

The Importance of Teaching and Learning About the Ocean: *Ocean Literacy as a Critical Component of Science and Environmental Literacy*

A Joint Position of NSTA and NMEA

Introduction

You cannot be scientifically or environmentally literate without being Ocean literate. As leaders in science education, the National Science Teaching Association (NSTA) and the National Marine Educators Association (NMEA) strongly support the inclusion of Ocean science as a critical component of curriculum and instruction.

Ocean Literacy is an understanding of the Ocean’s influence on you and your influence on the Ocean. An Ocean-literate person understands essential science concepts about the Ocean, can communicate about the Ocean in a meaningful way, and is able to make informed and responsible decisions about the Ocean and its resources (NOAA 2024). By integrating Ocean Literacy into science education, we empower students to address global challenges, including biodiversity loss, climate change, and resource sustainability. This will prepare students to address complex, interdisciplinary challenges, and inspire future generations to foster science, environmental, and Ocean Literacy. The importance of Ocean Literacy is acknowledged nationally, as highlighted in the National Research Council’s *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC 2012); in *The Rise and Fall of the Tide: Ocean Literacy in the United States* (Payne et al. 2022); and globally, as a key component of the United Nations’ (UN) initiatives (Glithero et al. 2024; Intergovernmental Oceanographic Commission at UNESCO 2023; Kennedy et al. 2024).

Declarations

As leading organizations for science teaching and learning, NSTA and NMEA assert that educators, schools, district and state administrators, parents, policymakers, developers of instructional materials and assessments, and providers of educator preparation and professional learning programs should implement the following recommendations. Each emphasizes the importance of incorporating the Ocean Literacy Framework into science education programs, classes, and instructional materials. Including essential Ocean concepts in science education is critical for learners to fully grasp the numerous Performance Expectations (PE) and Disciplinary Core Ideas (DCI) in the *Next Generation Science Standards* (NGSS).

1. To be scientifically or environmentally literate, you must be Ocean literate.

Scientific literacy refers to the understanding of what science is and how to use scientific information in daily decision-making (Ashbrook 2020). Environmental literacy refers to the knowledge of environmental concepts

and issues, and the attitudinal dispositions, motivation, cognitive abilities, skills, confidence, and appropriate behaviors to apply such knowledge to make effective decisions in a range of environmental contexts (Hollweg et al. 2011, 15 –16). To be scientifically or environmentally literate, one must understand key Ocean concepts. The Ocean provides half of the oxygen we breathe, absorbs about half of the CO₂ added to the atmosphere, is a major influence on weather and climate, contains 80% of the biodiversity on Earth, and provides food and jobs globally for millions of people and trillions of dollars in trade (World Bank Group 2024). The Ocean makes Earth habitable, and the health of the Ocean is essential to the health of the planet.

To make decisions and take action regarding current and future challenges, we need a scientifically and environmentally literate population with a deep understanding of the Ocean (Strang et al. 2007). One cannot fully understand climate change without understanding the Ocean’s role in climate variability and CO₂ absorption. One cannot fully understand plate tectonics without knowledge of seafloor spreading. One cannot fully understand biodiversity or evolution without understanding that most phyla on Earth live solely in the Ocean. Therefore, it is imperative that Ocean Literacy be included in science instruction for all learners.

2. Teaching and learning about the Ocean is essential for students to overcome terrestrial bias and achieve the goals of the NGSS.

There is an overwhelmingly terrestrial bias to many NGSS K–5 and Middle School Life Science standards. Examples include referring to living things as plants and animals, presenting plants as the only photosynthetic organisms on Earth, stating that animals need “air” to survive, describing decomposition as a process that takes place only in the soil, and referring to photosynthesis as the only mechanism of primary productivity (ignoring chemosynthesis). These oversights are factual errors and result in incomplete or inaccurate treatment of many fundamentally important scientific concepts. Terrestrial bias also occurs when Ocean ideas are subsumed or implied but not explicitly described within larger concepts about ecosystems, food webs, energy flow, or the carbon cycle. Since most educators and instructional materials developers are less familiar with the Ocean than with terrestrial systems, they are unlikely to teach these unique and important aspects of general concepts in NGSS unless they are explicitly called out. This terrestrial bias unintentionally ensures that students have few opportunities to learn about the unique and ecologically important organisms and processes that occur in the vast majority of the living space on Earth: in the Ocean. Learning about Ocean concepts is required for students to fully meet 20%–25% of all the PEs and DCIs in NGSS (Halversen et al. 2021). When Ocean concepts are not explicit, however, they are rarely, if ever, included. This is referred to as a terrestrial bias in curriculum and instruction (and more recently as an “Ocean blindspot”).

3. Everyone lives in the Ocean watershed.

The Ocean watershed refers to the idea that all water eventually reaches the Ocean, as it flows downstream and/or evaporates and returns as precipitation through the process of the hydrologic cycle. Understanding the Ocean helps us comprehend the wide array of services provided by the Ocean, and how watersheds regulate and maintain the flow of nutrients, biodiversity, and ecosystem services. Along its journey, water is exposed to pollutants from sediments, excess nutrients, and toxic chemicals carried in a closed system, impacting local, regional, and global bodies of water. With everyone living in the Ocean watershed, the Ocean perspective provides learners with access to and experience with an interdisciplinary and systems thinking approach needed to understand the complexity of Earth’s interacting biosphere, hydrosphere, geosphere, and atmosphere.

