group arose at an NMEA conference in 2005. The organization brings marine educators and scientists from around the Pacific Rim and seeks, "to become a leader in fostering the collaborative relationships that will lead to creation of resources, programs, training, and leadership necessary to build ocean literacy at every level of society in the Pacific region." (IPMEN, 2021)

In 2011, several marine education leaders from Europe attended the NMEA annual conference in Boston, Massachusetts. Three of these leaders, Evy Copejans, Fiona Crouch, and Géraldine Fauville founded the European Marine Science Educators Association (EMSEA), the first network in Europe dedicated to marine science education. EMSEA defines itself as a membership organization, explaining "...our shared vision is a society of Ocean Literate citizens who recognize the vital importance of the ocean, working together to ensure it is sustained for future generations" (EMSEA, 2021, About Us). Since its founding, EMSEA has served as an important connector of like-minded educators and others across Europe and beyond.

As EMSEA grew, Ocean Literacy efforts expanded in Europe and across the Atlantic. With support from the EMSEA leadership and other groups, the first European conference on Ocean Literacy was held in Bruges, Belgium in 2012. In 2013, the United States, European Union, and Canada signed the Galway Statement on Atlantic Ocean Cooperation which aimed to "align the resources of the three members to improve ocean health and stewardship, promote sustainable management of marine resources, and conserve biodiversity" (NOAA, 2018). The goal was to more tightly align research agen-

das and cooperation among the signatories. Ocean Literacy was explicitly noted: *"We further intend to promote our citizens' understanding of the Atlantic by promoting oceans [sic] literacy. We intend to show how results of ocean science and observation address pressing issues facing our citizens, the environment, and the world and to foster public understanding of the value of the Atlantic Ocean." (Galway Statement, 2013).*

The Atlantic Ocean Research Alliance (AORA) also formed to coordinate research efforts and is one of the working groups. Following the EMSEA 2013 Conference held in Plymouth, UK, a small group of marine education leaders from the three Galway Statement constituencies gathered for a Transatlantic Ocean Literacy meeting, seeking to set forth an Ocean Literacy agenda aligned with the Galway Statement initiatives. Additional Transatlantic Ocean Literacy meetings took place in 2014 (Gothenburg, Sweden) and 2015 (Copenhagen, Denmark).

Soon after, a flurry of international activity began. The Canadian Network for Ocean Education (CaNOE) formed in 2014 and has several goals including "Promoting Ocean Literacy in Canada" and "Celebrating and Sharing Current Efforts in Ocean Literacy" (Canadian Network for Ocean Education, 2014). After marine education leaders from several Asian nations met at a Global Ocean Science Education workshop and the 2015 NMEA Conference in Newport, Rhode Island, the Asia Marine Educators Association (AMEA) was formed. The organization hosted its first conference in Taiwan. The Korean Marine Educators Association, EMSEA-Med (Mediterranean subgroup), Ocean Literacy Italia, and Relato Oceano (a network of marine educators and organizations in Latin America and the Caribbean) also formed between 2016 and 2019.

In 2014, under the "Horizon 2020 initiative," the European Union (EU) funded two large, multinational projects aimed at increasing Ocean Literacy. These three-year projects were ambitious and collaborative, bringing together numerous partners and seeking to effect change in different sectors, including citizens, educators, businesses, and policymakers. In 2017, the Belem Statement on Atlantic Research and Innovation was signed. This agreement expanded the Galway Statement to the Southern Atlantic, connecting the EU with Latin American and African Nations. Ocean Literacy was again highlighted: *"The proposed outcomes of the Belém Statement include: better monitoring and forecasting capacities; improved safety at sea, human health and well-being; sustainable use of marine resources; new and emerging technologies to service societal needs and new value chains; and, ocean-engaged citizens through enhanced ocean literacy activities." (Polejack et al., 2021).*

The All Atlantic Cooperation for Ocean Research and Innovation Coordination and Support Action (AANCHOR- CSA) included the Belem statement signatories along with Argentina, Cape Verde, the United States, and Canada (Polejack *et al*., 2021). Ocean Literacy is also a focus of this initiative, with a working group charged with improving Ocean Literacy and supporting scientific working groups to share their findings in the hopes of broadly creating a more ocean literate citizenship.

In December 2017, the United Nations Educational, Scientific, and Cultural Organization (UNESCO), with support from the Swedish government, held an "Ocean literacy for all" conference in Venice, Italy. Ocean Literacy leaders from 30 countries representing all continents participated. The leaders included participants from diverse sectors including art, sports, science, and education. Attendees discussed the potential for multi sector collaboration and a more inclusive global framework for Ocean Literacy moving forward. Soon after the meeting, UNESCO published "Ocean Literacy for All: A toolkit" (Santoro *et al*., 2018). The toolkit included vignettes of different projects around the world and how they connected to the Ocean Literacy Essential Principles. The publication also included resources and activities to promote Ocean Literacy.

The Ocean Literacy Guide has been translated into several languages, including Dutch, Italian, Japanese, Polish, Portuguese, and Spanish (https://www.marine-ed.org/ocean-literacy/translations). The Scope and Sequence has been translated into Chinese, and the Essential Principles and Fundamental Concepts have been modified for specific regions, including the Bay of Bengal and the Mediterranean Sea.

In 2019, *Exemplary Practices in Marine Science Education: A Resource for Practitioners and Researchers* was published (Fauville *et al*., 2019). Springer describes the book as: *This edited volume is the premier book dedicated exclusively to marine science education and improving ocean literacy, aiming to showcase exemplary practices in marine science education and educational research in this field on a global scale. It informs, inspires, and provides an intellectual forum for practitioners and researchers in this particular context. Subject areas include sections on marine science education in formal, informal and community settings. This book will be useful to marine science education practitioners (e.g. formal and informal educators) and researchers (both education and science).*

Most recently, the United Nations (UN) kicked off the Decade of Ocean Science for Sustainable Development (Decade), which will run from 2021-2030. The Decade will seek to develop "The science we need for the ocean we want" and Ocean Literacy is cited as an important component of achieving the goals of the Decade. "Through stronger international cooperation, the Decade will bolster scientific research to ensure science responds to the needs of society" (UNESCO, 2019). One of the stated needs is for "An inspiring and engaging ocean where society understands and values the ocean" (UNESCO, 2019), which essentially states we need a more ocean literate global citizenry. The Decade will certainly provide opportunities for like-minded networks of marine educators to better collaborate - a critical step in the global effort (Marrero *et al*., 2019).

As Ocean Literacy work has expanded across the globe, a significant challenge remains to maintain a coordinated effort in the United States. What was once a well-funded initiative with a strong network of partners

now falls on the shoulders of a few members of NMEA, which is largely a volunteer-run organization. While some individuals and organizations have written successful small grant proposals, the financial and institutional support, once provided by NSF and others for the COSEE network, has waned tremendously. Without significant sustained funding, resources to support greater coordination are lacking.

NMEA is committed to fostering Ocean Literacy and will continue to provide professional learning and resources to assist organizations in sharing ocean literacy. The NMEA website serves as a conduit of ocean literacy resources by highlighting the OL Framework and translations of the Guide and other resources. One of the major hurdles to widespread adoption of the OL Framework continues to be getting information into the hands of educators. NMEA, with financial support from NOAA, published *A Handbook for Increasing Ocean Literacy: Tools for Educators and Ocean Literacy Advocates* in 2021, which will make the OL Framework more accessible to a wider and more diverse audience. As a global leader in Ocean Literacy, NMEA will continue to champion Ocean Literacy in the United States and provide opportunities and forums, including its annual conference and its peer-reviewed journal *Current: The Journal of Marine Education*, which is now publicly available through open access, to communicate and promote Ocean Literacy in the United States and worldwide.

The US should refocus and reconsider its commitment to Ocean Literacy, beginning with re-examining the reports of the Pew Oceans Commission (2003) and the US Commission on Ocean Policy (2004) as we begin the UN Decade of Ocean Science for Sustainable Development. The findings of the two reports should be reexamined and updated to integrate current ocean, climate, and social science research and reflect current social, economic, and ecological changes that have occurred since the early 2000's. Recommendations should be adjusted based on resources and opportunities. Alternatively, a new model, the Canadian Ocean Literacy Coalition (COLC), could be explored. A fundamentally different approach to advance Ocean Literacy, the COLC is not driven by any one funding entity but rather by diverse funding sources and information including the results of national surveys, action plans, policies, and in 2021, the Canadian Ocean Literacy Strategy and Implementation Plan. The coordinated effort resulted in co-developed consensus documents and activities that align with much of the Ocean Literacy Programme of the UN Decade.

Although the Ocean Literacy campaign began in the US, global interest and innovative thinking in Europe, Canada, and beyond have kept this initiative on track on an international scale. The global Ocean Literacy community should review the critical documents referenced in this paper and continue to build support in our own nations and as a collective.

Ocean Literacy resources

- Ocean Literacy Guide: https://www.marine-ed.org/ocean-literacy/essential-principles
- Ocean Literacy Scope and Sequence: https://www.marine-ed.org/ocean-literacy/scope-and-sequence
- Ocean Literacy Alignment with Next Generation Science Standards: https://www.marine-ed.org/ocean-literacy/ngss-alignment
- Translations of the Ocean Literacy Framework: https://www.marine-ed.org/ocean-literacy/translations
- Ocean Literacy Timeline: https://www.marine-ed.org/ocean-literacy/timeline
- National Marine Educators Association: https://www.marine-ed.org/
- COLC (Canadian Ocean Literacy Coalition): https://colcoalition.ca/
- CaNOE: http://oceanliteracy.ca/
- EMSEA: http://www.emsea.eu/default.php
- IPMEN: https://ipmen.net/
- AMEA: https://sites.google.com/view/asia-marine-ed/
- Relato Oceano: https://relatoceano.org/en/home_en/
- Ocean Literacy Italia: https://oceanliteracyitalia.it/
- Ocean Literacy Portal: https://oceanliteracy.unesco.org/?post-types=all&sort=popular
- United Nations Decade of Ocean Science for Sustainable Development: https://www.oceandecade.org/

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