As pollutants accumulate and reach the Ocean, they contribute to environmental concerns like Ocean acidification, algal blooms, dead zones, garbage patches, and microplastics. Watersheds are integral to maintaining the health of terrestrial, riverine, estuarine, coastal, and marine ecosystems. As human activities impact water in all parts of the hydrologic cycle, recognizing the interconnectedness of watersheds and the Ocean is vital to fostering a shift toward sustainable practices in areas such as agriculture, aquaculture, urban development, consumption, waste management, and energy use.

4. Ocean Literacy is a pathway to equity and Ocean justice.

Historically, students of color have been excluded from studying the Ocean and pursuing careers in Ocean science and related fields. For decades, the National Science Foundation (NSF) and National Academies of Science, Engineering, and Medicine (NASEM) have documented the disproportionately low numbers of advanced degrees in Ocean and aquatic fields awarded to Black, Latinx, and Indigenous students. This can be partially attributed to the lack of instruction about the Ocean in the curriculum. Including the Ocean throughout science curriculum and instruction can provide all students — especially those from communities of color, and in landlocked or urban areas — with inspiration, motivation, and access to the opportunity to continue learning about the importance of the Ocean.

Equally important, the impact of Ocean and climate disasters—from hurricanes to sea level rise to drought and fires—consistently and disproportionately harms low-income communities and communities of color in the United States, island nations, and around the world (Ebi et al. 2018; IPCC 2023). Understanding the impacts of these disasters on vulnerable and marginalized communities provides context, visibility, and cultural relevance to science curriculum. By learning about climate change–induced catastrophes through the lens of the Ocean, we can equip students with the knowledge necessary to advocate for Ocean justice and sustainable practices. Students who learn about the Ocean—often through outdoor and experiential learning, beginning in the earliest grades and throughout their K–12 experience—will be more likely to pursue Ocean-related careers, and to seek solutions that benefit their communities and the world.

5. Ocean Literacy is critical to meeting current and future climate-related challenges.

The Ocean is a major influence on weather and climate. It stores solar radiation, distributes heat and moisture around the globe, and drives weather systems. Changes in the Ocean-atmosphere system due to climate change are resulting in, and will continue to result in, dramatic physical, chemical, biological, economic, and social consequences. Many of Earth’s biogeochemical cycles, including the water, energy, and carbon cycles, are connected to the Ocean. The Ocean-atmosphere catastrophes related to climate change are experienced by both coastal and inland communities. Understanding the Ocean-atmosphere interface is critical for individuals and communities to make evidence-based decisions leading to actions that adapt to and mitigate the impact of climate change and build a more resilient future.

6. The Ocean Literacy Framework should be widely integrated into curriculum and instruction.

NSTA and NMEA recommend educators, administrators, and district leaders integrate the Ocean Literacy Framework (Ocean Literacy Essential Principles and Fundamental Concepts, Ocean Literacy Scope and Sequence for Grades K–12, Alignment of Ocean Literacy to NGSS, and International Ocean Literacy Survey) into their curriculum and instruction to enhance teaching and learning.

The inclusion of the Ocean Literacy Framework will foster a deeper appreciation and understanding of the Ocean that can contribute to stewardship, critical thinking, and the use of science and engineering practices. The Ocean Literacy Framework is designed to assist educators in teaching key ideas related to the essential role of the Ocean in Earth systems and the well-being of life on Earth.

The [Ocean Literacy Guide](#) describes the seven most important ideas, or Essential Principles, about the Ocean that all people should understand. The Essential Principles and 45 supporting Fundamental Concepts were developed through a community-wide consensus process, building on previous work to define Ocean Literacy, assess what the public knows about the Ocean, and address the lack of Ocean-related content in state and national science education standards, instructional materials, and assessments. The seven Essential Principles of Ocean Literacy are these:

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.

The [Ocean Literacy Scope and Sequence for Grades K–12](#) is an instructional tool that guides educators to help their students achieve a full understanding of the Ocean in ever more complex ways across years of thoughtful, coherent science instruction. The content is provided as conceptual flow diagrams for each of the seven Ocean Literacy Essential Principles in four grade bands: K–2, 3–5, 6–8, and 9–12.

The [Alignment of Ocean Literacy to the Next Generation Science Standards \(NGSS\)](#) details the correlations between the NGSS (specifically the Disciplinary Core Ideas [DCI] and Performance Expectations [PE]) and the concepts included in the Ocean Literacy Guide and Ocean Literacy Scope and Sequence. This alignment is a necessary tool to focus attention on places in the NGSS where Ocean Literacy is essential to understanding the DCI, but the connection may not be obvious. The alignment documents are organized by grade band and provide a four-point rating scale with an explanation for each rating.

The Ocean Literacy Scope and Sequence for Grades K–12 and the Alignment of Ocean Literacy to NGSS documents are available in print and online in [A Handbook for Increasing Ocean Literacy: Tools for Educators and Ocean Literacy Advocates](#) (Halversen et al. 2021). The online version includes the Scope and Sequence presented in two formats: one as conceptual flow diagrams and the other as an accessible table format compatible with screen readers.

The [International Ocean Literacy Survey \(IOLS\)](#) (Fauville et al. 2019) is a community-based measurement instrument that allows the comparison of levels of Ocean knowledge among 15 to 17-year-olds across time and location. The IOLS includes multiple choice questions addressing the ideas about the Ocean described by the Ocean Literacy Framework. It is a research-based measurement instrument thoroughly tested for statistical reliability and content validity in multiple languages and countries.

— Adopted by the NSTA and NMEA Boards of Directors, February 2025

References

- Ashbrook, P. 2020. Becoming scientifically literate. *Science and Children*, 57(8). Blue Economy. www.nsta.org/science-and-children/science-and-children-aprilmay-2020/becoming-scientificalliterate.
- Ebi, K. L., J. M. Balbus, G. Luber, A. Bole, A. Crimmins, G. Glass, S. Saha, M. Shimamoto, J. Trtanj, and J. L.White-Newsome. 2018. Human health. In *Impacts, risks, and adaptation in the United States: Fourth National Climate Assessment, Volume II*, ed. D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, 572–603. U.S. Global Change Research Program. <https://doi.org/10.7930/NCA4.2018.CH14>.
- Fauville, G., C. Strang, M. A. Cannady, and Y.-F. Chen. 2019. Development of the International Ocean Literacy Survey: Measuring knowledge across the world. *Environmental Education Research* 25 (2): 238–263. <https://doi.org/10.1080/13504622.2018.1440381>.
- Glithero, L. D., N. Bridge, N. Hart, J. Mann-Lang, R. McPhie, K. Paul, A. Peebler, C. Wiener, C. Yen, R. Kelly, J. McRuer, D. Hodgins, and F. Curtin. 2024. *Ocean Decade Vision 2030 White Papers—Challenge 10: Restoring society’s relationship with the Ocean*. UNESCO-IOC. [The Ocean Decade Series, 51.10]. <https://doi.org/10.25607/ekwn-wh61>.
- Halversen, C., S. Schoedinger, and D. Payne. 2021. *A handbook for increasing Ocean Literacy: Tools for educators and Ocean Literacy advocates*. College Park, MD: National Marine Educators Association. www.marine-ed.org/ocean-literacy/handbook.
- Hollweg, K. S., J. R. Taylor, R. W. Bybee, T. J. Marcinkowski, W. C. McBeth, and P. Zoido. 2011. *Developing a framework for assessing environmental literacy*. Washington, DC: North American Association for Environmental Education. <https://cdn.naaee.org/sites/default/files/inline-files/devframewkassessenvlitorlineed.pdf>.
- Intergovernmental Oceanographic Commission of UNESCO. 2023, October 23. *UNESCO assembles international group of experts on ocean literacy in Venice*. UNESCO. www.unesco.org/en/articles/unesco-assembles-international-group-experts-ocean-literacy-venice.
- Intergovernmental Panel on Climate Change (IPCC). 2023. Summary for policymakers. In H. Lee and J. Romero, ed. *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: 1–34*. <https://doi.org/10.59327/IPCC/AR6-9789291691647001>.
- Kennedy, T. J., O. Dufourneaud, M. P. Castillo, S. Deane, J. Durand, T. Gianccone, S. Jonda, T. Mascarenhas, C. Mtonga, K. Ng, S. Palazot, S. Paul, E. R. Salazar, R. Santisteban, X. Shuwen, A. Silva, V. Solis Rivera, H. van’t Land, and Y. Zhou. 2024. *Ocean Decade manual for non-governmental organizations (NGOs)*. UNESCO, Paris. [The IOC Ocean Decade Series, 54]. <https://unesdoc.unesco.org/ark:/48223/pf0000392198>.
- National Oceanic and Atmospheric Administration (NOAA). 2024. *Ocean Literacy: The essential principles and fundamental concepts of Ocean sciences for learners of all ages*. v 3.2, January 2024.
- National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press. <https://doi.org/10.17226/13165>.
- Payne, D. L., M. E. Marrero, S. E. Schoedinger, and C. Halversen. 2022. The rise and fall of the tide: Ocean Literacy in the United States. *Mediterranean Marine Science* 23 (2): 270 –276. <https://ejournals.epublishing.ekt.gr/index.php/hcmr-med-mar-sc/article/view/27410>.
- Strang, S., S. E. Schoedinger, and A. deCharon. 2007. Can you be science literate without being Ocean literate? *Current: The Journal of Marine Education* 23 (1) 7: 7–9. www.researchgate.net/publication/237286927_Can_you_Be_Science_Literate_Without_Being_Ocean_Literate.
- World Bank Group. 2025, January 14. *Blue economy*. www.worldbank.org/en/topic/oceans-fisheries-and-coastal-economies.